THE EFFECT OF ROLES ON COMPUTER-SUPPORTED COLLABORATIVE LEARNING

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Jan-Willem Strijbos

Coverart: University Hospital of the Good Shepard, Syracuse, NY. Operating room, early 20th century, three surgeons, anesthetist, three nurses.

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"Well," said Owl, "the customary procedure in such cases is as follows."
"What does Crustimoney Proseedcake mean?" said Pooh.
"For I am a Bear of Very Little Brain and long words bother me."
"It means the Thing to Do."
"As long as it means that, I don't mind," said Pooh humbly.

Winnie-the-Pooh, page 58. A. A. Milne (1996). *The Complete Winnie-the-Pooh: Containing Winnie-the-Pooh and the house at Pooh corner*. London, UK: The Bath Press. (Original work published in 1926).

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Frankly, the road ahead is still a mystery, but it is now time for a new adventure!

Jan-Willem Strijbos

August 2004

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3 The effect of functional roles on group efficiency: Using multilevel modeling and content analysis to investigate computer-supported collaboration in small groups

4 Content analysis: What are they talking about?

CHAPTER 1

General introduction

This chapter is based on parts of:

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 1st European conference on computer-supported collaborative learning* (pp. 569-576). Maastricht: Maastricht University.

1.1 Introduction

Suppose that you are walking in the park on a quiet afternoon, just strolling along in your blissful happiness, but suddenly you are approached by an eager young educational psychologist who is conducting a research project on conceptions of learning, asking you ‘What is learning?’. Fair enough, there is a large chance that you will tell him to get lost, but let us suppose that you give the question some serious thought. What is your answer? Memorisation of facts? Acquiring skills? Being taught by a teacher how to do something?

Irrespective of your description of learning, most likely it will be a process or activity in which an individual gains knowledge in a schooling setting – of course supported by a ‘knowledgeable’ teacher. Now let’s take a step back from formal to informal learning and consider how toddlers interact with theirs parents. Do we consider parents as teachers? Is play a schooling setting? Yet, children learn from the interaction with a parent. Moreover, they learn from the interaction with other children – or as L. S. Vygotsky (1978/1930) puts it: learn from their more knowledgeable peers. As soon as children start attending school, however, learning gradually ceases to be a social process. Throughout primary, middle and high school – all the way up to higher education – learning becomes more and more an individual activity. In the end, well-educated researchers lock themselves in their proverbial ivory towers to do their job as they were taught: in isolation.

Clearly, describing learning like this seems a bit exaggerated, but it is not far fetched. At present, most learning in educational settings is focused on the individual and the individual is supposed to acquire knowledge and show mastery of a skill. Yet, a very persistent complaint by companies and government institutions is that students are not able to function effectively in real world work environments after graduation. A real world work environment is not a collection of isolated tasks but these tasks are interdependent. Moreover, none of us work in isolation: most of the time we collaborate and coordinate our efforts with colleagues or we work in multidisciplinary project teams with other group members that have a variety of skills and educational – as well as personal – backgrounds. Did those students acquire the wrong skills? Not necessarily the wrong skills, but students often lack the ability to perform in a real world work setting – which includes collaboration. However, given the focus on the individual it is not surprising that a lack of these interrelated skills (often referred to as competencies) is observed. Apparently, orchestration and alignment of these various individual skills does not develop spontaneously.

Throughout our schooling and in social practices most of us gradually acquire skills to work together and pool individual efforts to construct a shared product. In fact, whether it takes place in a school or outside designated school hours, any learning depends on the sanctioning of what is considered as ‘agreed upon knowledge’ by others – be they parents, teachers or peers. This is what the social constructivist viewpoint argues. If any knowledge of what is perceived as the ‘world’ is socially constructed through constant interaction with our context, this social process of interaction and evolving of refined knowledge conceptions should be our main object of study.

Social constructivism is a philosophical orientation. It originates from constructivism that emphasises the active knowledge construction process that learners are engaged in. Social constructivism refers to a broad collection of theoretical perspectives on learning that share a fundamentally socially grounded and situated view of the learning process, e.g. ‘cognitive apprenticeship’ (Brown, Collins, & Duguid, 1989), ‘socially shared cognition’ (Resnick, 1990) and ‘situated learning’ (Lave & Wenger, 1991) (see for a more elaborate overview Kirschner, Martens, & Strijbos, 2004). As Bereiter (2002) points out: the mind is not a container. Learning is not a process of pouring isolated knowledge objects in an individual; instead an individual should learn the skills needed to make sense of the world. In fact, as Stahl (2004) shows, a social theory of knowledge and learning – as opposed to a theory that focuses on the individual – is not a novelty but dates back to Hegel’s 19th century dialectical philosophy.

Considering these historical roots, social constructivism can be seen as a renewed interest in the social dynamics of everyday life and the natural position of social processes with regard to learning. However, this is not a recent discovery. Illich (1971) and Reimer (1971) argued that most learning does not require formal schooling and that schooling could be replaced with self motivated learning taking place through learning webs (Illich) or networks of people (Reimer). Their alternative to formal schooling is to provide a learner with the means to obtain the kind of education – and the educator – that will help him/her to meet their individual learning interests or needs. Although it can be argued that this position is based on a very positive notion of a ‘rational’ human being making informed decisions as a ‘self regulated learner’, it is still very similar to many contemporary curricula and company training programmes. The choices may not be unlimited, but a learner is not only presented with an opportunity to take control: the learner is often urged to take control of his/her own learning or professional development.

Illich and Reimers ideas of ‘learning webs’ and ‘networks of people’ were developed in the 1960s and have lost much of their radicalism in light of the present Internet and Information and Communication Technology (ICT). Nevertheless, their focus on social practices and use of ‘webs’ and ‘networks’ makes them a noteworthy precursor for the present day applications of technology to support learning. In the past five years most educational institutions abroad and in the Netherlands have implemented forms of computer-mediated or ‘Networked learning’ – and in particular in distance education. The Open University of the Netherlands (OUNL) is one such a distance education institute and students control both the content and pace of their learning: they decide whether they enter in a degree program or only study a couple of modules. Most students – whether they aim for professional development or transition – have a job and a family; study is most of the time restricted to written materials and the opportunities to meet other students (and sanction or reify your learning or knowledge) are very limited.

Distance education is experienced by many as solitary education: sitting isolated at a desk in the corner of the attic (hidden behind unpacked boxes of your last move). Martens (1998) argues that ICT can play an important role in overcoming these specific disadvantages in distance education. It can make learning more reactive and interactive and can even turn it into a more social process. This is why distance-teaching universities all over the world have been a frontrunner in the use of ICT to improve their learning materials and environments.

In 1999 the research programme titled 'Instructional design for competence-based education in post-secondary higher education' (OTEC, 1998) was initiated. A specific component of this programme focused on the use of computer-mediated communication (CMC) to support learning – through interaction between students – in distance education. The present dissertation is a part of this research programme and focuses on a specific implementation – roles – to support this kind of learning environments, commonly referred to as 'Computer-Supported Collaborative Learning' (CSCL).

In the next sections, the concepts that have been touched upon here (i.e., social constructivism and distributed learning) are described in more detail to provide a context for the Chapters 2 – 7. First, the competency concept – as it is central to the pedagogical approach of the OUNL – is described. Competency-based education stresses the development of interrelated skills – which will enable a graduate to operate effectively in a real world context. Its connection to CSCL is made explicit. Next, a theoretical representation of collaboration is provided to illustrate the complexity and multifaceted nature of this process, its implications for CSCL research and to sketch a general context for this dissertation. Finally, the specific focus of the research reported in this dissertation is described and an outline of the chapters is provided.

1.2 Competencies as interrelated cognitive, motivational and social forces

Competencies have become a central issue in higher post-secondary education (Bos, Valcke, & Martens, 1999; Van Merriënboer, Van der Klink, & Hendriks, 2002) influenced by a shift in higher education towards education that more closely resembles 'work' in a professional context. Bastiaens and Martens (2000) describe this as a shift towards learning with real events; where behavioural objectives, knowledge, skills and attitudes have been key factors in curriculum design for several decades, competencies are now becoming the main focus.

In the OTEC research programme (OTEC, 1998) competencies are defined as the abilities that enable learners to recognise new problems in their domain of study and future work, as well as the abilities to solve such problems. Although competencies are conceptualised in many different ways (Stoof, Martens, Van Merriënboer, & Bastiaens, 2001), in general competencies refer to the ability to operate in ill-defined and ever-changing environments, to deal with non-routine and abstract work processes, handle decisions and responsibilities, to understand dynamic systems, to operate within expanding geographical horizons, and to work in groups. Development of such 'group work competencies' implies that group-based learning methods become part of the overall instructional approach. Thus, the trend towards competency-based education has become a reason in itself to use group-based learning, despite the challenges group-based learning poses.

Since competencies can be considered – in their most generic form – as an arrangement of knowledge, skills and attitudes, they can be transposed to inextricably intertwined cognitive, social and motivational components. Although it is acknowledged that these three aspects are closely connected (Boekaerts & Simons, 1993), there is no agreement on the premises of this relatedness. Strijbos (1999) argues that group-based learning resides in the combination of the cognitive, motivational and social components: motivation can influence cognition (persistence in practice) and social aspects (group cohesion and student responsibility), cognitive learning gains can lead to increased self-confidence which may stimulate the motivation to learn and improve social skills, this may stimulate cognitive gains through more effective collaboration. This position is supported by the diversity of the theoretical frameworks (cognitive, motivational and social) and the relationships between these processes that are studied in the context of group-based learning (see Slavin, 1995; Hakkarainen, Lipponen, Järvelä, & Niemivirta, 1999). Figure 1 illustrates the multi-dimensional character of group-based learning. Moreover, the fundamental reciprocal relationships (i.e., overlapping circles) between the cognitive, motivational and social components are depicted – group-based learning requires an interrelated perspective, integrating cognitive, motivational and social theories.

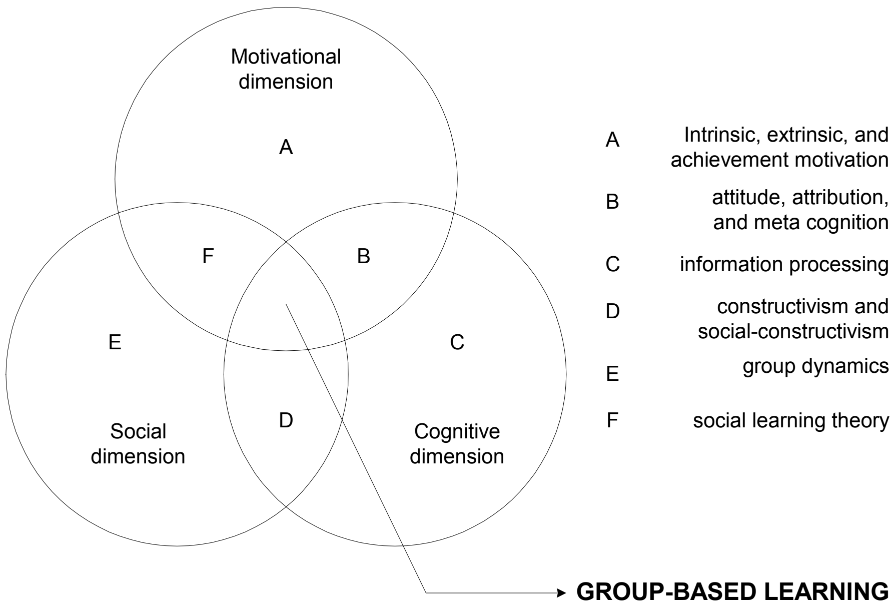

Figure 1 An interrelated theoretical perspective for group-based learning

An individual's cognitive, social and motivational characteristics, however, are not static; they develop over time as well as the reciprocal relationships between them. This dynamic nature of development – and learning – can be represented by the 'ecological' view of dynamic systems (Bronfenbrenner, 1979) and the social-constructivist theory of 'distributed cognition' (Salomon, 1993). Both theories tie in well with current thinking in terms of competencies.

1.3 Group-based learning as a dynamic distributed system

Bronfenbrenner's (1979) human ecology theory identifies four social systems: micro-system (e.g., a Ph.D. candidate and opponent interacting), meso-system (e.g., a local school), exo-system (e.g., the work environments of parents that indirectly influences the meso-system or micro-systems) and the macro-system (e.g., the Dutch society). Interaction between actors in each of these systems not only affects the actors present, but it may also indirectly affect other actors' behaviours in other systems.

Hatch and Gardner (1993) build on Bronfenbrenners' theory and define this reciprocity in their contextual influence model and distinguish three levels of influence: personal forces, local forces and cultural forces. Personal forces consist of the individual abilities and the individuals' experiences within a given culture. These personal forces can be affected by local forces, which can be construed as resources and people within a specific local setting such as home, school and work. Finally cultural forces such as institutions, practices and beliefs influence the local and personal forces through schooling, child rearing, language, religion, etc. Especially in distance education where students have a varied educational and personal background – often including a job and a family – the impact of family or work on their study is not only imaginable but appears to be inevitable (Kreijns, 2004).

Salomon (1993) defines distributed cognition as "a system that comprises an individual and peers, teachers or culturally provided tools" (p. 112). The distributed cognition should not be reduced to the sum of individual cognitions, but 'distributed cognition' refers to a new cognition that emerges during the interaction between the individuals: "The product of the intellectual partnership that results from the distribution of cognitions across individuals or between individuals and cultural artifacts is a joint one; *it can not be attributed solely to one or another partner* [Emphasis added] (p. 112). He continues that "Each partner can still be seen as having qualities his or her own, some of which enter the distributed partnership and are affected by it reciprocally, while other qualities may not be so influenced" (p. 121). This idea of qualities that are reciprocally influenced can be transposed to the emergent distributed cognition in the sense that the distributed cognition is internalised differently by each collaborating individual given their personal qualities. Figure 2 illustrates the emergent distributed cognition and how this is subsequently differently internalised by the interacting partners. Each student has his/her own cognitive skills and contributes a part (Ca = cognition of student A; Cb = cognition of student B) to the interactive process. Within the interaction a distributed cognition emerges (X) that is internalised differently (X′ = internalised distributed cognition by student A, and X″ internalised distributed cognition by student B).

The dynamic development of learning is emphasised by Fisher and Granott (1995). They observed that students "pursued several other related activities, including communicating about their joint efforts, moving themselves around the room (…) and testing hypotheses (…)" (p. 309) *at the same time*. Therefore, they argue that even task-focused collaboration unfolds at multiple levels and in separate concurrent non-linear and dynamic strands: each thread of activity showing a distinctive pattern of interaction different from the others.

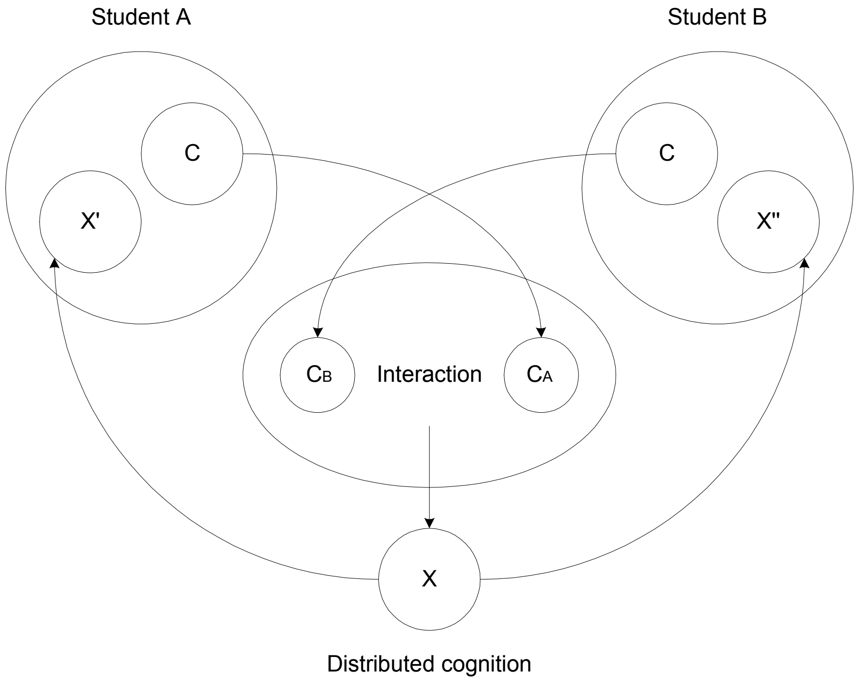

Figure 2 Emergent distributed cognition and internalisation by individuals

Furthermore, the conceptual framework of distributed cognition can be applied to social and motivational aspects as well. Perhaps Salomon (1993) included them implicitly in the phrase "Each partner can still be seen as having *qualities* his or her own" [Emphasis added] (p. 121) – as these qualities can also refer to the motivational and social component. Such social skills and/or motivation can also emerge during the interaction – in fact well-know approaches to group-based learning specifically target motivation (Sharan & Sharan, 1992; Group Investigation) and social skills (Johnson & Johnson, 1994; Learning Together).

In its most generic sense these qualities can be viewed as a combination of the expanded notion of distributed individual forces and Hatch and Gardner's contextual influence model. This implies that the individual forces consist of cognitive, motivational and social components and that they are influenced directly and indirectly by the contexts in which an individual acts.

Figure 3 illustrates a dynamic distributed system perspective on group-based learning and specifically the inextricably intertwined nature of group-based learning. It reveals the pivotal role for interdependence in being a prerequisite for interaction processes during group-based learning. Thus, it may come as no surprise that there is a strong relationship between the requirements for a group-based learning environment and social-constructivist visions regarding its design – these issues and their implications are discussed in more detail in Chapter 2.

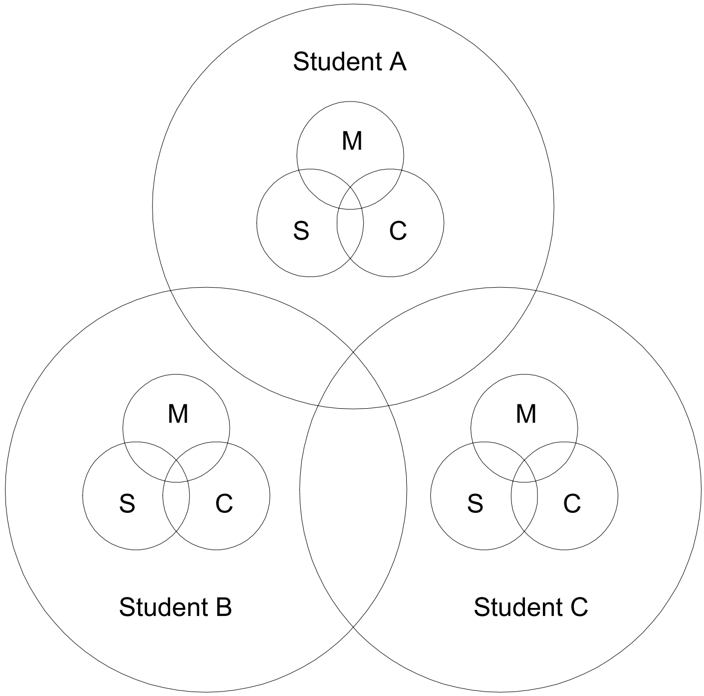

Figure 3 Schematic representation of group-based learning as a dynamic distributed system

(Forces are depicted by M = Motivational component, C = Cognitive component and S = Social component).

1.4 What's technology got to do with it?

With the establishment of the National Science Foundation (NSF) network in 1986 (Arpanet), which was transformed in the following decade into the 'Internet', the possibilities for using computers in educational settings expanded (Harasim, Hiltz, Teles, & Turoff, 1995). The Internet was rapidly accepted in the context of distance education. In particular e-mail was considered to be a good alternative for traditional communication modes (e.g., mail, telephone or face-to-face meetings) between students and educators (Mason & Bacsich, 1998).

Whereas e-mail and 'chat' now have become commonplace technology, their fame has also revealed some of their disadvantages. True, e-mail provides an easy communication means if group members are geographically distributed and in different time zones. At the same time, however, it is also argued that it is 'too easily' used resulting in information overload. Before e-mail, any report for discussion would be in a final concept stage, yet e-mail provides an easy way to share all twenty versions and the burden of reading and commenting on them.

In addition, e-mail and other forms of asynchronous (i.e., place and time independent) communication have another specific quality: the receiver determines whether s/he responds. Unlike a face-to-face setting, asynchronous communication lacks immediacy of feedback. In fact, this characteristic of e-mail created a whole new practice: the sender of the e-mail makes a phone call to its receiver to make sure that the e-mail has been received, read and – of course – that a response is *promptly* sent. This introduces a serious problem in distance education because of a dilemma between maximum flexibility (time independent learning) on the one hand and planned group activities (time dependent learning) on the other (Kreijns, 2004).

This example illustrates that technology in general – and e-mail more specifically – is not just a tool used for a certain purpose, but the technology mediates the social practice in which the tool is used and communication and interaction should not be taken for granted.

1.5 Computer-supported collaborative learning

Computer-Supported Collaborative Learning (CSCL) is a new discipline in the educational sciences that combines the notion of group-based learning and the potential of (communication) technology to support these practices. CSCL has attracted many researchers from a wide variety of disciplines, such as education, computer science, sociology, anthropology, psychology and communication studies (Koschmann, 1996). This diversity is reflected in both the topics, as well as the methodologies by which CSCL is studied: from communities of practice that involve a large group of people that share a common interest (see for example the Math Forum; Renninger & Shumar, 2002), to the interplay between theory and praxis in a community of learners (De Laat & Lally, 2003), and fine grained analysis of the interaction between middle school students around a computer software rocket simulation (Stahl, 2004).

Any implementation of CSCL involves to some degree the use of computers. In the early 1990s research on CSCL focused on the impact of a wide variety of CSCL systems (see CSILE/ Knowledge Forum© (Scardamalia & Bereiter, 1991) and Belvedere® (Suthers & Weiner, 1995) and was predominantly technology driven. At the end of the 1990s the general research direction shifted towards the pedagogical support for collaboration in these environments. This was reflected in a parallel shift in analysis from studying outcomes to the interaction process itself.

Nevertheless, these general research directions should not be mistaken for a shared research framework. In fact, the common denominator for this discipline (CSCL) is far from undisputed. The latest addition is a radical reverse ordering of the acronym in Learning Collaboratively Supported by Computers (LCSC), since according to Strijbos, Kirschner and Martens (2004a), this reflects the pivotal position of the primary process under investigation: learning through collaboration. Yet, the debate continues.

The diversity in CSCL research is not only reflected in the interpretation of its acronym, but as well in research objectives, practices, theory and methodologies. Lipponen, Hakkarainen and Paavola (2004) discuss that the diversity in research orientation and practice reside on the learning metaphor (acquisition, participation or knowledge creation) adopted by a researcher. The metaphor comprises the primary goal of collaboration: internalisation (individual knowledge gain), interaction (sharing expertise and distributed expertise) or transformation (the continuous advancement of shared knowledge). In addition, the metaphor has also important consequences for the theoretical foundation, the educational focus, the view on collaboration, and the function of technology and methodology used to study CSCL. Naturally, the perception of interaction has implications for assessment as well (Chan & van Aalst, 2004).

Obviously, computer support is a major focus in CSCL research, but as already discussed it is not the only source of support and pedagogical methods (instructional support) are also used. In addition, the human factor should not be ruled out and in most CSCL environments a teacher still has an important role – no longer a sage on the stage – as a facilitator of predominantly self-directed learning processes. Similar to the learning metaphor, support can be operationalised in many different ways: computer software support, instructional support and human support.

Jermann, Soller and Lesgold (2004) illustrate that the function of the computer software support in CSCL – be it merely providing communication facilities – determines its application in collaboration and distinguish two approaches: structuring and regulating. Even technology that only facilitates communication affords a specific use and structures collaboration (e.g., using e-mail), whereas regulation involves a specific approach to guide interaction such as the use of sentence openers (Baker & Lund, 1997; Soller, 2002) or widgets to increase students' awareness of the group process (Kreijns & Kirschner, 2004). Moreover, not only the software functionality is important, but also the characteristics of the learning context are equally important in this respect. Many higher education institutions have implemented a 'Virtual Learning Environment' (VLE) (WebCT©, Blackboard©, Edubox©) to some degree and these environments contain generic communication and collaboration tools (e.g., discussion board, chat). From the institutional point of view, using a standard environment (that supports the institution's pedagogical orientation) is the easiest and most practical to implement, but it should not restrict the use of specific CSCL tools (De Graaff, De Laat, & Scheltinga, 2004).

Järvelä, Häkkinen, Arvaja and Leinonen (2004) present an extensive overview of various approaches to instructional support and underline the variety in support (or scaffolding) that they provide: social, cognitive, motivational or increasing authenticity. They illustrate that these kinds of instructional support can be combined and should not be treated as mutually exclusive. Rather, they are a collection of methods that can be applied according to the processes needing support. Similarly, whereas human support in collaborative learning is traditionally either seen as student-student or teacher-student interaction, most current implementations of CSCL no longer combine the roles of technical expert and teacher. Hence, meta-support (Lund, 2004) becomes important, for example in the form of a community of teachers where they can clarify what it actually takes to be an online coach or how a facilitator role can be shaped given the software and instructional support provided (see Saarenkunnas, Järvelä, Häkkinen, Kuure, Taalas, & Kunelius, 2000).

The diversity of research on CSCL is reflected by the studies conducted in the OTEC research programme, with a direct or indirect relation to CSCL, for example studies about the implementation of peer assessment (Sluijsmans, 2002; Prins, Sluijsmans, Kirschner, & Strijbos, in press), the use of external representation to support collaboration (Van Bruggen, 2003), group awareness widgets to support social interaction (Kreijns, 2004), computer support for knowledge elicitation (Bitter-Rijpkema, Martens, & Jochems, 2002), group regulation (Dewiyanti & Brand-Gruwel, 2003), and a protocol to aid knowledge negotiation (Beers, Boshuizen, & Kirschner, 2004).

Clearly, CSCL is a broad discipline and involves simultaneous study of many different aspects that appear to interact (i.e., the cognitive, motivational and social components) – within the interaction process. Learning, or as it is referred to in CSCL, 'the process of building collaborative knowing, knowledge building or knowledge creation' remains the ultimate goal of most studies (Hakkarainen, Lipponen, & Järvelä, 2001; Veerman, 2000; Veldhuis-Diermanse, 2002). However, CSCL environments are not identical. Strijbos, Kirschner and Martens (2004b) illustrate that multiple collaborative environments exist and learning, interaction, support and technology should be aligned: they shape – to a varying extent – the CSCL environment and the interaction and collaboration that can take place. Each CSCL environment requires a specific set of tools and pedagogy (see Chapter 2).

1.6 Sustaining CSCL in distance education

The introduction of CSCL in Dutch university education started in the 1990's and gave rise to studies into the use of CSCL and the instrumentation. Well-known examples are the studies by Veerman (2000) on collaborative argumentation with Bevedere® and Veldhuis-Diermanse (2002) focused on collaborative knowledge building in CSILE/ Knowledge Forum©. As stated before, the use of CSCL seemed promising, especially in distance education. However, distance education is quite different from conventional university settings (Martens, 1998). Students in distance education are geographically dispersed, often have job and family obligations and therefore it is often not possible to meet at the same time. Asynchronous communication technology appears to be a natural choice in order to enable them to collaborate, but it has disadvantages such as the lack of immediate feedback. Collaboration also tends to reduce the flexibility of distance education (Kreijns, 2004). In addition, during collaboration coordination conflicts are more likely to occur in asynchronous CMC settings compared to face-to-face settings (Benbunan-Fich & Hiltz, 1999). Thus, for any collaboration to develop it is essential that students feel the need to engage in sustained interaction (which implies that they respond to messages by other students in an asynchronous communication format) before we can even expect that the students engage in an effective knowledge building discourse. This problem is addressed in this dissertation.

1.7 The use of roles to sustain CSCL

One approach to enlarge the students 'urge' to actively engage in a group process is to provide students with pedagogical support or a specific type of pre-structuring such as the use of roles. This is often also referred to as 'scripting' (Dillenbourg 2002; Weinberger, 2003). Roles can be defined as more or less stated functions, job, duties or responsibilities that guide individual behaviour and regulate intra-group interaction (Hare, 1994). Roles promote group cohesion and responsibility (Mudrack & Farrell, 1995). Group cohesion tends to increase stability, satisfaction and efficient communication (Shaw, 1981; Forsyth, 1999) and a greater sense of responsibility tends to increase group performance. Cohesion and responsibility can be used to foster 'positive interdependence' and 'individual accountability' (Brush, 1998), which are central concepts in group-based learning. Positive interdependence refers to the degree to which the performance of a single group member depends on the performance of all other members (Johnson, 1981). Individual accountability refers to the extent to which group members are held individually accountable for jobs, tasks or duties, central to group performance or efficiency (Slavin, 1981).

The use of roles appears to be most relevant when a group pursues a shared goal that requires a certain level of task division, coordination, and integration of individual activities. Three main categories of roles can be distinguished: individual roles, task roles, and maintenance roles. Each of these categories is composed of several different roles (Mudrack & Farrell, 1995). However, these roles are based on a self-report inventory and pertain to roles that participants can perform during collaboration. Moreover, each participant performs several roles simultaneously, thus making it difficult to implement such roles in educational contexts. Nevertheless, these role descriptions can guide the design of roles for pedagogical purposes.

Several pedagogical approaches, developed for cooperative learning, use roles to support coordination and group interaction (Johnson, Johnson, & Johnson-Holubec, 1992; Kagan, 1994). These roles are either content-oriented or process-oriented. Content-oriented roles focus on the facilitation of knowledge acquisition through individual differences, using for example 'Jigsaw' (Bielaczyc, 2001), 'scripted cooperation' (O'Donnell & Dansereau, 1992) or 'prompting scripts' (Weinberger, 2003). Process-oriented or management roles focus on individual responsibilities regarding the coordination of activities (e.g., Kynigos, 1999). These role descriptions, however, are similar in that they comprise one single job, task or duty (mainly because they were developed for face-to-face collaboration in primary education).

Although roles are widely regarded as an effective instructional strategy, in cooperative learning and in CSCL, their effect has not been investigated systematically in either higher or primary education. If cooperative learning pedagogies, and more specifically roles, were used in higher or in distance education, they were not adapted, although students in these settings vary considerably in (prior) knowledge, experience, and collaboration skills. Moreover, collaboration assignments in higher or distance education are more complex, they take place over an extended period of time (i.e., not restricted to classroom time), and thus they require more explicit coordination than in primary or secondary education. Finally, technology mediates the collaboration (social practice), so the practices developed in the 1970s and 1980s for face-to-face environments cannot be readily transferred to CSCL environments in higher education.

Consequently, the previously mentioned roles used in face-to-face collaboration appear inadequate to support collaboration in higher or distance education, let alone in asynchronous CSCL environments. Thus, explicit and detailed role descriptions should be provided that are applicable to a computer-mediated setting in higher and distance education. It was decided to focus on process-oriented roles, but these had to be context independent (i.e., not tied to the content of a specific domain such as law), consist of multiple tasks, be clearly distinguishable (individual accountability), they all should be essential for the collaborative process (positive interdependence), but 'rigid task division' (i.e., members only performing activities associated with their role) should be avoided.

Based on role descriptions in reports by Johnson, Johnson and Johnson-Holubec (1992), Kagan (1994) and Mudrack and Farrell (1995), so-called functional roles (i.e., combining both task related and managerial aspects, for example the role of an 'editor') were constructed and investigated in a project-based CSCL environment at the OUNL (see also Appendices A and B in Chapters 3 and 5). The next section describes the CSCL environment used in the studies that are reported in Chapters 3 – 7 in more detail, as well as the design decisions taken with respect to learning issues (competencies), interaction (asynchronous), support (functional roles) and technology (e-mail).

1.8 Research context and research design

The research reported in this dissertation was conducted during consecutive years of two competency-based courses at the OUNL on 'policy development' and 'local government'. Both courses were organised in a project-based learning format. Competency development is not the primary object of this research and the notion of competency in this dissertation is reflected by the research context and the problem studied. Thus, the aim of the research reported was not the development of a specific skill (for example social skills) or competency, although this was an aim of the specific context used in which the research was conducted.

Students were required to collaboratively write a policy report containing advice regarding the reorganisation of local administration, a timely subject in the Netherlands. Each group could decide whether they started with a practice group assignment or immediately with the final group assignment that would be graded. Students were given 12 to 18 months to complete the group assignment (depending on whether they elected to start in October 2000/2001 or March 2001/2002). A repository of background information was provided through Edubox©, but the students were required to select the relevant information for their assignment and search the Internet as well.

Since both courses used a project-based learning format and small groups, they were well suited to investigate functional roles from a group dynamics perspective, such that each student has a specific role for which s/he is accountable and all roles are essential for the collaboration to increase participation. Instructional support was implemented in the form of a prescribed role-instruction in half of the groups and aimed to promote both the coordination and organisation of activities that are essential for the group project (project planner, communicator, editor and data collector). In order to maximise the effect of these roles – and minimise potential role conflict or ambiguity – it was decided that roles would not rotate. The other half of the groups was left completely self-reliant regarding organisation and coordination of the activities. The groups in the first year (Study 1; see Chapters 3, 5 and 7) consisted of four students and the groups in the second year (Study 2, see Chapters 6 and 7) of three to five students. All communication in both studies was electronically mediated. Supervision was kept to a minimum and was focused on course content, so as not interfere with the research objective. Figure 4 presents an overview of the general research design.

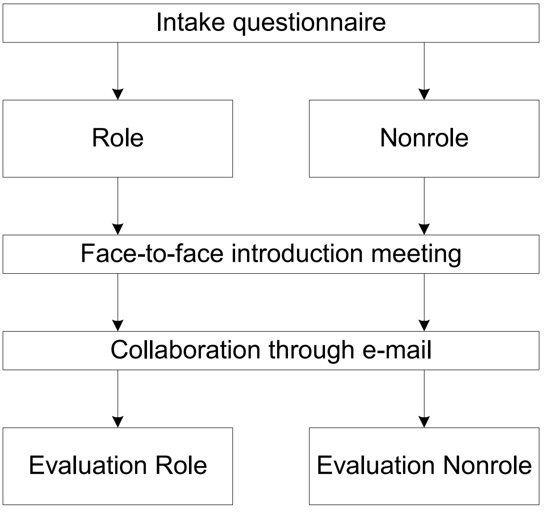

Figure 4 General research design for both studies

The design of both studies was a quasi-experimental random independent groups design. Two weeks priors to the course students were asked to fill out an intake questionnaire, followed by several months of electronic collaboration (depending on the pace selected by the group) and when a group completed an assignment (practice or final) an evaluation questionnaire was send.

Although competencies are not explicitly studied, indicators for social and motivational competencies – active or passive orientation towards collaboration and the level of achievement motivation – were included in this questionnaire (see for a full overview of all variables Chapters 3 and 6). Students could start with a group assignment at two points during each course and a face-to-face kick-off meeting was organised twice a year to introduce the course content, supervisors, technology (Edubox© and e-mail) and the research. A separate meeting was organised for each research condition. After the meeting all contact between students would be virtual.

As argued computer software – and technology in general – mediates social practice and interaction during collaborative learning. Given the distance education context it was decided to use asynchronous communication. E-mail was chosen first of all for the practical reasons that use of grouping requires the opportunity for fast re-grouping in case of dropout (which is not unlikely in distance education) and the discussion forum protocol at the OUNL was not sufficiently flexible at the time. Secondly, it was assumed that e-mail would be the lowest common denominator for the level of technology adoption among OUNL students that registered for an electronic course – especially given the broad range of students (i.e., their educational and personal background).

1.9 Structure of this dissertation and the research questions

In the previous sections it was shown that CSCL is a multifaceted discipline and that many processes are studied from various perspectives. Considerable attention has been given to theoretical debate, as well as to technical and pedagogical support of collaborative learning. In comparison less attention has been paid to methodology and methods of analysis. However, this is an important and very often undervalued aspect of the study of CSCL. As will be shown in the next chapters quite often researchers use inadequate analysis methods (for instance ANOVA – where the assumption of independence is violated) or they neglect to report or calculate critical reliability values for their analysis method (for example intercoder reliability). Studying CSCL poses not only many problems on a theoretical level, but also on a methodological level many shortcomings can be found. Therefore, the chapters in this dissertation are not limited to the results of the implementation of functional roles in a distance education context. Explicit attention is paid to analysis methods of the quantitative questionnaire data in Chapters 3 and 6, qualitative questionnaire data in Chapters 5 and 6, the analysis of e-mail communication content in Chapters 3, 4 and 6, the analysis of functional role behaviour in Chapter 7 and the need for triangulation of data sources and analysis techniques to construct an interpretation of the results in Chapter 6 and the general discussion (Chapter 8).

1.9.1 Research questions

Both studies reported in this dissertation address the following main research question: 'What is the effect of a prescribed functional roles instruction, as compared to no instruction, on group performance and collaboration?'. A conceptual and methodological breakdown leads to four derived research questions:

Do functional roles during CSCL lead to better learning outcomes?

It is expected that the use of functional roles will decrease the need for coordination and that as a result task focused activity will be stimulated – reflected in a higher grade for groups working with the functional roles.

Do functional roles during CSCL lead to a more satisfying collaborative experience?

It is expected that the functional roles will facilitate coordination and the ease of collaboration – reflected in a more positive CSCL experience for groups working with the functional roles.

Do functional roles during CSCL lead to a more efficient group process in terms of communication (coordination and content-focused statements)?

It is expected that the functional roles will decrease the amount of coordinative statements in the e-mail communication in favour of content-focused statements.

Do functional roles during CSCL lead to fewer dropouts?

It is expected that the functional roles will increase the experienced interdependence and the overall efficiency, so that dropout – due to a dysfunctional collaborative process, will be reduced in the groups working with the functional roles.

Prior to designing and conducting the studies reported in this dissertation, it was essential to embed the use of functional roles in the larger context of CSCL. Chapter 2 illustrates that this was certainly not a straightforward implementation – at least from a theoretical viewpoint. At the start of this dissertation the use of roles for instructional support was regarded a ‘cooperative learning’ strategy and proponents of collaborative learning argued that it was too restrictive. As will be shown this argument is beside the point. In this introduction thus far ‘group-based learning’ has been used to refer to CSCL environments and Chapter 2 illustrates that this was done so for a specific reason. Moreover, five critical elements are identified that shape the interaction that can take place in a group-based learning setting; surpassing the uni-dimensional distinction between cooperative and collaborative learning used by most researchers. Moreover, it provides a framework in which functional roles are a valid approach to instructional support in CSCL: its applicability depends on the learning objectives, task type, group size and technology of a specific CSCL environment.

Chapter 3 presents the results of the first study for the quantitative questionnaire data and the content analysis of the e-mail communication. Since an individuals’ perception of the collaborative group process depends on the activities of all group members, the evaluations are interdependent. This has important implications for the statistical method that can be used for analysis. Multilevel modelling (MLM) appears to be the best suited technique to analyse the questionnaire data and since it has not been applied to a small number of observations, it will be discussed in detail. In addition, results of the analysis of the e-mail communication regarding the amount of coordination and content-focused statements are reported and the content analysis method is described to some extent.

Chapter 4 discusses the development of this content analysis method in more detail. This chapter shows how our initial attempt to construct a reliable procedure failed because of the unit of analysis used. The implication of the unit of analysis (segmentation) for quantitative content analysis has not received much attention. It will be illustrated that a unit cannot be applied to any research objective, form of communication, collaboration type or technology environment. These four constraints shape the applicability of a unit. Whereas initially the accepted practice for segmentation in units of analysis was applied, the specific collaboration setting and content of the research context forced the development of an alternative procedure.

Chapter 5 investigates an alternative interpretation for the results reported in Chapter 3. It was hypothesised that dropout could have interfered with the functional roles and the open-ended evaluation questions were analysed to determine if this was the case. Cross case matrices were used to summarise the individual responses at the level of the research condition for comparison.

Chapter 6 presents the results of the second study for the quantitative questionnaire data, content analysis of the e-mail communication and the analysis of the open-ended questions. The second study was conducted as examination of the course design during the first study identified several preconditions that – if controlled – could decrease or prevent dropout, such as students’ preference for a practice assignment, setting up of a time schedule, establishing a communication discipline, slow or fast study pace and externalising expectations regarding effort (i.e., how much time each student can spend on the collaboration). Controlling for the preconditions could also ensure a more evenly matched comparison of both research conditions.

Chapter 7 reports the results of the fourth analysis method for both studies. Although the results reported in preceding chapters indicated that the functional roles affect the collaboration, a second content analysis procedure was developed to assess whether the functional role behaviour was indeed performed. The functional role descriptions were converted to analysis categories and all groups in both studies were analysed to determine functional (role condition) and spontaneous role behaviour (nonrole condition).

Chapter 8 will critically review the results reported in Chapters 2 – 7, as well as review the general research methodology and analysis methodologies used. The limitations of the studies will be outlined and directions for future research will be discussed.

The studies that are presented in Chapters 2 – 7 have been published in international journals or they have been submitted for publication. Each chapter can be read independently, but the effect of functional roles on CSCL emerges from their triangulation.

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CHAPTER 2

Designing for interaction:

Six steps to designing computer-supported group-based learning

Abstract

At present, the design of computer-supported group-based learning (CSGBL) is often based on subjective decisions regarding tasks, pedagogy and technology, or concepts such as 'cooperative learning' and 'collaborative learning'. Critical review reveals these concepts as insufficiently substantial to serve as a basis for CSGBL design. Furthermore, the relationship between outcome and group interaction is rarely specified a priori. Thus, there is a need for a more systematic approach to designing CSGBL that focuses on the elicitation of expected interaction processes. A framework for such a process-oriented methodology is proposed. Critical elements that affect interaction are identified: learning objectives, task-type, level of pre-structuring, group size and computer support. The proposed process-oriented method aims to stimulate designers to adopt a more systematic approach to CSGBL design according to the interaction expected, while paying attention to critical elements that affect interaction. This approach may bridge the gap between observed quality of interaction and learning outcomes and foster CSGBL design that focuses on the heart of the matter: interaction.

Keywords: Cooperative/collaborative learning; Computer-mediated communication; Distributed learning environments; Interactive learning environments; Distance education and telelearning

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2.1 Introduction

Learning in small groups has been intensively researched since the 1970s. Moreover, the rapid development of computer support for communication and collaboration stimulated its use for pedagogical practices. At the same time a new way of thinking about instruction emerged, to a large extent based on constructivism. According to Reiser (2001), the instructional principles associated with this emergence include requiring learners to (a) solve problems, (b) work together, (c) examine problems from multiple perspectives, (d) become responsible for their own learning process; and (e) become aware of their role in the instructional process. During the past decades (computer-supported) group-based learning CSGBL) has become an important aspect of contemporary education, and is also stimulated through learning environments that increasingly resemble authentic working processes (Bastiaens & Martens, 2000). At present, however, there are no clear guidelines to determine how a CSGBL setting (i.e. learning environment) should be designed (Van Berlo, 2000). Developers question what tasks or work methods should be used (Enkenberg, 2001). Many researchers have indicated considerable variations regarding the quality of interaction and learning outcomes (Häkkinen, Järvelä, & Byman, 2001). To a large extent this is caused by differences in group size, technology used, length of the study, research methodology and unit of analysis (Lipponen, 2001).

At present, the design of CSGBL settings often seems based on subjective decisions regarding tasks, pedagogy and technology. So far, research has mainly focused on the quality of collaborative products or individual learning results, but the outcome is mediated by the quality of group processes (Shaw, 1981). Moreover, there is considerable uncertainty about the relationship between interaction and outcome, because the effect of a CSGBL setting on group interaction is rarely specified a priori (Dillenbourg, 1999). However, recent interest in CSGBL from the instructional design domain may stimulate the development of a more systematic approach to CSGBL design (Gros, 2001).

In this article a framework for a process-oriented methodology to design CSGBL settings is proposed, which focuses on the elicitation of the specified expected interaction. This implies that researchers have a clear concept of interaction and how it relates to their CSGBL setting. Hence, before the process-oriented methodology can be discussed, four issues must be addressed: (a) the applicability of a classic instructional design view to CSGBL, (b) the conceptualisation of interaction, (c) the applicability of the terms ‘cooperative learning’ and ‘collaborative learning’ as design principles, and (d) the possibility to identify critical elements in CSGBL settings affecting interaction, and if so, what they are. These issues will be successively elaborated in Sections 2–5. Next, the design methodology is introduced. Finally, the potential applicability and its limitations will be discussed.

2.2 Instructional design for CSGBL

Classic instructional design focuses on individual learning outcomes and tries to control instructional variables to create a learning environment that supports the acquisition of a specific skill (person A will acquire skill B through learning method C). With respect to CSGBL, the use of groups complicates this view. The key questions are whether it is (a) possible and (b) feasible to pre-define independent static conditions of learning or instruction for a group setting. Can all relevant conditions that affect group interaction and individual skill acquisition be controlled? Regarding the multitude of individual and group level variables that may affect CSGBL processes, as well as the difficulties involved in pre-defining independent static conditions, a less stringent view is more useful. Although Gros (2001) indicates a need for a new paradigm of instructional design that expands to CSGBL settings, a first conceptualisation of such a paradigm is lacking. While Nelson (1999) provides design guidelines for teachers and students to guide activities during 'collaborative problem solving' (CPS), such as the teacher role and collaboration procedures, similarly it is specified neither whether these guidelines apply to other CSGBL settings nor how these guidelines affect interaction.

Instead of a classic causal view, the design of CSGBL settings requires a probabilistic view of design (Fig. 1) which corresponds with the distinction by Van Merriënboer and Kirschner (2001) between the 'world of knowledge' (outcome) and the 'world of learning' (process). In the world of knowledge, designers construct methods by which given *learning goals*, in a specific subject matter domain, can be attained by the learner. In the world of learning, however, designers focus on methods that support the *learning processes*, and not so much on the attainment of pre-defined goals.

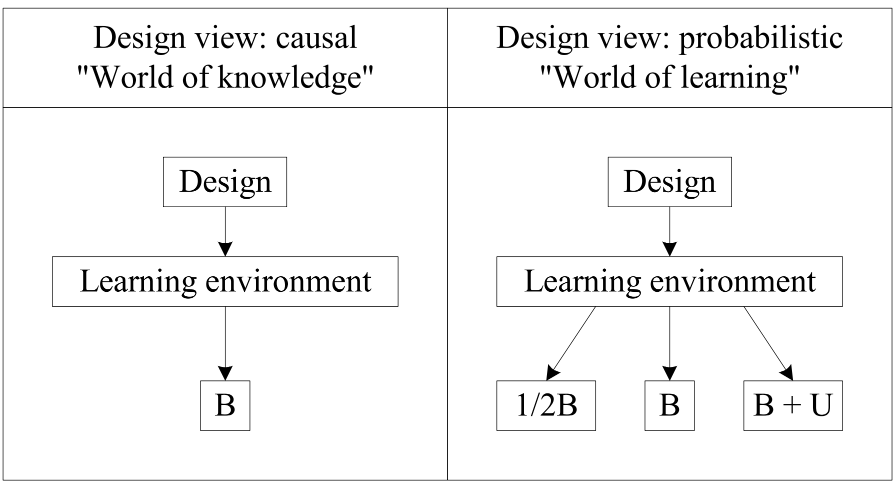


Figure 1 Two views on instructional design

A probabilistic view implies that more attention is paid to learning and interaction processes, instead of only to outcomes, especially with respect to CSGBL: person A in group X may acquire skill B through method C, but equally may acquire only a part of skill B, 1/2B or B and something unforeseen (B+U). Sometimes it is argued that the design of CSGBL settings should include individual differences that affect interaction, such as sex, intellectual capacities and social skills (Cohen, 1994). Such a view is mostly generated by an outcome-based perspective towards CSGBL stressing the importance of determining individual learning gains. A process-oriented view, however, treats these differences as ‘possibly’ intervening, but not as ‘certainly’ intervening with other students’ learning. In addition, these individual differences must not be confused with constructed differences that are imposed by the pedagogy, as is the case during Jigsaw (see Aronson & Thibodeau, 1992). Moreover, the effect of individual differences is likely to vary across CSGBL settings. Therefore, since it is difficult to specify a priori which individual differences will affect interaction in a given CSGBL setting, these cannot be included in a process-oriented design methodology, although retrospective analysis may reveal opportunities for re-design to compensate for the effects of individual differences on interaction. In sum, the proposed CSGBL design methodology that will be discussed in Section 6 should not be seen as a method that ensures learning benefits for all participants (causal). Rather it supports designing a CSGBL setting in which student participation is likely to lead to skill acquisition (probabilistic). If acquisition of learning outcomes cannot be guaranteed, a logical step is to focus on the process and identify critical elements (for example task type) that, although variable, shape the core of CSGBL settings, that is interaction. Thus, CSGBL design should enable interaction, seen as most supportive to reach the learning goals, to develop. Designing for interaction in advance, however, requires a clear conceptualisation of the expected interaction.

2.3 Conceptualising interaction

Collaboration essentially entails interaction. The issue of ‘how students interact’ has gradually received increasing attention in CSGBL research, but the impact of interaction processes on learning is explained in retrospect, i.e. it is determined whether outcomes were affected by the interaction observed. Retrospective examination of interaction can provide indicative evidence regarding a relationship between outcome and interaction, but there is little certainty that it can be reproduced since it was not planned. Since little or nothing is said about the expected interaction prior to CSGBL, the observed outcomes may equally likely be ascribed to other factors. In order to specify, a priori, how a CSGBL setting affects interaction ‘‘we should stop using the word ‘collaboration’ in general and start referring to precise categories of interaction’’ (Dillenbourg, Baker, Blaye, & O’Malley, 1996, p. 21).

Distinguishing levels of interaction can help to clarify ambiguous terms often used to conceptualise interaction. Rogoff (1995) characterises interaction in terms of three planes of activity: ‘guided participation’, ‘apprenticeship’ and ‘participatory appropriation’. However, guided participation and apprenticeship both implicitly contain information about the relative status of the actors. Thus it can be questioned whether they affect interaction processes differently. Moreover, King (1999) identifies interaction in terms of ‘peer tutoring’, ‘problem solving’ and ‘complex knowledge construction’, but it is not clear whether ‘guided participation’ and ‘peer tutoring’ actually evoke different interaction processes.

The next section discusses three prototypical conceptualisations of interaction, which can be seen as three levels of interaction specification. Level one specifies interaction to the extent of relationships between group members. Level two includes a temporal factor and thus it also specifies the development of those relationships. Finally, level three also includes actual communicative statements or acts during interaction, thus providing further insight into the causes of change and the development of interaction.

2.3.1 Level one: interaction conceptualised as communication networks

Since the 1950s, communication networks have been an important topic in small group research that has focused on concepts such as ‘leadership’, ‘status’, ‘organisational development’, ‘member reactions’ and ‘problem solving efficiency’. In 1964 Shaw described communication networks for three-, four- or five-person groups that differ in their level of ‘centrality’ (cf. Shaw, 1981, p. 152). Centrality provides information about which students are central participants (high influence on interaction) and which students are relatively isolated (little or no influence on interaction) (Haythornthwaite, 2001). Although most tasks used in social psychological research hardly resemble constructed ‘learning tasks’ (let alone authentic tasks), results indicate that decentralised networks outperform centralised networks when the task is more complex (Shaw, 1981).

Recently, CSGBL research has devoted more attention to communication networks between students through Social Network Analysis (SNA) (Wortham, 1999), as an extension to the common methodology of counting statements or length of contributions (Benbunan-Fich & Hiltz, 1999). SNA transforms all contributions into a graphical scheme from which the level of group cohesion can be inferred, using ‘centrality’ and ‘density’. Density provides information about the extent to which students respond to each other (Lipponen, Rahikainen, Lallimo, & Hakkarainen, 2001). However, neither the general ‘communication networks’ nor the more specific SNA analysis methodology, provide information about the development and change of interaction during CSGBL.

2.3.2 Level two: interaction conceptualised as temporal communication structures

A first approach to capture development and change in interaction patterns is to conceptualise interaction in terms of successive periods that define group interaction. Social psychology, in general, identifies five stages of group development: orientation, conflict, cohesion, performance and dissolution (Tuckman, 1965; Tuckman & Jensen, 1977). Although Forsyth (1990) indicates that these describe a common developmental pattern, this should be seen by no means as universal. Sometimes groups do not pass through all of these stages. However, they may stimulate educational researchers to specify interaction according to the succession of alternate stages. An example is provided by Jonassen and Kwon (2001) who distinguish stages during group problem solving and conceptualise interaction in terms of the *succession* of these stages.

A more common approach, among educational researchers, to specify a temporal relationship is that of Rafaeli and Sudweeks (1997). They distinguish three modes of dyadic communication: one-way, two-way and interactive communication, and illustrate the difference through a temporal sequence. One-way interaction refers to a situation in which the interaction is dominated by one student, for example a peer tutoring setting. Interactive and two-way cannot be distinguished as straightforwardly as Rafaeli and Sudweeks assume, because 'interactive' is by definition always 'two-way'. Their difference is better expressed by two other labels: 'reactive' ('two-way') and 'reciprocal' ('interactive'), and can be illustrated through an episodic representation (Fig. 2). Episodes are defined by meaningful statements and represent a temporal communication sequence: arrows represent a message within an episode, dotted arrows represent messages that build forth on a message in a preceding episode and constitute the input for messages in the next episode.

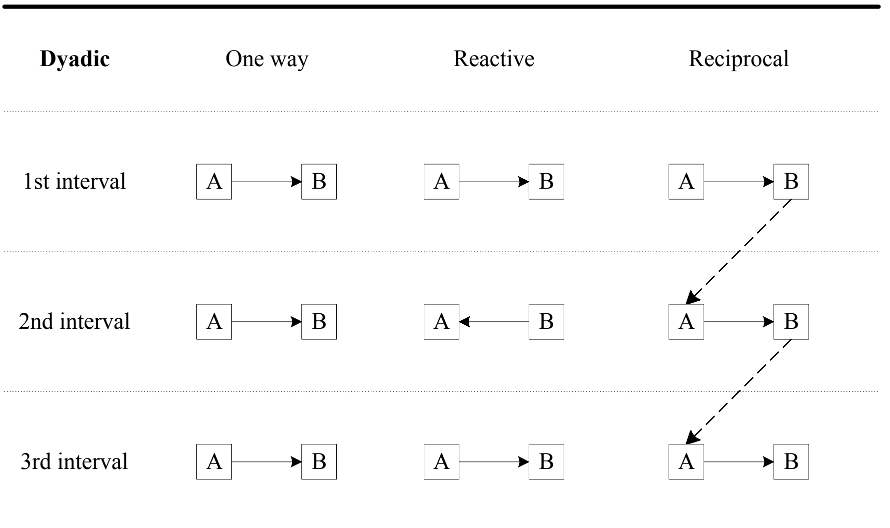


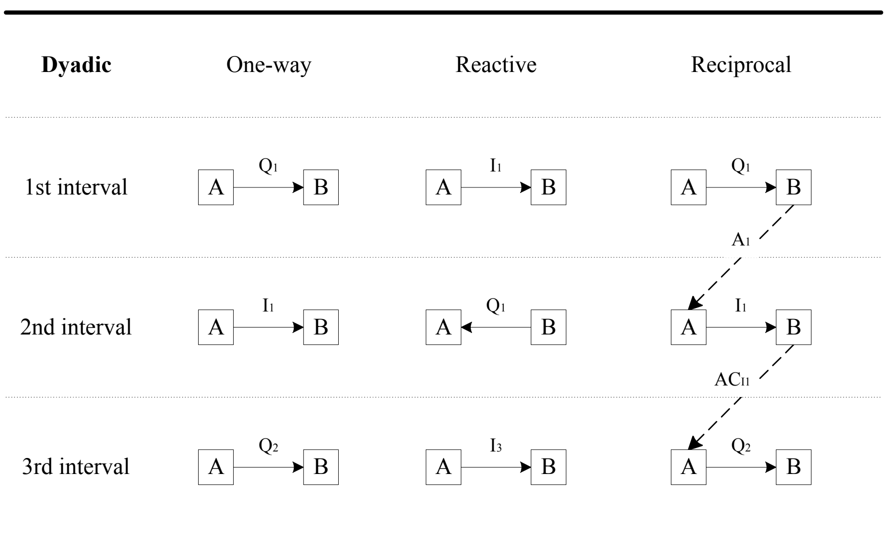
Figure 2 Typology of level two interaction (dyadic)

Reactive interaction refers to communication in separate episodes, but none of the students interacting build on information previously stated by another student. For example, one student states 'Volcanoes are like mountains', another states 'Lava is hot, so there can be no volcanoes in the sea', and the first states 'Volcanoes sometimes explode', etc. Reciprocal refers to communication that is spread across episodes, but now messages build on the input of preceding messages (italicised in example). For example, one student states 'Volcanoes are like mountains, *but they also produce lava*', another states '*Lava is hot*, so there can be *no volcanoes in the sea*', and the first states '*I read that islands are created by volcanoes*, so there are volcanoes in the sea'.

2.3.3 Level three: interaction conceptualised as communicative statements or acts

Apart from the temporal element in structural relationships, interaction can also be specified in terms of communicative statements or acts. Interaction specified on levels 1 and 2 does not provide information on why a person contributes less or why the input of a group member is ignored. To this end many researchers have adopted (sometimes modified) a content analysis approach to computer-mediated communication (CMC) and CSGBL developed by Henri (1992), which distinguishes three main categories of statements: interactive, cognitive and metacognitive (Aviv, 2000; Hara, Bonk, & Angeli, 2000; Gunawardena, Lowe, & Anderson, 1997; Lally & DeLaat, 2002; Newman, Webb, & Cochrane, 1995; Veldhuis-Diermanse, 2002). Another influence on interaction specification at this level is speech act theory that, in essence, aims to relate the way a statement is expressed to its function in the communicative process (Howell-Richardson & Mellar, 1996). Related to this approach is the so-called 'task acts' approach that links communicative acts to specific behaviours that are either supportive of, or in conflict with, effective task performance (Erkens, Jaspers, Tabachnek-Schijf, & Prangsma, 2001).

Content analysis, as well as speech/task act approaches (in general referred to as 'discourse analysis'), can for instance show that a group member contributed less because time had to be devoted to other courses as well. Fig. 3 is an extension of Fig. 2. A prototypical representation of successive communicative statements/ discourse acts is added.



Q = question, A = answer, I = information, AC = acknowledge, D = decline

Figure 3 Typology of level three interaction (dyadic)

In sum, specifying interaction on (at least one of) three different levels can clarify the processes under study, thus enabling researchers to assess the foreseen effect of the pedagogy or technology introduced. These levels of interaction also constitute the basis needed to formulate a process-oriented methodology for CSGBL design, since they are not restricted to specific domains or contexts but apply to any CSGBL situation. Taking interaction as the central object of any CSGBL design requires that critical elements, affecting interaction, need to be identified to construct a process-oriented methodology. Currently, most CSGBL designs are motivated with reference to 'cooperative' or 'collaborative', or principles like 'positive interdependence' and 'individual accountability'. Section 4 addresses their applicability for design of CSGBL settings.

2.4 Cooperation versus collaboration: design principle for GBL?

During the 1970s and 1980s 'cooperative learning' dominated CSGBL practices, but since the beginning of the 1990s 'collaborative learning' came into fashion. Although many researchers make a distinction between these perspectives on CSGBL, there is no agreement on what the distinction actually entails. Panitz (n.d.) sees collaboration as a personal philosophy of group interaction and cooperation as a (set of) structure(s) of interaction that facilitates group performance. Slavin (1997) states that 'cooperative' is being associated with well-structured domains whereas 'collaborative' is associated with ill-structured domains. Millis and Cottell (1998) state that both lie on a continuum: cooperative being the most structured and collaborative the least structured approach. In addition, many researchers emphasise the contributions of group members and associate cooperative with division of labour procedures and collaborative with equality of contributions to a problem solution (Brandon & Hollingshead, 1999; Dillenbourg, 1999; Lehtinen, Hakkarainen, Lipponen, Rahikainen, & Muukkonen, n.d.; Paechter, 2001; Scanlon, 2000). Finally, irrespective of their validity, most distinctions share a uni-dimensional approach for distinguishing both perspectives. Moreover, it is often stressed that there are more similarities than differences between them (Kirschner, 1999). In sum, this leads to the conclusion that cooperative and collaborative are insubstantial as design principles. Although it often seems that both perspectives are based on a design approach, structured versus unstructured, this distinction seems (a) only part of the puzzle and (b) the implications and effects on interaction are hardly made explicit in advance.

2.4.1 What about positive interdependence and individual accountability?

Most designs of CSGBL settings refer to two central concepts governing group interaction, irrespective of a 'general' cooperative or collaborative approach. Group interaction is generally affected by two well-known principles called 'positive interdependence' and 'individual accountability' (Johnson, Johnson, & Johnson-Holubec, 1992; Kagan, 1994; Lamberigts, 1988; Sharan & Sharan, 1992; Slavin, 1997). Positive interdependence (PI) and Individual Accountability (IA) were introduced in the early 1980s and both relate to well-known phenomena in group dynamics, such as group cohesion and social loafing.

PI refers to the degree to which the performance of a single member is dependent on the performance of all others (Johnson, 1981), as opposed to ‘negative interdependence’ that stresses competition. PI aims to promote cohesion and a heightened sense of ‘belonging’ to a group. It can be achieved through the task, resources, goals, rewards, roles or the environment (Brush, 1998). Although PI can have a strong influence on the level of group cohesion, these terms are not interchangeable, because cohesion encompasses many other additional social factors such as mutual trust and familiarity.

IA stands for the extent to which group members are held individually accountable for jobs, tasks or duties, central to group performance or group efficiency (Slavin, 1980). It was introduced to counter the ‘free-rider effect’: some students would deliberately not invest any (or little) effort into group performance. Thus, IA implies specifying individual responsibility: something someone can be held accountable for. It is related to group dynamics phenomena called ‘social loafing’ and ‘diffusion of responsibility’. Social loafing is a process that refers to members deliberately avoiding effort (so-called ‘free riders’) and if responsibilities are unspecified or unclear, students may assume, unconsciously, that another member will take up responsibility.

Since PI and IA are both closely related to well-known phenomena in group dynamics research, it can be concluded that, in essence, both are relevant aspects regarding performance and interaction in any CSGBL setting. Regardless of how the group cooperates or collaborates, this does not decrease the need to promote cohesion and to avoid ‘free-riding’. PI and IA both affect the way in which group interaction is structured (and subsequently interaction). Thus the use or non-use of PI and IA appears equally insufficient to guide CSGBL design. Both are relevant in any setting and their use varies. Moreover, merely focusing on the level of structure provided would not go beyond a previously criticised uni-dimensional approach to distinguish CSGBL settings. Section 5 discusses a multi-dimensional approach that is constituted by five critical elements that affect group interaction.

2.5 Five critical elements for process-oriented CSGBL design

Although instructional design researchers argue to develop an explicit and systematic approach to CSGBL design (Gros, 2001), it is not a new issue. Salomon argued in 1992 that ‘‘the whole learning environment, not just the computer program or tool, be designed as a well orchestrated whole (. . .) this includes curriculum, teachers’ behaviours, collaborative tasks, mode of peer collaboration and interaction, tasks, learning goals and the like’’ (p. 64).

We propose here a process-oriented approach that focuses on critical elements that affect the emergence of preferred interactions. This multifaceted approach to CSGBL design consists of five elements: three elements are depicted as dimensions: ‘learning objectives’, ‘task type’ and ‘level of pre-structuring’, and vary on a continuum with two poles (cf. Millis & Cottell, 1998), and two in terms of discrete categories namely, ‘group size’ and ‘computer support’.

2.5.1 Learning objectives

It is important to realise that the use of groups to increase individual learning benefits differs considerably from joint problem solving or collaborative inquiry. If the objective of a CSGBL setting is to assist student A's skill acquisition through student B, this will likely result in a different interaction pattern than when two students collaborate on an inquiry project. According to Slavin (1995), cooperative methods are ''most appropriate for teaching well-defined objectives'' (p. 5). Cohen (1994) refers to these as 'lower-level skills', but the concept of '*closed skills*' is less debatable. Closed skills are relatively fixed skills that can be learned separately, for instance a procedure for 'long divisions' or 'basic concepts' such as the concept of a variable. Contrasted with closed skills are '*open skills*', such as argumentation and negotiation. A closed skill will not likely elicit intensive interaction, i.e. interaction is prone to evolve around skill execution, and will most probably consist of 'reactive' remarks. Argumentation and negotiation are much more complex skills and, by definition, students not only react, but reciprocally *build on* each other's contributions; thus different types of interaction may be beneficial for learning different skills. In the case of a closed skill, interaction with a more skilled peer may influence an individual's learning, but interaction is essential for argumentation or negotiation skills (i.e. open skills). Thus, a first critical element that needs to be considered prior to CSGBL, because it affects expected interaction, are the learning objectives, which can be depicted on a continuum ranging from '*open skills*' to '*closed skills*'.

2.5.2 Task type

The second dimension comprises task type. In general, groups tend to be more effective when the task requires a variety of information, consisting of several successive steps, and can be solved by adding individual contributions (Shaw, 1981). Apart from 'additive', group tasks can also be 'disjunctive' (e.g. group performance depends on each individual's math quiz score) or 'conjunctive' (e.g. group decisions through consensus). McGrath and Hollingshead (1994) suggest a different typology and argue that most group tasks can be classified in four categories: generate, choose, negotiate and execute. Subsequently, they distinguish eight task types varying on two continua that create a two-dimensional space. One continuum varies from cognitive to behavioural tasks, the other from cooperative tasks to those that generate conflict. Strauss (1999) tested the effect of three task types on interaction and reports that 'idea generation', 'intellective' and 'judgement tasks' appear to have a significant effect on the type and amount of 'approving', 'disagreeing' and 'procedural' statements. Agreement, disagreement, and process communication corresponded to the needs for member interdependence in group tasks.

Another distinction, more common to educational research, is that of concept-learning tasks (i.e. fact-based) and design tasks (i.e. analysis and synthesis). Concept-learning tasks can be seen as a '*well-structured tasks*' which often require the application of a limited number of rules or principles and have one correct solution, whereas design tasks can be regarded as '*ill-structured tasks*' which have a considerable degree of uncertainty regarding the rules and principles that can be applied and often have no clear-cut solution (depending on many variables in the problem space) (Jonassen, 1997). In principle, well-structured tasks will elicit less interaction because they aim for convergence, i.e. there is only one correct solution (Jonassen & Kwon, 2001).

Apparently different task types constitute a varying degree of interdependence (Illera, 2001) and thus are likely to invoke different interaction processes (e.g. tasks with a higher need to establish common ground are likely to lead to different interaction processes than a task that has a predefined solution path). Thus, a second critical element is constituted by task type, and can be depicted on a continuum ranging from '*well-structured tasks*' to '*ill-structured tasks*'.

2.5.3 Level of pre-structuring

The third dimension addresses the observation that collaboration sometimes develops spontaneously, but more often it does not. Therefore, a continuum is proposed that addresses the level to which interaction is pre-structured in advance by either teacher or designer, through either instruction or the technological environment to ensure positive interdependence and individual accountability. Examples are 'Group Investigation' (Sharan & Sharan, 1992), 'Student Teams Achievement Division' (Slavin, 1995), 'Jigsaw' (Aronson & Thibodeau, 1992; Bielaczycs, 2001), 'Structural approach' by Kagan (1994) (each structure is a scenario to teach specific skills and, although not likewise articulated, it is implicitly assumed that no situation is identical), 'Progressive Inquiry' (Rahikainen, Lallimo, & Hakkarainen, 2001), the use of scripts (O'Donnell, 1999; Weinberger, Fischer, & Mandl, 2001), scenarios that pre-scribe collaboration activity (Wessner, Pfister, & Miao, 1999), feedback rules or requirements of a minimum degree of contributions to a discussion (Harasim, 1993; Harasim, Hiltz, Teles, & Turoff, 1995). It is important to note that most procedures have been tested and applied in elementary or secondary settings, but they can be adapted to other levels of education (college and higher education) or CMC settings (Miyake, Masukawa, & Shirouzou, 2001; Strijbos & Martens, 2001).

Given the abundance of research on different methods (or structures) to support interaction, pre-structuring seems an important element for design of any CSGBL setting. An unresolved issue is when, how and what kind of pre-structuring is used to support interaction. Too much structure may result in 'forced' artificial interaction, but no structure may result in fragmented interaction or a situation where interaction could be seen as an optional activity instead of an essential process. These methods differ considerably in the extent to which interaction, or student activity, is prescribed. For instance, 'Jigsaw' elicits rather 'rigid' task division, whereas 'Progressive Inquiry' scarcely prescribes the level of task division. Thus, the continuum of the third dimension regarding the level of pre-structuring ranges from '*high pre-structuring*' to '*low pre-structuring*'.

In sum, it has been illustrated that all three elements can be represented as dimensions on a continuum with two poles: 'open skills' to 'closed skills', 'well-structured tasks' to 'ill-structured tasks' and 'high pre-structuring' to 'low pre-structuring'. Fig. 4 illustrates these three dimensions of CSGBL and depicts how, in general, settings that use 'Jigsaw' (J) and 'Progressive Inquiry' (PRI) are designed.

Although it can be argued that open skills are in general best served with ill-structured tasks (as are closed skills with well-structured tasks), and conclude that one dimension would suffice for this distinction, it is important to note that collaborative discovery learning (depicted by 'D') uses ill-structured tasks for the acquisition of closed skills with little pre-structuring (cf. De Jong & Van Joolingen,

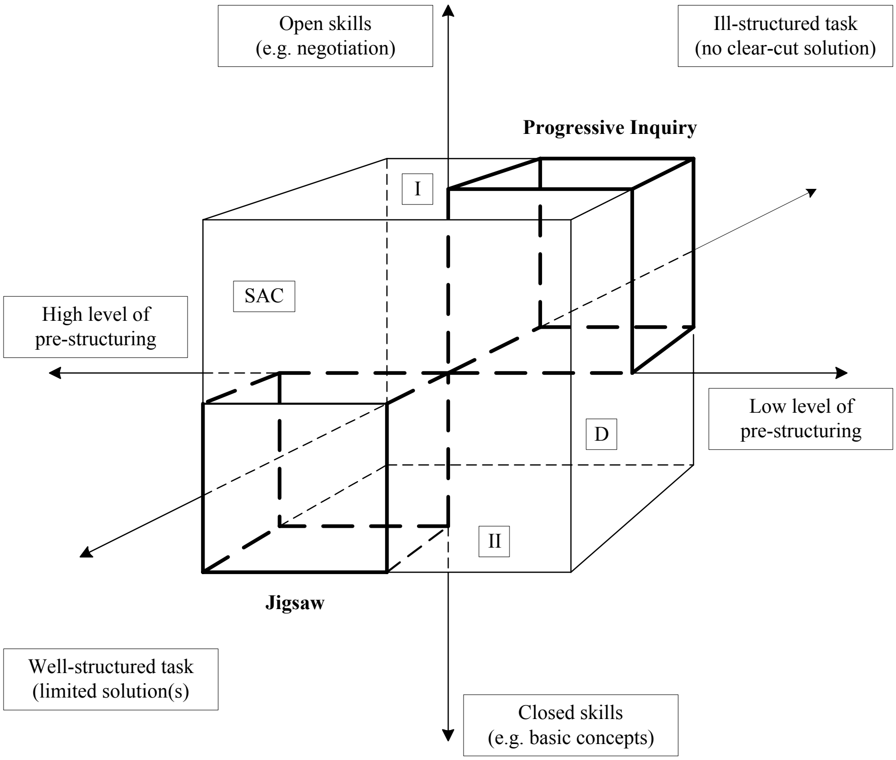


Figure 4 Three dimensions of CSGBL

1998). In the same sense, Structured Academic Controversy (depicted by 'SAC') uses well-structured tasks for the acquisition of open skills with a high level of pre-structuring (cf. Johnson et al., 1992).

Thus, distinguishing both dimensions does not complicate the model unnecessarily; rather a multidimensional representation transcends the enduring polarisation of a uni-dimensional 'cooperative/collaborative' distinction and reveals CSGBL design possibilities (roman numerals) that previously were not readily considered due to paradigmatic constraints. Moreover, the position on the three continua may explain interactions and outcomes that previously were hard to interpret. Apart from these three key elements, two additional elements can be identified that appear essential for the design of group-based learning: 'group size' and 'computer support'.

2.5.4 Group size

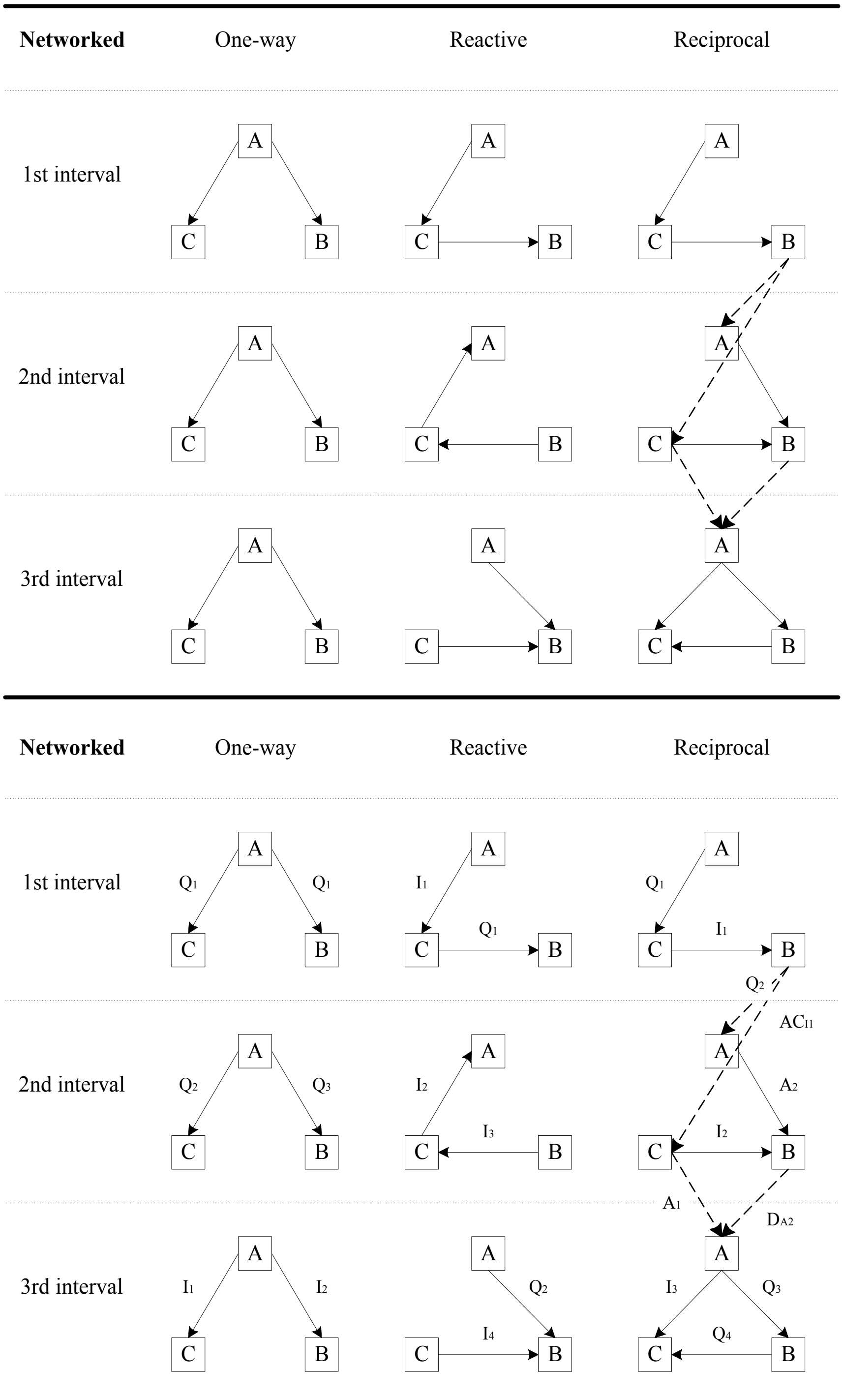
As group size increases, group performance effectiveness depends, on the one hand, on the group's use of increased resources and opinions and on the handling of increased coordination and group management processes on the other (Shaw, 1981; Saavedra, Earley, & VanDyne, 1993). In CSGBL settings, research that compares different group sizes and their effect on interaction is rare. In theory, however, differences can be expected between a dyad that collaborates for thirty minutes on a task and a group of four students collaborating for thirty minutes on the same task. Given the time constraint, students in dyads can make more contributions than students in a four-person group. Moreover, if a CSGBL setting aims at knowledge co-construction, it is important to note that not only does a two-, three- or four-person group differ in the number of alternative opinions, but that at the same time a larger group requires more effort from group members to achieve common ground or a problem solving approach. Hence, in some cases research results obtained with dyadic interaction cannot be readily transferred to other group size constellations.

Although publications often make no explicit distinction between dyads (two members), small groups (three to six members) and large groups (seven or more), there are indications that group size is related to different interaction patterns or learning benefits, especially if participation equality or shared products are required. Fuchs et al. (2000) compared dyadic and four-member groups and observed that four-member group compositions elicited more cognitive conflict (disagreement and negotiation) than dyads, and appeared better suited for average and high-achieving students. A non-significant trend was observed favouring dyads with respect to participation equality, especially in favour of low-achieving students. Fuchs et al. further argue that group size likely affects equality of interaction and contribution to a shared product. Another example is that of Veerman and Veldhuis-Diermanse (2001) who observed, in a higher education setting, a more intensive discussion flow in three-member groups compared to dyads. But they also note that it is not ‘‘(. . .) fruitful to discuss ‘ideal group size’ in relation to knowledge construction; i.e. the impact of group size is relative. Among other factors this depends on how group communication is organised, how the task is designed and what tools are available’’ (p. 630–631).

The typology of dyadic communication, discussed by Rafaeli and Sudweeks (1997), can be extended to networked interaction in small groups of students (three to six members). In concordance with the dyadic typology, three representations can be conceptualised. The first pattern represents interaction dominated by one student. In the second pattern all group members participate, but do not build on each other’s contributions. The third pattern represents interaction that is spread across episodes, and messages build on the input of preceding messages. Fig. 5 is a further modification of Rafaeli and Sudweeks’s representation of dyadic interaction and provides a conceptualisation of small group interaction on levels two and three (see also Sections 3.2 and 3.3).

Interaction in large groups can be more effectively conceptualised as a collection of dyadic and/or networked interaction. In large groups (seven or more members) students are less likely to affect all other members (Forsyth, 1990). Rogoff (1995), moreover, argues that studying interaction in learning communities or large groups (‘participatory appropriation’) requires that interaction on other planes of activity, i.e. in dyads or small groups, is kept in mind. Thus, interaction in large groups does not constitute a separate category.

In sum, although the few studies reported are too premature for a conclusion regarding the impact of group size on interaction, they point out that group size is an aspect of CSGBL that needs additional research (Gros, 2001) and must be considered with respect to expected interaction and CSGBL design.



Q = question, A = answer, I = information, AC = acknowledge, D = decline

Figure 5 Typology of level two and level three interaction (networked)

2.5.5 Computer support

Regarding the role of computer support technology, it is most often the distinction between effects *with* and *of* technology that is emphasised (Salomon, Perkins, & Globerson, 1991). Lipponen (2001) argues that such an awareness of technology use should be extended to CSGBL: effects with and of CSGBL; and introduces another distinction, namely between ‘collaborative use of technology’ and ‘collaborative technology’. Collaborative use of technology refers to generic technology that supports (one or more) basic aspects of communication, collaboration and coordination (e.g. ‘Learning Space’, ‘Blackboard’, ‘WebCT’ or ‘Firstclass’). Collaborative technology, on the other hand, refers to dedicated tools designed to provide specific support: dialogue structuring (C-CHENE) (Baker & Lund, 1997), diagrammatic representations (Belvedere) (Suthers, 1999), thinking types (CSILE; Knowledge Forum) (Scardamalia & Bereiter, 1991), anchoring through writing or discussion prompts (CaMILE) (Guzdial & Turns, 2000), or perspectives to represent information in a communal database (e.g. individual, team, class or comparison) (Webguide) (Stahl, 2001). A third important aspect that needs to be considered is how technology is used during interaction. Crook (1998) makes a distinction between interaction *with* computers, interaction *at* computers and interaction *through* computers. Interaction *with* computers refers to individual student interaction with a computer simulation or tutoring system, and will not be discussed further. Interaction *at* computers represents a group of students interacting with a computer program or tutorial and can be either face-to-face (F2F) or computer-mediated. Interaction *through* computers refers to interaction between group members via networked computers, i.e. group members are not present in the same place (e.g. e-mail, newsgroups, chat, Knowledge Forum, etc.).

It is only reasonable to assume that interaction through computers should only be used when it is relevant. However, many research reports indicate a lack of student participation in electronic discussion forums in formal educational settings (Guzdial & Turns, 2000; Lehtinen, Nurmela, & Salo, 2001). It is very likely too that in some evaluations, where it was concluded that (computer) technology did not elicit the expected interaction, this was actually caused by the design of the CSGBL setting. Oliver and Omari (2001) conclude that lack of student appreciation might be stimulated through further development of the web-based system, but a higher level of pre-structuring may equally likely elevate appreciation. Veerman (2000) concludes from several observations that the task, rather than the technological tool provided, affects discourse and interaction.

In sum, computer systems should be supportive of the needs of students in a group-learning situation (Jeong & Chi, 1997) and not all CMC tools provide the same opportunities for interaction (Chin & Carroll, 2000). Moreover, the fact that something is technologically possible does not imply that it is also educationally desirable (Salomon, 2000). Designers should not be lured in thinking that students use technological support exactly in the way intended (Martens, 1998). Thus, ‘‘whether the opportunities are actually taken and whether taking them upgrades performance and leaves some desired cognitive residue, is less dependent on the technology and far more on other factors.’’ (Salomon, 1992, p. 63).

2.6 Designing for interaction: a process-oriented methodology

In the introduction to this article, a need for a more systematic approach to CSGBL design was identified. The proposed process-oriented design methodology implies that a conceptualisation of the expected interaction is made explicit in advance and stresses the identification of critical elements that affect the interaction. Based on a literature review, five critical elements have been identified: learning objectives, task type, level of pre-structuring, group size and technology. We recommend that the design of any CSGBL setting starts with a conceptualisation of the expected (type of) interaction or changes in interaction due to pedagogical or technological tools. Subsequently, the chosen type of learning objectives, task type, level of pre-structuring, group size and computer support, deemed to elicit the expected interaction, need to be specified, and the CSGBL setting designed accordingly.

2.6.1 Six steps to design

The process-oriented design methodology for CSGBL settings consists of six steps. The design of *any* CSGBL setting starts with determining the learning objective because the expected interaction, seen as best suited to support the chosen learning objective, varies. Since a process-oriented design requires that the expected interaction is specified in advance, the first two steps are performed simultaneously. The six design steps are: (1) determine the learning objectives, (2) determine the expected (changes in) interaction, (3) select the task type, (4) determine whether and how much pre-structuring is needed, (5) determine group size, and (6) determine how computer support can be applied to support CSGBL. A list of questions has been compiled (Table 1) to assist CSGBL design from a process-oriented perspective.

Table 1 Six steps when designing computer-supported group-based learning

1. Determine which type learning objective will be taught:
(1) What type of skills will be taught?
Open skills: argumentation, negotiation, discussion of multiple alternatives
Closed skills: acquisition of basic skills, basic procedures (long division), concept learning
(2) Are all students required to learn the same skill(s)?
(3) Must all students individually display mastery of the learning objectives?
2. Determine the expected interaction:
(4) Specify the expected interaction according to three levels if applicable.
(5) Will the interaction focus on feedback (e.g. commenting draft/final version)?
(6) Will the interaction focus on exchanging (or creating) ideas (or findings)?
(7) Will the interaction focus on discussion, argumentation of multiple alternatives/ opinions?
(8) Does interaction require co-ordination of activities whilst solving a complex problem?
(9) Does interaction require a collaboratively written report representing shared understanding?

Table 2.1 Six steps when designing computer-supported group-based learning (continued)

3. Select task-type with respect to the learning objective and expected interaction:

(10) Which task-type is best suited for teaching the selected skills?

Open skills: ill-structured task with no clear solution, multiple alternatives, outcomes, opinions or procedures

Closed skills: well-structured task with (few) one possible solution(s) outcome(s) or procedure(s)

(11) Are all students required to study the same material?
(12) Will they have to solve a complex and ambiguous problem with no clear solution?
(13) Will the chosen learning objectives and task-type require communication?
(14) Will the chosen learning objectives and task-type require co-ordination?

4. Determine whether and how much structure is necessary with respect to learning objective, expected interaction and task-type:

(15) Determine to what extent the group interaction processes will be pre-structured in advance?

High level of pre-structuring: student interaction is prescribed by the teacher (giving or receiving feedback, suggestions or help), content focussed (content-based roles, resource interdependence)

Low level of pre-structuring: students shape their groups' interaction processes with little or none teacher involvement (knowledge building, case based discussion of multiple alternative solutions, problem based learning)

(16) Are students each assigned to a portion of the material?
(17) Are students each assigned individual responsibilities for interaction and group performance?
(18) Are students dependent on each other during the whole course or only a part of the course?
(19) How will the students be graded: individual test-scores, one group-score for the groups' performance, individual-score for each members' participation and contribution, or a combination?

5. Determine which group size is best suited with respect to learning objective, expected interaction, task type and level of pre-structuring:

(20) Is interaction with other group members obligatory ('positive interdependence') or optional?
(21) Is there a set minimum for group interaction participation (e.g. discussion entries)?
(22) Is the effort of all group members needed to achieve the learning objectives?
(23) Is the interaction focus on feedback (dyads preferred), idea generation (large group preferred) or consensus generation and negotiation (small group preferred)?
(24) Will all members have to contribute equally?
(25) Is there a need for diversity in opinion (discussion) or more focus on exchange of ideas (feedback)?

6. Determine how computer support is best used to support learning and expected interaction:

(26) How are students supposed to 'collaborate': <u>at</u> a computer or <u>via</u> computers?
(27) Will Communication be mainly face-to-face, computer mediated (CMC) or a combination?
Is student interaction same time/ same place (face-to-face: <u>with</u> and <u>at</u> computer)?
Is student interaction same time/ different place (synchronous CMC)?
Is student interaction different time/ different place (asynchronous CMC)?
(28) What kind of support is required: file sharing, communication, or a combination?
(29) Which tool e.g. newsgroup, groupware or chat supports the group-based learning setting best?

During the (re)design a teacher/designer is asked to determine the learning objectives and to specify the interaction process (and/or possible changes in interaction processes) that is considered most supportive to enable students to attain the learning objectives, according to the three levels of interaction. They have to indicate, in advance, how (changes regarding) key elements (for instance a different pedagogical approach) affect interaction, thus making it possible to assess afterwards whether the expected interaction (or changes) did occur. More importantly, differences regarding learning outcomes can be related to observed changes in interaction processes.

Although teachers/designers often prefer a clear set of design rules, a checklist with limited categories is a bridge too far, especially since CSGBL requires a probabilistic design view rather than a causal view. Therefore, a designer has to constantly review whether the critical element will elicit the expected (changes in) interaction. Therefore, each step implies that previous decisions are taken into account.

2.7 Discussion

Currently, the design of CSGBL settings is commonly motivated with concepts such as ‘cooperative’ versus ‘collaborative’, or ‘positive interdependence’ and ‘individual accountability’. A critical review reveals that neither are substantial enough to serve as a basis for the design of a CSGBL setting. In addition, research results show large variations regarding the relationship between interaction and learning outcomes, caused by differences in length of study, technology used, group size, research methodology and unit of analysis (Lipponen, 2001). Developers question what tasks or work methods should be used (Enkenberg, 2001) and express the need for a more systematic approach to CSGBL design (Gros, 2001).

In this article the framework for a process-oriented methodology for the design of CSGBL is proposed. This methodology is grounded on a probabilistic view on design, manifested through its focus on interaction processes rather than static learning outcomes. This implies a clear conceptualisation of interaction and that the expected interaction, or changes due to re-design, can be specified a priori. Since we argue that interaction is the core of any CSGBL setting, design should focus upon critical elements that affect interaction. Five critical elements were identified and their relationship with the expected interaction was discussed. Although most teachers and developers would prefer a clear set of design rules, CSGBL design depends on how learning objectives, task type, level of pre-structuring, group size and type of computer support affect the expected interaction specified a priori. As Sorenson (1971) argues: ‘‘(. . .) prediction of group performance qualities on the basis of task demands is not likely to have much success until research has mapped more explicitly the relationships between demands, behaviour and performance’’ (p. 493).

Some critical remarks about the proposed methodology can be made. First of all, it is based on literature analysis, often hindered by vague definitions used to describe design of CSGBL settings. Presently, there is no empirical evidence that the proposed design methodology provides better support for CSGBL design. Secondly, it is unrealistic to assume that the methodology provides a full guarantee that the expected interaction will be observed. CSGBL ‘‘describes a *situation* in which particular forms of interaction among people are expected to occur (. . .) but there is no guarantee that the expected interaction will occur’’ (Dillenbourg, 1999, p. 5). Based on a probabilistic view on the design of CSGBL, however, a process-based methodology increases the likelihood that the expected interaction can be observed. Finally, it would be utopian to expect that a group’s total interaction can be summarised through one of the prototypical interaction levels. Similarly, it can be questioned whether it is (a) feasible to fully prescribe the expected interaction in view of ‘self-regulated learning’ and (b) probable to exert full control over *a group as a learning environment*. However, the learning objectives, task type, level of pre-structure, group size and computer support (or changes) can trigger changes in part of the total interaction. In addition, CSGBL settings sometimes consist of different tasks that each can elicit different interaction (e.g. tutoring, brainstorm, discussion of information), or specific goals can be characterised by specific interaction processes (Suh, 2001). In other words, depending on the design, several types of interaction may occur, thus emphasising that designers should be aware which type of interaction is expected at a given state in a CSGBL design.

A future development of this methodology could be to apply this methodology as a yardstick for good practice, where good practice is defined as the extent to which CSGBL designs specify (changes in) expected interaction in advance and whether it elicited the expected interaction. At present, there is ‘‘(. . .) little descriptive dynamic data on the complexity of the process and how it might be affected by combinations of task, people, and technology attributes.’’ (Guastello, 2000, p. 174)., There is, however, a good indication that technology can assist to extract interaction patterns, for instance by using a computer tool to construct SNA networks of student communication (interaction on level one) (Ou, Wang, Chen, & Chen, 2001). Another approach may be a theory-based interaction analysis system to guide CSGBL design (Inaba et al., 2001). Nevertheless, it can be questioned whether ‘theoretical’ approaches can account for variations in group interaction (see Section 4 of this article). Some theoretical approaches may elicit similar interaction patterns, thus making it difficult to use these to guide CSGBL design. Finally, technology may be used to assess effective interaction patterns and eventually design intelligent agents that can guide interaction (Soller, 2002).

In sum, the process-oriented methodology outlined can stimulate designers (a) to adopt a more systematic approach to CSGBL design, (b) to design CSGBL according to the expected interaction while paying attention to critical elements that affect the interaction, (c) to bridge the gap between the quality of observed interaction and learning outcomes, (d) to stimulate cooperation between instructional design and CSGBL research and (e) to further CSGBL design that focuses on the heart of the matter: interaction.

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2.9 References

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CHAPTER 3

The effect of functional roles on group efficiency:

Using multilevel modeling and content analysis to investigate computer-supported collaboration in small groups

Abstract

The usefulness of roles to support small group performance can often be read; however, their effect is rarely empirically assessed. This article reports the effects of functional roles on group performance, efficiency, and collaboration during computer-supported collaborative learning. A comparison of 33 questionnaire observations, distributed over 10 groups in two research conditions (role and nonrole) revealed no main effect for performance (grade). A latent variable was interpreted as perceived group efficiency (PGE). Multilevel modeling yielded a positive, marginal effect for PGE. Groups in the role condition appear to be more aware of their efficiency as compared to groups in the nonrole condition, regardless of whether they performed well or poorly. Content analysis reveals more task-content focused statements in the role condition; however, this was not as we hypothesized (i.e., the premise that roles decrease coordination). In fact, roles appear to stimulate coordination that simultaneously increases the amount of task-content focused statements.

Keywords: functional roles; computer-supported collaborative learning; computer-mediated communication; multilevel modeling; content analysis

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3.1 Introduction

Since the 1970s, small group dynamics have been intensively studied in educational contexts. Cooperative learning research focused initially on face-to-face cooperation at the elementary school level but was gradually extended to college and higher education settings. Design of cooperative learning pedagogy focused on promoting group cohesion and group responsibility to increase promotive intragroup interaction. Because of the technology push in the 1980s resulting from rapid developments in computer-mediated communication (CMC), social psychological orientations gradually lost the upper hand, giving rise to a new discipline called computer-supported collaborative learning (CSCL) in the 1990s. CSCL is situated at the crossroads of educational psychology, social psychology, computer science, and communication science. In effect, CSCL cannot yet be regarded as an established research paradigm (Koschmann, 1996) because theoretical debate, as well as large varieties in technological and pedagogical support of collaborative learning, still prevails. However, it has been shown that CSCL promotes metacognitive processes (Ryser, Beeler, & McKenzie, 1995), that representational guidance can aid collaboration (Suthers & Hundhausen, 2002), that reflective interaction can be promoted with a structured dialogue interface (Baker & Lund, 1997), that more elaborated problem solving is increased (Jonassen & Kwon, 2001), and that high-level interaction promotes higher levels of cognitive knowledge gain (Schellens & Valcke, 2002).

Nevertheless, several researchers also identify large variations in the quality of interaction and of learning outcomes (Häkkinen, Järvelä, & Byman, 2001; Lehtinen, Hakkarainen, Lipponen, Rahikainen, & Muukkonen, 1999). On one hand, these are caused by differences in length of studies, technology used, group size, as well as differences in research methodology and the unit of analysis (Lipponen, 2001). On the other hand, the outcome of small group collaboration is mediated by the quality of group processes (Shaw, 1981). As the initial technological push slowly resides, small group dynamics have regained interest of the CSCL research community (Kreijns, Kirschner, & Jochems, 2003; Strijbos & Martens, 2001; Wood, 2001). In addition, it is gradually acknowledged that learning and collaboration reside in intragroup interaction (Strijbos, Martens & Jochems, in press), and thus, this is the primary process to be studied with respect to performance and to learning benefits in CSCL settings.

3.2 The use of roles to support coordination during asynchronous CSCL

Group performance effectiveness depends, as group size increases, on the group's use of increased resources and alternate opinions (process gains) and on the handling of increased coordination and group management processes (process losses) (Shaw, 1981). Conflicts regarding coordination are likely to occur in asynchronous CSCL settings; for example, the group members are not present at the same time or place (Benbunan-Fich & Hiltz, 1999). In addition, asynchronous communication is nonnatural in the sense that the immediacy of feedback, prone to

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face-to-face settings, is not present. Clearly, some support should be provided to help students overcome difficulties in group coordination.

Several processes in small group dynamics can indirectly affect coordination and the delicate balance of process gains versus process losses. Group responsibility is proportionally related to group performance (i.e., a greater sense of responsibility can increase group performance), whereas the effects of norms and of status depend on whether these stimulate or impede group performance. Group cohesion has been shown to increase stability, satisfaction, and efficient communication, as well as negative effects such as social pressure, inter- and intragroup aggression or conflict and polarization (Forsyth, 1999). Group cohesion and responsibility are the basis of two key concepts in collaborative learning: positive interdependence (Johnson, 1981) and individual accountability (Slavin, 1980). Positive interdependence refers to the degree to which the performance of a single group member depends on the performance of all other members. Individual accountability refers to the extent to which group members are held individually accountable for jobs, tasks, or duties that are central to group performance or efficiency.

Because roles promote group cohesion and responsibility (Mudrack & Farrell, 1995), they can be used to foster positive interdependence and individual accountability (Brush, 1998). Roles can be defined as more or less stated functions, duties, or responsibilities that guide individual behavior and regulate intragroup interaction (Hare, 1994). In addition, roles stimulate members' awareness of the overall group performance and each member's contribution. "The opinions that others form about one's contribution to the group effort will likely be influenced, in part, by which roles the focal group members play" (Mudrack & Farrell, 1995, p. 559). The use of roles appears to be most relevant when a group pursues a shared goal that requires a certain level of task division, coordination, and integration of individual activities.

Three main categories of roles can be distinguished: individual roles, task roles, and maintenance roles, each of which is composed of several different roles (Mudrack & Farrell, 1995). However, these roles are based on a self-report inventory and pertain to roles that participants can perform during collaboration. Moreover, each participant performs several roles simultaneously, thus making it difficult to implement such roles in educational contexts. Nevertheless, these role descriptions can guide the design of roles for pedagogical purposes.

Several pedagogical approaches, developed for cooperative learning, use roles to support coordination and intragroup interaction (Johnson, Johnson, & Johnson-Holubec, 1992; Kagan, 1994). These roles are either based on differences in individual expertise (content-based roles) (cf. Bielaczyc, 2001) or on individual responsibilities regarding group coordination (process-based roles) (cf. Kynigos, 1999). It can be questioned whether content-based roles are actual roles or merely rigid task division. Moreover, most roles developed for cooperative learning settings compose one single job, task, or duty, mainly because they were developed for face-to-face collaboration in primary education. Although roles are widely regarded as an effective instructional strategy, in cooperative learning and in CSCL, their effect has not been investigated systematically in both higher and primary education.

If cooperative learning pedagogies, and more specifically roles, were used in higher or in distance education, they were not adapted, although students in these settings vary considerably in (prior) knowledge, experience, and collaboration skills. Moreover, the collaboration assignments in higher or distance education are more complex, they take place over an extended period of time (i.e., not restricted to classroom time), and thus, they require more explicit coordination than in primary or secondary education. Consequently, the previously mentioned uni-dimensional roles for face-to-face collaboration appear inadequate to support collaboration in higher or distance education, let alone asynchronous CSCL settings. Thus, explicit and detailed roles descriptions should be provided.

The study reported in this article investigates the impact of from roles that counter process losses from coordination demands. We refer to these roles as functional roles. The roles are based on role descriptions in reports by Mudrack and Farrell (1995), Kagan (1994), and Johnson et al. (1992). In addition, they are adapted for an asynchronous CSCL setting in a higher/distance education context. The main research question can be summarized as the following: What is the effect of a prescribed functional roles instruction, as compared to no instruction, on group performance and collaboration? It is expected that roles will have a positive effect on group performance (grade) and on collaboration (efficiency) and that the amount of coordinative statements will decrease in favor of content-focused statements. The relationship between individual characteristics and group collaboration will be investigated, as well as the suggestion by Mudrack and Farrell (1995) that individual and group perception will be more unanimous in the role condition compared to the nonrole condition. Self-report questionnaires were used to measure students' perceptions of collaboration, and content analysis of communication transcripts was used to investigate actual behavior during intragroup collaboration.

3.3 Analysis of nonindependent observations and small sample sizes

Before we proceed to the analyses and results of the self-report questionnaire data, it is important to note the implications of nonindependent observations with respect to the analysis of intragroup collaboration. This issue was only recently raised in CSCL and small group research. In research on cooperative learning, frequently the ANOVA procedure has been used to investigate the impact of an instructional strategy using individual level observations (see Slavin, 1995). This is no exception in some CSCL studies (Reiserer, Ertl, & Mandl, 2002). However, ANOVA appears not to be suited for this type of data. Stevens (1996) points out that the assumption of independence, between scores of members of the same small group, is violated. Students' perceptions of group performance depends on all other members' activities. Violation of independence increases as a function of the interdependence in a group, thus yielding a major increase of a Type 1 error. Stevens (1996) suggest either to test with a stricter level of significance ($p < .01$ or even $p < .001$) or to use the group average. Bonito (2002) discusses three alternative procedures that take nonindependence into account, with respect to the analysis of participation in small groups: the actor-partner interdependence model, the social relations model, and multilevel modeling (MLM).

Another point is that, unlike a considerable amount of studies in social psychology, CSCL is not conducted in laboratory settings. Its naturalistic context adds to its ecological validity but simultaneously complicates analysis. Most CSCL studies suffer from a relatively small number of participants, and research designs in general do not exceed 20 participants (see Stahl, 2002). Furthermore, quantitative statistical analyses are rarely used. Analysis focuses on qualitative methodologies to explore intragroup interaction and the level of collaboration. MLM appears to be best suited to investigate questionnaire data that consists of self-report perceptions (cf. Bonito, 2002). However, MLM analyses with a small sample size (less than 50) are not often reported. Therefore, the methodological and analytical considerations will be discussed in more detail in the Method and Results section that covers the MLM analyses.

3.4 Content analysis

Analysis of written electronic communication transcripts has gained increased attention in CSCL in the past decade (Hara, Bonk, & Angeli, 2000; Lally & De Laat, 2003). In general, two approaches exist: the quantitative and the qualitative approaches. In the first approach, communication is coded and obtained frequencies and percentages are used in statistical comparisons. The latter deploys techniques such as phenomenography, ethnography, and participant observation techniques to reveal descriptive trends (Miles & Huberman, 1994).

Large variations with respect to the unit of analysis exist; it can be a message, paragraph, theme, a unit of meaning, illocution, utterance, statement, sentence, or proposition. Common to all is that the unit is ill defined and arguments for choosing a specific unit lack (Strijbos, Martens, Prins, & Jochems, 2003). Furthermore, although it is acknowledged that reliability for a quantitative content analysis procedure is essential—and many studies often report an intercoder reliability statistic—reliability is seldom addressed with respect to the unit of analysis (Rourke, Anderson, Garrison, & Archer, 2001).

Nevertheless, examples of statistical comparison without any intercoder reliability being provided are not uncommon in CSCL research (Pata & Sarapuu, 2003). However, as Neuendorf (2002) states, “Without the establishment of reliability, content analyses measures are useless” (p. 141). Moreover, if the outcomes are used for statistical comparisons, quantitative content analysis requires that codes are mutually exclusive. Hence, more rigor with respect to reliability of both segmentation in unit of analysis and coding is essential to warrant the accuracy of observations (Strijbos, Martens, Prins, & Jochems, 2003).

Irrespective of the segmentation reliability, units should still be meaningful with respect to coding. Or in other words, enable a researcher to answer the research question. We used a sentence or part of a compound sentence as the unit of analysis. A procedure to segment transcripts in these units was developed, as was a procedure for coding. The reliability of both procedures and outcome of the analyses will be provided in the Results section.

3.5 Method

3.5.1 Participants

At the Open University of the Netherlands (OUNL), 57 students enrolled in a course on policy development (PD) and 23 students in a course in the subject domain of local government (LG). Eighty students enrolled (49 male and 31 female). Their ages ranged from 23 to 67 years (*M* = 34.4, *SD* = 9.03). Five students enrolled in both courses. Participants varied considerably in educational and professional background, which is common to higher or distance education. The course was successfully completed by 43 students, of which 33 returned both questionnaires and were included in this study.

3.5.2 Design of study

The study has a quasi-experimental, random, independent groups design. The experimental manipulation involved the introduction of a prescribed role instruction in half of the groups (R groups). The instruction aimed at promoting the coordination and the organization of activities that were essential for the group project, in half of the groups. The other half of the groups was left completely selfreliant regarding organization and coordination of their activities (NR groups). Each group initially consisted of four students, and throughout the course they communicated by e-mail. To assess the effects of roles on performance, group-level grades in both conditions are compared. To investigate the effect of roles on the perceived collaboration, each student's perception of their team development, group process satisfaction, the task strategy, the level of intragroup conflict, the quality of collaboration, and the usefulness of e-mail has been measured. Finally, students' attitudes toward collaboration and computer-mediated communication were measured prior to the course and after successful completion.

3.5.3 Materials

3.5.3.1 *Instructions*

Half of the groups were instructed to use functional roles: project planner, communicator, editor, and data collector (see Appendix A), the other half received a nondirective instruction (e.g., obvious, unspecific, and general information regarding planning and task division), and they were instructed to rely on their intuition or collaboration experiences (see Appendix B). Students in the R groups had to distribute the roles themselves and exerted their role for the full duration of the course (roles did not rotate). Instructions in both conditions were delivered as a short electronic text at the beginning of the course. They were also presented to students present during a face-to-face meeting at the start of the course.

3.5.3.2 *Intake questionnaire*

The intake questionnaire consisted of two sections. One section combined several scales addressing individual characteristics such as attitudes, need for closure, and achievement motivation. All items were rated on a 5-point likert-type scale. These scales were all already previously tested, and their reliability ranged from .78 to

.86. Reliabilities that will be reported further apply only to this study. Both attitude scales (Clarebout, Elen, & Lowyck, 1999) were reliable and measured at the intake and evaluation: attitude toward computer-mediated communication (intake: $\alpha = .78$; 8 items) and attitude toward collaborative problem solving (intake: $\alpha = .70$; 7 items). A scale to assess active or passive orientation to group work ($\alpha = .63$; 6 items) was constructed and tested prior to this study (Strijbos, 2000). Need-for-closure questionnaire is developed by Kruglanski (cf. De Grada & Kruglanski, 1999), translated into a Dutch version by Cratylus (1994), the version that was used in this study. Need for closure consist of five subscales: need for structure, need for predictability, decisiveness, intolerance for ambiguity, and closed mindedness. The subscales need for structure ($\alpha = .79$; 8 items) and decisiveness ($\alpha = .67$; 6 items) were sufficiently reliable to be used in further analyses. Achievement motivation (Hermans, 1976) was measured using the achievement subscale (P-scale) of this questionnaire ($\alpha = .86$; 44 items). Information and communication technology experience was measured through several nonscaled questions adapted from Valcke (1999). Finally, background characteristics (such as received education or training, occupational group, and branch of industry) were collected using a standard OUNL questionnaire. Out of the 80 students that enrolled in the course, 75 students (93.8%) returned the intake questionnaire. The course was successfully completed by 43 students (53.8 %), of which 33 returned both the intake and the evaluation questionnaires (76.7 %). These figures indicate a high dropout rate, but this is not uncommon in a distance-education context (Martens, 1998).

3.5.3.3 *Evaluation questionnaire*

The evaluation questionnaire consisted of 46 items, belonging to six scales that are rated on a 5-point likert-type scale: attitude toward computer-mediated communication, attitude toward collaborative problem solving, team development, group process satisfaction, intragroup conflict, and task strategy. In addition, students were requested to answer several questions on a 10-point scale (including perceived quality of collaboration and perceived usefulness of e-mail) and about 25 open-ended questions or opportunities for extended feedback. Results that will be reported in this article are restricted to the six scales, which were already previously tested (reliability ranged from .76 to .92), and to two questions that were rated on 10-point scale: perceived quality of collaboration and perceived usefulness of e-mail for collaboration. Reliabilities that will be reported further apply only to this study. Attitude toward computer-mediated communication in the evaluation had $\alpha = .84$ (8 items) and attitude toward collaborative problem solving had $\alpha = .76$ (7 items). Team development ($\alpha = .95$; 10 items) provides information on perceived level of group cohesion, whereas group process satisfaction ($\alpha = .67$; 6 items) provides the perceived satisfaction with general group functioning (both cf. Savicki, Kelley, & Lingenfelter, 1996; translated into Dutch). Intragroup conflict ($\alpha = .68$; 7 items) provides the perceived level of conflict between group members, and task strategy ($\alpha = .86$; 8 items) indicates whether students perceive that their group deployed an appropriate strategy for the given task (both cf. Saavedra, Early, & Van Dyne, 1993; translated into Dutch).

3.5.4 Procedure

After course registration, students were informed that the research focused on investigating the group processes of students collaborating through e-mail and on determining the suitability of this format in distance education. Two weeks prior to the start of the course, students had to indicate whether they wanted to start with the group assignment in October 2000 or March 2001. Next, students were randomly assigned to groups, and geographical distance between group members was maximized to discourage face-to-face meetings.

Prior to collaboration, a face-to-face meeting was organized for all students. A separate meeting was organized for each research condition. General information and the instructions in both conditions were provided during this meeting and electronically afterward. After the meeting, all remaining contact between students was virtual. Role groups were required to inform their supervisor about the assignment of the roles in their group within 2 weeks. Contact with the supervisor was restricted to a single group member in the role condition, whereas students in nonrole groups were all allowed to contact the supervisor. Supervisors were instructed to answer questions that focused on the content of the assignment. Under no circumstance were they to provide support regarding coordination and group management. If a request for support was received, students in the role condition were told to rely on the roles, whereas students in the nonrole condition were told to rely on their intuition or experiences with collaboration. Although students were instructed to use e-mail, it is by no means possible nor feasible to exclude customary communication channels, such as telephone and face-to-face contact. If used, students were requested to send transcripts to all group members to retain transparency of communication. During collaboration, the telephone was used occasionally, but most contact was by e-mail. In spite of geographical distance, three groups organized a face-to-face meeting. Five students participated in both courses and were placed in the same research condition. This did not pose difficulties in the final analyses. Some groups did not complete the course timely or were excluded from the research because only two group members remained (and thus were no longer included in the research). None of these five students finished both courses.

3.6 Results

3.6.1 Investigation of correlations between individual characteristics and dependent variables

Pearson correlations were computed to investigate whether the variables measured at the intake could be used as covariates. A correlation matrix was computed. No correlations were found between any of the variables measured on intake. Neither between these constructs and any dependent variables measured at the evaluation, nor between these constructs and grade, were any correlations found. It was concluded that none of the variables from the intake, signifying individual characteristics, could be used as covariates in any of the further analyses.

3.6.2 Effect of condition on grade

Grades were administered on a group level. A Mann-Whitney test was performed to investigate the difference between the role ($M = 6.6$, $SD = .89$) and nonrole ($M = 7.4$, $SD = .54$) conditions. A nondirectional test was performed. No main effect was observed for grade ($z = -1.549$, $df = 4$).

3.6.3 Descriptives and correlations between dependent variables

Descriptives were computed for both conditions. A considerable spread of scores is indicated by standard deviations, occurring in both conditions (Table 1). Pearson correlations between these variables were computed for the entire sample ($N = 33$). Medium to high correlations (.45 to .89, $p < .01$) were found between all of the variables, except for attitude toward CMC and attitude toward CL.

Table 1 Mean and standard deviations of dependent variables by experimental condition

	Role (N = *14*)		*Nonrole* (N = *19*)		
	M	SD	M	SD	Min, max
Quality of collaboration	5.21	2.78	5.37	1.74	1, 10
Usefulness of e-mail	5.21	2.72	6.53	2.04	1, 10
Team development	3.53	0.85	3.17	1.04	1, 5
Group process satisfaction	3.35	0.76	3.35	0.70	1, 5
Intra-group conflict	2.48	0.68	2.68	0.58	1, 5
Task strategy	3.10	0.96	3.22	0.76	1, 5
Attitude towards CMC	3.39	0.71	3.59	0.64	1, 5
Attitude towards CL	3.40	0.76	3.53	0.54	1, 5

NOTE: CMC = computer mediated communication; CL = collaborative learning.

To avoid the problem of multiple testing (which will be addressed in more detail when the multilevel (ML) analyses are discussed), principal axis factoring was performed to investigate whether a possible latent variable existed.

Table 2 Factor extraction for dependent variables

	Factor loading	
	Extraction I	Extraction II
Quality of collaboration	.908	.860
Team development	.842	.884
Group process satisfaction	.811	.822
Intra-group conflict	-.900	-.907
Task strategy	.997	.989
Usefulness of e-mail	.601	

Table 2 shows the factor loading scores. Usefulness of e-mail attributes less to the common factor than all other variables (Extraction 1); therefore, a second extraction was computed excluding this variable (Extraction 2). The second extraction explains 79% of all common variance between the dependent variables. Based on the Extraction 2, factor scores were computed. The resulting factor can be interpreted as perceived group efficiency (PGE). Standardized factor scores were computed for all variables used in Extraction 2.

3.6.4 Multilevel modeling

Before discussing the outcomes of our multilevel modeling analyses, a more detailed view on our dataset is required. Our sample consists of 10 groups, and the number of observations in each group varies between two and four. This design is skewed (i.e. the number of observations on Levels 1 (group) and 2 (individual) are not balanced (five groups with five observations each 5 × 5, 10 × 10, and so forth). Mok (1995) identifies three basic designs. Our design (Type C in terms of Mok), is less efficient in the so-called random component on both levels; however, ML analyses can be applied. Secondly, our sample size is rather small (N = 33). This has some implications for performing ML analyses, especially with respect to statistical power.

Investigating the influence of roles on perceived levels of group efficiency (PGE) suggests the use of a *t* test or of its equivalent reformulation into an ordinary least squared regression model (OLS). However, OLS regression assumes that the residuals are independent, and this assumption is obviously violated because the scores of students in the same group will be more similar than the scores of students from different groups.

Analysis showed the intraclass correlation coefficient, a measure of the dependency between scores within the same group, to be equal to .47. Failure to incorporate this interdependency among scores in a statistical model will lead to an underestimation of the standard errors of model parameters, resulting in a much larger than nominal probability of a Type 1 error (Snijders & Bosker, 1999).

Instead, a multilevel model (Equation 1) was constructed using CONDITION as a predictor of the dependent variable PGE, yielding a so-called random-intercept model (Snijders & Bosker, 1999):

$$PGE_{ij} = y_{00} + \beta_1 \times CONDITION_j + U_{0j} + e_{ij} \qquad (1)$$

The score on PGE of person i in group j is the result of Equation 1, where y_{00} is a fixed intercept; β_1 is the regression coefficient of group-level variable condition; CONDITION is a 0–1 indicator variable with 1 corresponding to a nonrole group; U_{0j} is grouplevel variance; and e_{ij} is individual-level variance. Estimation of this model yielded the following fixed parameter values (with corresponding standard errors within parentheses): PGE_{ij} = .045 (.362) – 027 (.502) × CONDITION. An overview of the random parameters is provided in Table 3.

The deviance reported in this table is equal to minus twice the log-likelihood and can be used for a formal test of the goodness of fit of the model. By comparing this deviance value with the deviance of the model without CONDITION as predictor (the so-called null or empty model), a significance test for CONDITION is provided. The effect of providing roles to group members is shown not to be significant ($\chi 2 = .003$, $df = 1$, $p > .05$).

Table 3 Random variance estimates of the random intercept model

Parameter	*Estimate*	SE
Group-level variance	.465	.285
Individual-level variance	.526	.155
Deviance = 86.000		

In general, at this point, no further ML analyses would have to be performed, unless there would be a theoretical ground to assume heteroscedasticity instead of the assumption of homoscedasticity underlying the fixed intercept model. To explain the implication of this assumption, we will briefly discuss model one. This model uses a fixed intercept (y_{00}). This intercept corresponds to the zero (0) group of CONDITION. In each nonrole group, CONDITION is given the value one (1), and a constant of –0.027 is added to the fixed intercept. Thus, the fixed intercept for nonrole groups takes a slightly lower value than does that of the role groups. Of course, the PGE score of each individual student depends on that individual's score and on the group-dependent random effect (U_{0j}). The model assumes that all group-dependent random-effects (U_{0j}) values are taken from a normal distribution with an average of zero and variance σ^2_{U0j} and that the variance of U_{0j} is equal for levels of CONDITION. This assumption is known as homoscedasticity. Opposed to homoscedasticity is the assumption of heteroscedasticity: the variance for group-dependent random effects (U_{0j}) is unequal for both levels of CONDITION. Because roles, in theory, are likely to increase individual awareness of group efficiency, a theoretical foundation for the assumption of heteroscedasticity is provided. Heteroscedasticity can be included in a ML model by allowing a random slope—the regression coefficient of CONDITION is allowed to vary in both levels (see Snijders & Bosker, 1999, p. 119):

$$PGE_{ij} = y_{00} + \beta_{1j} \times CONDITION_j + U_{0j} + e_{ij} \tag{2}$$

In Equation 2, the intercept and the effect of CONDITION are allowed to vary for each group. Equation 2 can be transformed into Equation 3:

$$PGE_{ij} = y_{00} + y_{10} \times CONDITION_j + U_{0j} + U_{1j} \times CONDITION_j + e_{ij} \tag{3}$$

In Equation 3, $y_{00} + y_{10} \times CONDITION_j$ represents the fixed part and $U_{0j} + U_{1j} \times CONDITION_j + e_{ij}$ the random part. Analysis of the fixed part of the model yielded the following results: PGE = .056 (.446) + .039 (.515) × CONDITION. Estimations of the random part of the model are provided in Table 4.

The residual variance on group level has now been translated in a variance of the intercept (0.805), a variance of the regression slope (zero) and a covariance between values of U_{0j} and of U_{1j} values (–0.305). The estimation of the regression slope variance produced a value smaller than would be expected on the basis of the within-group variability, and as a result, the ML-wiN (Version 1.10) program automatically inserts the value zero for this variance.

Table 4 Random variance estimates of the random slope model

	Group level	
Parameter	*Estimate*	SE
Variance intercept	.805	.629
Variance slope	.000	.000
Covariance slope and intercept	-.305	.331
	Individual level	
Parameter	*Estimate*	SE
Variance	.518	.153
Deviance = 84.763		

However, in case of a limited number of observations, it is not uncommon that the estimated variance between groups will be small in comparison to the estimated variance within groups. This can be a consequence of the comparatively small power of the test. Thus, a closer look at the data is warranted. We looked at predictions of PGE generated for each group (R = role group, NR = nonrole group), based on, respectively, the model with random slope (RS), parameter (Equation 3), and the model without RS parameter (Equation 1). Results are provided in Table 5 (for descriptives, see Appendix C).

Table 5 PGE prediction estimates by group with and without random slope parameters

	Role	
Group	*Model with RS*	*Model without RS*
PD 1	-.68	-.60
PD 2	1.08	.92
PD 3	1.00	.88
PD 4	-.67	-.58
LG 1	-.46	-.40
	Nonrole	
Group	*Model with RS*	*Model without RS*
PD 5	-.14	-.19
PD 6	.60	.77
PD 7	.06	.08
LG 2	.00	.00
LG 3	-.44	-.57

If we leave out the RS parameter, predictions of estimates based on PGE become less extreme for the role groups (move closer toward zero), whereas predictions of estimates for the nonrole groups become more extreme (move further from zero). This is caused by the underlying assumption of equal population variances in the model without random slope. Population variance of the role condition is estimated as .82 for the model with random slope and as .62 for the model without random slope. Population variance of the nonrole condition is estimated as .14 with RS and .24 without RS.

An F test for the homogeneity of variances was performed to investigate the hypothesis of equality of variances, both for the role and nonrole groups; ANOVA was used for the model without random slope ($F = 2.86$, $df = 4$, $p > .10$) and for the model with random slope ($F = 5.86$, $df = 4$, $.05 < p < .10$). This difference is graphically represented in Figures 1 and 2. The results suggest to us that the assumption of homogeneity of variances leads to a distortion of a clearly discernable pattern in the data.

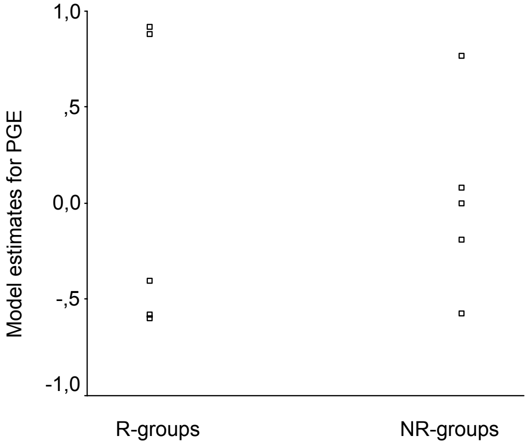

Figure 1 Model estimates of PGE without random slope

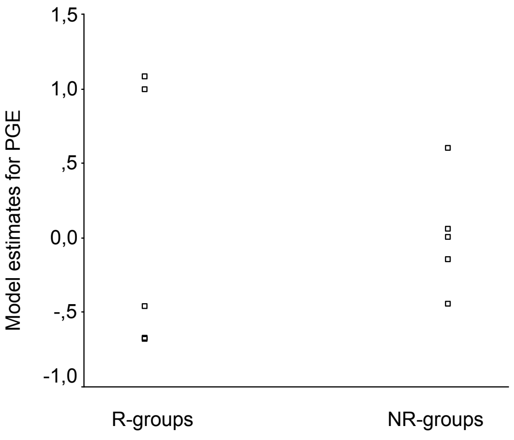

Figure 2 Model estimates of PGE with random slope

3.6.5 Content analysis

Before discussing the outcomes of the content analyses, it must be noted that the data consist of all contributions by all group members of the groups previously included in the MLM analyses, regardless whether they successfully finished the course or returned an evaluation questionnaire. Content analysis was performed on all e-mail messages contributed by 40 subjects equally distributed across research conditions (role and nonrole; $N = 5$ and $n = 20$).

A segmentation procedure that would be systematic and independent of the coding categories was developed (Strijbos, Martens, Prins, & Jochems, 2003). Although the sentence as a unit of analysis is not uncommon (e.g. Fahy, Crawford, & Ally, 2001; Hillman, 1999), segmentation of compound sentences was added. The unit was defined as a sentence or part of a compound sentence that can be regarded as a meaningful sentence in itself, regardless of coding categories. Punctuation and the word *and* mark potential segmentation, but this is only performed if both parts before and after the marker are a meaningful sentence. Intercoder reliability of two segmentation trials was .82 and .89 (proportion agreement) and was corroborated by a cross-validation check on an English-language dataset (.87). In addition, a coding scheme was constructed with five main categories—task coordination (TC), task content (TN), task social (TS), nontask (NT), and noncodable (NOC)—and 18 subcategories depicted in Table 6. Reliability on subcategory level (Cohen's kappa) proved to be, on average, .60 (moderate), and, on main category level, .70 (substantial) (cf. Landis & Koch, 1977).

Again, the issue of nonindependence has to be taken into account. For the questionnaire data, it was possible to reduce the number of dependent variables to a single factor to avoid the problem of multiple testing. Principal axis factoring of the five main categories, however, does not result in a factor that can be meaningfully interpreted; therefore, statistical comparisons were restricted to the number of messages, segments, and the frequency for each main category on the level of the group. As ANOVA is not appropriate, the Mann-Whitney test was performed to compare the research conditions (five groups in each condition). Results are depicted in Table 7.

Table 7 Mean, standard deviations and Mann-Whitney rank scores for the number of messages, number of segments and the five main categories

	Role (N = *20*)			*Nonrole* (N = *20*)		
Item	M	SD	*Rank*	M	SD	*Rank*
Number of messages	78.20	22.30	7.2	52.40	17.47	3.8
Number of segments	759.60	173.04	7.8	401.20	156.12	3.2
Task coordination	63.95	16.99	7.2	37.35	20.45	3.8
Task content	37.65	17.22	7.4	16.35	16.48	3.6
Task social	4.40	2.73	7.5	1.95	0.48	3.5
Non task	21.40	7.76	7.1	12.55	4.83	3.9
Non-codable	62.55	13.73	8.0	32.10	10.33	3.0

Table 6 Abbreviated overview of the content-analysis coding categories

Code			
Main	*Sub*	*Description*	*Example*
TC	G	All statements with (a) a choice with no reference to time, the group or individuals; (b) coordination, but time nor activity, is indicated; (c) asking for a reaction but the object is unclear; (d) request a life sign from group members; (e) information on contextual factors that affects individual contribution to group work.	Why is nobody responding? Please give your ideas.
TC	TU	All types of statements regarding coordination in time, where time is indicated unspecifically.	I will be in touch again soon.
TC	TS	All types of statements regarding coordination in time, where time is indicated specifically.	I will be on holiday from June 8 until June 26.
TC	AU	All types of statements regarding coordination on activity, where the activity is (to be or was) performed by the group.	Who will make an inventory of all pressure groups involved?
TC	AS	All types of statements regarding coordination on activities or division of activities, where is indicated specifically who will perform that activity (i.e., by persons or by a (sub) group).	As far as I know, John Doe will perform the PERS analysis.
TC	TAU	All types of statements regarding coordination in time and activities or division of activities, where either time, division or both are indicated unspecifically.	I would like to know who will send me their comments on our report before Wednesday.
TC	TAS	All types of statements regarding coordination in time and activities or division of activities, where time and division are both are indicated specifically.	As agreed I expect that John Doe will send the analysis on Thursday.
TN	G	All types of statements that concern the general goal, or assessment criteria regarding the group assignment.	The assignment is about the public transport in Amsterdam.
TN	S	All types of statements that concern the content of the task (i.e., analysis of a policy problem) such as questions, comments, requests, providing information, information sources, content issues, discussion of that content, and so forth.	I believe that we have a different opinion about the interpretation of the analysis.

Table 6 Abbreviated overview of the content-analysis coding categories (continued)

Code			
Main	*Sub*	*Description*	*Example*
TN	R	All statements that concern the layout, structure and revision of the policy report.	We should delete section two and check for typing errors in three.
TS	G	All statements that concern general functioning or attitude toward the group, without reference to it or to individuals.	That's more like it!
TS	GR	All types of statements concerning group functioning, effort or attitude toward the group with reference to the group (i.e., use of we, all group members, or everybody).	I think we as group did a great job in a virtual project team.
TS	IN	All types of statements concerning an individual's functioning, effort or attitude toward another individual (i.e., with reference to names, he, she, I, you, they, (sub) Group 1).	John Doe, my compliments for your PERS analysis.
NT	A	All statements that concern the face-to-face meeting at the start of the course and statements that concern acquaintance after the meeting (e.g., providing personal background information).	I have already met John Doe during the face-to-face meeting.
NT	T	All statements that concern technical issues (i.e., how to use, problems, evaluative remarks about computers, e-mail, specific software, and missing or forgotten attachments).	I am still struggling to find out how I am supposed to operate Edubox.
NT	S	All statements with a social orientation that are not related to the assignment (i.e., vacation, Christmas wishes).	How was your holiday in France?
NT	M	All statements wit an explicit reference to communication with the moderator or in which a group discusses the response.	We should ask the moderator if an analysis is useful.
NOC		All types of statements that not belong to any category specified (e.g., statements that signal receipt of a message or attachment).	Attached is a new schedule with the latest deadlines and tasks.

NOTE: Main = main code; Sub = subcode; TC = task coordination; TN = task content; NT = nontask; NOC = noncodable; G = general; TU = time unspecific; TS = time specific; AU = activity unspecific; AS = activity specific; TAU = time and/or activity unspecific; TAS = time and activity specific; S = social or specific; R = revision; GR = group; IN = individual; A = acquaintance; T = technical; M = moderator.

No main effect was observed for the amount of messages sent[i], but a significant difference was observed for the amount of segments (z = 2.402, df = 4, p < .05)[ii]. Regarding the content of the communication, a main effect was observed in favor of the role condition. Significantly more TC (z = 1.776, df = 4, p < .05; one sided), TN (z = 1.984, df = 4, p < .05), TS (z = 2.121, df = 4, p < .05), and NOC statements (z = 2.619, df = 4, p < .05) were made in the role condition. A one-sided test was performed for TC; it was expected that roles would decrease TC in favor of TN. Finally, a significant positive correlation was found between the amount of TC and TN statements (.73, p < .01). Kendall's tau was computed, and a correlation plot revealed that most role groups (PD 1-4, LG 1) cluster in the upper right quadrant, whereas most nonrole groups (PD 5-7, LG 2-3) cluster in the lower left quadrant (see Figure 3).

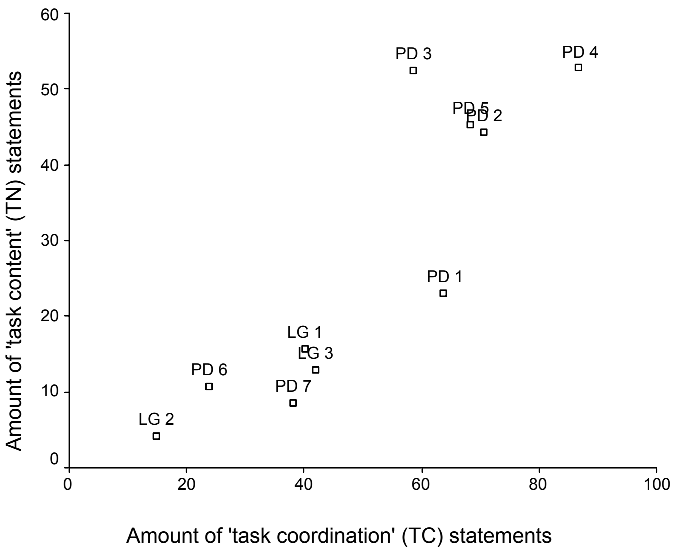

Figure 3 Three dimensions of CSGBL

3.6.6 Summary of results

A Mann-Whitney test revealed no main effect of roles regarding grade. Examination of Pearson correlates revealed significantly high, positive correlations between several variables that measured group functioning. Principal axis factoring was performed on the remaining dependent variables, and one factor was extracted. The factor was interpreted as the level of PGE.

[i] Note: All values reported in Table 7 apply to the group level (n = 5) and not the individual level (N = 20) as presented.

[ii] Note: z-value is reported instead of Mann-Whitney U-value. The statically significant differences still apply as reported.

Next, multilevel analyses were performed. The intraclass correlation was regarded to be substantial enough to indicate the use of a multilevel model. Subsequent analyses revealed no difference between the role and nonrole condition regarding PGE using a fixed- or random-slope model. However, when the estimates of a model with random-slope parameters were compared to a model without random-slope parameters, a tendency was observed revealing a difference regarding the assumptions of homogeneity.

Content analysis was performed on the e-mail communication that took place in the groups that were included in the multilevel analysis. All messages were divided in units of analysis and subsequently coded with one of five main categories. A Mann-Whitney test revealed more segments coded as TC, TN, TS, and NOC statements in the role condition. Finally, a significantly high, positive correlation was observed between TC and TN statements.

3.7 Discussion

In this study, the impact of functional roles, adapted for a computer-mediated context in a distance-education setting, was investigated. Such functional roles can be easily generalized to other content domains. The main research question was summarized as the following: What is the effect of a prescribed functional roles instruction, as compared to no instruction, on group performance and on collaboration?

Roles did not affect group performance in terms of a group grade. However, this may primarily be due to the lack of variation (grades varied between 6 and 8.5 on a 10-point scale). Some groups were given the opportunity to revise the report that they had submitted for grading, which of course decreased the variance in the final grades. Whether the group performed well or poorly, the effect of the roles is better reflected by their self-report evaluation of perceived group efficiency.

The MLM technique proved fruitful and showed that roles appear to affect the perceived level of group efficiency (i.e., to increase students' awareness of intragroup interaction and collaboration). In the nonrole condition, participants appear to be less aware of these processes. The outcome of the content analysis corroborates this interpretation, as a significant difference was observed with respect to TS statements. Students in the role condition contributed more statements that expressed either a positive or negative evaluation or attitude in general toward the group or toward an individual group member.

Furthermore, as hypothesized, more TN statements were observed in the role condition. However, the assumption that this would be because of a decrease in the amount of coordinative statements was not confirmed. In fact, in the role condition, the amount of coordinative statements also increased. Apparently, roles stimulated coordination, and as a result, TN statements increased as well. Students in the role condition contributed more TN and TC statements, as compared to students in the nonrole condition.

In this study, the MLM analyses reveal that the functional roles appear to have stimulated the PGE, and the content analyses reflect that the functional roles stimulated the amount of coordination and content-focused statements through cohesion (positive interdependence) and responsibility (individual accountability). The outcomes of the MLM analysis indicates that the groups in the role condition appear to be more susceptible to intragroup conflict and/or to drop out. In the nonrole condition, the lack of interdependence or responsibility appears to have less detrimental effects on intragroup conflict and/or drop out. Perhaps their self-reliance provided nonrole groups with higher flexibility to cope with changes in the organization and in coordination of activities. Another possible explanation is that the descriptions of the functional roles were not sufficient to guide collaboration. The outcomes of the content analyses, however, clearly indicate that roles stimulated collaboration, expressed in more TC and TN statements.

We are confident to recommend the MLM technique, although it is not frequently used with small sample sizes. Nevertheless, it provides new possibilities for the analysis of nonindependent questionnaire data. The results, however, must be treated with some caution. This study was conducted in a setting of high ecological validity, but it is imperative to investigate natural collaborating groups in an educational setting—hence, the sample size is very likely to be small as it depends on the number of students that register for a course. Because many external sources that can potentially influence outcomes were beyond control, and because of the small sample size, it can be argued that a significance level of $.05 < p < .10$ is justified. In addition, perceptions in the nonrole condition are also affected by so-called free riders (i.e., group members that abstain from any effort to participate in collaboration), but these members tend to rate their perception of collaboration as a very positive one. Nevertheless, the interpretation of the MLM results should be kept in perspective. This favors the interpretation of these results as a marginal effect or as a tendency toward differences between the role and nonrole conditions. Following the suggestions by Mudrack and Farrell (1995), the role condition can be seen as a strong situation "in which most individuals will behave in similar ways – There are clear expectations about appropriate behaviours and adequate incentives for these behaviours exist" (pp. 566-567), whereas the nonrole condition is seen to reflect a weak situation that "is characterised by some ambiguity, and the definition of appropriate behaviours is more open to interpretation" (p. 567). Because of the ecological setting, the results may have been confounded by lack of clarity about time schedules, a lack of communication discipline, or a lack of externalization of expectations and norms regarding effort and input of group members prior to collaboration. It was confirmed that the Netherlands is a small country, as three groups organized a face-to-face meeting. After reviewing open-ended questions in the evaluation, it was concluded that the confounding effect of these meetings on the overall collaboration could be regarded as minimal.

The reported data will be extended with a follow-up study in which, apart from the use of functional roles, the need for a time schedule, communication discipline, and expectations regarding input of group members are externalized prior to collaboration (currently these data are being analyzed). In the near future, it is planned to investigate other probable causes for PGE differences between groups in the role condition, such as role conflict and role ambiguity, and the efficiency of roles that may have spontaneously emerged in nonrole groups through group members' previous collaboration experiences. It is clear that more systematic research regarding the use of functional roles in small groups and in CSCL is needed.

3.8 Appendix A: Functional roles instruction

Experience has revealed that roles can afford the work organization and communication between team members. Each member of the team is to exert one of these four roles: project planner, communicator, editor, or data collector.

Project Planner

Responsibility: project planning and project progress monitoring.

Activities:

- You are responsible for recording all activities to be performed and associated deadlines;
- You will supervise these to make sure that all team members comply;
- You will make an inventory about the group's progress on a regular basis, and you will communicate the outcome to the other team members;
- You will stimulate active participation of all team members to the report;
- You are required to set up an agenda for discussion (Which aspects need to be discussed, Which aspects have priority), make an inventory of discussion topics suggested by team members, and you will compose an overview of all suggestions and decisions taken;
- You will initiate (and stimulate) discussion of the literature sources extracted from the database and additional information sources that your team has obtained (Which information sources are relevant?, How can certain information be used in the final report?); and
- In case team members prefer to distribute literature sources extracted from the database or additional sources (for instance, the Internet), you are required—in collaboration with the team member that performs the role of data collector—to plan this distribution.

Communicator

Responsibility: communication with supervisor and progress reports.

Activities:

- Your supervisor will only contact the team member that performs this role, not the other team members. The e-mail address of your supervisor is (. . .);
- You will communicate the distribution of roles in your team to your supervisor;
- You are responsible to make an inventory of questions and problems that team members experience during the assignment and for communicating these to your supervisor and his or her answer to the remaining team members;
- You will construct an archive on the discussion of the literature, differences between perspectives, knowledge domains, and various theories that are introduced and discussed;
- You will construct an archive of the various versions of the report;
- You will initiate (and stimulate) discussion of the comments suggested by team members and changes made to the report;
- Every two weeks you will prepare a short progress report (half a page) that contains the most important decisions and/or developments. You will e-mail this progress report to your supervisor to keep him or her informed about the progress of your team; and
- You are responsible for submitting your team's report to your supervisor.

Reporter

Responsibility: editing the input from all team members into a shared report.

Activities:

- You will edit the input from all team members into a draft version of the report and distribute it among team members. They are required to respond to this draft within a timeline that you have specified (for example, 5 days) with comments, questions, reformulations, additional information, and text formulation; and
- You will revise each draft according to comments provided by team members. You will distribute the next version among team members with another request for comments and suggestions.

Data collector

Responsibility: inventory of the literature database and gathering of additional information.

Activities:

- You will make an inventory of the literature database that was provided. Based on this inventory, you will indicate about those aspects for which sufficient or relevant knowledge or information lacks. You will distribute this inventory and analysis among team members with a request for suggestions for additional literature;
- Based on all comments and suggestions by team members on your inventory, you will adapt the list according to their suggestions; either from the literature database or additional information sources, such as library or Internet sources; and
- You are responsible for providing the additional information sources to your other team members, and/or distributing these sources among team members for further study—in collaboration with the team member that performs the role of project planner.

3.9 Appendix B: Nonrole instruction

You and your team members decide how you are going to work on the assignment. The timely completion of the policy report is the responsibility of your team.

Below are some general guidelines on how you can proceed. It might be useful to pay attention to planning of activities and/or division of tasks.

Planning:
Differences in study pace can lead to irritation; for example, some students have a slower pace than others and may feel stressed by a higher pace. Also, it might be useful to pay attention to holidays; some students study during holidays and some do not. You might use a general planning or a planning that specifies parts of the assignment.

Task division:
It might be useful to make arrangements about each team member’s activities. This can either be general or specific. Is everybody going to do all tasks individually, or will the assignment be split in separate activities (one member collects data, one member writes), or will each task be divided in smaller parts between team members (one member collects data on X, one member collects data on Y)?

3.10 Appendix C: Mean and standard deviation for dependent variables by condition and by group

	Role Condition									
	PD 1 (N = 3)		*PD 2* (N = 2)		*PD 3* (N = 3)		*PD 4* (N = 3)		*LG 1* (N = 3)	
Item	M	SD	M	SD	M	SD	M	SD	M	SD
Quality of collaboration	3.33	1.53	7.50	0.71	8.67	0.58	3.33	2.08	4.00	2.65
Usability of e-mail	3.67	1.53	7.50	2.12	8.33	0.58	3.00	2.65	4.33	2.08
Team development	2.97	1.10	4.35	0.21	4.33	0.23	3.16	0.57	3.10	0.72
Group process satisfaction	2.89	0.19	4.00	0.47	4.27	0.42	2.67	0.44	3.11	0.67
Intra-group conflict	3.05	0.29	1.93	0.30	1.57	0.14	3.05	0.21	2.62	0.54
Task strategy	2.42	0.38	4.37	0.18	4.12	0.37	2.41	0.40	2.57	0.67
Attitude towards CMC	3.12	1.30	3.25	1.06	3.45	0.29	3.41	0.75	3.67	0.31
Attitude towards CL	3.05	1.07	3.92	0.10	4.05	0.43	3.09	0.82	3.05	0.58
	Nonrole Condition									
	PD 5 (N = *4*)		*PD 6* (N = *4*)		*PD 7* (N = 3)		*LG 2* (N = *4*)		*LG 3* (N = *4*)	
Item	M	SD	M	SD	M	SD	M	SD	M	SD
Quality of collaboration	4.75	1.50	7.00	0.00	5.67	2.31	5.50	1.00	5.37	1.74
Usability of e-mail	5.25	1.50	7.25	1.71	7.33	1.15	6.50	0.58	6.50	3.87
Team development	3.22	1.15	4.00	0.00	3.23	1.19	3.30	0.88	2.05	0.83
Group process satisfaction	3.12	1.01	3.87	0.52	3.44	0.58	3.54	0.67	2.79	0.28
Intra-group conflict	2.92	0.37	1.85	0.26	2.76	0.79	2.85	0.35	3.00	0.35
Task strategy	3.00	0.62	3.93	0.16	3.33	0.97	3.25	0.70	3.59	0.79
Attitude towards CMC	4.06	0.56	3.87	0.52	3.42	0.56	3.50	0.37	3.03	0.82
Attitude towards CL	3.92	0.27	3.82	0.39	3.48	0.54	3.00	0.00	3.39	0.80

NOTE: PD = policy development; LG = local government; CMC = computer-mediated communication; CL = collaborative learning.

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CHAPTER 4

Content analysis:

What are they talking about?

Abstract

Computer-supported collaborative learning (CSCL) is an emerging field in educational research. Whereas theory and instructional support are extensively debated, methodological debate on both research and analysis are relatively lacking. Quantitative content analysis of computer-mediated communication is increasingly used to surpass surface level analyses (e.g., counting e-mail messages), but critical reflection on accepted practice has generally not been reported. A meta-analysis of CSCL conference proceedings was conducted that revealed a general vagueness in definitions of units of analysis. In general, arguments for choosing a unit were lacking and decisions made while developing the content analysis procedures were not made explicit. In this article, it will be illustrated that the currently accepted practices concerning the 'unit of meaning' are not generally applicable to quantitative content analysis of electronic communication. Such analysis is affected by 'unit boundary overlap' and contextual constraints having to do with the technology used. The analysis of e-mail communication required a different unit of analysis and segmentation procedure. This procedure proved to be reliable, and the subsequent coding of these units for quantitative analysis yielded satisfactory reliabilities. These findings have implications and recommendations for current content analysis practice in CSCL research.

Keywords: content analysis, methodology, reliability, unit of analysis, segmentation, coding

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4.1 Introduction

Koschmann (1996) identified computer-supported collaborative learning (CSCL) as an emerging field in educational research. Considerable attention has been paid to theoretical debate, as well as to technical and pedagogical support of collaborative learning. In comparison, however, less attention has been paid to issues of methodology and analysis methods (Strijbos, Kirschner, & Martens, 2004).

Initially, analyses in CSCL and computer-mediated communication (CMC) research focused on questionnaires or surface level characteristics of the communication (Harasim, Hiltz, Teles, & Turoff, 1995). For example, participation degree was determined by the number of messages sent by group members (Harasim, 1993). Also, it was assumed that the mean number of words in a message was positively related to the quality of the content of that message (Benbunan-Fich & Hiltz, 1999). Surface level measurements are still used in current research and several methods have been added such as 'thread-length' (Hewitt, 2003) and 'social network analysis' (SNA; Lipponen, Rahikainen, Lallimo, & Hakkarainen, 2003). However, it is now widely acknowledged that such surface level methods provide at best a rough analysis of the communication. Furthermore, the quality of group performance (product or grade) provides no insight into the actual collaborative process and contextual factors that affect group collaboration. Hence, it is imperative that the groups' communication is subjected to content analysis to determine *why* one student contributes more or appears to be more influential in a group (Strijbos, Martens, Jochems, & Broers, 2004).

Analysis of communication transcripts has gained attention in the past decade (Hara, Bonk, & Angeli, 2000; De Laat & Lally, 2003; Wang, Laffey, & Poole, 2001) and roughly two approaches to communication analysis can be derived from CSCL literature. In the 'quantitative' approach the communication is coded, summarised and frequencies/ percentages are used for comparisons and/or statistical testing. This approach contrasts with the 'qualitative' view, that uses methods such as participant observation (Louca, Druin, Hammer, & Dreher, 2003), case summaries (Lally & De Laat, 2003) and ethnomethodology (Stahl, 2002b) to infer trends or a specific phenomenon in transcripts (Miles & Huberman, 1994) – without computing frequencies for statistical testing. This distinction coincides with the difference between a prospective and retrospective orientation toward analysis (Strijbos, Martens, & Jochems, 2004).

The statistical comparisons in the quantitative approach require a hypothesis – derived from theory – formulated in advance (prospective), whereas the aim of 'understanding' a phenomenon (retrospective) requires less explicit a priori expectations or even none (e.g., in a grounded theory approach). Reliability is a concern in both approaches, but is treated differently. In the quantitative approach, reliability is expressed in a numeric value that indicates the level of agreement between two independent coders. In the qualitative approach the reliability (credibility) is established through using multiple analysts, comparing two or more interpretive perspectives of independent coders and/or triangulation with external sources or quantitative data (Elliot, Fischer, & Rennie, 1999; Madill, Jordan, & Shirley, 2000).

In this article it is argued that the quantitative approach – specifically its application in CSCL research – requires more rigour with respect to reliability to warrant the apparent ‘accuracy’ of conclusions. Lack of reliability increases the probability of Type II errors (wrongly accepting the null-hypothesis) and, to a smaller degree, Type I errors (wrongly rejecting) occur. Conclusions derived from statistical tests of data, for which the reliability of the method used is ‘unknown’ (not reported), are questionable and should be treated with caution. Furthermore, reliability does not only apply to ‘assigning codes’, but in those instances where the granularity of the unit of analysis is very small, reliability also applies to determining those ‘units’. Rourke, Anderson, Garrison and Archer (2001) conclude: “Characteristics such as objectivity and reliability are not accidental features of some studies: rather, they are important criteria for any studies using this technique.” (p. 20). Neuendorf (2002) puts it even more strongly by stating, “Without the establishment of reliability, content analyses measures are useless.” (p. 141).

To illustrate why reliability is important, consider how ‘questionnaires’ should be treated methodologically speaking. If a questionnaire is used in research, at least an alpha statistic should be reported to warrant the internal consistency of items that measure the psychological construct. If a previously constructed (and reported) questionnaire is used in other research, two statistics should be reported: the original alpha, as well as the alpha pertaining to the new research that was conducted. If the questionnaire is adapted, again, the original alpha, as well as the alpha of the adapted questionnaire should be reported. Unfortunately, statistical tests on ‘quantitative content analysis data with an unknown reliability’ are still reported (see Pata & Sarapuu, 2003; Rasku-Puttonen, Eteläpelto, Arvaja, & Häkkinen, 2003).

In this article the importance of reliability for quantitative content analysis will be illustrated with an account of the development of a segmentation procedure and its impact on the coding of the communication. The organisation of the article will be somewhat unorthodox, as it follows the developmental process and the decisions made when developing the segmentation procedure. First of all, the need for a clear definition of the ‘unit of analysis’ and the variety in ‘units’ used is illustrated through a review of papers in recent CSCL conference proceedings. In the next section some information is provided about the research project for which the content analysis procedure was developed; followed by a section with an account of the original procedure: segmentation rules and coding categories and rules. In the fourth section four factors will be discussed that – in retrospect – affect the applicability of a ‘unit of analysis’, it is shown that problems with reliably determining the unit of analysis turned out to be the primary cause for the failure of the original procedure. In the next section an alternative ‘unit of analysis’ is introduced, as well as a procedure to segment the communication in these units. In addition, the reliability of this segmentation procedure (and its computation), the definitions of coding categories and coding rules, and the reliability of this coding scheme, will be elaborated. Finally, the implications and recommendations for content analysis methodology in CSCL research will be discussed.

4.2 Defining and determining the unit of analysis: a meta analysis

Rourke et al. (2001) distinguish five types of units. From large to small they are a message (e-mail or forum contribution), paragraph (section), 'unit of meaning' (or thematic unit), sentence (or syntactical unit) and illocution. The most frequently reported units are a message, a 'unit of meaning' and the sentence. The definition of a unit of analysis, however, is often vague, which makes it hard to distinguish between them. Veldhuis-Diermanse (2002), for example, defines a 'unit of meaning' – following Henri (1992) and Chi (1997) – as a unit that represents "*an idea*, argument chain or discussion topic" (p. 46), whereas Muukkonen, Lakkala and Hakkarainen (2001) define the 'proposition unit' as "representing *a single idea*" (p. 462). These definitions illustrate the lack of clarity: a 'unit of meaning' and 'proposition' are both defined as 'an idea'. Moreover, the argumentation for choosing a specific 'unit of analysis' is rarely discussed.

To assess the current state of the art with respect to the types of units used in CSCL research, the CSCL 2001, 2002 and 2003 conference proceedings were reviewed, because a conference is the primary forum where innovative methods are discussed and reflection on current practice is stimulated. Also, journal publications take considerably more time to appear, thus a conference proceeding will reveal new developments faster. The review included 14 out of 18 papers in the 'analysis track' of CSCL 2001 (Dillenbourg, Eurelings, & Hakkarainen, 2001), 2 out of 5 long 'methodology' and 4 out of 30 short 'qualitative analyses' papers presented at CSCL 2002 (Stahl, 2002a), and 11 out of all 60 papers in the CSCL 2003 proceedings (Wasson, Ludvigsen, & Hoppe, 2003). Table 1 presents an overview of the various unit types reported (see Appendix A for an overview of the studies that used a specific unit of analysis).

Table 1 Overview of unit types reported in CSCL 2001, 2002 and 2003 proceedings (largest unit on top)

CSCL 2001		*CSCL 2002*		*CSCL 2003*	
Unit type	*Frequency*	*Unit type*	*Frequency*	*Unit type*	*Frequency*
				discourse*	1
message*	7	message*	1		
meaning	3	meaning	1	meaning	1
argument	1			argument	1
		utterance	1	utterance	2
proposition	1	proposition	1	proposition	1
unclear	2	unclear	2	unclear	5

* The discourse and message (e.g., e-mail or forum contribution) are non-ambiguous fixed units.

This review reveals that in 9 out of 31 papers (29%) the unit is not indicated and/or defined. Although conference papers in general do not offer the opportunity to describe the research in full, the content analysis methodology used should be clearly described or at least indicated – even if the paper length is restricted (also note that half of the studies in the Rourke et al. meta-analysis do not report *any* reliability statistic). Moreover, none of the thirteen papers that use units smaller than a message (42%) report an intercoder reliability statistic for segmentation of these smaller units. In addition, the segmentation procedure is either non-existent or is not described in length. In contrast, all of the papers do provide intercoder reliability for assigning codes.

The meta-analysis by Rourke et al. (2001), in which nineteen studies (conducted between 1991–2000) of 'asynchronous text-based quantitative content analysis' were reviewed, supports this picture. Only ten out of nineteen studies included in this meta-study report a reliability statistic (proportion agreement or Cohen's kappa) and it is unclear whether the statistic refers to the 'unit of analysis', 'assigning codes' or a combination of both procedures. An exception is the recent study by Fischer, Bruhn, Gräsel and Mandl (2002) who define their unit as 'speech acts' and the segmentation reliability is addressed but limited to the remark that transcripts were 'segmented by trained evaluators' (p. 220).

In sum, most conference papers and CSCL articles provide information on the reliability of their coding categories but little information is provided on segmentation. In addition, virtually no information is given on the process involved in developing a content analysis procedure (one exception is Chi (1997), but this article is about face-to-face communication), nor is argumentation provided for the decisions made during the construction of the whole coding procedure. Most decisions appear to have been made intuitively or based on accepted practices. In the next sections, the process of developing a content analysis procedure will be discussed and illustrated with examples.

4.3 Developing a content analysis procedure: original approach

The project for which a content analysis procedure was to be developed, is set in higher/distance education in the domain of 'policy development'. Students collaborate in groups of four. They have to collaboratively write a policy report containing a recommendation regarding reorganisation of local administration, a timely subject in the Netherlands (and a very wicked problem). They communicate only via e-mail. In such asynchronous CSCL settings, where group members are not present at the same time and place, coordination conflicts are very likely to occur (Benbunan-Fich & Hiltz, 1999). Clearly, some type of support should be provided to overcome coordination difficulties. Several processes indirectly affect coordination, such as group cohesion and responsibility. Roles can facilitate both these processes (Mudrack & Farrell, 1995), and can be defined as functions and/or responsibilities that guide behaviour and coordinate group interaction (Hare, 1994). In order to provide support for coordination in CSCL, functional roles were implemented in half of the groups in the course. The hypothesis was that such roles decrease the amount of coordinative statements ('who-does-what' or 'when something is due') in favour of statements that focus on the 'content' (such as solving the assignment) and thus affect group performance due to an increase in collaboration efficiency. All e-mail communication was to be coded and quantified for statistical comparison of both research conditions.

4.3.1 Procedure

The original procedure was developed at the time that the data collection of the project was still in progress, so it was decided to test the procedure on a similar type of collaboration data collected at an earlier stage: six students, collaborating via e-mail, on an authentic (wicked) problem in the domain of 'corporate law'. In the first stage our choice was guided by the accepted practice in CSCL research and thus the 'unit of meaning' was applied (Aviv, 1999; Gunawardena, Lowe, & Anderson, 1997; Hara, Bonk, & Angeli, 2000; Henri, 1992; Newman, Webb, & Cochrane, 1995). Although proponents of a 'unit of meaning' argue that segmentation and coding should be performed simultaneously (Gunawardena et al., 1997; Henri, 1992), it was decided to separate segmentation and coding to be more precise. The 'meaningfulness' of a statement should not be determined by coding categories (or a researcher). The statement "I went to the beach." may not have meaning with respect to the coding scheme, but this does not automatically reduce it to having no meaning. If segmentation and coding are combined, then all the instances where two independent coders disagree should still be carefully documented and the unit (or part) should be recoded by both coders in order to compute a reliability statistic (Prins, Busato, Elshout, & Hamaker, 1998).

	Segmentation rules
1.	An e-mail message is a fixed unit. The order of the messages is ignored.
2.	The salutation (Dear …) and close (Best wishes ...) will be ignored.
3.	The unit of analysis is the 'unit of meaning'. A unit of meaning consists of one or several sentences, or a paragraph, that in all contains a single 'meaning' (coordination in time, content-focussed etc.). Note: Spelling errors and missing capitals at the start of sentences may affect the segmentation.
4.	A post-script at the bottom of a message is considered to a separate 'unit of meaning'.
5.	In case of a summation, each point – or several points – that share a single 'meaning' (coordination in time, content-focussed etc.) are segmented as one 'unit of meaning'.
6.	Mark the start and end of each unit with brackets […].
	Coding rules
1.	In case activities are organised according to the content of the task (for example several topics that need to be addressed in the report), these units are regarded as 'coordinative' and not as 'content'. Note: to determine if this is the case it is useful to review previous messages.
2.	In case a single unit can be assigned to more than one category, the unit is split in two.
3.	In case a single unit can be assigned to more than one category, but it is impossible to split these units, it is allowed to assign two codes to this unit (Note: this must be kept to a bare minimum!).
4.	If two consecutive units are assigned the same code, both units will remain separate units.
5.	Mark each segment with a code between parentheses (…).

Figure 1 Original segmentation and coding rules

The original procedure included several rules to guide the segmentation (Figure 1) in units of meaning, and subsequently each unit was assigned a single code (marked bold, Figure 2).

Task statements (T)	
Coordinative statements (C)	
Description	Example
Time planning (TCT) are units in which statements are made to coordinate in time (deadline's, when someone can perform a task).	"I am still working on (X) but I hope to finish it this week". "I am on holiday from June 6th until June 26th."
Time planning problem (TCTP) are units in which statements signal that a member or the group as a whole is not performing as planned.	"I have read that this should have been submitted in week 24, but that week has already passed."
Task division (TCD) are units in which statements are made to coordinate the task of group members	"John, I assume that we have settled the issue and that we will proceed with Mary's proposal for dividing the tasks."
Task division problem (TCDP) are units in which statements signal that a member or the group as a whole is not performing according to the task division.	"You are now writing that Mary and you will split section five. Who is now going to write section two?"
Asking moderator for advice (TCM) are units in which statements are made to ask advice to the moderator	"Maybe our moderator can give us some advice about this issue"
Content statements (N)	
Task content (TN) are units in which the statements discuss the content of the task.	"Is it not the case that the company …" "I think we should use the theory of …"
Non-task statements (NT)	
Social statements (S)	
Positive social (NTS+) are units in which a positive attitude toward a member or the group is expressed.	"Thanks for your effort."
Negative social (NTS-) are units in which a negative attitude toward a member or the group is expressed.	"I have no problem with Mary being in the group as long she does her share."
Technical statements (T)	
Technical (NTT) are units in which technical problem (hardware, software) is expressed.	"My computer crashed last week, I hope it is fixed now."
Non codable (NOC)	Any unit that cannot be assigned one of the other codes.

Figure 2 Original coding categories

The reliability of segmentation was computed by the proportion agreement because there is only one category involved with two values (agree = 1, disagree = 0), whereas two or more categories require computation of Cohen's kappa to correct for chance agreements. A threshold for the proportion agreement reliability of segmentation (or unitising) does not exist in CSCL research nor in the domain of content analysis (see Neuendorf, 2002; Riffe, Lacy, & Fico, 1998; Rourke et al., 2001). Thus, the proportion agreement threshold for coding used in the domain of content analysis is the most applicable where "a minimum level of 80% is usually the standard" (Riffe et al., 1998, p. 128).

4.3.2 Reliability of segmentation and coding

Two coders (A and B) received half an hour of training in the segmentation procedure, followed by segmenting a selection of 20 e-mail messages (12.5 % of a total of 160 messages), resulting in a proportion agreement of 41% – well below the 80% threshold. Next, a set of 20 e-mails segmented by one of the principal investigators was coded by two coders (C and D) who received two hours of training with the coding categories. Cohen's kappa proved to be .30 (.60 is regarded as a minimum requirement; cf. Landis & Koch, 1977). It proved too difficult to separate segmentation and coding. It was decided to try to combine the segmentation and coding (now using communication sampled from the 'policy development' course). Still, the reliability of combined segmentation and coding of the units of meaning remained unsatisfactory (Cohen's kappa .45).

4.3.3 Conclusion

It was assumed that the coding categories were not sufficiently developed or precisely defined and therefore too difficult to distinguish from one another. For example, how should statements be coded in which 'time planning' and 'task division' occur simultaneous? What are indicators for a 'problem' that students experience regarding time planning or task division? However, although the coding scheme could be improved, reflection on a possible explanation for the disappointing reliability of the procedure revealed a methodological problem with respect to the chosen unit of analysis (unit of meaning): unit boundary overlap.

Although several studies that used a 'unit of meaning' report high intercoder reliabilities (Schellens & Valcke, 2002; Veldhuis-Diermanse, 2002), it is likely that – due to the combined segmentation and coding – variations in the length of the 'unit of meaning' result in overlapping units with different codes. If these codes are treated as 'mutually exclusive' – as is the case in the 'quantitative content analysis' approach – this causes a serious methodological problem, which is illustrated in Figure 3.

Figure 3 depicts the independent segmentation of two coders. Horizontal lines represent sentences in the communication transcript, brackets signal the start and end of a segment and the numbers represent a coding category. Coder A assigns the grey area to coding category 1, coder B thinks it belongs to coding category 2. Is the communication in the grey area trivial or not? Is the grey area a sentence, several sentences, or a paragraph? To date, proponents of the 'unit of meaning' have failed to address these questions.

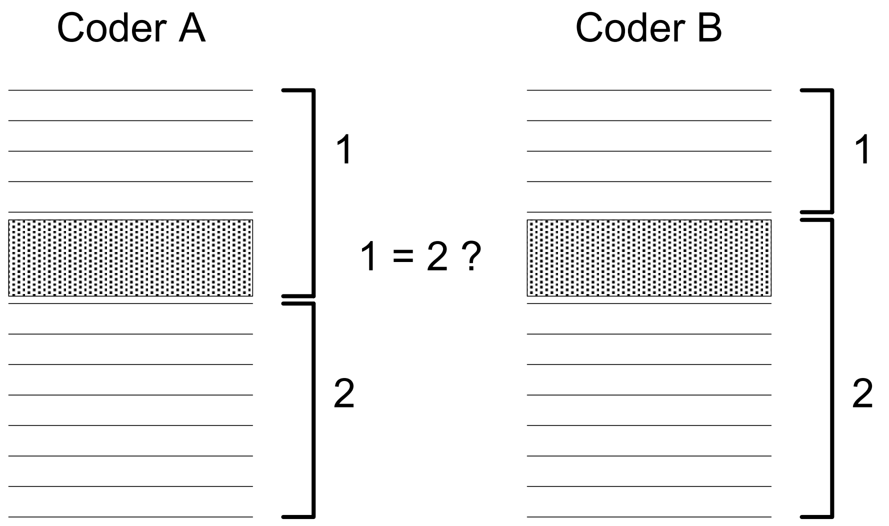

Figure 3 Unit boundary overlap

To overcome the methodological problem of overlapping unit boundaries, the relative amount of 'communication' in the transcript that was assigned to a different segment and also received a different code (grey area in Figure 3) should be determined. Another solution would be to use a smaller unit to minimise the relative amount of the total communication that received a different – mutually exclusive – code by two independent coders. However, unit boundary overlap is not the only factor involved; the applicability of a unit is also affected by four contextual constraints.

4.4 Four contextual constraints

Apart from the 'unit boundary' problem the applicability of a unit that is smaller than a message is also affected by four constraints: a) the object of the study, b) the nature of communication, c) the collaboration setting, and d) the technological communication tool used.

With respect to the *object of the study*, the difference between manifest and latent variables is most important (Neuendorf, 2002). Whereas 'quantitative' content analysis attempts to answer either descriptive or experimental research questions derived from manifest variables (prospective view), the object of 'qualitative' content analysis are latent variables that cannot be directly observed and need to be inferred from a communication transcript (retrospective view). Most qualitative approaches focus on latent variables (e.g., 'knowledge construction') expanding over segments and messages, and thus being more susceptible to subjectivity and more difficult to replicate. In sum, prior to conducting any type of content analysis it is important to determine the variables of interest and how these are derived from the communication (manifest or latent).

In general, the *nature of communication* can be easily observed in the differences between transcribed verbal and written communication. In parallel, there are also striking differences in communication style between written synchronous and asynchronous communication. Rourke et al. (2001), for instance, indicate that in messages submitted to an asynchronous text-based communication environment (e.g., forum), ‘telegraphic’ and ‘oral’ communication styles were intermixed. Messages in an asynchronous environment are often careful compositions and resemble a ‘formal’ letter in many respects, such as the frequent use of compound sentences. In comparison, discussions in chats, resemble ‘oral’ communication in the sense that utterances are short and similar to speech utterances. In addition, the educational level can affect the communication style. In primary education most messages tend to be short and on a single topic (Lipponen, Rahikainen, Lallimo, & Hakkarainen, 2003), whereas in higher education messages are far more complex and contain several topics that can belong to different coding categories.

The *collaboration setting* also affects the applicability of a unit. For example, in a forum discussion on a specific topic, statements mainly focus on the topic of the discussion, and they can be characterised as ‘cognitive’ and/or ‘task focussed’ (Schellens & Valcke, 2002; Veldhuis-Diermanse, 2002). Here, comparatively little coordination is observed. In a project-based collaboration setting, coordinative statements (dividing tasks, keep track of deadlines) will likely form a larger part of group communication because, in general, coordination occurs in a prolonged period (months) compared to discussion of a topic (one or two weeks). In a project-based setting it can be more difficult to distinguish qualitatively different statements because these are mixed.

Finally, the *technological tool* influences communication. A synchronous chat environment evokes shorter statements than an e-mail or a threaded forum. The exchange rate of contributions is much higher than in an asynchronous forum. In addition, the chat-tool design facilitates smaller communicative statements, whereas delay of feedback in e-mail or threaded forums tends to force the participants to address multiple issues in a single message. Finally, video conferencing places a specific demand on the construction of a content analysis procedure as it involves both oral and non-verbal communication and is in this respect comparable to videotaped face-to-face conversation.

It can be concluded that choosing a unit of analysis can be guided by ‘accepted practices’, but the unit should be clearly defined and ‘unit boundary overlap’ should be either limited or else computed (and reported). A unit of analysis that is smaller than a message cannot generally be applied to the study of every type of research objective, nature of communication, collaboration setting and technological communication tool. These four contextual constraints should be taken into account prior to selecting and/or developing a content analysis procedure.

Reflection on the unit boundary problem and the four contextual constraints resulted in the definition of an alternative unit of analysis, as well as a revised segmentation procedure and coding categories for the analysis of the research context discussed. The alternative unit, the segmentation procedure and the revised coding categories will be discussed next.

4.5 Developing a content analysis procedure: alternative approach

Reviewing the coded transcripts from the original procedure (using a 'unit of meaning') revealed that a considerable amount of the communication had been subject to 'unit boundary overlap'. In addition, when assessed with respect to the four contextual constraints, the research objective focused on experimental comparison and involved 'manifest variables'. Furthermore, it became apparent that e-mail communication combined 'oral' and 'telegraphic' communication styles. Where a pause would occur in natural speech, punctuation appeared. Compound sentences were a rule rather than an exception. Messages were long and a remarkable tendency to make all kinds of summations was observed. Given the project-based collaboration setting, the students addressed multiple issues in a single compound sentence. The original segmentation procedure provided virtually no guidance to distinguish such small segments. Finally, some of the coordination categories ('time' and 'task division') posed coding problems.

It was concluded that the use of a 'unit of meaning' appeared to be too ambiguous to enable the coding of the kinds of statements of interest to answer the research question. Nevertheless, the objective to code and quantify the communication for statistical comparison remained. An approach to decrease the probability of 'unit boundary overlap' is using a smaller unit, such as a sentence or a proposition. Although using smaller segments will probably increase the number of segments that cannot be coded, the accuracy of coding is improved because the ambiguity of the content of the segments is reduced. In other words, sentences or parts of compound sentences will more likely contain a single concept, expression or statement. Using the 'proposition' would be most adequate with respect to the four contextual constraints. However, such an analysis is very time consuming because it requires that the communication transcript is re-written into single propositional utterances (Van Dijk & Kintsch, 1983).

4.5.1 Procedure

It was decided to develop an alternative segmentation procedure that would be systematic and independent of the coding categories. Although a sentence as unit of analysis is not uncommon (e.g., Fahy, Crawford, & Ally, 2001; Hillman, 1999), segmentation of compound sentences was added. The unit of analysis was thus defined as: a sentence or part of a compound sentence that can be regarded as 'meaningful in itself, regardless of the meaning of the coding categories'. Note that 'meaningful' is here used in a sense that is very different from its use in relation to a 'unit of meaning'. The statement "I went to the beach." still has 'meaning in itself' although it has no meaning with respect to the coding categories. Punctuation and the word 'and' are 'segmentation markers' to segment compound sentences if the parts – before and after the segmentation marker – can be regarded as a 'meaningful' sentence. This procedure is practical, not laborious and can be mastered in a single day. Figure 4 depicts the segmentation rules of this procedure. Figure 5 presents three out of eighteen examples included in the procedure to aid segmentation.

1. Each message is first segmented in sentences by using a ‘full stop’, ‘question mark’ or ‘exclamation mark’ that the author of the message has written.
2. Each sentence that is followed by a ‘full stop’ constitutes a segment, regardless whether a ‘finite form’ or ‘verb’ is missing.
3. Each compound sentence is split in segments using punctuation signs and symbols or signs that are used for punctuation purposes:

    a. Comma
    b. Semicolon
    c. Colon
    d. Brackets
    e. The word ‘and’
    f. Dash
    g. (…) or …

    Segmentation is **always** subject to the criterion that:

After segmentation, each part of that compound sentence can be regarded as a ‘meaningful’ sentence in itself (regardless of the coding categories).

4. When determining whether a part of a compound sentence can be regarded as a ‘meaningful’ sentence in itself, the following rules apply:
    a. It is allowed to ignore the words that form the collocation;
    b. It is **not** allowed to add mentally a ‘finite form’ or ‘verbs’, if it has not been written.
    c. It is **not** allowed to leave out words that are written;
    d. It is allowed to mentally rearrange the order of ‘verbs’ and ‘finite form’ to create a ‘meaningful’ sentence;
    e. In case parts of a compound sentence share a conditional relationship, those parts are not regarded as separate segments;
    f. Statements between brackets are often in a telegraphic style, and thus they are difficult to rearrange in a ‘meaningful’ sentence. If either the ‘finite form’ or ‘verb’ is missing, the statement between parentheses will be regarded as a separate segment. The statement is **not** regarded as a separate segment if **both** are missing;
    g. Citations and hyperlinks that are included in the message are segmented according to the previous rules and examples below (see point five of this procedure that addresses the handling of summations (including summations of hyperlinks);
    h. If an abbreviation is used in the middle of a sentence, the sentence is **not** split after the ‘full stop’ at the end of that abbreviation;
    i. An introductory statement, two or three words, is **not** regarded as a separate segment (even if placed as such by the author) and is added to the next sentence that it introduces;
    j. An introductory sentence is regarded as a separate segment.

Figure 4 Alternative unit of analysis and segmentation procedure

5. Segmentation of summations: textual and lists (or bullets)
    a. If the majority of statements in a summation can be regarded as a 'meaningful' sentence in itself, each statement is treated as a separate segment;
    b. If the majority of statements in a summation can not be regarded as a 'meaningful' sentence in itself, all statements are treated as one segment;
    c. If half of the statements in a summation can be seen as a 'meaningful' sentence in itself, all statements are treated as a separate segment;
    d. In case the introductory sentence of a summation can be regarded as a 'meaningful' sentence in itself, this sentence is regarded as a separate segment. If not, this sentence is added to the first statement of the summation;
    e. If the main point in a summation is divided in sub points (e.g. 2.1, 2.2 etc.), than the above rules (see a, b, c) apply. **An exception is a 'claw construction' in a summation:** the main point and sub points comprise separate segments and the sentences in between can be regarded as a 'meaningful' sentence in itself. They are not directly part of the summation and thus behave as an appropriation in a summation.

Figure 4 Alternative unit of analysis and segmentation procedure (continued)

Example 1
[I agree that you will start with data collection and commitment,]
[*(however)* we have to decide first whether we will use the PERS method or the method by Hoppe.]
This sentence is segmented after the comma. Both parts of this compound sentence can be regarded as 'meaningful' sentences in itself.
Example 2
[If John has completed the PERS analysis, I can start the analysis of public support.]
The first part of this sentence before the comma cannot be regarded as a 'meaningful' sentence in itself. This is an example of a 'conditional clause'. Examples of indicators are 'if', 'since', 'before', 'as long as', 'in case', 'because' and 'given'. This sentence is NOT segmented.
Example 3: Claw exception
Just a response on the mail by John, I am sending this mail by the way during my professional work, about the fact that he was supposed to respond on Wednesday last week.
[Just a response on the mail by John (…) about the fact that he was supposed to respond on Wednesday last week.]
[I am sending this mail by the way during my professional work]
If the second part of a sentence is an apposition, a 'claw construction' can be observed. The first and third parts of the sentence are inextricably related, yet separated by the apposition. In these cases the apposition is treated as a separate segment, and the first and third part are combined and treated as a separate segment.

Figure 5 Three examples of segmentation

An initial reliability test was performed on forty messages that were extracted from four groups (ten messages from each group). Two of these groups worked with pre-defined roles and two groups worked without them. The messages were independently segmented by two coders (A and B). The coders received only the written instruction (Figure 4) and no explicit training. Each coder needed approximately ninety minutes to segment the messages. Afterwards, the proportion agreement (number of segments identified) was determined from the perspective of each coder, in contrast to most studies, that report a single proportion agreement (see also Prins et al., 1998). As shown in Figure 6 the selection of only one of either perspectives can significantly affect the proportion agreement (0 = disagree, 1 = agree): from perspective A there is 50% agreement (upper bound) and from perspective B there is only 33% agreement (lower bound).

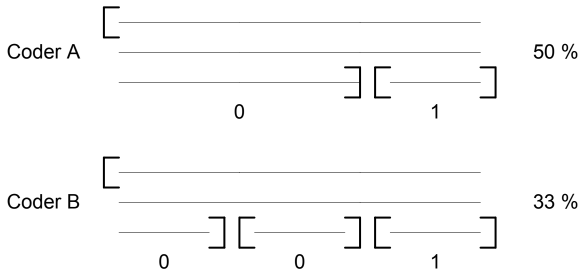

Figure 6 Proportion agreement from two intercoder perspectives

The proportion agreement for the number of segments identified (the perspective of each coder serving as an upper and lower bound of the 'true' agreement) had a lower bound of 79.33 % (coder A) and an upper bound of 85.39 % (coder B).

A second reliability test was performed on fifty messages, extracted from four groups. Twenty of the fifty messages were similar (ten messages from two role groups) to test the rules 4a, 4d and 5e, added after the first reliability test (see Figure 4). Fourteen and sixteen messages were sampled from two other groups working without the roles. All messages were independently segmented by two coders (A and C). Proportion agreement had a lower bound of 85.50 % (coder A) and an upper bound of 88.05 % (coder C).

Finally, cross-validation of the alternative procedure was performed on a dataset of English communication. Students collaborated in a networked learning community (hosted in WebCT©) in small project groups during seven weeks, during a course in a MEd programme on E-learning (for more information see De Laat & Lally, 2003). Sixty-five messages were sampled from an asynchronous forum. Examination of the communication revealed a crucial difference, whereas in Dutch a dash is rarely used for punctuation it is quite common in English. In addition, symbols such as '(…)' or '…' were frequently used to indicate pauses that ordinarily occur in 'oral' communication.

Sixty-five messages were sampled: 22 in the first week, 24 in the third and fourth week and 19 in the sixth and seventh week. Messages were independently segmented by two coders (A and C). Reliability of the segmentation had a lower bound of 87.47 % (coder A) and an upper bound of 91.44 % (coder C). The level of proportion agreement shows that the alternative procedure can be applied to other asynchronous settings and that it is not language specific.

4.5.2 Reliability of coding

Quantifying the communication for comparative statistical analysis requires first of all that the two independent coders code the same segments. As long as the reliability of the segmentation is sufficiently high (a minimum of 80 %, see p. 10) – to decrease the probability that differences in unit boundaries result in overlapping but different codes – in principle, it does not matter whether the segmentation of coder A or B is coded. It is also possible to choose the segmentation of the coder that discerns the smallest units, since the aim is to be precise (Prins et al., 1998).

4.5.3 Revising the coding categories

Simultaneous to the development of an alternative segmentation procedure, the coding categories were refined. Eleven iterations were performed on the coding categories, during which categories were reformulated, added, and removed. Most significant changes will be discussed compared to the original scheme (Figure 2). First of all, the two categories ‘time planning problem (TCTP)’ and ‘task division problem (TCVP)’ were removed. The interpretation of what constituted a ‘problem’ was problematic, and the codes were substituted for ‘specific’ and ‘unspecific’ references to ‘time’ and ‘activity’ (activity was formerly defined as task division), resulting in four subcategories. Elaborated definitions were developed for all categories, including identifying markers for what constitutes a ‘specific’ and ‘unspecific’ reference with respect to time or an activity (Figure 7).

Task-oriented *(T)* is defined as: ‘A coordinative, content-focussed or task-social statement, that is directly related to the collaborative process and/or product.’

Coordination (C) is defined as: ‘The alignment of the collaboration through references with respect to time, references with respect to an activity (that is to be or has been) performed by a group member or the whole group, or a reference with respect to time and an activity.’

Task-oriented coordination with reference to Time *(TCT)* is defined as: ‘Making an explicit reference to a moment in time or a period in time.’

A moment or period is specific *(S)* if it can be clearly demarcated (or inferred).

1. **TCTS markers**: 23 September, tomorrow, day after tomorrow, today, tonight, next Tuesday, Wednesday, before Friday, until today, next week, last week, this week, this weekend, upcoming weekend, before Christmas, before the end of week 3, until X returns from holiday (if the return date has been communicated), until end of may, within this college year.

A moment or period is unspecific *(U)* if it cannot be clearly demarcated (or inferred).

2. **TCTU markers**: the past weeks, forthcoming days, at certain moments in time, deadline (with no day or date indicated), use of the word ‘time planning’, soon, in some time, on short notice, quick, fast, as soon as possible, shortly, until X returns from holiday (if the return date has been NOT been communicated), when, sooner, later, a couple of weeks, ahead of schedule, behind schedule.

Figure 7 Example of the definition of a revised coding category

Two new subcategories, specific and unspecific, were added for statements that combined ‘time’ and ‘activity’. Also, a category was added for ‘general coordination’. Furthermore, the ‘content-focussed’ category was expanded with two subcategories, one referring to statements about the ‘assignment’ and one to statements on ‘editing of their report’. Finally, a new main category was added for social statements about task performance with three subcategories that stress the focus of the statement: ‘general’, ‘towards an individual’ and ‘towards the group’. An overview of the final scheme consisting of five main categories and eighteen subcategories is shown in Figure 8.

In addition, systematic rules for coding were developed. An example is provided in Figure 9. Mastery of the coding rules and categories is quite laborious. It takes about twenty hours of extensive training: ten hours of coding and ten hours of discussion, in consecutive cycles of two hours, with an experienced coder.

1. Determine whether the statement concerns coordination with reference to time, activity or a combination of time and activity.
    a. Determine if the reference to time (moment or period) is specific or unspecific. If a contextual factor is provided, proceed to X.
        i. If the reference in time is unspecific: TCTU;
        ii. If the reference in time is specific: TCTS.

       If a statement is just an observation of the amount of time involved to perform an activity, it is regarded as noncodable (NOC).

       [I have worked three evenings on this.] (NOC)
       [I will see if I can free some extra time tomorrow evening.] (TCTS)
    b. Determine whether the activity is explicitly stated and/or explicitly related to a group member or the (sub) group as a whole.
        i. If the activity is not related to a specific group member: TCAU;
        ii. If the activity is related to a specific group member: TCAS;
        iii. If the activity performed is related to one of the activities stated in the pre-defined roles or a reference is made to the pre-defined roles or collaborating according to these roles, than +R is added to the code assigned to that segment.
    c. Determine if the segment contains a reference to time and to activity. If a segment contains both, a separate code signalling a combination is given to that segment.
        i. If the reference in time and the reference to activity are BOTH specific, the segment is coded as TCTAS;
        ii. If the reference in time or the reference to activity is unspecific, the segment is coded as TCAU;
        iii. If the activity performed is related to one of the activities stated in the pre-defined roles or a reference is made to the pre-defined roles or collaborating according to these roles, than +R is added to the code assigned to that segment.

Figure 9 Example of coding rules

Code			
Main	*Sub*	*Description*	*Example*
TC	G	All statements with (a) a choice with no reference to time, the group or individuals; (b) coordination, but time nor activity, is indicated; (c) asking for a reaction but the object is unclear; (d) request a life sign from group members; (e) information on contextual factors that affects individual contribution to group work.	Why is nobody responding? Please give your ideas.
TC	TU	All types of statements regarding coordination in time, where time is indicated unspecifically.	I will be in touch again soon.
TC	TS	All types of statements regarding coordination in time, where time is indicated specifically.	I will be on holiday from June 8 until June 26.
TC	AU	All types of statements regarding coordination on activity, where the activity is (to be or was) performed by the group.	Who will make an inventory of all pressure groups involved?
TC	AS	All types of statements regarding coordination on activities or division of activities, where is indicated specifically who will perform that activity (i.e., by persons or by a (sub) group).	As far as I know, John Doe will perform the PERS analysis.
TC	TAU	All types of statements regarding coordination in time and activities or division of activities, where either time, division or both are indicated unspecifically.	I would like to know who will send me their comments on our report before Wednesday.
TC	TAS	All types of statements regarding coordination in time and activities or division of activities, where time and division are both are indicated specifically.	As agreed I expect that John Doe will send the analysis on Thursday.
TN	G	All types of statements that concern the general goal, or assessment criteria regarding the group assignment.	The assignment is about the public transport in Amsterdam.
TN	S	All types of statements that concern the content of the task (i.e., analysis of a policy problem) such as questions, comments, requests, providing information, information sources, content issues, discussion of that content, and so forth.	I believe that we have a different opinion about the interpretation of the analysis.

Figure 8 Abbreviated overview of the revised coding categories

Code			
Main	*Sub*	*Description*	*Example*
TN	R	All statements that concern the layout, structure and revision of the policy report.	We should delete section two and check for typing errors in three.
TS	G	All statements that concern general functioning or attitude toward the group, without reference to it or to individuals.	That's more like it!
TS	GR	All types of statements concerning group functioning, effort or attitude toward the group with reference to the group (i.e., use of we, all group members, or everybody).	I think we as group did a great job in a virtual project team.
TS	IN	All types of statements concerning an individual's functioning, effort or attitude toward another individual (i.e., with reference to names, he, she, I, you, they, (sub) Group 1).	John Doe, my compliments for your PERS analysis.
NT	A	All statements that concern the face-to-face meeting at the start of the course and statements that concern acquaintance after the meeting (e.g., providing personal background information).	I have already met John Doe during the face-to-face meeting.
NT	T	All statements that concern technical issues (i.e., how to use, problems, evaluative remarks about computers, e-mail, specific software, and missing or forgotten attachments).	I am still struggling to find out how I am supposed to operate Edubox.
NT	S	All statements with a social orientation that are not related to the assignment (i.e., vacation, Christmas wishes).	How was your holiday in France?
NT	M	All statements wit an explicit reference to communication with the moderator or in which a group discusses the response.	We should ask the moderator if an analysis is useful.
NOC		All types of statements that not belong to any category specified (e.g., statements that signal receipt of a message or attachment).	Attached is a new schedule with the latest deadlines and tasks.

NOTE: Main = main code; Sub = subcode; TC = task coordination; TN = task content; NT = nontask; NOC = noncodable; G = general; TU = time unspecific; TS = time specific; AU = activity unspecific; AS = activity specific; TAU = time and/or activity unspecific; TAS = time and activity specific; S = social or specific; R = revision; GR = group; IN = individual; A = acquaintance; T = technical; M = moderator.

Figure 8 Abbreviated overview of the revised coding categories (continued)

Cohen's kappa was computed for three samples. Sample one consisted of 40 messages, samples two and three both contained 50 messages. Each sample contained groups that worked with pre-defined roles and groups that worked without, and was independently coded by two coders (A and B). Cohen's kappa was computed for the subcategory level (sample 1, k = .62; sample 2, k = .60; sample 3, k = .63) and the main category level (sample 1, k = .69; sample 2, k = .70; sample 3, k = .68). Overall aggregation of the samples resulted in a kappa of .60 on subcategory level, which is considered satisfactory. On the main category level kappa proved to be .70; considered to be substantial (cf. Landis & Koch, 1977).

4.5.4 Conclusion

The alternative unit of analysis can be determined reliably using the segmentation procedure. This procedure is easy to use, not laborious and more precise. A cross-validation on an English language dataset revealed that – after addition of two 'punctuation' markers – the procedure was reliable for English datasets as well. Three samples were coded according to the revised coding categories, definitions and coding rules. This resulted in a satisfactory kappa for the subcategory level and a substantial kappa for the main category level.

4.6 Discussion

The use of quantitative content analysis has increased in CSCL research. However, a review of CSCL 2001, 2002 and 2003 proceedings reveals that a considerable number of reports are vague in their definition of the unit of analysis used. Moreover, argumentation for choosing a specific unit of analysis, as well as a reliability statistic for coding – let alone for the segmentation if the unit is smaller than a message – is often not provided. Finally, the coding categories are briefly described and coding rules are not made explicit.

Rourke et al. (2001) state that the only coding procedure that has been debated (and thus been subject to the some degree of replication) is the procedure by Henri (1991). However, they point out that all attempts at replication resulted in a reformulation of the procedure to some extent. Recent reports in which the 'unit of meaning' is used and either the original framework – or an adapted version – is used for categorising the units are studies by Schellens and Valcke (2002), De Laat and Lally (2003) and Rasku-Putonen et al. (2003).

Schellens and Valcke (2002) conducted a cross-validation of previously developed coding schemes by Gunawardena et al. (1997) and Veldhuis-Diermanse (2002): reporting a kappa for the original framework as well as the kappa statistic that they obtained in their research context. De Laat and Lally (2003) adapted two coding schemes, but neither the reliability of the original schemes nor the reliabilities of both adapted versions are reported. Similarly, Rasku-Puttonen et al. (2003) state that their coding scheme is based on categories used in another study, but they fail to report the reliability of the original categories, as well as the reliability of their own coding scheme.

Although the initial aim of the research presented in this article was to develop a procedure for reliable content analysis of electronic communication in a project-based learning context, several issues emerged while developing this procedure that are not addressed in most CSCL research – but which have important implications for content analysis methodology and practice.

Apart from a clear need for methodological rigour in content analysis, as well as reporting the reliability, it is apparent that the limitations of the applicability of a unit smaller than a message are barely addressed. Practical experience with the 'unit of meaning' revealed a methodological issue that was defined as 'unit boundary overlap'. Supporters of the 'unit of meaning' argue that separating segmentation and coding is irrelevant because segmentation depends on the coding categories, however the 'unit boundary overlap' problem has clearly revealed that this argument is beside the point. Independent coders can assign different borders and codes, thus a reliability statistic must be reported for both. Therefore, the questions regarding segmentation and coding in the case where the unit is smaller than a message (specifically the 'unit of meaning') still remain to be addressed (see Figure 3).

In addition four contextual constraints were identified that affect the applicability of a unit of analysis smaller than a message. Practical experience with a 'unit of meaning' and re-examining the transcribed communication according to the 'object of research', 'nature of communication', 'collaboration setting' and 'technological tool', revealed a necessity to develop an alternative unit of analysis and segmentation procedure for these units accordingly. It has been shown that this procedure, as well as its cross-validation, proved to be sufficiently reliable.

Thus, although a specific methodology or approach to content analysis may be regarded as an 'accepted practice' it is important that researchers are explicit about decisions taken during the development of a segmentation and/or coding procedure. The use of 'accepted practice' should not distract from criticism and rigour with respect to the reliability. Researchers should beware that 'accepted practice' does not evolve into 'non-criticised practice'. With respect to 'quantitative' content analysis, intercoder reliability of both segmentation *and* coding are crucial to warrant the professed objectivity, reliability and replication. Especially if the research question requires the use of mutually exclusive categories to construct manifest variables for statistical comparison of experimental conditions. The procedure to determine the units and rules that guide the coding should be systematically described, i.e. either it should be reported how much of the total number of segments and/or coding overlap or they should be performed as separate steps in the analysis and a reliability statistic should be provided for both. We favour the latter approach.

A final issue concerns the computation of reliability. Proportion agreement is appropriate with respect to the segmentation. Regarding the coding categories, Cohen's kappa is mostly used, but the issue of the number of categories included is ignored. The higher the number of categories, the smaller the likelihood of chance agreement as opposed to possible deviations. In other words, kappa tends to be more strict (a comparatively larger chance agreement correction) in the case of fewer categories. For this reason we have reported two kappa statistics, one for the subcategory level and for the level of the main categories. Neuendorf (2002) suggests an even stricter approach to compute a separate kappa for each variable involved. However, in the case of collaboration the coding categories are not independent and separate statistics would be meaningless in light of the psychological construct of ‘collaboration’ that is being studied.

Related to this issue, the ‘interpretative’ analysis of ambiguous communication with a non-ambiguous coding scheme will always result in a lower kappa statistic. Although the definitions and rules can be non-ambiguous, the issue is whether these – given the nature of communication – will be sufficient to guarantee a pre-defined lower bound of intercoder reliability. If electronic communication is highly ambiguous, it will most likely result in a lower kappa. The degree of ambiguity of the data (communication transcript) in view of the coding scheme, the obtained kappa statistic *and* the power of the results are interrelated. Researchers must be cautious with generalisations if kappa is low. Although they should refrain from statistical comparisons, the qualitative results need not be ignored.

A scientific discourse is needed to answer the question, ‘What is an acceptable Cohen’s kappa statistic, given the research objective, nature of communication, collaboration setting and technical tool?’. Such a discourse could begin by introducing conventions for systematic reporting of coding and segmentation reliabilities and procedures. The procedures should be made available for cross-validation studies and a secondary analysis (through scientific reports or websites). Finally, if a previously validated coding scheme is used or adapted, the kappa of the original and adapted schemes should be reported.

In sum, based on the presented experiences in developing a content analysis procedure, five steps are recommended: 1) determine the unit of analysis given the probability of ‘unit boundary overlap’ and the four contextual constraints, 2) develop a segmentation procedure, 3) determine the reliability of the segmentation procedure, 4) develop coding categories and coding rules, and 5) determine the reliability of the coding categories. Although the segmentation procedure could possibly be applied to some extent to the analysis of verbal protocols of text and reading comprehension (Prins et al., 1998), transferability of the segmentation procedure to other research settings may be limited. However, researchers are invited to test the alternative unit of analysis and/or report whether the contextual constraints were useful to guide their choice for an applicable ‘unit of analysis’ given their research context.

CSCL may be a still emerging paradigm in educational research. Nevertheless, methodological discourse needs to be part of any research paradigm – be it still evolving or not. Hopefully, this article can serve as a starting point for such a discourse.

4.7 Acknowledgements

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4.8 Appendix A: Overview of the analysis units reported in CSCL 2001, 2002 and 2003 proceedings

CSCL 2001

Study	*Unit of analysis*	*Segmentation reliability*
Archer, Garrison, Anderson, & Rourke	message	1)
Arnseth, Ludvigsen, Wasson, & Mørch	unclear	2)
Erkens, Japsers, Tabachneck-Schijf, & Prangsma	episode	not reported
Häkkinen, Järvelä, & Byman	message	1)
Hume & Järvelä	message	1)
Lally	unit of meaning	not reported
Lenell & Stahl	message	1)
Ligorio, Minnini, & Traum	unclear	2)
Lipponen, Rahikainen, Lallimo, & Hakkarainen	message	1)
Mäkitalo, Salo, Häkkinen, & Järvelä	message	1)
Muukkonen, Lakkala, & Hakkarainen	proposition	not reported
Schwarz, Neuman, Gil, & Ilya	argument	not reported
Tosonoglu-Blake & Rapanotti	unit of meaning	not reported
van Aalst & Chan	message	1)

CSCL 2002

Study (long papers)	*Unit of analysis*	*Segmentation reliability*
Armitt, Slack, Green, & Breer	utterance	not reported
Lally & De Laat	unit of meaning	not reported
Study (short papers)	*Unit of analysis*	*Segmentation reliability*
De Laat	unit of meaning	not reported
Ligorio, Talamo, & Simons	unclear	2)
Seitema-Hakkarainen, Lahti, Iivonen, & Hakkarainen	proposition	unclear
Svensson	unclear	2)

CSCL 2003

Study	*Unit of analysis*	*Segmentation reliability*
Baker, Quignard, Lund, & Séjourné	argument	not reported
Kirschner, Van Bruggen, & Duffy	utterance	4)
Komis, Avouris, & Fidas	unclear	2)
Lally & De Laat	unit of meaning	not reported
Law & Wong	discourse	3)
Mulder, Graner, Swaak, & Kessels	unclear	2)
Pata & Sarapuu	unclear	2)
Suthers, Girardeau, & Hundhausen	proposition	not reported
Van Amelsfoort & Andriessen	unclear	2)
Van Drie, Van Boxtel, Erkens, & Kanselaar	utterance	not reported
Van Oostendorp & Juvina	unclear	2)

1) A message or note is a fixed unit that (in general) can be determined objectively and reliable.
2) The unit of analysis is unclear, thus a reliability measure would not make sense.
3) Each group has only one discourse.
4) Utterances were determined by turn taking, a fixed unit that (in general) can be determined reliable.

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CHAPTER 5

The impact of functional roles on perceived group efficiency and dropout during CSCL in distance education

Abstract

This article reports a study in which functional roles were implemented during computer-supported collaborative learning (CSCL) in distance education. Students were distributed over two research conditions (role and nonrole). Comparison of Likert-scale evaluation questionnaire responses in both conditions revealed a latent variable: perceived group efficiency (PGE). Analysis of PGE with multilevel modelling (MLM) revealed that role groups appear to be more aware of their efficiency (positive and negative). Cross case matrices of open-ended evaluation questions – to investigate whether role groups were less flexible in coping with dropout – revealed that more students in the nonrole condition failed to receive course credits.

Keywords: Computer-supported collaborative learning, roles, coordination, dropout, computer-mediated communication, distance education

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5.1 Introduction

Collaborative learning has become a popular pedagogical approach at most education levels and increasingly so in higher post-secondary education (Strijbos, Kirschner, & Martens, 2004). Whereas behavioural objectives, knowledge, skills and attitudes have been the key factors in curriculum design for several decades, there is a shift in higher education towards education that more closely resembles ‘working’ in a professional context: which includes - almost without exception - always some degree of collaboration. Bastiaens and Martens (2000) describe this as a shift towards learning with real events. Naidu and Oliver (1999) illustrate the potential of using computer-mediated collaborative learning activities to enrich distance education with authentic learning experiences to create a more authentic learning environment. In authentic environments a student is trained to operate in ill-defined and ever-changing environments, to deal with non-routine and abstract work processes, to handle decision making and responsibilities, to work in groups, to understand dynamic systems, and to operate within expanding geographical and time horizons. This is in line with a trend deemed ‘student-centred education’ instead of ‘teacher-centred education’ (Boekaerts, 1997; Pincas, 1995). Collaborative learning can empower the students with learner control and a sense of ownership over their learning experience (Kirschner, Martens, & Strijbos, 2004); especially in distance education students have a strong preference to direct their learning (Huang, 2002).

A second powerful development in this respect has been the rapid development of computer technology. With the establishment of the National Science Foundation (NSF) network in 1986, which was transformed in the following decade into the ‘Internet’, the possibilities for using computers in educational settings expanded (Harasim, Hiltz, Teles, & Turoff, 1995). Internet was first used in the context of distance education. Especially e-mail was found to be a good alternative for traditional communication modes (e.g., mail, telephone or face-to-face meetings) between students and educators (Mason & Bacsich, 1998). The many informal ‘chat’, Multi-User-Dungeon (MUD) and newsgroups triggered ideas for using these communication facilities for educational purposes to deliver educational content and stimulate interaction between staff and students or groups. This approach is widely know as ‘computer conferencing’ and described by Harasim et al. (1995) as creating learning networks in which a group of people is learning together, time and place independent, by means of computer-mediated communication (CMC). One example of an early computer conferencing approach at the institutional level is the ‘Virtual University’ (see Hiltz, 1994). On the course level various forms of group-based learning methods are used: group discussions, role-plays, interchange of homework/ exams and having students commenting on each other’s papers. Student interaction, however, is product-oriented and mainly concerns an increase in the amount of corrective feedback. Group discussions are used, but these are often optional or limited to a specific part of a task. Rarely are students required to collaborate for the full duration of a project. Finally, students are mostly individually evaluated and graded. In contrast to computer conferencing, a new field of study – commonly referred to as computer-supported collaborative learning (CSCL) – emerged midway in the 1990s. CSCL focuses on computer environments that aim to *support* collaboration – not just enable communication –

in computer-supported collaborative learning settings; as opposed to the laissez-faire character of most computer conferencing settings where group collaboration is not specifically supported by technology, pedagogy or a combination of technology and pedagogy.

5.2 Designing computer-supported collaborative learning

Computer-supported collaborative learning combines views from educational psychology, social psychology, computer science and communication science; but is not yet an established research paradigm as theoretical debate, as well as large varieties in the technological and pedagogical support of collaborative learning, still prevails. Developers question what kind of tasks or work methods should be used (Enkenberg, 2001) and they have indicated considerable variations in the quality of interaction and learning outcomes (Häkkinen, Järvelä, & Byman, 2001). To a large extent this is caused by differences in group size, technology used, length of the study, research methodology and unit of analysis (Lipponen, 2001).

Most CSCL design is often based on subjective decisions regarding tasks, pedagogy and technology, or views like ‘cooperative learning’ or ‘collaborative learning’. Cooperative learning is associated with division of labour and collaborative learning with equality of group member contributions to a shared problem solution (Dillenbourg, 1999; Brandon & Hollingshead, 1999; Lehtinen, Hakkarainen, Lipponen, Rahikainen, & Muukkonen, 1999), however, there are far more similarities than differences between both views. Most approaches rely on two principles called ‘positive interdependence’ (Johnson, 1981) and ‘individual accountability’ (Slavin, 1980). Positive interdependence promotes ‘group cohesion’ and a heightened sense of ‘belonging’ to a group; and can be achieved through the task, resources, goals, rewards, roles or the environment (Brush, 1998). Individual accountability refers to the extent that group members are individually accountable for jobs, tasks or duties, and it was introduced to counter the ‘free-rider effect’: some students would deliberately not invest any (or little) effort. Both principles, however, relate to well-known group dynamics phenomena ‘group cohesion’ and ‘social loafing’, and thus they apply to any form of group-based learning.

Furthermore, it is generally more acknowledged that ‘learning’ and ‘collaboration’ both rely on interaction, and thus that *interaction* is the primary process to be studied to investigate performance and learning in CSCL settings (Stahl, 2004). Strijbos, Martens and Jochems (2004) propose a process-oriented design method for (computer-supported) group-based learning that focuses on fostering the envisioned group interaction that is thought to enhance learning instead of focussing on the final product of such interaction (which still tends to be the dominant view in most institutes that provide higher education). This method centres on five elements that directly shape the face of group interaction: learning objectives, task-type, level of pre-structuring, group size and the technological tool used. For example, the group size in most computer conferences tends to be large (more than seven) (Harasim, 1993; Harasim et al. 1995) and a lack of participation may be due to the size of the group, as ‘free-riding’ is more likely to occur in larger groups and equal participation during group interaction is difficult to assure.

The need for systematic design of CSCL is amplified by some observations that conflicts regarding coordination are more likely to occur in asynchronous CMC settings compared to face-to-face settings, since group members are not present at the same time and/or place (Benbunan-Fich & Hiltz, 1999). Finally, asynchronous communication is also 'non-natural' as immediacy of feedback, prone to face-to-face settings, is not present. Clearly, some support should be designed to help students overcome difficulties in group coordination during asynchronous collaboration. As concluded by Gunawardena and McIsaac (2003), "(…) it is the well designed instructional situation that allows learners to interact with the technology in the construction of knowledge." (p. 389). One approach is to provide students with pedagogical support or a specific type of pre-structuring – which is also referred to as 'scripting' (Dillenbourg 2002; Weinberger, 2003) – to aid collaboration, for example in the use of roles.

5.3 The use of roles to support coordination during asynchronous CSCL

Group performance effectiveness depends on the one hand on the groups' use of their alternate opinions and on the other hand on the handling of increased coordination (Shaw, 1981). Roles can promote group cohesion and responsibility (Mudrack & Farrell, 1995) and thus they can be used to foster 'positive interdependence' and 'individual accountability' (Brush, 1998). Roles can be defined as more or less stated functions/duties or responsibilities that guide individual behaviour and regulate intra-group interaction (Hare, 1994). Roles appear to be most relevant when a group pursues a shared goal requiring a certain level of task division, coordination and integration of individual activities.

Three main categories of roles can be distinguished: individual roles, task roles and maintenance roles, each of which is comprised of several different roles (Mudrack & Farrell, 1995). However, these are based on a self-report inventory and pertain to roles that participants can perform during collaboration and each participant performs several roles simultaneously, thus making it difficult to implement such roles in educational contexts. Several pedagogical approaches, developed for cooperative learning, use roles to support coordination and group interaction (Johnson, Johnson, & Johnson-Holubec, 1992; Kagan, 1994). These roles are either content-focussed facilitating knowledge acquisition through differences in individual knowledge using 'Jigsaw' (e.g., Bielaczyc, 2001), 'scripted cooperation' (O'Donnell & Dansereau, 1992), or 'prompting scripts' (Weinberger, 2003) – or process-focussed roles on individual responsibilities regarding the coordination (e.g., Kynigos, 1999). Most roles developed for cooperative learning settings, however, comprise one single job, task or duty – mainly because they were developed for face-to-face collaboration in primary education. Although the use of roles is widely regarded as an effective instructional strategy, in cooperative learning and CSCL, their effect has not been investigated systematically in both higher/distance and primary education.

If cooperative learning pedagogies, and more specifically roles, were used in higher or distance education, they were not adapted, although students in these settings vary considerably in (prior) knowledge, experience and collaboration skills. Moreover, collaboration assignments in higher/distance education are more complex, they take place over an extended period of time (i.e., not restricted to classroom time) and thus they require more explicit coordination than in primary/secondary education. Consequently, the previously mentioned uni-dimensional roles for face-to-face collaboration appear inadequate to support collaboration in higher and/or distance education, let alone asynchronous CSCL settings. Thus, explicit and detailed roles descriptions should be provided. The study reported in this article investigates the impact of 'functional roles' (based on descriptions by Johnson et al., 1992; Kagan, 1994; Mudrack & Farrell, 1995) that were adapted for an asynchronous CSCL setting in higher and distance education.

The main research question can be summarised as: 'What is the effect of a prescribed functional roles instruction, compared to no instruction, on group collaboration?'. It is expected that roles will have a positive effect on group collaboration such as the experienced efficiency and satisfaction. Self-report evaluation questionnaires are used to measure students' perception of collaboration using Likert-scale and open-ended questions. Initial analyses of the responses to the Likert-scales has revealed that groups working with prescribed roles – compared to groups without such roles – appear to be more susceptible to dropout, which is indicated by an apparent amplified awareness of group efficiency. This study will briefly review the outcomes reported by Strijbos, Martens, Jochems and Broers (2004) and investigate students' responses to the open-ended questions for any evidence that supports or refutes that interpretation. Cross case matrices are used to summarise the individual student's responses at the level of the group, which are subsequently aggregated at level of research conditions for a comparison.

5.4 Method

5.4.1 Participants

At the Open University of the Netherlands (OUNL) 57 students enrolled in a course on 'policy development' (PD) and 23 students in a course on 'local government' (LG). In total 80 students enrolled (49 male and 31 female). Their age ranged from 23 to 67 years (Mean = 34.4, SD = 9.03). Five students enrolled in both courses. Participants varied in their educational and professional background (common to distance education). The course was completed by 43 students, of which 33 returned the evaluation questionnaires and were included in this study.

5.4.2 Design of study

The study has a quasi experimental random independent groups design. The experimental manipulation involved the introduction of a prescribed role-instruction in half of the groups (R-groups). The instruction aimed at promoting the coordination and organisation of activities that were essential for the group project. The other half of the groups was left completely self-reliant regarding organisation and coordination of their activities (NR-groups). Each group initially consisted of four students and throughout the course they communicated electronically by e-mail. Their task was to collaboratively write a policy report containing advice regarding reorganisation of local administration, a topical subject in the Netherlands.

In order to assess the effect of roles on performance, group-level grades are compared. To investigate the effect of roles on the perceived collaboration each student's perception of their team development, group process satisfaction, the task strategy, the level of intra-group conflict, the quality of collaboration and the usefulness of e-mail have been measured. Finally students' attitude towards collaboration and computer-mediated communication was measured prior to the course and after successful completion.

5.4.3 Materials

5.4.3.1 *Instructions*

Half of the groups were instructed to use functional roles: 'Project planner', 'Communicator', 'Editor' and 'Data collector'. The other half of the groups received a non-directive instruction (e.g., obvious, unspecific and general information regarding planning and task division) and they were instructed to rely on their intuition or previous collaboration experiences (for instructions used see appendices A and B). Students in the R-groups had to distribute the roles themselves and exerted their role for the full duration of the course (roles did not rotate). The instructions in both conditions were delivered as a short electronic text at the beginning of the course. They were also presented to the students present during a face-to-face meeting at the start of the course.

5.4.3.2 *Evaluation questionnaire*

The evaluation questionnaire consisted of forty-six items, belonging to six scales that are rated on a five-point Likert-scale. Attitude towards computer-mediated communication ($\alpha = .84$; 8 items) and attitude towards collaborative problem solving ($\alpha = .76$; 7 items) are self-evident. Team development ($\alpha = .95$; 10 items) provides information on the perceived level of group cohesion, whereas group process satisfaction ($\alpha = .67$; 6 items) provides the perceived satisfaction with general group functioning (both, cf. Savicki, Kelley, & Lingenfelter, 1996; translated into Dutch). Intra-group conflict ($\alpha = .68$; 7 items) provides the perceived level of conflict between group members and task strategy ($\alpha = .86$; 8 items) indicates whether students perceive that their group deployed an appropriate strategy for the given task (both cf. Saavedra, Early, & Van Dyne, 1993; translated into Dutch). In addition, students were requested to answer several questions on a ten-point scale (e.g., perceived quality of collaboration and perceived usefulness of e-mail) and about twenty open-ended question – or opportunities for extended feedback – in each condition. The open-ended questions were divided in six categories: 'general issues', 'collaboration progress', 'task division', 'assessment', 'supervision' and 'reflection'. Previous reported results with respect to the Likert-scale evaluation questions and the two items answered on a ten-point scale will be reviewed in this article, however, the emphasis is put on the analysis and outcome of the open-ended questions.

5.4.4 Procedure

After course registration students were informed that the research investigated the group processes of students collaborating through e-mail and to determine the suitability of this format for distance education. Two weeks prior to the start of course students had to indicate whether they wanted to start with the group assignment in October 2000 or March 2001. Next, students were randomly assigned to groups and geographical distance between the group members was maximised to discourage face-to-face meetings.

Prior to collaboration a face-to-face meeting was organised for all students. A separate meeting was organised for each research condition. General information and the instructions in both conditions were provided during this meeting and electronically afterwards. After the meeting all remaining contact between students was virtual. Role groups were required to inform their supervisor about the distribution of the roles in their group within two weeks. Contact with the supervisor was restricted to a single group member in the role condition, whereas students in nonrole groups were all allowed to contact the supervisor. Supervisors were instructed to answer questions that focused on the content of the assignment and they were not to provide support regarding coordination and group management. Although students were instructed to use e-mail, it is by no means possible nor feasible to exclude customary communication channels, such as telephone and face-to-face contact. If used, students were requested to send transcripts to all group members to retain transparency of communication. During collaboration the telephone was used occasionally, but most contact was by e-mail. In spite of geographical distance three groups organised a face-to-face meeting. Five students participated in both courses and were placed in the same research condition. This did not pose difficulties in the final analyses. Some groups did not complete the course timely or were excluded from the research because only two group members remained (and thus were no longer included in the research). None of these five students finished both courses.

5.4.5 Data analysis

5.4.5.1 *Multilevel modelling*

Before we proceed to the review of the self-report Likert-scale data, it is important to note the implications of non-independent observations with respect to the analysis of group collaboration. This issue was only recently raised in research on CSCL and small group collaboration. In past research on cooperative learning frequently the ANOVA procedure has been used to investigate the impact of an instructional strategy using individual level observations (see Slavin, 1995). This is no exception in some CSCL studies (Hübscher-Younger & Narayanan, 2003). However, since the group a student belongs to influences individual scores, these scores are not independent. Non-independent observations have strong implications for the analysis of group processes: ANOVA appears not to be suited (Stevens, 1996). The assumption of independence is violated, because students' perception of efficiency depends on all members' contributions. Failure to incorporate this interdependency will lead to an underestimation of the standard errors of model parameters, resulting in a much larger than nominal probability of a Type I error (Snijders & Bosker, 1999). This is, however, taken into account by multilevel modelling (MLM) and thus this technique is best suited to investigate the responses to Likert-scale questions as they consist of self-report perceptions (cf. Bonito, 2002).

5.4.5.2 *Cross case matrices*

The open-ended questions in the evaluation questionnaire were divided in six categories: ‘general issues’, ‘collaboration progress’, ‘task division’, ‘assessment’, ‘supervision’ and ‘reflection’. Groups in the role condition answered twenty-three open-ended questions – or opportunities for extended feedback – and nonrole groups answered twenty questions (a slight difference due to specific evaluation of the roles). Cross case matrices were used to analyse students’ responses to the open-ended questions (see Miles & Huberman, 1994). First, all individual responses were aggregated per group and per category. At this stage it was decided to extract two questions from the ‘collaboration progress’ category to form a new category called ‘coordination impact’. The categories ‘assessment’ and ‘supervision’ were aggregated to a single category because assessment contained in the end only one useful question. Next, the individual responses were summarised at the level of the group for each of six categories (general issues, collaboration progress, coordination impact, task division, assessment and supervision, and reflection). Finally, four group level matrices were aggregated at the level of research conditions. At both the group and condition level the number of students reporting a specific response was included in the matrices to indicate whether a specific type of response accounted for the majority of the respondents within a research condition.

5.5 Results

5.5.1 Multilevel modelling

Pearson correlations between the Likert-scales and the two ten-point scales items were computed for the entire sample (N = 33). Medium to high correlations (.45 to .89, $p < .01$) were found between all of the variables, except ‘Attitude towards computer-mediated communication’ and ‘Attitude towards collaborative problem solving’. To avoid the problem of multiple testing, principal axis factoring was performed and one factor was extracted and explained 79% of all common variance. The factor included the perceived quality of collaboration, team development, group process satisfaction, intra-group conflict and task strategy. The factor was interpreted as ‘perceived group efficiency’ (PGE) and standardised factor scores were computed and used in further analyses (for a more detailed discussion of the methodological assumptions and outcomes of the MLM analyses, see Strijbos, Martens, Jochems, & Broers, 2004). Multilevel modelling was performed (ML-wiN, Version 1.10) and the intraclass correlation, which indicates the level of interdependence among scores, was substantial enough to indicate the use of a multilevel model (.47). The analyses, however, revealed no differences in PGE estimates for a model with and without a random slope model. However, in the case of a limited number of observations it is not uncommon that the estimated variance between groups will be small in comparison to the estimated variance within groups. This can be a consequence of the comparatively small power of the test. Thus, a closer look at the data is warranted. We looked at PGE predictions generated for each group (R = role group (n = 5; N =14) and NR = nonrole group, (n = 5; N = 19), based on respectively the model with random slope parameter and the model without parameter (estimates are presented in Table 1).

Table 1 PGE prediction estimates by group with and without random slope parameters

	Role	
Group	*Model with RS*	*Model without RS*
PD 1	-.68	-.60
PD 2	1.08	.92
PD 3	1.00	.88
PD 4	-.67	-.58
LG 1	-.46	-.40
	Nonrole	
Group	*Model with RS*	*Model without RS*
PD 5	-.14	-.19
PD 6	.60	.77
PD 7	.06	.08
LG 2	.00	.00
LG 3	-.44	-.57

An F-test for the homogeneity of variances was performed to investigate the hypothesis of equality of variances for the model with random slope parameter (F = 5.86, df = 4, .05 < p < .10) and the model without random slope parameter (F = 2.86, df = 4, p > .10). The outcome suggests that the assumption of homogeneity leads to a distortion of a discernable pattern in the MLM data. The predictions of estimates based on PGE become less extreme for the role groups (move closer towards zero), whereas the predictions for nonrole groups become more extreme (move further from zero). This difference is depicted in Figures 1 and 2.

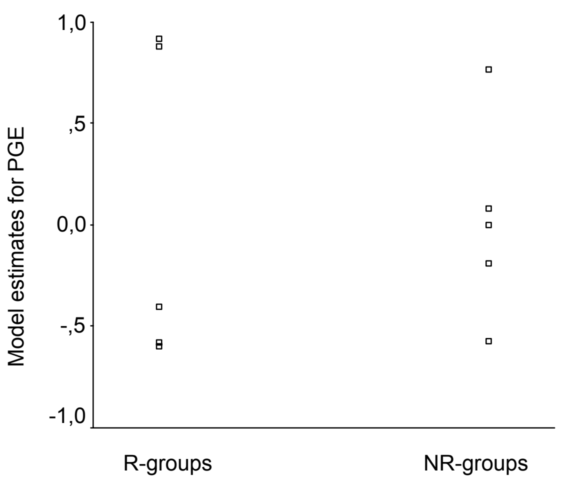

Figure 1 Model estimates of PGE without random slope

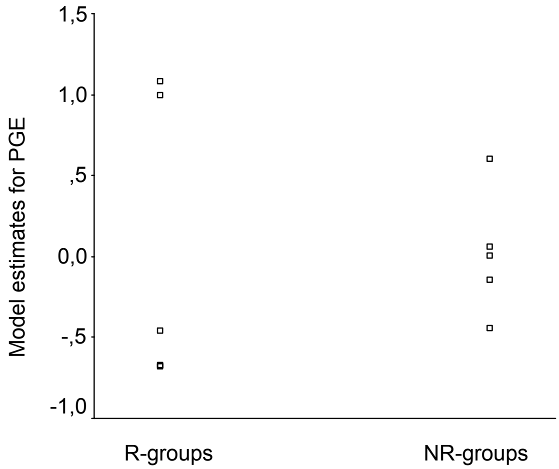

Figure 2 Model estimates of PGE with random slope

A comparison of both figures suggests that the groups in the role condition may be more susceptible to conflict or dropout – which is indicated by an apparent amplified awareness of perceived group efficiency (PGE). The lack of interdependence or responsibility in the nonrole condition appears to have had less effect on conflict or dropout. Another possible explanation could be that the functional roles were not sufficient to guide collaboration. In the next section the results from the analysis of the open-ended questions are presented to investigate whether dropout or lack of guidance by the functional roles can explain the observed difference.

5.5.2 Cross case matrices

Student responses to the open-ended questions were aggregated at the condition level for the categories ‘general issues’, ‘collaboration progress’, coordination impact’ and ‘assessment and supervision’. Responses to both other categories were aggregated at the group level because the questions for ‘functional roles and task division’ differed for both conditions and student ‘reflection’ on collaboration and writing a policy report turned out to be very diverse.

5.5.2.1 *General issues*

General issues concerned three questions: ‘Did your group use other information and communication tools (ICT) than e-mail or organise a face-to-face meeting?’, ‘Did your group use the revise tool in Microsoft Word©?’ and ‘What is your opinion about the group size with respect to collaboration?’. Student responses to these questions are shown in Table 2. Students in the nonrole condition – compared to students in role groups – report using the telephone more frequently.

Table 2 Matrix for general issues category by condition

General issues	*Role* (n = *5;* N = *14)*	*Nonrole* (n = *5;* N = *19)*
Use of other ICT tools?	Four students in four different groups used the phone once. One student used it twice. Two students in two different groups used mail once.	Two students in two different groups used the phone once. Six students in three groups used the phone several times. One student in a group used the phone twice.
Use of revise tool in Word?	Eleven students in four different groups used the tool. Four students add the tool was useful. One adds to have used it reluctantly at first. Three student of another group did not use the tool at all.	Ten students in four different groups used the tool. Two add that it was pleasurable and/or convenient to use, one adds that it required some time getting used to, one adds to have used it regularly prior to the course.
Applicability of group size for the collaboration?	Nine students in four different groups report that the size was fine. Three of them add that a size larger than four would increase the time needed and decreases the responsibility felt. Four students from two different groups report that the group size was too large. One adds it was caused by difficulties in coordination; according to another student of this group due to members not reading their e-mail. One student in the other group suggests that the project planner and communicator role should be combined with both other roles.	Twelve students in five different groups report that the size was fine. One adds a larger groups takes more time and a smaller group more effort, another student adds that a group of four can still be coordinated. Four students in three different groups report that the groups' size was too large. One of these students adds to prefer a dyad; one prefers a triad. Two students in the same group report that group size was too small and connect this to the dropout of one group member and one of them adds that one of the remaining members also contributed less.

It is also interesting that students in the nonrole group with the highest level of PGE collectively keep silent about the fact that their group met twice for a face-to-face meeting (revealed by the e-mail communication transcripts). With respect to the use of the revise tool and students' opinion about the applicability of group size for collaboration there is no noticeable difference between the research conditions.

5.5.2.2 *Functional roles and task division*

Functional roles and task division comprises different questions for each condition. Students in the role condition were asked three questions: 'How did you experience your role?', 'Do you think that the functional roles were adequate and equal in workload?' and 'Do you believe that your role increased your involvement with the collaboration?'. Students in nonrole groups were asked to 'Describe how your group divided the tasks: did you group split-up the content of the product and divide it amongst their members or did your group use functional tasks or roles?'. Given the diversity of the questions in both conditions the student responses are only summarised at the group level. The results are shown in Table 3.

Table 3 Matrix for the functional roles and task division category by group

	Role				
	PD 1 (N = 3)	*PD 2* (N = 2)	*PD 3* (N = 3)	*PD 4* (N = 3)	*LG 1* (N = 3)
How was the role experienced?	One student experienced the role as important. The other two describe their task.	One student reports his/her role is important for the report. One reports his/her role was comfortable, but that E does the work.	One student reports that the communication role with the supervisor was secondary. One reports that his/her role was pleasurable. One reports that the other group members provided freedom for writing.	One student reports the role suited him/her, as s/he enjoys writing. One reports the role frustrated as communication was slow and often e-mails received no response.	One student reports it was interesting to find new data. One reports a lack of support by the other group members.
Role division equal?	Two students report that roles were not equal. One adds that PP and CO are too easy. One student reports roles were equal.	Two students report that roles were not equal. One adds that E takes more effort and PP and CO are easier. One adds that E has to do the most work	Two students report that roles were not equal. One adds that DC should be spread among members. One adds DC was easier and E harder. One adds that E was not so hard.	Two students report roles were not equal. One adds that PP was easy compared to other roles and E was harder. One adds his/her planning ideas were not agreed with.	Three students report roles were not equal. One adds that CO was easier; one that CO was not performed, but CO and PP are easier. One adds putting in the most effort.
Role increased your involvement?	Three students report more involvement. One adds that a role stimulated the sense of responsibility. One adds that DC is the most complete role. One adds that the content had to be reviewed/written.	One student reports to have been absolutely more involved. One adds involvement was different since collaboration also requires attention to individual time schedules.	One student reports more involvement as regular e-mail contact was required. One reports that the role did not result in more involvement.	Three report involvement was not increased. One adds that DC and E have the most influence on the outcome. One adds that s/he almost quit, as communication was difficult. One adds planning was hard.	Two students report more involvement. One adds that it increased his/her satisfaction. One adds that s/he had to do almost all of the work.

NOTE: PP = Project planner; CO = Communicator; E = Editor; DC = Data collector

Table 3 Matrix for the functional roles and task division category by group (continued)

	Nonrole				
	PD 5 (N = *4*)	*PD 6* (N = *4*)	*PD 7* (N = *3*)	*LG 2* (N = *4*)	*LG 3* (N = *4*)
Describe how your group divided tasks? Splitting up content or use of roles?	Four students report that the group was split in two dyads. Each dyad wrote a part of the task, which was then reviewed by the other dyad, and then it was finished by the first dyad. Two add no use of roles.	One student reports that tasks were divided, but one member took the lead in content and one in planning. Two students report that members worked on a part of the task, then a member wrote the report. One student reports there was no functional task division, but adds one student stimulated communication.	One student reports that solely a content focussed division in tasks was made. One student reports that chapters were divided and that there was one 'editor' assigned. One reports chapters were divided: each week one member wrote a chapter and others commented on it; and also adds there were no roles or functional tasks.	One student reports there was one project chair, no roles. Three report that members wrote an individual report and these were combined in a shared report by a member serving as 'editor'. One adds individual work is essential to maintain an overview. One adds that one of the members pushed the group forward.	Three students report that a content focussed task division was made. Two add that roles emerged during collaboration ('editor', 'project chair'). One adds there was a free-rider. One adds that two members kept to the agreed tasks and deadlines.

Students in the role condition express that the functional roles were not equal with respect to the effort that had to be invested in the associated tasks. Although the students performing the roles of ‘Project planner’ and ‘Communicator’ can limit their contribution to occasional check-ups on group progress – compared to students being ‘Editor’ or ‘Data collector’ – students in the role condition were informed that all students were required to provide input and effort for the group product (policy report). In nonrole groups students’ responses indicate a pattern that can be referred to as ‘splitting up the task’: the content of the task was divided between the group members (or subgroup dyads) and each studied the associated literature and wrote a part of the shared policy report individually. In two groups a leader or editor role emerged spontaneously during the collaboration – mostly because of experienced necessity with respect to maintaining the groups’ progress rather than an individual preference.

5.5.2.3 *Collaboration progress*

Collaboration progress consists of four questions: ‘How was the progress of collaboration in your group?’, ‘Do you believe that group members contributed equally to the collaboration?’, ‘Did you often experience that you had to wait for other group members during collaboration?’ and ‘Did group members dropout during collaboration, and if so were there any consequences?’.

Table 4 Matrix for the collaboration progress category by condition

Collaboration progress	*Role (*n = *5;* N = *14)*	*Nonrole (*n = *5;* N = *19)*
How was the progress of collaboration?	Six students in three different groups report that progress was fine. One of them adds investing more effort, one adds that progress on the level of the content was fine but agreements were often not met. Three students in the same group report that all members contributed and kept agreements. In three different groups three students report that a group member dropped out and two students in two different groups indicate that it was without a notification.	Four students in three different groups report that progress was fine. One adds that it was fine initially but it decreased during collaboration. Six students in three different groups report that progress was difficult or delayed. Two students in two groups add that one group member invested less effort. Four students add there were difficulties with coordination of task division, deadlines or making agreements. Three students add there were delays in responses.
Members contributed equally?	Nine students in four different groups indicate that group members did not contribute equally. Three students in three different groups indicate roles were unequal in the effort demand, but another student claims it should not mind, another student adds it may be subjective, and one indicates it may be due to personal contexts. Four students in two groups report that all members contributed equally to their duties.	Twelve students in four different groups indicate that members did not contribute equally. Six add it was due to a lack of participation of one group member. Two students in the same group add that the member that wrote the report invested more effort. Four students of a single group report that all of them contributed equally. Four students in four different groups report that all group members contributed equally (two are free-riders).

Table 4 Matrix for the collaboration progress category by condition (continued)

Experienced having to wait for other group members?	Nine students in four different groups experienced having to wait for other group members. Five students in three groups add that this was due to deadlines, response delays and/or lack of communication. Three students in two different groups report that they did not experience waiting.	Thirteen students in four different groups experienced having to wait during the collaboration for group members. Five students in three different groups add it was due to difficulties in planning. One student adds waiting is common to distance education, another student indicates the interference of the personal context. One student reports occasional waiting, but that the planning was kept. One student reports not having to wait at all (free-rider).
Consequences of dropout by group members?	Ten students in four different groups report a member dropped out. Three students in three different groups add it affected coordination. One adds it took a long time before s/he decided to quit, one adds that the dropout did not respond during the collaboration. Two students in two different groups add dropout by a group member did not have consequences. Three students in the same group report that none of the members dropped out.	Sixteen students in four different groups report no dropout. Three students in the same group report that one member dropped out. Two students add his/her work being done by two group members; one student adds that the work was shared among all of the remaining group members.

Table 4 presents the responses to these four questions. In comparison, more students in the role condition report that the progress of the collaboration was fine, whereas more students in the nonrole condition report that progress was difficult or slow. With respect to student perception of the equality of participation there is no difference between both conditions. In the nonrole condition this attributed to a lack of participation of a group member(s), whereas students in the role condition ascribe the perceived inequality to the functional roles. Analysis of the extent that students report they experienced waiting for other group members is closely connected with the first question in this category. Students in the nonrole condition already reported that collaboration progress was difficult or slow, but they also report frequently that they had to wait for group members; however not more often than students in role groups. Interestingly, students in both conditions consider a lack of planning or meeting agreed tasks or deadlines (agreements) as the prime cause for waiting. Moreover, examination of communication transcripts reveals two students, in two different groups, as 'free-riders' and both indicate that they did not experience any waiting whereas other group members attribute waiting to that specific 'free-riding' group member. Finally, with respect to the dropout Table 4 reveals a clear difference between both conditions. In the role condition more students report that a group member dropped out during the collaboration. Figure 3 shows the distribution of various dropout categories: students that registered but never started with a group ('Not start'), students that dropped out during the collaboration ('During'), students in groups that never dropped out but failed to

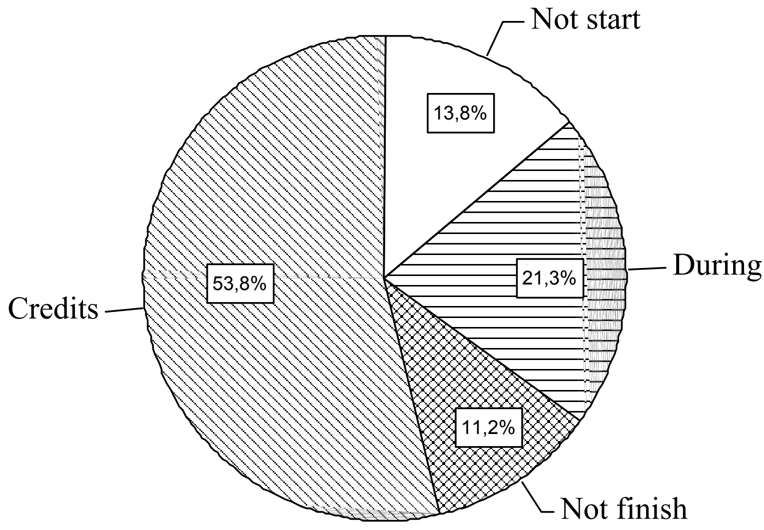

Figure 3 Overview of dropout rates and the level of course completion

turn in a product to receive course credits ('Not finish') and students that finished the course and received course credits ('Credit'). A comparison of dropout rates during the collaboration reveals no differences in the distribution between the conditions (R = 8, NR = 9). A comparison of the combined total number of students that dropped out during the course or did not finish the course does reveal a significant difference between both conditions ($\chi^2 = 6.118$, $df = 1$, $p < .05$). Eighteen students in the nonrole condition – compared to eight students in the role condition – dropped out during collaboration or failed to get course credits. Although these figures indicate a high dropout rate, this is not uncommon in a distance education context (Martens, 1998).

5.5.2.4 *Coordination impact*

Coordination impact addresses two questions: 'Did your group make many agreements about activities or deadlines?', 'Did these agreements stimulate the groups' progress?'. Table 5 shows students' responses to these questions. The results in Table 5 show no difference between conditions in the extent to which agreements were made concerning activities or deadlines. Similarly, there is no difference in whether these agreements focussed on organisational issues or the content of the task. There does seem to be a tendency revealing more students in nonrole groups indicating that the agreements did not stimulate progress, however, the number of students holding the counter position is about equal.

Table 5 Matrix for the coordination impact category by condition

Coordination impact	*Role (*n = *5;* N = *14)*	*Nonrole (*n = *5;* N = *19)*
Were there many agreements made? Focused on content or process?	Eleven students in five different groups report that agreements were made. Three students in two different groups add that these were content and process focused, five students in three different groups report that the agreements were mainly procedural, two students in the same group add that too little were made. One student reports that no agreements were made and one student cannot recall.	Nineteen students in five different groups report that agreements were made. Thirteen students add that these were both content and process focused. Six students in four different groups add that the agreements were mainly focused on the process (procedural).
Agreements stimulated progress?	Five students in two different groups report that the agreements stimulated progress. Three add that these provided something to hold on to hold on to, or clarified expectations. Six students in three different groups indicate that the agreements did not stimulate their progress as expected. Five add that agreements about task division and/or deadlines were not kept. One student adds that no agreements were made.	Seven students in four different groups report that the agreements stimulated progress. One student adds that agreements were kept later than agreed. Two students in two different groups report that agreements more or less stimulated progress. Ten students in four different groups report that the agreements did not stimulate the progress. Six students in four groups add that it delayed the process; two of them add it led to a lack of clarity about task division or unequal workload.

5.5.2.5 *Assessment and supervision*

Assessment and supervision is comprised of three questions: ‘Do you think it is justified that all group members get the same grade?’, ‘Did your group contact the supervisor and how do you rate the response?’ and ‘How would you rate the supervision throughout this assignment?’. Table 6 presents students’ responses to these questions. Students in both condition do not differ in their opinion towards the use of group grades, in fact most students consider this an ‘accepted practice’ to assess collaboration. With respect to the contact with a supervisor Table 6 shows that more students in the role condition report that their group contacted the supervisor – compared to students in the nonrole groups where the majority report that the supervisor was not contacted. The opinion of students in the nonrole group about supervision during the assignment amplifies their response to the previous question: they indicate more often that they did not experience any supervision.

5.5.2.6 *Reflection*

Reflection consists of two questions: ‘Describe what you have learned from collaborating during this course’ and ‘Describe what you have learned from writing a policy report?’.

Table 6 Matrix for the assessment and supervision category by condition

Assessment & supervision	*Role* (n = *5;* N = *14)*	*Nonrole* (n = *5;* N = *19)*
Justified that members get the same grade?	Eight students in five different groups report that a group grade is justified. Five students in four different groups add that this is accepted practice for group work. One student adds s/he does not care about the group grade. Five students in three different groups report it is not justified to give a group grade. Four students indicate that individual involvement and effort should be considered. Two students add that one group member invested less effort (free-rider). One student adds that one member got ill and another put in more effort.	Twelve students in five different groups report that a group grade is justified. Nine students distributed over four different groups add that this is accepted practice for group work; one also add s/he does not know of any alternative; one also adds it forces students to collaborate; and one also adds it is justified because members performed as agreed. Six students in four different groups report that it is not justified. Four students add that a member invested less effort; one adds the same in a more general statement.
Did the group contact the supervisor and how was the response?	Eleven students in five different groups report that the supervisor was contacted. One student adds it was to get clarity about the assignment. One student adds it concerned choices that had to be made regarding the content. Three students in two groups add it concerned dropout of a member. In addition, in total six students add that the supervisors' response was useful and/or good.	Six students in three different groups report the supervisor was contacted. Two students in the same group add it concerned a member that put in less effort. One reports that no response was given; one reports that s/he got an appropriate response. One student cannot recall his/her response. Twelve students in five different groups report that the supervisor was not contacted.
What is your opinion about the supervision?	Three students in two different groups indicate that a response was given when asked. One student adds feedback on progress reports would be appreciated. Four students in three different groups report there was no contact or supervision. Two students in the same group indicate that no supervision was needed.	Seven students in four different groups report that there was no supervision. One student reports that the starting meeting was very badly organised. One student suggests making the meeting obligatory.

As there is a lot of diversity in students' responses in both conditions their answers are summarised at the group level for each question to enable comparison. Table 7 shows what the students report that they learned from collaboration and Table 8 presents what they learned from writing the report. Students in the role condition are not extremely enthusiastic in their reflections on collaboration in their group; however, they appear to be more positive about collaborating than students in the nonrole condition. Students in nonrole groups, however, tend to place more emphasis on what they learned from writing the policy report or the assignment in general.

Table 7 Matrix for reflection on collaboration category by group

		Role		
PD 1 (N = *3*)	*PD 2* (N = *2*)	*PD 3* (N = *3*)	*PD 4* (N = *3*)	*LG 1* (N = *3*)
One student reports s/he prefers to have individual assignments. One reports students should be aware of what is expected, as well as the individual priorities and the technological problems affect the process. One student reports disappointment as some members did not invest any effort and that collaboration by e-mail is do-able but depends on the effort by group members.	One student reports agreements are useful. Accountability and stimulating others are important. Collaboration stimulates to create a good report. One student reports that using collaboration creates more ideas than one would individually; adds it is important that all group members feel appreciated (similar to some face-to-face contexts.)	One student reports that (surprisingly) it was possible to get a good product without some face-to-face communication, but adds it was rather formal. One reports the collaboration provides that one does not have to do it all and it know all. One reports that division of roles; agreements on time schedule and activities increase collaboration.	One student reports difficulty with solely communicating by e-mail; and adds it is better to meet face-to-face halfway. One reports that s/he should learn to let the control go and not assume all responsibility; s/he adds that the electronic collaborative learning was detrimental to other courses. One reports to have learned that it is essential that a team meets face-to-face.	One student reports to have learned to apply roles for a writing task and how it went. One reports that more focus on agreements was needed. One reports to have learned that it is difficult to align all the members regarding the time schedule and the content.
		Nonrole		
PD 5 (N = *4*)	*PD 6* (N = *4*)	*PD 7* (N = *3*)	*LG 2* (N = *4*)	*LG 3* (N = *4*)
One student reports it is required to stay positive and adds that they maybe should have split the group. One student reports that agreements are very essential and a need for taking personal situations into account. One student reports that any type of collaboration requires more contact and adds that at least one meeting face-to-face is needed. Unfamiliarity leads to lack of critics.	One student reports not to have learned very much. Collaboration is complicated and it results in power plays. One reports that it is possible to collaborate through e-mail (fast response, in own pace). One reports that it was nothing new as most people collaborate in their normal job. One student reports teamwork is essential for writing a report.	One student reports that collaboration is inefficient and the product is not better than an individual product if members strive for individual goals (and this had no consequences). One reports teamwork requires equal input, if not it causes frustration.	One student reports to have learned that it is difficult to work on a product with different persons (in background and goal of study). One reports that planning must be strict, there is need for structure and make sure members perform the agreed tasks. One student reports that the assignment was not pleasing because s/he is dependent on the time investment and input of others.	One reports that it confirmed his/her fear: collaboration was too difficult; smaller group would be better. One student reports electronic collaboration without any acquaintance is impossible: unclear expectations lead to irritations, people do not try to clarify them during the process; the result is all that matters. One student reports to have learned nothing; s/he prefers a written module (individual study).

Table 8 Matrix for the reflection on writing a policy report category by group

Role				
PD 1 (N = 3)	*PD 2* (N = 2)	*PD 3* (N = 3)	*PD 4* (N = 3)	*LG 1* (N = 3)
One student reports learning to write, PC skills, societal issues insights and editing texts.	Two students report to have learned about the theoretical foundation for policy reports.	One student reports to have learned about the theoretical foundation for such reports. One student reports to have learned about the gathering of data. One reports having enjoyed looking for data on the Internet.	One student reports to have learned about the theoretical foundation for policy reports; but adds missing any supervisor feedback. One student reports to have learned about the gathering of data. One student reports to have learned most from the individual assignments.	One student reports having done a course on writing policy reports before. One student reports learning to analyse and select relevant information. One reports to have written a lot of policy reports in his/her work.
Nonrole				
PD 5 (N = 4)	*PD 6* (N = 4)	*PD 7* (N = 3)	*LG 2* (N = 4)	*LG 3* (N = 4)
One student reports learning to distinguish the major and minor issues in a pool of information; teamwork is common to the practice of writing policy reports. One student reports learning a systematic approach to writing of a policy report. One student reports s/he learned about the structure of a policy report.	One student reports it was an extra exercise (works as a policy employee). One reports to have learned to find information. One reports that any problem has several perspectives. One reports that the style and content of the report differs between institutions.	One student reports to have learned about writing different types of reports (including the individual assignments). One student reports to have learned about the theoretical foundation for policy reports.	One student reports to have learned about making a research description and about choosing a method. One reports that it is difficult for the report to please the supervisor and also the team members. One reports that style of policy reports varies between the different administrations. One reports to have learned about the theoretical foundation for policy reports.	One student reports not having learned from writing, but the Cd-rom provided useful information. One reports that the Cd-rom is too in-depth; a better introduction should be given. One reports that online communication required far too much time.

5.6 Discussion

In this study the impact of functional roles, adapted for a computer-mediated context in a distance education setting, was investigated. Such functional roles can be easily generalised to other content domains. The main research question was summarised as: 'What is the effect of a prescribed functional roles instruction, compared to no instruction, on group collaboration?'. The analysis of the quantitative questionnaire data revealed a latent variable that was interpreted as 'perceived group efficiency' (PGE). Multilevel modelling (MLM) revealed a positive tendency with respect to the awareness of group efficiency. Students in the role condition appeared to be more aware of their collaboration reflected in their level of perceived group efficiency (PGE).

It was hypothesised that groups in the role condition might be more susceptible to group conflict or dropout suggested by the initial outcomes of the multilevel analyses, whereas the lack of interdependence – which possibly increased the flexibility of groups in the nonrole condition to cope with changes in the organisation and coordination – might have had less effect on group conflict or dropout in the nonrole groups. In this article the students' responses to the open-ended questions were investigated – using cross case matrices – for evidence supporting or refuting this interpretation. These questions were grouped in six categories: general issues, functional roles and task division, collaboration progress, coordination impact, assessment and supervision, and reflection.

Results from the open-ended questions in the 'general issues' category reveals students in nonrole groups using the telephone and face-to-face meetings more frequently during the collaboration than students in role groups. Apparently students in nonrole groups are more prone to revert to 'traditional' communication channels. With respect to the 'functional roles and task division' category, students in the role groups considered the roles not to be equal in terms of effort that had to be invested. However, the role instruction was more guiding than coercive and thus it left students room for an individual interpretation on how they actually performed their role. Perhaps students in role groups with a high PGE level acted more closely according to the prescribed instruction than students in role groups with a low PGE level. Moreover, a strong allegiance to prescribed roles could be in line with teamwork and collaboration in a professional context. Similarly, the nonrole groups tend to organise collaboration by splitting the task (policy report) into smaller components that are handled individually (or in dyads), which is also similar to a professional context, where task allocation is often based on expertise. Such a performance view underlies the task role distribution theory by Stempfle, Hübner and Badke-Schaub (2001) that aims to increase performance and efficiency based on several individual performance indicators. From a learning point of view optimising task performance is not the most preferred approach, as group members tend to be assigned to tasks that they have already mastered and thus their learning opportunity is undermined (note that Stempfle et al. tested their theory in a learning context).

With respect to the 'collaboration progress' category, students in the role groups confirm the perceived inequality of the roles. Whereas students in both conditions indicate free-riding, students in the nonrole groups are more elaborate about apparent free-riders (and there were also two clear free-riders in two nonrole groups). This seems to indicate that functional roles level out the negative experiences associated with having a free-rider in a group. With respect to the level of dropout, there appeared to be no difference between both conditions in the number of students that quit during the collaboration. However, a comparison of the combined total number of students that dropped out during the course or did not finish the course, revealed a significant difference to the detriment of the nonrole groups. Student reflections on collaboration during the course provide some support to this interpretation, as students in the role condition appear to be more positive about collaboration during this course than students in the nonrole groups. This can explain why students in the nonrole condition put more emphasis on what they learned from writing the policy report (or course content): their experience with asynchronous collaboration through e-mail seems to have been less satisfactory compared to students in the role groups.

Matrices of the questions in the 'assessment and supervision' category show that the students in both research conditions consider the use of group grades as an 'accepted practice' to assess group work. Irrespective of perceived or actual free-riding, the idea of 'partnership' takes precedence over grade differentiation. Nevertheless, students in nonrole groups with one of the two apparent free-riders were more inclined to argue for differentiation. With respect to the experienced supervision, students in role groups contacted their supervisor more often than the students in nonrole groups. In fact, students in the nonrole condition indicated that they hardly experienced any supervision. In part, this difference may have been due to the functional roles, as one of the tasks of a 'Communicator' was to write a progress report every two weeks. However, groups were informed prior to collaboration that requests for supervision had to be indicated in the e-mail subject header and that requests embedded in a progress report would not be answered. It is possible, however, that these reports induced a sense of 'supervision' awareness.

In contrast to the initial interpretation that the groups in the role condition might be more susceptible to group conflict or dropout, the analysis of the open-ended questions revealed that there was a higher level of dropout – represented by the combined total of students that quit during the collaboration or did not finish the course – in the nonrole groups. In addition, the analysis for the categories 'collaboration progress' and 'coordination impact' do not support the assumption that the nonrole groups were more flexible and thus better able to cope with changes in the organisation and coordination. Results for the 'coordination impact' category show that non-observance of agreements with respect to tasks or deadlines is seen as the primary cause for lack of collaboration progress. Coordination appears to play a pivotal role during collaboration.

The reported data will be extended with a follow-up study in which – apart from using functional roles – preconditions (such as a time schedule, communication discipline, etc.) will be established. It is also planned to investigate the extent to which students in role groups acted more stringently according to the prescribed functional roles, compared to 'roles' that may have spontaneously emerged in nonrole groups. Although CSCL provides a valuable opportunity to alleviate distance education students' feelings of isolation, it is also clear that more systematic research regarding instructional support for CSCL in higher and distance education is needed before CSCL can live up to its promise.

5.7 Appendix A: Functional roles instruction

Experience has revealed that roles can afford the work organisation and communication between team members. Each member of the team is to exert one of these four roles: project planner, communicator, editor, or data collector.

Project planner

Responsibility: project planning and project progress monitoring.

Activities:

- You are responsible for recording all activities to be performed and associated deadlines;
- You will supervise these to make sure that all team members comply;
- You will make an inventory about the group's progress on a regular basis, and you will communicate the outcome to the other team members;
- You will stimulate active participation of all team members to the report;
- You are required to set up an agenda for discussion (Which aspects need to be discussed, Which aspects have priority), make an inventory of discussion topics suggested by team members, and you will compose an overview of all suggestions and decisions taken;
- You will initiate (and stimulate) discussion of the literature sources extracted from the database and additional information sources that your team has obtained (Which information sources are relevant?, How can certain information be used in the final report?); and
- In case team members prefer to distribute literature sources extracted from the database or additional sources (for instance, the Internet), you are required—in collaboration with the team member that performs the role of data collector—to plan this distribution.

Communicator

Responsibility: communication with supervisor and progress reports.

Activities:

- Your supervisor will only contact the team member that performs this role, not the other team members. The e-mail address of your supervisor is (. . .);
- You will communicate the distribution of roles in your team to your supervisor;
- You are responsible to make an inventory of questions and problems that team members experience during the assignment and for communicating these to your supervisor and his or her answer to the remaining team members;
- You will construct an archive on the discussion of the literature, differences between perspectives, knowledge domains, and various theories that are introduced and discussed;
- You will construct an archive of the various versions of the report;
- You will initiate (and stimulate) discussion of the comments suggested by team members and changes made to the report;
- Every two weeks you will prepare a short progress report (half a page) that contains the most important decisions and/or developments. You will e-mail this progress report to your supervisor to keep him or her informed about the progress of your team; and
- You are responsible for submitting your team's report to your supervisor.

Reporter

Responsibility: editing the input from all team members into a shared report.

Activities:

- You will edit the input from all team members into a draft version of the report and distribute it among team members. They are required to respond to this draft within a timeline that you have specified (for example, 5 days) with comments, questions, reformulations, additional information, and text formulation; and
- You will revise each draft according to comments provided by team members. You will distribute the next version among team members with another request for comments and suggestions.

Data collector

Responsibility: inventory of the literature database and gathering of additional information.

Activities:

- You will make an inventory of the literature database that was provided. Based on this inventory, you will indicate about those aspects for which sufficient or relevant knowledge or information lacks. You will distribute this inventory and analysis among team members with a request for suggestions for additional literature;
- Based on all comments and suggestions by team members on your inventory, you will adapt the list according to their suggestions; either from the literature database or additional information sources, such as library or Internet sources; and
- You are responsible for providing the additional information sources to your other team members, and/or distributing these sources among team members for further study—in collaboration with the team member that performs the role of project planner.

5.8 Appendix B: Nonrole instruction

You and your team members decide how you are going to work on the assignment. The timely completion of the policy report is the responsibility of your team.

Below are some general guidelines on how you can proceed. It might be useful to pay attention to planning of activities and/or division of tasks.

Planning:
Differences in study pace can lead to irritation; for example, some students have a slower pace than others and may feel stressed by a higher pace. Also, it might be useful to pay attention to holidays; some students study during holidays and some do not. You might use a general planning or a planning that specifies parts of the assignment.

Task division:
It might be useful to make arrangements about each team member's activities. This can either be general or specific. Is everybody going to do all tasks individually, or will the assignment be split in separate activities (one member collects data, one member writes), or will each task be divided in smaller parts between team members (one member collects data on X, one member collects data on Y)?

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CHAPTER 6

The effect of functional roles on perceived group efficiency during computer-supported collaborative learning:

A matter of triangulation

Abstract

In this article, the effect of functional roles on group performance and collaboration during computer-supported collaborative learning (CSCL) is investigated. Especially the need for triangulating multiple methods is emphasised: Likert-scale evaluation questions, quantitative content analysis of e-mail communication and qualitative analysis of open-ended questions were used. A comparison of forty-one questionnaire observations, distributed over thirteen groups in two research conditions – groups with prescribed functional roles (n = 7, N = 18) and nonrole groups (n = 6, N = 23) – revealed no main effect for performance (grade). Principal axis factoring of the Likert-scales revealed a latent variable that was interpreted as perceived group efficiency (PGE). Multilevel modelling (MLM) yielded a positive marginal effect of PGE. Most groups in the role condition report a higher degree of PGE than nonrole groups. Content analysis of e-mail communication of all groups in both conditions (n = 7, N = 25; n = 6, N = 26) revealed that students in role groups contribute more 'coordination' focussed statements. Finally, results from cross case matrices of student responses to open-ended questions support the observed marginal effect that most role groups report a higher degree of perceived group efficiency than nonrole groups.

Keywords: Computer-supported collaborative learning, roles, coordination, collaboration, computer-mediated communication

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6.1 Introduction

Small group dynamics have been studied in educational contexts since the 1970s. Whereas cooperative learning research initially focused on face-to-face cooperation at the elementary school level, it was gradually extended to higher education. The technology push in the 1980s, resulting from rapid developments in computer mediated communication (CMC), stimulated the rise of a new discipline in the 1990s called Computer-Supported Collaborative Learning (CSCL). CSCL draws its inspiration from various research disciplines such as sociology, computer science, educational psychology, social psychology and communication science. Nevertheless, CSCL has become a popular pedagogical approach at most education levels and increasingly so in higher education (Strijbos, Kirschner, & Martens, 2004).

At present, however, there are no clear guidelines to determine how a CSCL environment should be designed (Gros, 2001). Developers question what tasks or work methods should be used (Enkenberg, 2001) and they have indicated considerable variations in the quality of interaction and learning outcomes (Häkkinen, Järvelä, & Byman, 2001). To a large extent this is caused by differences in group size, technology used, length of the study, research methodology and unit of analysis (Lipponen, 2001). Design of CSCL seems often based on subjective decisions regarding tasks, pedagogy and technology, or views such as 'cooperative learning' or 'collaborative learning'. Although cooperative learning is associated with division of labour and collaborative learning with the equality of group member contributions to a shared problem solution (Dillenbourg, 1999; Brandon & Hollingshead, 1999; Lehtinen, Hakkarainen, Lipponen, Rahikainen, & Muukkonen, 1999), there are far more similarities than differences between both views. Most CSCL approaches rely on two common principles – adopted from cooperative learning – called 'positive interdependence' (Johnson, 1981) and 'individual accountability' (Slavin, 1980). Positive interdependence promotes 'group cohesion' and a heightened sense of 'belonging' to a group; and can be achieved through the task, resources, goals, rewards, roles or the environment (Brush, 1998). Individual accountability refers to the extent to which students are individually accountable for jobs, tasks or duties, and it was introduced to counter the 'free-rider effect': some students would deliberately not invest any (or little) effort. Both principles, however, relate to group dynamics phenomena 'group cohesion' and 'social loafing' (Forsyth, 1999), and thus they apply to any form of small group learning.

Furthermore, it is gradually becoming more widely acknowledged that 'learning' and 'collaboration' both rely on interaction (Baker, 2002; Stahl, 2004; Strijbos, Martens, & Jochems, 2004), and thus that *interaction* is the primary process to be studied to assess performance and learning benefits in CSCL environments. Strijbos, Martens and Jochems (2004) propose a process-oriented design method for (computer-supported) group-based learning that focuses on fostering the envisioned group interaction that is thought to enhance learning instead of focussing on the final product of such interaction (which tends to be the dominant view in most institutes providing higher education). This method centres on five elements that directly shape group interaction: learning objectives, task-type, level of pre-structuring, group size and the technological tool used.

The need for systematic design of CSCL is amplified by some observations that conflicts regarding coordination during group interaction are more likely to occur in asynchronous CMC settings compared to face-to-face settings, since group members are not physically present at the same time and/or place (Benbunan-Fich & Hiltz, 1999). Finally, asynchronous communication is also ‘non-natural’ as immediacy of feedback, common in face-to-face settings, is not present. Clearly, some support should be designed to help students overcome difficulties in group coordination during asynchronous collaboration. One approach is to provide students with pedagogical support or a specific type of pre-structuring – which is often also referred to as ‘scripting’ (Dillenbourg 2002; Weinberger, 2003) – such as the use of roles.

6.2 The use of roles to support coordination during asynchronous CSCL

Group performance effectiveness depends on the one hand on the groups’ use of their alternate opinions and on the other hand on the handling of increased coordination (Shaw, 1981). Roles can promote group cohesion and responsibility (Mudrack & Farrell, 1995) and thus they can be useful in fostering ‘positive interdependence’ and ‘individual accountability’ (Brush, 1998). Roles can be defined as more or less stated functions/duties or responsibilities that guide individual behaviour and regulate group interaction (Hare, 1994). In addition, roles can stimulate a group members’ awareness of the overall group performance and each members’ contribution. As stated by Mudrack and Farrell (1995): “The opinions that others form about one’s contribution to the group effort will likely be influenced, in part, by which roles the focal group members play.” (p. 559). Finally, roles appear to be most relevant when a group pursues a shared goal requiring a certain level of task division, coordination and integration of individual activities.

Three main categories of roles can be distinguished: individual roles, task roles and maintenance roles, each of which is comprised of several different roles (Mudrack & Farrell, 1995). However, these are based on a self-report inventory and pertain to roles that participants can perform during collaboration and each participant performs several roles simultaneously, thus making it difficult to implement such roles in educational contexts. Several pedagogical approaches, developed for cooperative learning, use roles to support coordination and group interaction (Johnson, Johnson, & Johnson-Holubec, 1992; Kagan, 1994). These roles are either content-focussed – facilitating knowledge acquisition through individual knowledge differences using ‘Jigsaw’ (e.g., Bielaczyc, 2001), ‘scripted cooperation’ (O’Donnell & Dansereau, 1992), or ‘prompting scripts’ (Weinberger, 2003), or process-focussed roles on individual responsibilities regarding the coordination (e.g., Kynigos, 1999). Most roles developed for cooperative learning settings, however, comprise one single job, task or duty; mainly because they were developed for face-to-face collaboration in primary education. Although the use of roles is widely regarded as an effective instructional strategy in cooperative learning and CSCL, their effect has not been investigated systematically in both higher/distance and primary education.

If cooperative learning and more specifically roles were used in higher education, they were not adapted to higher education, although students in these settings vary considerably in (prior) knowledge, experience and collaboration skills, as compared to students in secondary/ primary education. Moreover, collaboration assignments in higher education are more complex and they take place over an extended period of time (i.e., not restricted to classroom time), thus requiring more explicit coordination than in primary or secondary education. Consequently, the previously mentioned uni-dimensional roles for face-to-face collaboration appear inadequate to support collaboration in higher education, let alone asynchronous CSCL settings. Thus, explicit and detailed roles descriptions should be provided.

6.3 Investigating the effect of functional roles in CSCL

The study reported in this article investigates the impact of roles that counter ‘process losses’ because of coordination demands. These roles are referred to as ‘functional roles’ based on role descriptions in reports by Johnson et al. (1992), Kagan (1994), and Mudrack and Farrell (1995); and adapted for an asynchronous CSCL setting in higher education. The present study is a follow-up to a previous study of ours (Strijbos, Martens, Jochems, & Broers, 2004). We found that functional roles appear to increase awareness of group efficiency, whether the group performs well or not. The outcomes also indicated that groups in the role condition appeared to be more susceptible to conflict and/or dropout. Examining dropout (‘during’ and ‘not finishing the course timely’ combined) revealed a significantly higher rate in nonrole groups (Kirschner, Strijbos, Kreijns, & Beers, in press) and students’ responses to open-ended evaluation questions revealed that the role groups experienced no negative consequences with respect to progress as a result of dropout (Strijbos, Martens, & Jochems, submitted). Clearly, dropout is not a preferable outcome from an educational point of view. Examination of the course design identified several preconditions that – if controlled – could decrease or prevent dropout, such as their preference for a practice assignment, slow or fast study pace, setting up of a time schedule, establishing a communication discipline and externalising expectations regarding effort prior to collaboration. Controlling for these preconditions can ensure a more evenly matched comparison of both research conditions.

The present study is a replication of the first, however, explicit attention was paid to the aforementioned preconditions and to control their possible confounding influence. The research question remains similar: ‘What is the effect of a prescribed functional roles instruction, compared to no instruction, on group performance and collaboration?’. Based on the outcomes of the first study it is expected that functional roles will have no effect on group performance (in terms of grade) because of lack of variance, however, it is expected that the roles will have a positive effect on collaboration in terms of perceived group efficiency. It is also expected that roles will decrease the amount of coordinative statements during collaboration in favour of content focused statements. Multiple methods were used to investigate the effect of these roles: self-report Likert-scales, quantitative content analysis of e-mail communication and cross case matrices of open-ended questions. It will be shown that triangulation of outcomes (obtained with different methods) is essential to investigate the effect of the functional roles in particular and to study CSCL in general.

6.4 Triangulating multiple methods to investigate CSCL

Before we proceed to the method and analyses of the self-report questionnaire data and e-mail communication it is important to point out that CSCL research requires triangulation of multiple methods to analyse data from multiple sources. In this study both quantitative and qualitative questionnaire data – as well as – quantitative analysis of a qualitative source (e-mail) are used. Analysis of each of these data sources requires a separate method.

6.4.1 Multilevel modelling

With respect to the analysis of self-report Likert-scale data, it is important to note the implications of non-independent observations with respect to the analysis of group collaboration. This issue was only recently raised in research on CSCL and small group collaboration. Cooperative learning research has frequently applied the ANOVA procedure to investigate the impact of an instructional strategy using individual level observations (see Slavin, 1995). This is no exception in some recent CSCL studies (Hübscher-Younger & Narayanan, 2003; Van Oostendorp & Juvina, 2003). However, individual scores are influenced by the group a student belongs to, thus their scores are not independent. Non-independent observations have strong implications for the analysis of group processes. Stevens (1996) points out that ANOVA is not suited: the assumption of independence is violated, because students' perception of efficiency depends on all members' contributions. Violation of independence increases as a function of the interdependence in a group, thus yielding a major increase of a Type I error. As an alternative Stevens (1996) suggest either to test with a stricter level of significance ($p < .01$ or even $p < .001$) or to use the group average. Multilevel modelling (MLM) is a technique that pays explicit attention to nested structures of data (individual in groups) and the subsequent interdependence between individual scores, without loosing variance as is the case when the group mean is used. MLM appears to be the best suited technique to investigate self-report perception questionnaire data (cf. Bonito, 2002). Since most CSCL research designs do not exceed 20 participants (Stahl, 2002) and MLM-analyses with a small sample size (less than 50) are rarely performed, we will discuss the methodological and analytical considerations in more detail in the method and results section that covers the MLM-analyses.

6.4.2 Content analysis

Analysis of written electronic communication transcripts has gained increased attention in CSCL in the past decade (Hara, Bonk, & Angeli, 2000; De Laat & Lally, 2003). In general two approaches exist: the 'quantitative' and the 'qualitative' approach. In the first approach communication is coded and obtained frequencies and percentages are used in statistical comparisons. The latter approach deploys techniques such as phenomenography, ethnography and participant observation techniques to reveal descriptive trends (Miles & Huberman, 1994). Large variations with respect to the unit of analysis exist; it can be a message, paragraph, theme, unit of meaning, illocution, utterance, statement, sentence or proposition. Common to all is that the unit is ill-defined and arguments for choosing a specific unit are lacking (Strijbos, Martens, Prins, & Jochems, in press). Furthermore, although it is acknowledged that reliability for a quantitative content analysis procedure is essential – and studies often report an intercoder reliability statistic – reliability is seldom addressed with respect to the unit of analysis (Rourke, Anderson, Garrison, & Archer, 2001). Although Neuendorf (2002) states, “Without the establishment of reliability, content analyses measures are useless.” (p. 141), some examples of statistical comparison without any intercoder reliability being provided can be found in CSCL research (Pata & Sarapuu, 2003). More rigour regarding the reliability of ‘segmentation in units of analysis’ and ‘coding’ are essential to warrant the accuracy of observations. Irrespective of the segmentation reliability, the units should still be meaningful with respect to coding; in other words enable a researcher to answer the research question. We used ‘a sentence or part of a compound sentence’ as the unit of analysis. A procedure to segment transcripts in the units was developed, as well as a procedure for coding. Data with respect to the reliability of both procedures and outcome of the analyses will be provided in the results section.

6.4.3 Cross case matrices

Open-ended questions were included in the evaluation questionnaire to provide opportunities for extended feedback. The questions were divided in five categories: ‘general issues’, ‘functional roles and task division’, ‘collaboration progress’, ‘coordination impact’ and ‘assessment and supervision’. Groups in the role condition answered twenty open-ended questions and students in the nonrole groups answered seventeen questions (a slight difference due to specific evaluation of the roles). Cross case matrices were used to analyse students’ responses to the open-ended questions (see Miles & Huberman, 1994). The matrices were constructed by aggregating individual responses per group and per category. Next, individual responses were summarised at the level of the group to create a cross case matrix at the group level for each category. Finally, group level summaries were aggregated to construct cross case matrices at the level of the condition for four categories.

6.5 Method

6.5.1 Participants

At the Open University of the Netherlands (OUNL) 39 students enrolled in a course on ‘policy development’ (PD) and 25 students in a course on ‘local government’ (LG). In total 64 students enrolled (36 male and 28 female). Their age ranged from 22 to 55 years (Mean = 38, SD = 8.42, 1 missing). Five students enrolled in both courses. Also, four students enrolled who had already participated in either course in the previous year. Participants varied in their educational and professional background (common to distance education). The course was completed by 49 students, of whom 41 returned the evaluation questionnaire.

6.5.2 Design of study

The study has a quasi experimental random independent groups design. The experimental manipulation involved the introduction of a prescribed role-instruction in half of the groups (R-groups). The instruction aimed at promoting the coordination and organisation of activities that were essential for the group project. The other half of the groups was left completely self-reliant regarding organisation and coordination of their activities (NR-groups). Each group consisted of three to five students – depending on the number of students that chose to start with a practice assignment and whether they elected a slow of fast study pace – and the groups communicated electronically by e-mail throughout the course. Their task was to collaboratively write a policy report providing a recommendation regarding reorganisation of local administration, a topical subject in the Netherlands.

To assess the effect of roles on performance, group-level grades are compared. In order to investigate their effect on the perceived collaboration each students' perception of their teams' development, group process satisfaction, their task strategy, the level of intra-group conflict and the quality of collaboration have been measured. All e-mail communication was analysed to investigate whether the roles decreased coordination in favour of statements focusing on the content of the task. Finally, students' responses to open-ended questions were analysed to complete and strengthen the interpretation of results obtained.

6.5.3 Materials

6.5.3.1 *Instructions*

Half of the groups were instructed to use functional roles: 'Project planner' (PP), 'Communicator' (CO), 'Editor' (E) and 'Data collector' (DC). The other half received a non-directive instruction (e.g., obvious, unspecific and general information regarding planning and task division) and they were instructed to rely on their intuition or previous collaboration experiences (for instructions see Strijbos, Martens, Jochems, & Broers, 2004). Students in the R-groups had to distribute the roles themselves and exerted their role for the full duration of the course (roles did not rotate). Instructions in both conditions were delivered as a short electronic text at the beginning of the course. They were also presented to students present during a face-to-face meeting at the start of the course.

6.5.3.2 *Intake questionnaire*

The intake questionnaire consisted of two sections. One section combined several scales addressing individual characteristics such as attitudes, need for closure and achievement motivation. All items were rated on a five-point Likert-scale. These scales were all already previously tested and their reliability ranged from .78 to .86. Reliabilities that will be reported further, only apply to this study.

Both attitude scales (Clarebout, Elen, & Lowyck, 1999) were reliable and measured at intake and evaluation: attitude towards computer-mediated communication (intake: α = .67; 8 items) and attitude towards collaborative problem solving (intake: α = .81; 7 items). A scale to assess active or passive orientation to group work (α = .62; 6 items) was constructed and tested prior to this study (Strijbos, 2000). The Need for closure questionnaire is developed by Kruglanski (cf. De Grada & Kruglanski, 1999) and translated into a Dutch version by Cratylus (1994); the latter version was used in this study. Need for closure consist of five subscales: need for structure, need for predictability, decisiveness, intolerance for ambiguity and closed-mindedness. The scales need for structure (α

= .79; 8 items), need for predictability (α = .67; 7 items) and need for decisiveness (α = .71; 6 items) were sufficiently reliable to be used in further analyses. Achievement motivation (Hermans, 1976) was measured using the P-scale of this questionnaire (α = .86; 44 items). ICT-experience was measured through several non-scaled questions adapted from Valcke (1999). Finally background characteristics (such as received education/training, occupational group and branch of industry) were collected using a standard Open University of the Netherlands (OUNL) questionnaire. Out of the 64 students that enrolled in the course – controlling for the five students that registered for both courses – 56 out of a possible 59 students (95%) returned the intake questionnaire. The course was successfully completed by 49 students (76.5 %), of whom 41 returned the evaluation questionnaire (83.7 %).

6.5.3.3 *Evaluation questionnaire*

The evaluation questionnaire consisted of forty-six items, belonging to six scales that are rated on a five-point Likert-scale and several questions that were rated on a ten-point scale. Results that will be reported in this article are restricted to the six scales, which were already previously tested and showed reliabilities ranging from .76 to .92, and one question rated on a ten-point scale: perceived quality of collaboration. Reliabilities that are reported further, only apply to this study.

Attitude towards computer-mediated communication (α = .85; 8 items) and attitude towards collaborative problem solving (α = .85; 7 items) are self-evident. Team development (α = .90; 10 items) provides information on the perceived level of group cohesion, whereas group process satisfaction (α = .71; 6 items) provides the perceived satisfaction with general group functioning (both cf. Savicki, Kelley, & Lingenfelter, 1996; translated into Dutch). Intra-group conflict (α = .80; 7 items) provides the perceived level of conflict between group members and task strategy (α = .86; 8 items) indicates whether students perceive that their group deployed an appropriate strategy for the given task (both cf. Saavedra, Early, & Van Dyne, 1993; translated into Dutch). In addition students were requested to answer about twenty open-ended questions (opportunities for extended feedback).

6.5.4 Procedure

After course registration students were informed that the research investigated the group processes of students collaborating through e-mail and to determine the suitability of this format for distance education. Two weeks prior to the start of the course students had to indicate whether they wanted to start with the group assignment in October 2001 or March 2002. Based on the evaluation of the first study students were asked to indicate whether they wanted to start with a practice assignment or to proceed right away with the final assignment that would be graded. They were also asked whether they preferred a slow (ten months) or fast (six months) pace to complete the group assignment. In contrast to the first study, geographical distance was not increased, as the first study had revealed that students would organise a face-to-face meeting regardless of distance. Most students could be grouped according to their preference regarding the assignment and the study pace, however, given the number of registering students it was not always possible to maintain groups of four students. Overall, three groups in the role condition constituted of three members from the start. A separate role instruction was provided for these groups in which the tasks of the data collector were added to the reporter. It was assumed that it did not increase that students' workload too much as the role instruction explicitly stated that studying the data could be distributed. The other four role groups started with four group members. In the nonrole condition, two groups started out with five members and the other four groups with four group members.

Prior to collaboration a separate face-to-face meeting was organised for each research condition. General information and the instructions in both conditions were provided during this meeting and electronically afterwards. Students were introduced to a communication discipline (visible prior to registration) and a project planning form. The communication discipline (see appendix A) was introduced to ensure that students would start with the assignment within two weeks after the meeting. In the first study some groups had to be excluded because students did not respond until four weeks after the start of the assignment, destabilising and ultimately wrecking the group. In addition, a project planning form was introduced to focus students' attention on the need to coordinate their resources, but they were also asked to indicate how many hours they could contribute to the group assignment on a weekly basis; as the first study had revealed that students greatly varied in the amount of hours they could spent on their study.

After the meeting all remaining contact between students was virtual. Role groups were required to inform their supervisor about the distribution of the roles in their group within two weeks. Contact with the supervisor was restricted to a single group member in the role groups and s/he (Communicator) was required to hand in a progress report every two weeks, whereas all students in nonrole groups were allowed to contact the supervisor. In contrast to the first study, however, nonrole groups had to hand in a progress report every four weeks: on the one hand to increase a 'sense' of supervision but on the other hand to retain a difference with the role groups. Supervisors were instructed to answer questions that focused on the content of the assignment. Supervisors were not allowed to provide support regarding coordination and group management. If a request for support was received, students in the role condition were told to rely on the roles, whereas students in the nonrole condition were told to rely on their intuition or experiences with collaboration. Although students were instructed to use e-mail, it is by no means possible nor feasible to exclude customary communication channels, such as telephone and face-to-face contact. If used, students were requested to send transcripts to their group to retain transparency of communication. Occasionally students used the telephone during their collaboration, but most contact was by e-mail. Three groups organised a face-to-face meeting; two of them organised a meeting twice. Five students participated in both courses and were placed in the same research condition (three students in the role condition and two in the nonrole condition). Since students had two opportunities to start with the group assignment and given their preference regarding the assignment and study pace, two students that participated in both courses at the same time had to be grouped in the same condition in the same group (one of them dropped out in both groups due to a conflict with the other member that also participated in both groups). Four students already participated in either course in the previous year and were placed in the same research condition (three students in the role condition and one in the nonrole condition; they had not participated in particularly well performing groups in the first study). None of the students that had participated in the previous year were grouped together in the same group. Although some of the students participated in both courses and/or for a consecutive time, they were included in the analyses because firstly group efficiency and collaboration relies on the interaction with other group members and secondly they collaborated with three other members with whom they had not worked before. One student that was placed in a role group never contacted the group, as only two members remained that group was excluded from all of the analyses. All remaining groups managed to finish the course timely.

6.6 Results

6.6.1 Investigation of correlations between individual characteristics and dependent variables

Pearson correlations were computed to investigate whether the variables measured at the intake could be used as covariates. A correlation matrix was computed. No correlations were found between any of the variables measured on intake. Neither at the individual level between these constructs and any dependent variables measured at the evaluation, nor at the group level between these constructs and grade were any correlations found. It was concluded that none of the variables from the intake, signifying individual characteristics, could be used as covariates in further analyses.

6.6.2 Effect of condition on grade

Grades were administered on a group level. A Mann-Whitney U-test was performed to investigate the difference between the role (Mean 7.4, SD = .70) and nonrole (Mean 7.8, SD = .34) condition. A non-directional test was performed. No main effect was observed for grade Mean $\text{Rank}_{\text{role}}$ = 5.71; Mean $\text{Rank}_{\text{nonrole}}$ = 8.50; $U = 12.000$, $df = 5$).

6.6.3 Descriptives and correlations between dependent variables

Descriptives were computed for both conditions. A considerable spread of scores is indicated by standard deviations, occurring in both conditions, shown in Table 1. Pearson correlations between these six variables were computed for the entire sample (N = 41). Medium to high correlations (.49 to .78, $p < .01$) were found between all of the variables, except for 'Attitude towards CMC' and 'Attitude towards CL'.

To avoid the problem of multiple testing principal axis factoring was performed to investigate whether a possible latent variable existed. Table 2 shows the factor loading scores. The extraction explains 71% of all common variance between the dependent variables and factor scores were computed.

Table 1 Mean and standard deviations of dependent variables by experimental condition

	Role (N = *18*)		*Nonrole* (N = *23*)		
	M	SD	M	SD	Min, max
Quality of collaboration	7.22	2.01	6.57	1.38	1, 10
Team development	3.75	0.64	3.39	0.62	1, 5
Group process satisfaction	3.91	0.60	3.61	0.57	1, 5
Intra-group conflict	1.94	0.64	2.56	0.53	1, 5
Task strategy	3.88	0.56	3.47	0.55	1, 5
Attitude towards CMC	3.79	0.43	3.52	0.64	1, 5
Attitude towards CL	3.82	0.62	3.54	0.58	1, 5

Table 2 Factor extraction for dependent variables

	Factor loading
	Extraction I
Quality of collaboration	.736
Team development	.734
Group process satisfaction	.791
Intra-group conflict	-.878
Task strategy	.859

The resulting factor was interpreted as ‘perceived group efficiency’ (PGE). Standardised factor scores were computed for all variables used in the Extraction. In the subsequent analysis we will refer to this variable as PGE.

6.6.4 Multilevel modelling

Our sample consists of 13 groups and the number of observations in each group varies between two and five. This design is skewed, i.e. the number of observations on levels 1 (group) and 2 (individual) are not balanced. Although our model is less efficient in the so-called random component on both levels, however, ML-analyses can be applied (Mok, 1995). Secondly, our sample size is rather small (N = 41). This has some implications for performing ML-analyses, especially with respect to statistical power. Although the technique will be discussed to some extent, we refer to Strijbos, Martens, Jochems and Broers (2004) for more detail.

Investigating the influence of roles on perceived level of group efficiency (PGE) suggests the use of a t-test or its equivalent reformulation into an ordinary least squared regression model (Ordinary Least Squares – OLS). However, OLS-regression assumes that the residuals are independent and this assumption is obviously violated, because the scores of students in the same group will be more similar than the scores of students from different groups. MLM is more appropriate and thus the intra-class correlation coefficient, a measure of the dependency between scores within the same group, was computed (.45). Failure to incorporate this interdependency among scores in a statistical model will lead to an underestimation of the standard errors of model parameters, resulting in a much larger than nominal probability of a Type I error (Snijders & Bosker, 1999). Instead a multilevel model (model one) was constructed using CONDITION as a predictor of the dependent variable PGE yielding a so-called random intercept model (Snijders & Bosker, 1999):

$$PGE_{ij} = \gamma_{00} + \beta_1 \times CONDITION_j + U_{0j} + e_{ij} \quad (1)$$

The PGE score of person *i* in group *j* is the result of equation (1), where γ_{00} is a fixed intercept, β_1 is the regression coefficient of group level variable condition, CONDITION is a 0–1 indicator variable with 1 corresponding to nonrole group, U_{0j} is group level variance and e_{ij} is individual level variance. Estimation of this model (ML-wiN, Version 1.10) yielded the following fixed parameter values (with corresponding standard errors within parentheses): PGE_{ij} = .403 (.256) - .745 (.362) × CONDITION. An overview of the random parameters is provided in Table 3.

Table 3 Random variance estimates of the random intercept model

Parameter	*Estimate*	SE
Group-level variance	.254	.171
Individual-level variance	.521	.139
Deviance = 101.517		

The deviance reported in this table is equal to minus twice the log-likelihood and can be used for a formal test of the goodness-of-fit of the model. By comparing this deviance value with the deviance of the model without CONDITION as predictor (so-called null or empty model), a significance test for CONDITION is provided. In spite of the small number of observations the effect of providing roles to group members is shown to be marginally significant ($\chi^2 = 3.525$, $df = 1$, $.05 < p < .10$).

However, in our first study we also tested the hypothesis that roles, in theory, are likely to increase individual awareness of group efficiency. Indeed, evidence for such ‘heteroscedasticity’ (unequal error variances), instead of the homoscedasticity underlying a random intercept model, was found in our earlier study. Groups in the role condition were divided in two distinct clusters whereas groups in the nonrole condition were more homogenous, thus it is reasonable to assume that this might be the case for our present data. Heteroscedasticity can be included in a ML-model by allowing a *random slope*: the regression coefficient of CONDITION is allowed to vary in both levels (see Snijders & Bosker, 1999, p. 119):

$$PGE_{ij} = \gamma_{00} + \gamma_{10}CONDITION_j + U_{0j} + U_{1j}CONDITION_j + e_{ij} \quad (2)$$

In model (2) $\gamma_{00} + \gamma_{10}CONDITION_j$ represents the fixed part and $U_{0j} + U_{1j}CONDITION_j + e_{ij}$ the random part. Analysis of the fixed part of the model yielded the following results: PGE = .396 (.302) - .737 (.369) × CONDITION. Estimations of the random part of the model are provided in Table 4.

Table 4 Random variance estimates of the random slope model

	Group level	
Parameter	*Estimate*	SE
Variance intercept	.434	.343
Variance slope	.000	.000
Covariance slope and intercept	-.149	.187
	Individual level	
Parameter	*Estimate*	SE
Variance	.507	.135
Deviance = 100.821		

The residual variance on the group level has been translated in a variance of the intercept (0.434), a variance of the regression slope (zero) and a co-variance between values of U_{0j} and U_{1j} values (- 0.149). Comparing the deviance of the random slope model (2) with the deviance of the fixed slope model (1), shows that the model fit does not improve after including a random slope parameter (χ^2 = 0.696, *df* = 2, *p* >.05). In addition, the estimation of the regression slope variance was estimated as zero. However, in the case of a limited number of observations the statistical power of the test is comparatively small and a closer look at the marginally effect for the random intercept model is warranted. We looked at predictions of PGE for each group (R = role group, NR = nonrole group), based on the random intercept model. The results are shown in Table 5 and graphically depicted in Figure 1.

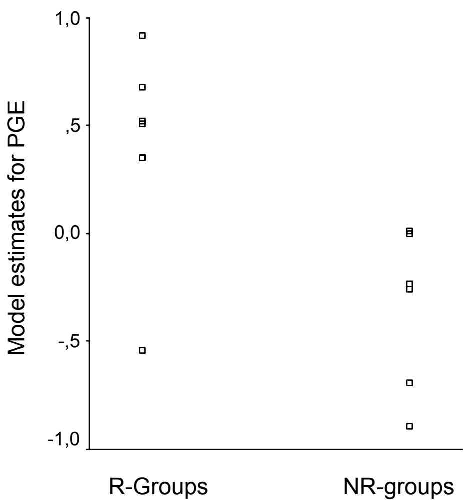

Figure 1 Model estimates of PGE for the random intercept model

Table 5 PGE prediction estimates by group for the random intercept model

Role	
Group	PGE estimate
PD 1	.52
PD 2	-.54
PD 3	.35
PD 4	.92
PD 5	.51
LG 2	.68
LG 4	.35

Nonrole	
Group	PGE estimate
PD 6	-.69
PD 7	-.89
PD 8	.00
PD 9	.01
LG 1	-.26
LG 3	-.23

Figure 1 shows that the level of PGE for most role groups is consistently higher than the level for nonrole groups. In addition, the variances in the role and nonrole condition are for the most part equal. The lack of statistical significance seems to be affected by an apparent outlier in the role condition. However, given our previous finding, this outlier in fact signals a meaningful difference, i.e. roles appear to increase awareness of group efficiency and more extreme scores in the role condition are thus to be expected.

6.6.5 Content analysis

Before discussing the outcomes, it is must be noted that all contributions by group members of the groups used in the MLM analyses, regardless whether they finished the course or returned the evaluation questionnaire, were included. Content analysis was performed on all e-mail messages contributed by fifty-one subjects equally distributed across research conditions (role n = 7, N = 25; nonrole n = 6, N = 26). All communication on the first assignment the group performed (practice or final) was analysed. Although one nonrole group started with the practice assignment but switched halfway to the final assignment, it was decided to include only the communication on the practice assignment in the analysis. Including all communication would not only result in an increase of statements coded, but specifically coordination would be affected as this is typically conducted in the first half of the collaboration (which is corroborated by an overall examination of communication in all groups).

A segmentation procedure that would be systematic and independent of the coding categories was developed (Strijbos, Martens, Prins, & Jochems, in press). Although the sentence as a unit of analysis is not uncommon (e.g., Fahy, Crawford, & Ally, 2001; Hillman, 1999), segmentation of compound sentences was added. The unit was defined as 'a sentence or part of a compound sentence that can be regarded as a meaningful sentence in itself, regardless of coding categories'. Punctuation and the word '*and*' mark potential segmentation, but this is only performed if both parts before and after the marker are a 'meaningful sentence' in itself. Intercoder reliability of two segmentation trials was. 82 and .89 (proportion agreement, for more detail see Strijbos, Martens, Prins, & Jochems, in press) and corroborated by a cross-validation check on an English language set of messages contributed to a discussion forum during project-based learning (high similarity to our research context): proportion agreement turned out to be .87. In addition, a coding scheme was constructed with five main categories 'task coordination (TC)', 'task content (TN)', 'task social (TS)', 'non task (NT)' and 'non-codable (NOC)'. Reliability (Cohen's kappa) proved to be on average .70 (substantial) (cf. Landis & Koch, 1977).

Statistical comparisons were restricted. For the questionnaire data it was possible to reduce the number of dependent variables to a single factor to avoid the problem of multiple testing. Principal axis factoring of the five main categories, however, does not result in a factor that can be meaningful interpreted, therefore statistical comparisons were restricted to the number of messages, segments and the frequency for each main category on the level of the group. Because of the small number of observations, the Mann-Whitney U-test was performed to compare the research conditions. Results are depicted in Table 6.

Table 6 Mean, standard deviations and Mann-Whitney rank scores for the number of messages, number of segments and the five main categories

	Role (n = *7*)			*Nonrole* (n = *6*)		
Item	M	SD	*Rank*	M	SD	*Rank*
Number of messages	128.57	29.27	9.0	80.29	41.14	4.7
Number of segments	1053.71	348.62	7.1	1059.17	526.13	6.8
Task coordination	114.96	46.06	8.7	75.73	32.98	5.0
Task content	61.90	41.90	6.6	65.82	52.97	7.5
Task social	9.63	5.25	8.6	5.20	4.82	5.2
Non task	26.68	14.52	7.4	21.99	8.09	6.6
Non-codable	92.60	48.36	7.4	81.92	53.16	6.5

A main effect was observed for the number of messages send ($U = 7.000$, $df = 5$, $p < .05$), however, no difference was observed for the number of segments coded. Significant more 'task coordination' ($U = 9.000$, $df = 5$, $p < .05$; one-sided) was observed in favour of the role groups. A one-sided test was performed, as it was expected that roles would decrease 'task coordination' in favour of 'task content'. No main effect was found for any of the other main categories.

6.6.6 Cross case matrices

Student responses to the open-ended questions were aggregated at the condition level for the categories 'general issues', 'collaboration progress', coordination impact' and 'assessment and supervision'. Responses to the category 'functional roles and task division' were aggregated at the group level because the questions differed for both conditions and students' responses turned out to be very diverse.

6.6.6.1 *General issues*

General issues concerned two questions: 'Did your group use other information and communication tools (ICT) than e-mail or organise a face-to-face meeting?' and 'Did your group use the revise tool in Microsoft Word©?'. Differences between the conditions were only observed for the first question and student responses are shown in Table 7.

Table 7 Matrix for the use of other ICT tools by condition

Role (n = *7;* N = *18)*	*Nonrole (*n = *6;* N = *23)*
Four students in two different groups used the phone. One adds they used it twice and one once. Two students in another group add they used the phone several times.	Three students in three different groups used the phone. One adds it was used once. One adds using it twice and one adds using it on a regular basis with another student. Two students in two different groups report that a face-to-face meeting was organised. One student adds it was held twice. Four students in the same group report that they used chat ('Netmeeting') twice.

Students in the nonrole condition – compared to students in role groups – report using other communication tools (telephone, chat and/or a face-to-face meeting) more frequently. Interestingly students of the role group with a high level of PGE collectively keep silent about the fact that they met twice for a face-to-face meeting (revealed by the e-mail communication transcripts).

6.6.6.2 *Functional roles and task division*

Functional roles and task division comprises different questions for each condition. Students in the role condition were asked three questions: 'How did you experience your role?', 'Do you think that the functional roles were adequate and equal in workload?' and 'Do you believe that your role increase your involvement with the collaboration?'. Given the diversity of the responses these are summarised at the group level and shown in Table 8.

Students in the nonrole groups were asked to 'Describe how your group divided the tasks: did you group split-up the content of the product and divide it amongst their members or did your group use functional tasks or roles?'. Given the diversity of questions in both conditions the student responses are only summarised at the group level. The results are shown in Table 9.

Table 8 Matrix by group for students' experience, perception of equality and increased involvement in role groups

	Functional roles						
	BK 1 (N = 3)	*BK 3* (N = 2)	*BK 5* (N = 2)	*BK 7* (N = 2)	*BK 9* (N = 3)	*GK 2* (N = 3)	*GK 4* (N = 3)
How was role experienced?	Three experienced the role as positive. One adds that the progress reports are important. One adds that s/he did not have to remind the others. One adds s/he liked his/her role as s/he likes to write, but adds it's the most dependent role and s/he doesn't prefer it.	One student reports performing the role as was expected but others had a lack of discipline. One states that his/her role felt important but s/he only got comments from one member.	One student reports that s/he did not have to remind others of their task, so the execution of the role went fine. One states that his/her role was not intensive.	One student reports the prescribed roles were good, although it left little room for interpretation. One of the students reports that s/he experienced the role as constructive and adds also thinking outside his/her role but in the interest of the team.	One experienced the role as pleasant. One describes the role. One student reports that his/her role was not executed as s/he had intended.	Two experienced the role as good. Two add that the group applied flexibility in execution. One adds s/he worked with roles in his/her work environments and it influences the final result.	Two experienced the role as pleasant. One adds all (but one) did keep to their role and one adds his/her role was not difficult as s/he had prepared a part of it in advance. One of the students describes the role.
Role division equal?	Three students report that roles were not equal. One adds that CO is easier and one adds the E role requires more effort.	Two students report that roles were not equal. One adds that E takes more effort. One adds that CO takes the least effort.	One student reports that roles were equal, but adds the writing must be distributed, but revising by one. One adds the E role was not important in their group.	One student reports that roles were equal, but adds that CO was lighter. One reports roles were not equal and adds that PP is quite intensive at the start and CO vague.	Two students report that roles were not equal. Two add that E takes more effort, one also adds CO is lighter. One reports the roles were equal, but s/he put in more effort voluntarily.	Two students report that roles were not equal. Two add CO takes the least effort and one also adds DC is lighter. One reports the roles were equal, given that they were handled flexibly.	One student reports that roles were not equal and adds that E and DC require more effort. Two report the roles were equal and one adds investing more effort voluntarily.

NOTE: PP = Project planner; CO = Communicator; E = Editor; DC = Data collector

Table 8 Matrix by group for students' experience, perception of equality and increased involvement in role groups (continued)

	Functional roles						
	BK 1 (N = 3)	*BK 3* (N = 2)	*BK 5* (N = 2)	*BK 7* (N = 2)	*BK 9* (N = 3)	*GK 2* (N = 3)	*GK 4* (N = 3)
Role increased involvement?	Two students report the roles increased involvement. One of them also adds that the progress reports did increase activity. One adds that of the roles, the E role is most demanding.	Two students report the roles increased involvement. One of them adds s/he now knows a lot about the topic. One adds that helping with editing increased the value.	One student reports that roles increase involvement equally. One reports his/her role was not very important in their group.	Two students report their role did not raise involvement. One of them adds that you simply have to go for it at all times.	Two students report their role did not raise involvement. Both of them add all group members were very involved. One also adds that they did not stick to the roles. One adds that his/her role was pivotal in the team.	Two students report the role raised their involvement. One of the students adds that s/he integrated comments by others. One adds that the coordination requires decisions to keep the group on track. One student reports roles made no difference for involvement.	Two students report the role raised their involvement. One of them adds selecting information felt as being important. One student adds performing a pivotal role and that s/he motivated the others. One reports roles did not raise involvement ('a role is a role').

Table 9 Matrix by group for students' perception of the organisation and task division in nonrole groups

	Task division					
	BK 2 (N = *3*)	*BK 4* (N = *4*)	*BK 6* (N = *3*)	*BK 8* (N = *4*)	*GK 1* (N = *5*)	*GK 3* (N = *4*)
Describe how your group divided tasks? Splitting up content or use of roles?	Three students report the work was done in two sub groups: one group would do everything for the practice assignment; the other group would do the most work for the final assignment. One adds that two members in the end finished the report. One adds there were no roles used. One adds the progress reports were made in rotation.	Four students report that in the end a student was assigned as a 'director'. One adds this member became also a 'process' guard. Two add that the individual contributions were combined in the report by this member. One adds s/he proposed to have a 'coordinator', which s/he became.	Three students report the use of roles. Two add it was a 'coordinator' and a 'writer' role. One adds that each group member was assigned a part of the content. One adds the roles were established only after a face-to-face meeting.	Four students report the content was split up and divided between the group members. Two add that there were no roles, but an editor was assigned. One adds that functional tasks were performed in a natural way. One adds that the progress reports were made in rotation.	Four students report the content was split up and divided between group members. Three add that there were no roles, but an 'editor' and the task of progress reports were assigned. One adds that a 'chair' could prevent some of the difficulties in their coordination. One adds s/he took the lead in the beginning and s/he suggested that group members choose a part of the content to their personal interest. One reports a list of the tasks that were assigned.	Three students report the content was split up and divided between the group members. All add that one member voluntarily took the task of adding individual contributions into a shared report and one voluntarily took up the task to write progress reports. Two add there was no conscious use of functional roles or task division.

Students in the role condition express that the functional roles were not equal with respect to the associated task. Although the students performing the roles of ‘Project planner’ (PP) and ‘Communicator’ (CO) can limit their contribution to occasional check-ups on group progress, students in the role condition were informed that all students were required to provide input and effort for the group product (policy report). In the nonrole groups students’ responses indicate a pattern that can be referred to as ‘splitting up the task’. In most groups the content of the task was divided between the group members (or subgroup dyads) and each studied the associated literature and individually wrote that part of the shared policy report. In four groups a leader or an editor role emerged spontaneously during the collaboration, mostly because of experienced necessity with respect to maintaining the groups’ progress rather than an individual preference.

6.6.6.3 *Collaboration progress*

Collaboration progress consists of four questions: ‘How was the progress of collaboration in your group?’, ‘Do you believe that group members contributed equally to the collaboration?’, ‘Did you often experience that you had to wait for other group members during collaboration?’ and ‘Did group members dropout during collaboration, and if so were there any consequences?’. Differences between the conditions were only observed for the first and third question. Student responses to these questions are shown in Table 10.

Table 10 Matrix for perceived collaboration progress and waiting by condition

Role (n = 7; N = 18)	
How was the progress of collaboration?	Experienced waiting for group members?
Thirteen students in six different groups report that the progress was fine. Three students in the same group add it was rough in the beginning, but after a member that did not contribute dropped out it was fast, good and pleasant. Two students in another group add that it refers to three of the four members, but one student in the same group adds that it refers to all. Four students in three groups add that there was a good division of labour and signal there was mutual understanding. One adds that although the collaboration was pleasing it required some time to get a grip on the assignment. Two students in the same group report collaboration did not progress smoothly, One of them adds that activities were taken up slowly and agreements not kept. One adds that only two of the four members were active.	Three students in two different groups experienced having to wait for other group members. One student adds this involved often an extra e-mail for clarification. One adds s/he had to wait often and describes it as de-motivating; one student in the same group adds that sometimes no response was received. One student reports having to wait occasionally and adds this involved holidays but also adds that the members informed each other regularly enabling them to anticipate. Fourteen students in five different groups report that they did not have to wait. Five students add that they kept to the planning (tasks/deadlines). One student in two different groups adds s/he is pleased that the other members adjusted to his/her faster study pace. One student adds that the members might have waited for him/her. One student in another group adds that the collaboration was fast and relaxed.

Table 10 Matrix for perceived collaboration progress and waiting by condition (continued)

*Nonrole (*n = *6;* N = *23)*	
How was the progress of collaboration?	Experienced waiting for group members?
Ten students in five different groups report that progress was fine. Two students in the same group add that it was fine with one of the members and that both other member did not contribute. One student in another group adds that this refers only to three of the four members. One student in another group adds it was better during the final assignment than during the practice and one student in the same group adds that the face-to-face meetings improved progress. Six students in three different groups report that progress was difficult or not smooth. Two students in the same group add that the collaboration was better during the final assignment than the practice assignment. In another group one student adds that a group member acted negatively towards another and one adds forced collaboration is always difficult. Three students in three different groups add that there were differences of opinion. One student reports that the other two members wanted to proceed faster, but s/he elected the OUNL to determine his/her individual study pace.	Nine students in six different groups experienced having to wait. Three students in the same group add that this refers to the practice assignment and not to the final assignment. Two students from the same group add that they had to wait for the social loafer. Five students in four different groups indicate this involved waiting for a response. One also adds that it seemed at times that group members were attending to other (non study related) matters; and one adds that another group member only spend one night per week on the group assignment. Three students in two different groups report that they waited occasionally. Eleven students in four different groups report that they did not have to wait. Two students in the same group indicate that s/he also not responded fast. Two students in two different groups indicate that waiting involved holidays and that this was not annoying. One adds not having to wait but is not pleased that the group finished ahead of schedule. One student reports that waiting was no problem as s/he focused on other courses in the mean time.

In comparison, more students in the role condition report that the progress of the collaboration was fine, whereas more students in the nonrole condition report that progress was difficult or slow. With respect to student perception of the equality of participation, there is no difference between both conditions. In the nonrole condition, this was attributed to a lack of participation of a group member(s), whereas student in the role condition ascribe the perceived inequality to the functional roles. Analysis of the extent to which students report that they experienced waiting for other group members is closely connected with the first question in this category. Students in the nonrole condition already reported that collaboration progress was difficult or slow, but they also report frequently that they waited for group members – however not more often than students in the role groups. Interestingly, students in both conditions consider a lack of planning or not meeting agreed tasks or deadlines (agreements) as the prime cause for waiting. Finally, with respect to the dropout there is no difference between the conditions and students report that this had no serious consequences. In general, however, the role or task(s) of the member that dropped out was taken over by one of the remaining members and not evenly distributed.

6.6.6.4 *Coordination impact*

Coordination impact addresses two questions: 'Did your group make many agreements about activities or deadlines?', 'Did these agreements stimulate the groups' progress?'. There were no differences in the extent to which agreements were made with respect to activities or deadlines. Similarly, there was no difference between the conditions whether these agreements focussed on organisational issues or the content of the task. Although there was no difference with respect to making agreements, students in nonrole groups indicate more frequently that the agreements did not stimulate progress. Table 11 presents students' responses.

Table 11 Matrix for whether agreements stimulated progress by condition

Role (n = *7;* N = *18)*	*Nonrole* (n = *6;* N = *23)*
Fourteen students in six different groups report the agreements stimulated progress. One of them reports that agreements did not stimulate progress, however, s/he adds that other group members were sufficiently professional to keep them. Four students in four different groups add that agreements provided clarity and members knew what they were expected to do. One students adds a planning forces members to respond timely. One student adds agreements are essential. One student reports that agreements sometimes stimulated progress, but also lead to delay while waiting for an answer. Two students in the same group report that agreements did not stimulate progress. Both add that they were often not kept.	Twelve students in four different groups report the agreements stimulated progress. One student adds that members kept to the agreements and another student in the same group adds any changes in the agreements were timely communicated. One adds that sometimes members had to be reminded. One adds the agreements stimulated progress but that it only refers to three of the four group members. Two students in the same group report that the agreements stimulated progress mostly. Eight students in four different groups report that the agreements did not stimulate progress. Six students in four different groups report that it was mostly caused by one group member not responding or keeping the agreements. Three of them explicitly add it resulted in frustration and irritation. One student adds that the others wanted to move faster which also happened.

In most cases, the perceived lack of progress from making agreements is attributed to group members not keeping them or not responding at all. Three students explicitly state that this was frustrating and resulted in irritation.

6.6.6.5 *Assessment and supervision*

Assessment and supervision is comprised of three questions: 'Do you think it is justified that all group members get the same grade?', 'Did your group contact the supervisor and how do you rate the response?' and 'What is your opinion about the supervision throughout this assignment?'. Students in both conditions do not differ in their opinion towards the use of group grades. In fact, most students consider this appropriate because it concerns a 'shared report'. With respect to the contact with a supervisor also no differences were observed, however, rating the supervision did reveal differences between conditions which are shown in Table 12. Students in the nonrole condition report more often that the supervisor feedback was late and/or insufficient and some report that the supervisor did not seem to be involved and/or stayed in the background.

Table 12 Matrix for students' opinion about the supervision by condition

Role (n = *7;* N = *18)*	*Nonrole* (n = *6;* N = *23)*
One student reports they asked supervision once and that it was good. One student in a different group reports the supervision focused on the process and not the content. One student in yet another group reports that s/he expected an answer to the issue of a non-participating group member. Three students in two groups report they asked for little supervision and one adds they did not really need it. Eight students report that their group did not ask for it or need supervision. Two students in different groups report that a group member(s) had done a similar course before. One of the students add it seemed that the supervisor paid attention as revealed by their requests for late progress reports. Two students report supervision does not apply.	One student reports that the supervision put them on the right track. One student reports it was available if needed. Five students in three different groups report the supervisor did not seem to be involved and/or stayed in the background. One student reports s/he did not experience any sense of supervision. Five students in three groups report that the response was late and/or the feedback was insufficient or lacked. One student adds it amplified his/her insecurity about a novel study format. Six students in two different groups report that they did not contact the supervisor and/or that it was not needed.

6.7 Discussion

In this study the impact of functional roles, adapted for a computer-mediated context in a distance education setting, was investigated. The main research question was: 'What is the effect of a prescribed functional roles instruction, compared to no instruction, on group performance and collaboration?'. Roles did not affect group performance in terms of a group grade. However, this is largely due to a lack of variation (grades varied between 6 and 8.5 on a ten point scale).

The data used in this study was gathered from multiple sources: self-report Likert-scale questions, open-ended questions and content analysis of electronic communication. Investigating functional roles during CSCL requires triangulation of data sources, analysis methods and their outcomes. In fact, it can be argued that CSCL research in general requires triangulation because a variety of processes are studied simultaneously (e.g., learning, group efficiency, communication, social interaction, etc.) and the instruments used to measure these processes vary with respect to their quality, e.g. reliability.

Multilevel modelling (MLM) revealed that roles are likely to affect the perceived level of group efficiency (PGE). A positive marginal effect was found in favour of the roles groups: PGE in most role groups is consistently higher than in nonrole groups. This study was conducted in an ecologically valid setting, but it is imperative to investigate naturally collaborating groups in an educational setting – hence, the sample size is very likely to be small as it depends on the number of students that register for a course. Given the small sample size and small degree of statistical power, it can be argued that a significance level of $.05 < p < .10$ is justified. Moreover, the statistical significance is also hampered by an apparent outlier in the role condition, which appears to result from an increase in awareness of group efficiency by the roles. Students' responses with respect to the open-ended questions on the progress of collaboration and whether agreements stimulated progress, shows that two students from the same group in the role condition report that progress was difficult and the agreements did not stimulate progress. Both of them participated in the 'outlier' group. More importantly, however, the MLM results indicate that using functional roles elevates students' perceived group efficiency (PGE).

Results from the content analysis illustrate that roles did affect coordination, but this did not turn out as hypothesised. In the role condition the number of 'task coordination' statements was increased instead of decreased. Although a main effect was observed for the number of messages, the significant difference in coordinative statements is not invalidated because no difference was observed for the number of segments coded. More importantly, this finding replicates the earlier outcomes in the first study, however, the increase of 'task coordination' statements did not increase the number of 'task content' communication – as was the case in the first study. Apparently the changes in the preconditions appear to have levelled out some of the disadvantages of the nonrole groups. Also, the fact that groups in both conditions were required to hand in progress reports may have kept nonrole groups 'on task' and stimulated content-focused statements.

Cross case matrices of the open-ended questions revealed that nonrole groups reported more frequently the use of additional communication channels. With respect to the 'functional roles' and 'task division' category, students in role groups considered the roles unequal in terms of effort. However, the role instruction was more guiding than coercive and thus it left students room for an individual interpretation on how they actually performed their role. Perhaps students in role groups with a high PGE level acted more closely according to the prescribed instruction than students in the role group with low PGE. Moreover, a strong allegiance to prescribed roles could be in line with teamwork and collaboration in a professional context. Similarly, nonrole groups tended to organise collaboration by splitting the task (policy report) into several smaller components that were handled individually (or in dyads) which is also similar to a professional context where task allocation is often based on expertise. With respect to 'collaboration progress' role groups report more frequently that the progress was fine, compared to students in nonrole groups who report it was difficult or slow. Moreover, progress appears to be inversely related to the extent that students experienced that they had to wait for other group members. Finally, the role groups report more frequently that the agreements that they made about tasks and deadlines stimulated progress than their counterparts in nonrole groups.

Nevertheless, the outcomes obtained with these three different methods of analysis for three different data sources, illustrates the need for triangulation of multiple data sources and methods. Self-report Likert-scale can be a fast and relatively easy approach to investigate the impact of any instructional intervention, but this would not have revealed *why* role groups perceive themselves as more efficient. Results from the open-ended questions reveal that it appears to be due to that they experienced a lower degree of waiting for responses, which ties in with the observation that students in role groups contributed more 'task coordination' statements than students in nonrole groups. Apparently roles increase coordination, decrease the extent of experienced 'waiting', which in turn increased students' perception that agreements stimulated progress and is ultimately expressed in a higher level of perceived group efficiency for most of the role groups. Finally, the observation that most nonrole groups have a lower level of PGE is in line with them reporting that agreements did not affect progress much, they experienced waiting and also their opinion about supervision; which clearly reveals that nonrole students experienced a higher need for supervisor feedback and express that it was either not there or insufficient. The latter may also be related to the fact role groups handed in a progress report twice as frequently as the nonrole groups and thus they may have had a heightened sense of supervision awareness compared to students in the nonrole groups.

In sum, this study reveals that functional roles stimulate coordination and overall group efficiency in a project-based CSCL course in distance education. Changes in the preconditions – compared to the first study – not only decreased dropout, but also appear to have controlled for some external sources that may have interfered with the functional roles in the first study. In the near future it is planned to investigate other aspects of functional roles, such as role conflict and role ambiguity, but it is clear that more systematic research regarding the use of functional roles in small groups and CSCL is needed.

6.8 Appendix A: Communication discipline

1) Depending on your study pace, you will check at least once every two days (6 months) or once every four days (10 months) for new messages. This is just a minimum; it is advised to check more often.
2) If you receive a message that requires a response or an answer, you will respond as soon as possible. This prevents unnecessary waiting on the part of your group members for your answer or response.
3) If you send a message, you will always send it to the shared e-mail address (list address) so that all members will be informed of the developments within your group.
4) If you wish to change your e-mail adress on the list – to which messages send to the shared e-mailadress are redirected – you will send a request to the list owner who will change it.
5) If you wish to add a second e-mail address to the list (for instance you home or work address) – to which messages send to the shared e-mail address are redirected – you will send a request to list owner who will add your second address.
6) If you receive a message from the list owner, you will respond promptly.
7) If personal circumstances (work, family or holiday) cause that you will not be able to read and respond to messages for a certain amount of time, you will notify your group in advance.
8) If you are unable to continue with the group assignment, you will inform your group members. In case you started in October 2001 and you are confident that you will be able to start in a new group in March 2002, send a request to your supervisor and s/he will contact you.
9) When you have been placed in a group you are obliged to establish contact with your fellow group members within the first two weeks and make work arrangements.
10) When you have been placed in group, but you fail to establish contact with your fellow group members in the first two weeks, you will be eliminated from that group. In case you started in October 2001 you can send a request to your supervisor to start in a new group in March 2002, however, given your failure to establish contact in your first group no consideration will be given to your preferences regarding the assignment (practice yes/no) or study pace.

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CHAPTER 7

Functional versus spontaneous roles during CSCL:

Using content analysis to investigate communication and role behaviour in small groups

Abstract

In this article, the effect of functional roles on computer-supported collaborative learning (CSCL) is investigated. Two studies are reported – the second is a replication of the first – in which prescribed functional roles were implemented in half of all groups during a project-based course in higher education and all communication was through e-mail. Analysis of Likert-scale evaluation questionnaires gathered in both studies revealed a latent variable (perceived group efficiency) which – depending on the level of constraints set by preconditions – appears to increase awareness of efficiency (study 1) or the level of efficiency (study 2). Nevertheless, Likert-scale designs provide a surface level analysis of actual behaviour: the perceived group efficiency provides no insight in the collaborative process. The collaboration was investigated with two content analysis procedures: content analysis of the type of communicative statements and analysis of the role behaviours performed by the students in both conditions. Results from both studies reveal that significantly more statements are focused on coordination in role groups. In addition, analysis of role behaviour reveals that students in role groups perform significantly more according to the functional roles than their counterparts in nonrole groups: the prescribed functional roles affected actual collaborative actions.

Keywords: Computer-supported collaborative learning, roles, coordination, collaboration, computer-mediated communication, triangulation

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7.1 Introduction

Computer-Supported Collaborative Learning (CSCL) is a relatively new discipline in the field of educational technology. Rapid developments in computer-mediated communication (CMC) and a renewed interest in the social dimension of learning stimulated the rise of this discipline in the 1990s (Lave & Wenger, 1991; Koschmann, 1996). CSCL combines various different research disciplines such as sociology, computer science, educational psychology, social psychology and communication science.

The study of small groups in education is, however, not a novelty. Small groups have been studied in educational contexts since the 1970s. Whereas cooperative learning research initially focused on face-to-face cooperation at the elementary school level, it was gradually extended to higher education. The technology push in the 1980s offered new tools for teacher-student communication and these were first implemented in distance education (Harasim, 1993; Mason & Bacsich, 1998). In a relatively short time frame, however, CSCL has become a popular pedagogical approach at most education levels and increasingly so in higher education (Strijbos, Kirschner, & Martens, 2004).

At present, there are no clear guidelines to determine how a CSCL environment should be designed (Gros, 2001). To a considerable extent this is caused by differences in group size, the technology used, the length of the study, the research methodology and the unit of analysis (Lipponen, 2001). CSCL analyses initially applied surface level methods to investigate the effects – such as Likert-scale questionnaires – and the amount of messages sent or read (De Jong & Veldhuis-Diermanse, 2001). At present, it is increasingly acknowledged that ‘learning’ and ‘collaboration’ rely on interaction (Baker, 2002; Stahl, 2004; Strijbos, Martens, & Jochems, 2004) and thus that the *intra-group interaction* is the primary process to be studied to assess performance and learning benefits in CSCL environments.

The design of CSCL environments often seems based on subjective decisions regarding tasks, pedagogy and technology, or general views regarding pedagogical support such as cooperative learning or collaborative learning. Cooperative learning is associated with a division of labour and collaborative learning is associated with equality of contributions by group members to a shared problem solution (Dillenbourg, 1999; Brandon & Hollingshead, 1999; Lehtinen, Hakkarainen, Lipponen, Rahikainen, & Muukkonen, 1999). However, there are far more similarities than differences between them (see Strijbos, Martens, & Jochems, 2004). Järvelä, Häkkinen, Arvaja and Leinonen (2004) present an extensive overview of various pedagogical approaches (instructional support) and they illustrate that these kinds of instructional support can be combined and should not be treated as mutually exclusive. Rather, they form a collection of methods that can be applied according to the processes needing support.

7.2 The use of roles to support coordination during asynchronous CSCL

Group performance effectiveness depends, as group size increases, on the one hand on the groups’ use of increased resources and alternate opinions (‘process gains’) and on the other hand on the handling of increased coordination and group management processes (‘process losses’) (Shaw, 1981). Conflicts regarding coordination are likely to occur in asynchronous CSCL settings, where group members are not present at the same time and/or place (Benbunan-Fich & Hiltz, 1999). Asynchronous communication is also ‘non-natural’ in the sense that the immediacy of feedback, common in face-to-face settings, is not present. Clearly, support should be designed to help students overcome difficulties in coordinating asynchronous collaboration.

Group cohesion and a sense of responsibility can affect coordination. Responsibility is proportionally related to group performance (i.e., a greater sense of responsibility can increase group performance), whereas the effect of norms and status depends on whether these stimulate or impede group performance. Group cohesion has been shown to increase stability, satisfaction and efficient communication, as well as negative effects such as social pressure, inter- and intra group aggression or conflict and polarisation (Forsyth, 1999). Roles can promote group cohesion and responsibility (Mudrack & Farrell, 1995). Group cohesion and responsibility correspond with two key concepts in collaborative learning: ‘positive interdependence’ (Johnson, 1981) and ‘individual accountability’ (Slavin, 1980). Positive interdependence refers to the degree to which the performance of a single group member depends on the performance of all other members. Individual accountability refers to the extent to which group members are held individually accountable for jobs, tasks or duties, central to group performance or efficiency.

Since roles promote group cohesion and responsibility (Mudrack & Farrell, 1995), they can be used to foster positive interdependence and individual accountability (Brush, 1998). Roles can be defined as more or less stated functions/duties or responsibilities that guide individual behaviour and regulate intra-group interaction (Hare, 1994). In addition, roles can stimulate a group members’ awareness of the overall group performance and each members’ contribution. As stated by Mudrack and Farrell (1995): “The opinions that others form about one’s contribution to the group effort will likely be influenced, in part, by which roles the focal group members play.” (p. 559). Finally, roles appear to be most relevant when a group pursues a shared goal requiring a certain level of task division, coordination and integration of individual activities.

One possible approach to implemented roles is in the form of instructional support, which is referred to as ‘scripting’ in CSCL (Dillenbourg 2002; Weinberger, 2003). Several pedagogical approaches that have been developed for cooperative learning use roles to support coordination and intra-group interaction (Johnson, Johnson, & Johnson-Holubec, 1992; Kagan, 1994). These roles are either content-oriented or process-oriented. Content-oriented roles focus on the facilitation of knowledge acquisition through individual differences, using for example ‘Jigsaw’ (Bielaczyc, 2001), ‘scripted cooperation’ (O’Donnell & Dansereau, 1992) or ‘prompting scripts’ (Weinberger, 2003). Process-oriented or management roles focus on individual responsibilities regarding the coordination (e.g., Kynigos, 1999). These role descriptions share, however, that they comprise one single job, task or duty (mainly because they were developed for face-to-face collaboration in primary education). Although the use of roles is widely regarded as an effective instructional strategy in cooperative learning and CSCL, their effect has not been investigated systematically in both higher/distance and primary education (although the interest in the opportunities that roles can offer for collaborative learning in higher education is growing, see De Laat & Lally, in press; Pilkington & Walker, 2003).

Since students in higher education vary considerably in (prior) knowledge, experience and collaboration skills – as compared to students in both secondary and primary education – the results obtained in primary/secondary education cannot be automatically transferred to higher education. Moreover, collaboration assignments in higher education are more complex and they take place over an extended period of time (i.e., not restricted to classroom time), thus requiring more explicit coordination than in primary or secondary education. Consequently, the previous uni-dimensional roles for face-to-face collaboration appear inadequate to support collaboration in higher education, let alone asynchronous CSCL settings. Thus explicit and detailed descriptions of the roles should be provided.

7.3 Investigating the effect of functional roles in CSCL

Both studies reported in this article investigate the impact of roles that counter 'process losses' because of coordination demands. These roles are referred to as 'functional roles' based on role descriptions in reports by Johnson et al. (1992), Kagan (1994), and Mudrack and Farrell (1995). The roles were developed for a project-based learning environment in which the students collaborated in small four person groups by CMC (e-mail). The roles were designed to give each student an individual responsibility for the group process. However, at the same time all roles were essential to the collaboration and thus the functional roles were interdependent (project planner, communicator, editor and data collector; for a detailed description see the Appendices in Strijbos, Martens, Jochems, & Broers, 2004).

The second study is a replication of the first, as examination of the course design in the first study identified several preconditions that – if controlled – could ensure a more evenly matched comparison of the research conditions, such as preference for a practice assignment, slow or fast study pace, setting up of a time schedule, establishing a communication discipline and externalising expectations regarding effort prior to collaboration.

The research question in both studies was: 'What is the effect of a prescribed functional roles instruction, compared to no instruction, on group performance and collaboration?'. It is expected that roles will have a positive effect on group performance (grade) and collaboration (efficiency) and that roles will decrease the amount of coordinative statements in favour of content focused statements. Multiple methods were used in both studies to investigate the effect of functional roles: grade, self-report Likert-scales and quantitative content analysis of e-mail communication.

In one previous study (Strijbos, Martens, Jochems, & Broers, 2004) no effect of the functional roles was found for grade. Principal axis factoring of several 5-point Likert-scales (i.e., team development, group process satisfaction, task strategy and the level of intra-group conflict) and a single question rated on a 10-point scale (the quality of collaboration) from the evaluation questionnaire revealed a latent variable (explaining 79% of all common variance) that was interpreted as 'perceived group efficiency' (PGE). Multilevel modelling (MLM) of PGE yielded a positive marginal effect revealing that functional roles appear to increase students' *awareness* of perceived group efficiency. This study is hereafter referred to as Study 1. Another previous study (Strijbos, Martens, Jochems, & Broers, submitted) – controlling for the preconditions – showed again no effect of the functional roles for grade. Analysis of the evaluation questionnaire revealed again the latent variable PGE (explaining 71% of all common variance) and MLM showed that the functional roles appeared to increase the *level* of perceived group efficiency. This study is in the remainder of this article referred to as Study 2.

In most cases, questionnaires – especially Likert-scales – provide a surface level analysis of actual behaviour. The perception of collaboration gives no insight in the actual collaborative process or the contextual factors that affect group collaboration. It is possible for instance that role groups and nonrole groups in Study 1 were equally active in organising and coordinating their activities, hence no difference regarding their level of PGE could be found. Similarly, the difference between role groups with a high and low level of PGE might have been caused by a higher degree of 'rigid' role behaviour, i.e. just strictly performing the task belonging to the assigned role without any flexibility. Similar arguments can be made for the Likert-scale questionnaire outcomes in the second study.

Hence, it is imperative that the groups' communication is subjected to content analysis to determine *why* one student contributes more or appears to be a more influential group member, and to explore *how* the students coordinate and organise their collaborative learning together (Strijbos & De Laat, 2003). The limitations of grade and Likert questionnaires underlines the added value of content analysis of communication, as well as the need for triangulation of both quantitative and more qualitative data sources and analysis methods to investigate the effect of the functional roles in CSCL.

This article emphasises two content analysis procedures that have been developed and used to complement the Likert-scale questionnaire design and outcomes. In both studies all e-mail communication has been analysed: one analysis method focuses on the kind of statements made during collaboration (for example about coordination) and one focuses on the extent to which students in role groups executed behaviours associated with their role and to assess if any spontaneous roles might have emerged in the nonrole groups. Analysis of electronic transcripts is neither straightforward nor is there general consensus on methodology; therefore this technique will be introduced in more detail before both studies are presented.

7.4 Content analysis of electronic communication transcripts

Initially, analyses in CSCL and CMC research focused on questionnaires or surface level characteristics of the communication (Harasim, Hiltz, Teles, & Turoff, 1995). For example, participation degree was determined from the number of messages sent by group members (Harasim, 1993). Also, it was assumed that the mean number of words in a message was positively related to the quality of the content of that message (Benbunan-Fich & Hiltz, 1999). Surface level measurements are still used in current research and several methods have been added such as 'thread-length' (Hewitt, 2003) and 'social network analysis' (SNA; Lipponen, Rahikainen, Lallimo, & Hakkarainen, 2003), but it is now widely acknowledged that such surface level methods provide just a rough analysis of the communication.

Analysis of communication transcripts has gained increased attention in the past decade (De Laat & Lally, 2003, Hara, Bonk, & Angeli, 2000; Rourke, Anderson, Garrison, & Archer, 2001). Two approaches to communication analysis can be derived from CSCL literature. In the 'quantitative' approach the communication is coded, summarised and frequencies or percentages are used for comparisons and statistical testing. This approach contrasts with the 'qualitative' view, in which methods such as participant observation (Louca, Druin, Hammer, & Dreher, 2003), case summaries (Lally & De Laat, 2003) and ethnomethodology (Stahl, 2004) are used to infer trends or a specific phenomenon in transcripts (Miles & Huberman, 1994).

Reliability is a concern in both approaches, but because of the quantitative comparison and/or statistical testing, the quantitative approach requires more rigour with respect to reliability to warrant the apparent robustness of conclusions. Lack of reliability increases the probability of Type II errors (wrongly accepting the null-hypothesis) and to a smaller degree, Type I errors (wrongly rejecting) can occur. Conclusions derived from statistical tests on data, where the reliability of the method by which these were obtained is 'unknown' (not reported) should be treated with caution: "Without the establishment of reliability, content analyses measures are useless." (Neuendorf, 2002, p. 141). However, examples of statistical comparison without any intercoder reliability are not uncommon (see review by Rourke et al., 2001) and appear also in CSCL reports (Pata & Sarapuu, 2003; Rasku-Puttonen, Eteläpelto, Arvaja, & Häkkinen, 2003).

To illustrate why this is very important, consider how Likert-scale questionnaires are to be treated in methodological respect: at least an alpha statistic should be reported to warrant the internal consistency of a set of items that measure the psychological construct. In the case of a previously constructed questionnaire two alpha statistics should be reported: the original alpha as well as an alpha pertaining to the current research. In the case where an adapted questionnaire is used, the original alpha and the alpha for the adapted questionnaire should be reported. Why does this methodological rigour apparently not apply to quantitative content analysis? It is clear that content analysis is far from straight forward and it is not an undisputed unified practice.

Furthermore, large variations with respect to the unit of analysis exist (i.e., message, paragraph, theme, unit of meaning, illocution, utterance, statement, sentence or proposition). Common to all, however, is that if the unit is ill-defined and in most cases the arguments for choosing a specific unit of analysis are missing. Yet, the applicability of a unit of analysis is affected by four contextual constraints: the object of the study, the nature of communication, the collaboration setting and the technological communication tool (Strijbos, Martens, Prins, & Jochems, in press). Moreover, when the granularity of the unit of analysis is smaller than a message, the reliability of determining these units is of equal importance. Hence, to warrant the accuracy of observations, more rigour – regarding the reliability of 'segmentation in units of analysis' and 'coding' – is essential. Nevertheless, irrespective of the segmentation reliability, the units should still be meaningful with respect to coding.

To conduct the research that is reported in this article, two content analyses procedures were constructed. Although the research context was similar, the unit of analysis was different. One content analysis procedure was developed to investigate the e-mail communication in the form of communicative statements. A ‘sentence or part of a compound sentence’ was used as the unit of analysis and a segmentation procedure was developed (see Strijbos, Martens, Prins, & Jochems, in press). Although the sentence as a unit of analysis is not uncommon (e.g., Fahy, Crawford, & Ally, 2001; Hillman, 1999), segmentation of compound sentences was added. The other content analysis procedure was designed to investigate role behaviour and a message was used as the unit of analysis (no need to develop a separate segmentation procedure). Data on the reliability of both content analysis procedures will be provided in the results section of Study 1.

7.5 Study 1

7.5.1 Participants

At the Open University of the Netherlands (OUNL), 57 students enrolled in a course on ‘policy development’ (PD) and 23 in a course on ‘local government’ (LG). In total 80 students enrolled. Five students enrolled in both courses making a total of 75 participants (45 male and 30 female; age 23-67 years, Mean = 34.4, SD = 9.03) and 43 completed the course successfully (53.8 %).

7.5.2 Design

The design was a quasi-experimental random independent groups design with the manipulation being the introduction of four functional roles in half of the groups (distributed by the members amongst themselves), aimed at promoting coordination and organisation of activities essential for the group project: project planner, communicator, editor and data collector (see Strijbos et al., 2004). The other half of the groups received a non-directive instruction (e.g., obvious, unspecific and general information regarding planning and task division) and the students were told to rely on their intuition and/or collaboration experiences (see Strijbos et al., 2004). Each group consisted of four students and during the course they communicated electronically via e-mail. Their task was to collaboratively write a policy report regarding reorganisation of local administration.

7.5.3 Method

To assess the effect of the prescribed functional roles on communication and role behaviour, all e-mail communication of the groups that successfully finished the course (regardless whether they lost a group member) was analysed to investigate the extent to which the functional roles had an effect on the types of communicative statements and the role behaviours performed by group members. If only two members remained in a group, that group was excluded from the analyses.

7.5.4 Procedure

After course registration students were informed that the research focused on investigating the group processes of students collaborating through e-mail and to determine the suitability of this format in distance education. Two weeks prior to the start of the course students had to indicate whether they wanted to start with the group assignment in October 2000 or March 2001. Next, students were randomly assigned to groups and geographical distance between group members was maximised to discourage face-to-face meetings.

Prior to collaboration a face-to-face meeting was organised for all students. A separate meeting was organised for each research condition. General information and the instructions in both conditions were provided during this meeting and electronically afterwards. After the meeting all remaining contact between students was virtual. All groups were required to inform the supervisor whether they started with the practice assignment or right away with the final assignment. Role groups were required to inform their supervisor about the assignment of the roles in their group within two weeks. Contact with the supervisor was restricted to a single group member in the role condition, whereas students in nonrole groups were all allowed to contact the supervisor. Supervisors were instructed to answer questions that focused on the content of the assignment. Under no circumstance were they to provide support regarding coordination and group management. If a request for support was received, students in the role condition were told to rely on the roles, whereas students in the nonrole condition were told to rely on their intuition or experiences with collaboration. Although students were instructed to use e-mail, it is by no means possible or feasible to exclude customary communication channels, such as telephone and face-to-face contact. If used, students were requested to send transcripts to all group members to retain transparency of communication. During collaboration the telephone was used occasionally, but most contact was by e-mail. In spite of geographical distance three groups organised a face-to-face meeting. Five students participated in both courses and were placed in the same research condition. This did not pose difficulties in the final analyses. Some groups did not complete the course timely or were excluded from the research because only two group members remained (and thus were no longer included in the research). None of these five students finished both courses.

7.5.5 Results

7.5.5.1 *Content analysis of communication*

To analyse the types of statements made during collaboration a ‘sentence or part of a compound sentence that can be regarded as a meaningful sentence in itself, regardless of coding categories’ was used as the unit of analysis (see Strijbos, Martens, Prins, & Jochems, in press). Punctuation and the word ‘*and*’ mark potential segmentation, but this is only performed if both parts – before and after the segmentation marker – are a ‘meaningful sentence’ in itself.

Intercoder reliability of two segmentation trials was .82 and .89 (proportion agreement) and this was corroborated by a cross-validation check on an English language set of messages contributed to a discussion forum during project-based learning (with a high similarity to the research context) and proportion agreement turned out to be .87.

Table 1 Abbreviated overview of the communication coding categories

Code	*Description*	*Example*
TC	Any statement that concerns the alignment of intra-group collaboration through references with respect to time, references with respect to an activity (that is to be or has been) performed by a group member or the group, or a reference to time and an activity.	"Why is JW not responding?" "Who makes an inventory of pressure groups that are involved?"
TN	Any statement that is aimed at the content of the task or assignment in general, statements focusing on the problem solving or discussion of task content, and/or focusing on the content or editing of the report.	"The assignment is about the public transport in A'dam." "We should delete section two."
TS	Any statement that contains a qualitative judgment, an evaluation or attitude towards collaboration in general, towards the whole group or specifically towards (the effort by) an individual group member.	"I think we did a great job." "Maarten, my compliments for your PERS analysis."
NT	Any statement regarding previous experiences, face-to-face meetings, acquaintance, technical problems, and social affairs not directed towards the task, or that expresses to contact the moderator.	"I am still struggling to find out how I am to operate Edubox." "How was your holiday?"
NOC	Any statement that cannot be assigned any of the other codes previously described.	"Attached a new schedule with the latest deadlines and tasks."

In addition, a coding scheme was constructed with five main categories 'task coordination (TC)', 'task content (TN)', 'task social (TS)', 'non task (NT)' and 'non-codable (NOC)', depicted in Table 1, and eighteen subcategories. Reliability on subcategory level (Cohen's kappa) proved to be on average .60 (moderate) and on the main category level .70 (substantial) (cf. Landis & Koch, 1977).

Content analysis was performed on all e-mail messages contributed by forty students equally distributed across both research conditions (in each conditions; n = 5 and N = 20). For the questionnaire data it was possible to reduce the number of dependent variables to a single factor to avoid the problem of multiple testing (see Strijbos et al., 2004). Principal axis factoring of the five main categories, however, does not result in a meaningful factor. Therefore statistical comparisons were restricted to the number of messages, segments and the frequency for each main category on the level of the group.

Because of the small number of observations, a Mann-Whitney U-test was performed to compare research conditions (five groups in each condition). All communication on the first assignment that a group performed (practice or final) was analysed. Results are depicted in Table 2.

Table 2 Mean, standard deviations and Mann-Whitney rank scores for the number of messages, number of segments and the five main categories

	Role (n = 5)			*Nonrole* (n = 5)		
Item	M	SD	*Rank*	M	SD	*Rank*
Number of messages	78.20	22.30	7.2	52.40	17.47	3.8
Number of segments	759.60	173.04	7.8	401.20	156.12	3.2
Task coordination	63.95	16.99	7.2	37.35	20.45	3.8
Task content	37.65	17.22	7.4	16.35	16.48	3.6
Task social	4.40	2.73	7.5	1.95	0.48	3.5
Non task	21.40	7.76	7.1	12.55	4.83	3.9
Non-codable	62.55	13.73	8.0	32.10	10.33	3.0

No main effect was observed for the amount of messages send, but a significant difference was observed for the amount of segments ($U = 1.000$, $df = 4$, $p < .05$). Regarding the content of the communication several main effects were observed in favour of the role condition: significant more ‘task coordination’ ($U = 4.000$, $df = 4$, $p < .05$; one-sided), ‘task content’ ($U = 3.000$, $df = 4$, $p < .05$), ‘task social’ ($U = 2.500$, $df = 4$, $p < .05$), and ‘non-codable’ statements ($U = 0.000$, $df = 4$, $p < .05$) were made in the role condition. A one-sided test was performed for ‘task coordination’ as it was expected that roles would decrease ‘task coordination’ in favour of ‘task content’ statements.

7.5.5.2 *Content analysis of role behaviour*

In addition to an analysis of the communicative content, it was decided to investigate to what extent students in the role groups acted according to their functional roles and/or whether they were more aware of their roles, as well as whether spontaneous roles emerged in the nonrole groups. Research shows that coordination and role behaviour emerges spontaneously to some extend when groups work together at a collaborative task, hence it is important to investigate (De Laat & Lally, 2003; Lally & De Laat, 2003).

A ‘message’ was the best suited unit of analysis given our research objectives (i.e., explorative; see also Strijbos, Martens, Prins, & Jochems, in press). In order to analyse the groups in both conditions according to ‘role behaviour’ each of task belonging to one of the four functional roles was re-worked into a coding category (i.e., a main category for each role, fifteen subcategories for each task, and a main category to record if no code was assigned). During three trials the categories were refined and the subcategory ‘role awareness’ was added. This category is defined as any statement that clearly reveals a group members’ awareness of other members’ task(s) or a statement in which a task is specifically delegated to the group member that performs the role to which the task belongs (a specific type of project planning behaviour). A fourth trial was performed to assess the reliability of the schema. A selection of sixty messages (about 10% of all communication) from two role and two nonrole groups (fifteen messages each) were analysed.

Table 3 Abbreviated overview of the role behaviour main coding categories

Code	*Description*	*Example*
P	Statements about data, activities and deadlines and statements that remind other group members of their activities; as well as delegating an activity to a fellow group member, setting-up a discussion agenda and stimulating discussion around the information sources.	"I cannot guarantee that I will be able to send my part tomorrow." "When everybody has responded, Lisette can set-up a planning."
C	Statements that concern communication with the supervisor; as well as informing the supervisor about the groups' progress and asking questions on behalf of group members and communicating the answers.	"I will send a message to our supervisor with information about our progress."
E	Statements that concern writing a first draft of the group report and any subsequent versions; each of them followed by a request for comments and suggestions by all other group members.	"I have written a first draft of the report; please send you comments as soon as possible."
D	Statements regarding the pre-selection of relevant information (data) sources provided on a Cd-rom; as well as statements concerning the collection of alternative information sources, and distributing them amongst other team members.	"I have found some relevant sources on the Cd." "I will send the information through regular mail tomorrow."
NC	No code assigned to an e-mail message.	N/A

Role behaviours occur less frequent than the communicative statements and it was decided to summarise the behaviours at the level of the message, i.e. the number of times that specific role behaviour was performed in a single e-mail was not taken into account. Each e-mail was assigned one of the five main categories, 'project planner' (P), 'communicator' (C), 'editor' (E), 'data collector' (D) and 'no code' (NC) if no role behaviour was performed. The main categories are depicted in Table 3. The proportion of intercoder agreement was 81% and Cohen's kappa (correction for chance agreement) was .67, which is substantial for research purposes (Landis & Koch, 1977).

Case summaries were made for each group (Table 5). Role behaviour is indicated by the capitals P, C, E and D. Members of the role groups are represented according to their role (Pp, Co, Ed and Dc). Nonrole group members are represented by their initials. To investigate whether group members performed according to a specific role, an analysis of concordance appears to be applicable. Although such an analysis conceptually fits the role groups (i.e., behaviour according to the roles) it does not fit the nonrole groups. In nonrole groups every group member *could* have performed a role, but s/he is *by no means expected* to do so. It should be noted, that the students in nonrole groups were less likely to exert C-behaviour since they were not required to hand in a progress report on a two weekly basis, however, the role descriptions were guiding and not very coercive and thus it is likely that even students in role groups performed other behaviours than those specified in their role description. In sum, an analysis of concordance neglects the likely possibility of role behaviour by chance in nonrole groups, thus correcting for behaviour by chance fits both conditions and since any member of a nonrole group could have performed a role, the kappa for a nonrole group is based on the distribution with the most possible scores on the diagonal. Cohen's Kappa was computed for each matrix. Table 4 present the total amount of role behaviour for each group and the obtained kappa values.

Table 4 Total amount of role behaviour and consistent role behaviour (Cohen's kappa) per group

	Role	
Group	Total behaviour	Kappa
PD 1	49	.41
PD 2	62	.40
PD 3	63	.22
PD 4	116	.31
LG 1	65	.02
	Nonrole	
Group	Total behaviour	Kappa
PD 5	75	.00
PD 6	23	.09
PD 7	53	.03
LG 2	32	.14
LG 3	54	.11

No main effect was observed for the total amount of role behaviours aggregated at the group level (Mean $\text{Rank}_{\text{role}}$ = 6.80; Mean $\text{Rank}_{\text{nonrole}}$ = 4.20; $U = 6.000$, $df = 4$). A directional Mann-Whitney U-test revealed a significant difference between the research conditions with respect to the extent that – functional or spontaneous – roles were performed ($U = 4.000$, $df = 4$, $p < .05$; one-sided). These results indicate that – although sometimes behaviour is performed that does not belong to a functional role that a group member performs – group members in role groups perform the tasks (and thus role behaviour) that are expected. Table 4 reveals that the role groups with the highest (PD 2) and lowest (PD 1) level of perceived group efficiency (PGE) (Strijbos et al., 2004) did not differ in their kappa value, illustrating that role groups with a low PGE level did not act more rigidly according to the functional roles than groups reporting a high PGE level (see also Strijbos & De Laat, 2003). However, simultaneously Table 4 shows a very low kappa value for LG 1 and this coincides with a low level of PGE previously reported (Strijbos et al., 2004). The kappa values for nonrole groups are consistently low or very low and the slightly higher values for LG 2 and LG 3 indicate that roles may have emerged spontaneously.

Table 5 Case summaries of role behaviour per individual, group and condition

Role						*Nonrole*					
PD 1						PD 5					
	P	C	E	D	Σ		P	C	E	D	Σ
Pp	**19**	1	0	1	21	Re	**20**	1	**14**	1	36
Co	12	**3**	0	1	16	Ve	**9**	0	**4**	0	13
Ed	4	0	**7**	0	11	Ni	**9**	0	**5**	1	15
Dc	4	1	0	**6**	11	Vd	**8**	0	**3**	0	11
PD 2						PD 6					
	P	C	E	D	Σ		P	C	E	D	Σ
Pp	**19**	0	1	4	24	Wi	**5**	0	**4**	0	9
Co	3	**8**	3	3	17	Jo	**4**	0	**2**	0	6
Ed	7	0	**9**	3	19	Bo	**4**	1	**5**	0	10
Dc	2	0	0	0	2	St	**1**	0	**2**	1	4
PD 3						PD 7					
	P	C	E	D	Σ		P	C	E	D	Σ
Pp	**17**	0	6	3	26	Mo	**20**	1	**4**	1	26
Co	12	**3**	3	0	18	Kn	**4**	0	**0**	0	4
Ed	4	0	**7**	0	11	Ro	**10**	0	**4**	1	15
Dc	2	0	4	**2**	8	Ka	**7**	0	**1**	0	8
PD 4						LG 2					
	P	C	E	D	Σ		P	C	E	D	Σ
Pp	**8**	0	6	1	15	Gr	**8**	1	**2**	0	11
Co	31	**19**	8	2	60	Va	**7**	1	**2**	0	10
Ed	7	0	**16**	3	26	Ap	**3**	0	**4**	0	7
Dc	2	0	2	**11**	15	Te	**4**	0	**0**	0	4
LG 1						LG 3					
	P	C	E	D	Σ		P	C	E	D	Σ
Pp	**8**	0	5	1	14	Ho	**7**	0	**4**	1	12
Co	4	**0**	1	0	5	Jh	**4**	0	**3**	0	7
Ed	8	2	**8**	2	20	Ve	**10**	1	**13**	2	26
Dc	11	1	12	**2**	26	Bk	**3**	0	**4**	2	9

Table 5 illustrates that students in role groups performed predominantly according the functional roles (bold scores on the diagonal) and also that ‘role behaviour’ emerged spontaneously to some extent in nonrole groups, i.e. a project planner in LG 2 (Gr) and an editor in LG 3 (Ve).

It is also apparent, however, that whether a student in a nonrole group assumed a specific role s/he still performed other role behaviours; predominantly P and E behaviours. Moreover, the E-behaviour in the nonrole groups is mostly spread across all members (bold scores), whereas in role groups this behaviour is more bound to a single member exerting the specific functional role. This same pattern can also be identified to some extent with the P-behaviour (bold scores).

7.6 Study 2

7.6.1 Participants

At the Open University of the Netherlands (OUNL), 39 students enrolled in a course on ‘policy development’ (PD) and 25 in a course on ‘local government’ (LG). In total 64 students enrolled. Five students enrolled in both courses making a total of 59 participants (32 male and 27 female; Age 22-55 years, Mean = 38, SD = 8.42, 1 missing) and 49 completed the course successfully (76.5 %). Four students enrolled who had participated in either course in Study 1.

7.6.2 Design

The design was similar to Study 1: the introduction of four functional roles in half of the groups (distributed by the members), aimed at promoting the coordination and organisation of activities essential for the group project. The other half of the groups was left completely self-reliant with respect to coordination of their activities. Their task was similar to Study 1 (i.e., a shared policy report regarding reorganisation of local administration). All communication was through e-mail.

7.6.3 Method

Based on the evaluation of the first study students were asked to indicate whether they wanted to start with a practice assignment or proceed right away with the final assignment that would be graded. They were also asked whether they preferred a slow (ten months) or fast (six months) pace to complete the group assignment. Most students could be grouped according to their preference regarding the assignment and the study pace; however, given the number of registering students it was not always possible to maintain groups of four students. Overall, three groups in the role condition were composed of three members from the start. A separate role instruction was provided for these groups in which the tasks of the data collector were added to the editor. It was assumed that this did not increase the students’ workload too much as the instruction explicitly stated that studying the data could be distributed. The other four role groups started with four group members. In the nonrole condition, two groups started with five members and the other four groups with four group members. To assess the effect of the prescribed functional roles on communication and role behaviour, all e-mail communication of groups that successfully finished the course (regardless whether they lost a group member) was analysed to investigate the extent to which the functional roles had an effect on the types of communicative statements and the kinds of role behaviours performed by group members. If only two members remained in a group, that group was excluded from the analyses.

7.6.4 Procedure

Students were introduced to a communication discipline (visible prior to registration) and a project planning form. The communication discipline (Appendix A) was introduced to ensure that students would start with the assignment within two weeks after the meeting. In the first study some groups had to be excluded because students did not respond until four weeks after the start of the assignment –

destabilising and ultimately wrecking the group. In addition, a project planning form was introduced to focus students' attention on the need to coordinate their resources, but they were also asked to indicate how many hours they could contribute to the group assignment on a weekly basis. The first study had revealed that students greatly varied in the amount of hours they could spent on their study.

In contrast to the first study, however, nonrole groups handed in a progress report every four weeks: on the one hand to increase a 'sense' of supervision, but on the other hand to retain a difference with the role groups who handed in a report every two weeks. Five students participated in both courses and they were placed in the same research condition (three students in the role condition and two in the nonrole condition). Since the students had also two opportunities to start with the group assignment and given their preference regarding the assignment and study pace, two students that participated in both courses at the same time had to be grouped in the same condition in the same group (one of them dropped out in both groups due to a conflict with the other member that also participated in both groups).

Four students already participated in either course in the previous year and were thus also placed in the same research condition (three students in the role condition and one in the nonrole condition). None of the four students that had participated in the previous year were grouped together in the same group. Although some of the students participated in both courses and/or for a consecutive time, they were included in the analyses because efficiency and collaboration relies on the intra-group interaction with other group members and they collaborated with three other students with whom they had not worked before.

7.6.5 Results

7.6.5.1 *Content analysis of communication*

The analysis methodology was similar to Study 1. Content analysis was performed on all e-mail messages contributed by fifty-one students equally distributed across both research conditions (role $n = 7$, $N = 25$; nonrole $n = 6$ and $N = 26$). All communication on the first assignment that the group performed (practice or final) was analysed.

One nonrole group started with the practice assignment, but half way this group switched to the final assignment, yet it was decided to include only the communication on the practice assignment in the analysis. Including all communication would not only result in an increase of statements coded, but specifically coordination would be over represented as this is typically conducted in the first half of the collaboration (as revealed by an overall examination of communication in all groups).

A Mann-Whitney U-test was performed to compare research conditions. Results are depicted in Table 6. A main effect was observed for the number of messages sent ($U = 7.000$, $df = 5$, $p < .05$), however, no difference was observed for the number of segments coded.

Table 6 Mean, standard deviations and Mann-Whitney rank scores for the number of messages, number of segments and the five main categories

	Role (n = 7)			*Nonrole* (n = 6)		
Item	M	SD	*Rank*	M	SD	*Rank*
Number of messages	128.57	29.27	9.0	80.29	41.14	4.7
Number of segments	1053.71	348.62	7.1	1059.17	526.13	6.8
Task coordination	114.96	46.06	8.7	75.73	32.98	5.0
Task content	61.90	41.90	6.6	65.82	52.97	7.5
Task social	9.63	5.25	8.6	5.20	4.82	5.2
Non task	26.68	14.52	7.4	21.99	8.09	6.6
Non-codable	92.60	48.36	7.4	81.92	53.16	6.5

Significant more 'task coordination' (U = 9.000, df = 5, p < .05; one-sided) was observed in favour of the role groups. A one-sided test was performed, as it was expected that roles would decrease 'task coordination' in favour of 'task content'. No main effect was found for any of the other main categories.

7.6.5.2 *Content analysis of role behaviour*

Case summaries were made for each group (Table 8). Role behaviour is indicated by the capitals P, C, E and D, the members of the role groups are represented according to their role (Pp, Co, Ed and Dc) and nonrole group members by their initials. Similar to Study 1, the role behaviour distribution was investigated by computing a Cohen's kappa for each matrix – using the scores on the diagonal as the indicator for functional role behaviour. In contrast to Study 1, the students in nonrole groups now handed in a progress report every four weeks: still retaining a difference with students in role groups who handed in a report every two weeks. Nevertheless, compared to Study 1 students in nonrole groups are more likely to exert C-behaviour (and the role descriptions were still guiding and not very coercive).

Whereas all groups in Study 1 formed a perfect four by four matrix, the analyses in Study 2 were more complicated. Three role groups performed according to three roles and thus the behaviours in the E-column represents the combined total of E and D behaviour. This does not favour the role groups because D-behaviours are generally distributed across all members and thus this aggregation leads to more deviations from the diagonal than scores on the diagonal. In addition, two nonrole groups consisted of five group members. Similar to Study 1 the kappa in nonrole groups is based on the distribution with the most possible scores on the diagonal because any member could have performed a role consistently. In addition, the group member that in any combination caused the highest number of deviations from the diagonal was eliminated. In other words, similar to Study 1 the most optimal four by four matrices – in terms of functional roles – were created for the nonrole groups. Table 7 present the total amount of role behaviour for each group and the obtained kappa values.

Table 7 Total amount of role behaviour and consistent role behaviour (Cohen's kappa) per group

	Role	
Group	Total behaviour	Kappa
PD 1	72	.35
PD 2	64	.32
PD 3	131	.09
PD 4	95	.20
PD 5	103	.10
LG 2	95	.41
LG 4	115	.17
	Nonrole	
Group	Total behaviour	Kappa
PD 6	67	.09
PD 7	66	.14
PD 8	45	.07
PD 9	108	.09
LG 1	42	.23
LG 3	77	.10

In contrast to Study 1, a significant main effect was observed for the amount of role behaviour aggregated at the group level (U = 9.000, df = 5, p < .05; one-sided). Students in role groups performed more role behaviours than students in nonrole groups. A directional Mann-Whitney U-test showed a significant difference between the research conditions with respect to the extent that – functional or spontaneous – roles were performed (U = 7.500, df = 5, p < .05; one-sided). Similar to Study 1 the results indicate that – in general – group members in role groups perform functional role behaviour that is expected. Table 7 reveals that the role groups with the highest (PD 4) and lowest (PD 2) level of perceived group efficiency (PGE) do differ slightly in their kappa value. However, PD 2 is the only role group in the second study with a low PGE level and compared to the other groups with a high PGE level (see Strijbos et al., submitted) the kappa obtained for PD 2 does not indicate that this group acted more rigidly according to the functional roles. In Table 7 also a high kappa value can be observed for PD 3, but a low PGE level was observed, signalling that behaviour according to functional roles does not automatically result in a higher level of PGE. The kappa values for nonrole groups are low or very low, but compared to Study 1 these are a little higher, apparently because the nonrole groups were required to hand in progress reports as well. The slightly higher values for PD 7 and LG 1 indicate that roles may have emerged spontaneously.

Table 8 Case summaries of role behaviour per individual, group and condition

Role

PD 1

	P	C	E	Σ
Pp	**13**	0	7	20
Co	11	**7**	5	23
Ed	8	0	**21**	29

PD 2

	P	C	E	D	Σ
Pp	**18**	1	3	0	22
Co	6	**4**	1	1	12
Ed	8	1	**9**	1	19
Dc	7	0	1	**3**	11

PD 3

	P	C	E	Σ
Pp	**28**	0	12	40
Co	28	**11**	11	50
Ed	30	0	**11**	41

PD 4

	P	C	E	Σ
Pp	**36**	0	8	44
Co	15	**7**	3	25
Ed	18	1	**7**	26

PD 5

	P	C	E	D	Σ
Pp	**15**	5	8	1	29
Co	4	**1**	2	0	9
Ed	21	2	**21**	2	46
Dc	9	0	7	**3**	19

LG 2

	P	C	E	D	Σ
Pp	**27**	0	4	3	34
Co	7	**7**	0	4	18
Ed	11	0	**16**	1	28
Dc	9	0	0	**6**	15

LG 4

	P	C	E	D	Σ
Pp	**18**	0	8	0	26
Co	5	**5**	0	0	10
Ed	28	4	**21**	1	54
Dc	15	1	6	**3**	25

Nonrole

PD 6

	P	C	E	D	Σ
Mc	**18**	2	**7**	1	28
Ev	**6**	4	**3**	0	13
Ne	**13**	2	**6**	0	21
Db	**5**	0	**0**	0	5

PD 7

	P	C	E	D	Σ
Re	**13**	3	**1**	0	17
Vk	**13**	2	**2**	1	18
Wa	**14**	2	**8**	2	26
Sw	**3**	0	**1**	1	5

PD 8

	P	C	E	D	Σ
Ra	**14**	0	***0***	0	14
Th	**10**	1	***0***	0	11
Le	**5**	0	***0***	0	5
Vg	**13**	1	***0***	1	15

PD 9

	P	C	E	D	Σ
Sc	**29**	6	**4**	2	41
Vb	**10**	0	**7**	0	17
Me	**7**	3	**10**	3	23
Vl	**19**	1	**6**	1	27

LG 1

	P	C	E	D	Σ
Vo	**8**	1	**1**	0	10
Mo	**5**	4	**2**	0	11
Va	**5**	2	**4**	1	12
Ev	**5**	1	**2**	1	9

LG 3

	P	C	E	D	Σ
Gr	**17**	0	**4**	0	21
We	**15**	4	**2**	0	21
Ma	**16**	2	**6**	0	24
We	**8**	0	**3**	0	11

Table 8 illustrates that students in role groups performed predominantly according the functional roles (bold scores on the diagonal) and also that role behaviour emerged spontaneously to some extent in nonrole groups, i.e. a project planner emerged in LG 1 (Vo) and PD 9 (Sc), an editor emerged in PD 7 (Wa), and in PD 6 (Ev), LG 1 (Mo) and LG 3 (We) a communicator emerged. It is also apparent that students with an emergent role in a nonrole group still perform various other role behaviours. Finally, similar to Study 1, E-behaviour – and to some extent also P-behaviour (bold scores) – in nonrole groups is spread predominantly across all group members (bold scores), whereas in role groups this behaviour is on average bound to the member exerting the specific functional role.

7.7 Discussion

In this article the impact of functional roles, adapted for a computer-mediated context in a higher and distance education setting, was investigated. The main research question was: 'What is the effect of a prescribed functional roles instruction, compared to no instruction, on group performance and collaboration?'. Results from two consecutive studies were reported.

Previous reported results for both studies showed that no effect of the functional roles was found for grade. Principal axis factoring of several 5-point Likert-scales from the evaluation questionnaire (i.e., team development, group process satisfaction, task strategy and the level of intra-group conflict) and a single question rated on a 10-point scale (the quality of collaboration), revealed a latent variable that was interpreted as perceived group efficiency (PGE). Multilevel modelling of PGE yielded for the first study a positive marginal effect revealing that functional roles appear to increase students' *awareness* of perceived group efficiency (Strijbos, Martens, Jochems, & Broers, 2004). Multilevel modelling of PGE for the second study showed that the functional roles appear to increase the *level* of perceived group efficiency (Strijbos, Martens, Jochems, & Broers, submitted). The lack of significance regarding grades is likely due to a lack of variation (grades varied between 6 and 8.5 on a ten point scale). Some groups were given the opportunity to revise the report that they had submitted for grading, which of course decreased the variance in the final grades. In sum, both grades and Likert-scale questionnaires tend to provide a surface level analysis of actual behaviour. Hence, it is imperative to investigate the actual intra-group interaction. Two content analysis procedures were developed and applied to supplement the grades and multilevel modelling outcomes.

In Study 1 content analysis of the communication shows – as hypothesised – more 'task content' statements in the role condition. However, the assumption that this is due to a decrease in the amount of coordinative statements was not confirmed. In fact, the amount of coordinative statements increased in the role groups as well, which disproves the alternative interpretation for the lack of significant difference between research conditions regarding PGE, i.e. that the groups in both conditions were equally active in coordinating their collaboration. Apparently, the roles stimulated coordination and as a result 'task content' statements increased as well. Students in the role condition contributed more 'task content' and 'task coordination' statements, compared to students in the nonrole condition. Students in the role condition also contributed significantly more 'task social' statements, expressing either a positive or negative evaluation or attitude in general, towards the group or towards an individual group member. Moreover, the role groups communicated on average more as indicated by the significant difference in the number of segments but they did not do so by sending more messages.

Content analyses with respect to 'role behaviour', functional or spontaneous, revealed qualitative differences between role and nonrole groups regarding the collaboration process. No difference was observed in the total amount of role behaviour, but group members of role groups performed role behaviours, associated with their functional role, more frequently than members with a different functional role. The kappa values for nonrole groups are consistently low or very low and the slightly higher values for LG 2 and LG 3 indicate that roles emerged spontaneously to some extend. In other words, the functional roles affected the organisation and coordination of the collaboration and thus the impact of the instruction is validated. In addition, a plausible alternative interpretation for the observed PGE difference in the first study (Strijbos et al., 2004) was disproved: the role groups with the highest (PD 2) and lowest (PD 1) PGE did not differ in their kappa value, illustrating that group members in the role group with a low level of PGE did not act more rigidly according to the functional roles. However, the variability in adherence to the functional roles (as expressed by the kappa values) shows that the roles acted as a guiding principle rather than as a set of coercive rules – which underlines the need for the computation of kappa instead of other statistical techniques. Two role behaviours (i.e., P and E) were frequently exerted by students in the nonrole groups, but these were not bound to a single group member, but in fact distributed across all group members. Spontaneous roles emerged in two nonrole groups, but these group members still performed other role behaviours. Overall, the results indicate an overall involvement of each student in nonrole groups with the group task, especially where it concerns P-behaviour. The spread of E-behaviours in nonrole groups across members indicates that these groups organised their collaboration by splitting the content of the shared report into (sub)topics which were individually studied, written and subsequently assembled (A+B+C+D) in a 'collaborative' report. To some extend this behaviour seems to have occurred in some of the role groups as well, but appears to have been less consistent across these groups. Although it can be argued that this distributed enhances involvement in the task, it impedes the collaboration if the outcomes of the individual study phase are not discussed with the other group members. The apparent approach to split the task into individual topics could explain why less D-behaviours are observed as they were likely combined with E-behaviours.

In Study 2, the content analysis of communicative statements illustrates that the roles affected coordination, but again this did not turn out as hypothesised. Similar to Study 1 the number of 'task coordination' statements was increased instead of decreased. A main effect was observed for the number of messages – but not for the segments – indicating that students in the role groups interacted more frequently than students in nonrole groups. More important, this difference in 'task coordination' replicates the earlier outcomes of the first study, however, the number of 'task content' communication did not increase in Study 2. Thus, changing the preconditions appears to have levelled out some of the disadvantages of the nonrole groups. The groups in both conditions were required to hand in progress reports and this may have stimulated content-focused contributions.

Content analysis with respect to 'role behaviour', functional or spontaneous, revealed the same qualitative differences with respect to the collaboration process between role and nonrole groups. In contrast to Study 1, a significant difference was observed in the total amount of role behaviour. Compared to Study 1 the impact of the preconditions is reflected in the total amount of messages send and the role behaviours scored. In addition, the nonrole groups were required to hand in a progress every four weeks, resulting in a more even comparison as C-behaviour was more likely to be exerted. Similar to Study 1, students in role groups predominantly performed their functional role behaviour more frequently than group members with a different role – again validating the impact of the functional roles. The kappa values for nonrole groups in Study 2 were again consistently low or very low and the slightly higher values for PD 7 and LG 1 indicate that roles emerged spontaneously to some extend. Three types of role behaviour were observed in the nonrole groups, but these were not bound to a single group member and in fact distributed across all group members showing again overall involvement. Finally, the spread of E-behaviours in nonrole groups – similar to Study 1 – was observed, indicating that these groups tend to split the content of the task into individual topics, which are assembled (A+B+C+D) in a single 'collaborative' report.

Nonrole groups in both studies tended to organise their collaboration by splitting the task in individual contributions, which is very similar to a professional context where task allocation is often based on expertise. In fact, several role groups in both studies pursued this strategy to some extend. Although expert roles can have a positive impact on the amount of information shared (see Stasser, Stewart, & Wittenbaum, 1995), it should be noted that students – in general – are not to be considered an expert in a professional sense. It is also possible that some students have already internalised some models or strategies for collaboration – especially when they arrive at the level of higher and distance education – which may conflict with a pedagogical model that is offered to them. Nevertheless, this distinct pattern seems to have occurred in some role groups (although less consistent across the groups) and thus one future analysis should focus on investigating the content-focused statements and the level of discussion (collaborative knowledge building as it is referred to in CSCL) in more detail.

The results reported in this article clearly underline that investigating functional roles during CSCL requires triangulation of data sources, analysis methods and outcomes. In fact, it can be argued that CSCL research in general requires triangulation because a variety of processes are studied simultaneously (e.g., learning, group efficiency, communication, social interaction, etc.) and the instruments used to measure these processes vary with respect to their quality, e.g. reliability. The outcomes of both studies reveal that functional roles stimulate coordination and overall group efficiency in a project-based CSCL course in higher education. Changing the preconditions in Study 2 – compared to Study 1 – appears to have controlled for some external sources that may have interfered with the functional roles in the first study. This is in line with a current view on educational science as design research (Collins, Joseph, & Bielaczycs, 2004) – although the exact methods and procedures are still debated (Kelly, 2004). However, where changes are often made to the instructional intervention when an initial study provides unsatisfactory results, the present data clearly demonstrates that such a drastic adjustment is not always needed.

Comparison of both studies reveals the possibility of a different added value of functional roles in educational environments with a varying degree of teacher-student control, such as small groups of students in an educational setting controlled by the teacher (Study 2) versus students in a community of learners who construct their own groups and shape their learning opportunities (Study 1). It is clear that more systematic investigation is needed to investigate the use of functional roles and the diversity of spontaneous roles – in controlled versus uncontrolled CSCL environments – to support this interpretation.

7.8 Appendix A: Communication discipline

1) Depending on your study pace, you will check at least once every two days (6 months) or once every four days (10 months) for new messages. This is just a minimum; it is advised to check more often.
2) If you receive a message that requires a response or an answer, you will respond as soon as possible. This prevents unnecessary waiting on the part of your group members for your answer or response.
3) If you send a message, you will always send it to the shared e-mail address (list address) so that all members will be informed of the developments within your group.
4) If you wish to change your e-mail address on the list – to which messages send to the shared e-mail address are redirected – you will send a request to the list owner who will change it.
5) If you wish to add a second e-mail address to the list (for instance you home or work address) – to which messages send to the shared e-mail address are redirected – you will send a request to list owner who will add your second address.
6) If you receive a message from the list owner, you will respond promptly.
7) If personal circumstances (work, family or holiday) cause that you will not be able to read and respond to messages for a certain amount of time, you will notify your group in advance.
8) If you are unable to continue with the group assignment, you will inform your group members. In case you started in October 2001 and you are confident that you will be able to start in a new group in March 2002, send a request to your supervisor and s/he will contact you.
9) When you have been placed in a group you are obliged to establish contact with your fellow group members within the first two weeks and make work arrangements.
10) When you have been placed in group, but you fail to establish contact with your fellow group members in the first two weeks, you will be eliminated from that group. In case you started in October 2001 you can send a request to your supervisor to start in a new group in March 2002, however, given your failure to establish contact in your first group no consideration will be given to your preferences regarding the assignment (practice yes/no) or study pace.

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CHAPTER 8

General discussion

8.1 Introduction

Computers have become an integral component of everyday life and education, like other technological advancements have done in the past and they have enhanced the possibilities for how learning environments can be improved. One of these is the application of computer-supported collaborative learning (CSCL). In the introduction it was shown that this form of technology-enhanced education is of special interest to distance education, the type of education the Open University of the Netherlands (OUNL) is delivering. Yet, the implementation of CSCL is far from straight forward. Simply providing communication technology to participants at a different place and time (asynchronous) does not result automatically in collaboration; coordination conflicts are more likely to occur in asynchronous CMC settings compared to face-to-face settings (Benbunan-Fich & Hiltz, 1999). In addition, most students in distance education have a job and a family that compete for attention, thus it is very likely that e-mail is left unattended in the heat of everyday obligations. Consequently, if it is believed that computer-supported collaborative learning is beneficial for students, we have to make sure that students will actively participate. If the participation of other students is uncertain, the chances that any student will be willing to engage in collaboration are minute.

One approach to stimulate collaboration and sustain student involvement during CSCL is instructional support, i.e. a pedagogical method that structures (or scripts) the collaboration in a way that is believed to be more efficient and effective. One form of such instructional support is the use of roles. Although the use of roles is often advocated, they are in many cases part of an overall implementation of instructional support (see for example Bielaczyc, 2001): rarely is their effect studied in isolation. Yet, in order to determine the added value of roles, it is important to single-out the roles and investigate them.

Many different interpretations of the role concept can be found in research. Mudrack and Farrell (1995) describe three different dimensions – task roles, maintenance roles and individual roles – and each group member can play roles of each dimension simultaneously. Several pedagogical approaches that have been developed for cooperative learning use roles to support coordination and group interaction (Johnson, Johnson, & Johnson-Holubec, 1992; Kagan, 1994). These roles are either content-focussed – facilitating knowledge acquisition through individual knowledge differences using 'Jigsaw' (e.g., Bielaczyc, 2001), 'scripted cooperation' (O'Donnell & Dansereau, 1992), or 'prompting scripts' (Weinberger, 2003), or process-focussed roles on individual responsibilities regarding the coordination (e.g., Kynigos, 1999). Most roles developed for cooperative learning settings, however, comprise one single job, task or duty; mainly because they were developed for face-to-face collaboration in primary education. In addition, their effect has not been investigated systematically in both higher/distance and primary education (although the interest in the opportunities that roles can offer for collaborative learning in higher education is growing, De Laat & Lally, in press-a; Pilkington & Walker, 2003).

In this thesis the effect of functional roles on CSCL during project-based learning was investigated. The functional roles are based on role descriptions by Johnson et al. (1992), Kagan (1994) and Mudrack and Farrell (1995). The role descriptions were integrated and adapted (in collaboration with the course supervisors) for implementation in project-based learning where the students would collaborate in small groups of four persons using CMC (e-mail). The roles were designed to give each student an individual responsibility for the group process, but at the same time all roles were interdependent, i.e. essential to the collaboration. The functional roles that were implemented are: project planner, communicator, editor and data collector (for a detailed description see the Appendices A and B of Chapters 3 and 5).

The studies reported in this dissertation address the following main research question: 'What is the effect of a prescribed functional roles instruction, as compared to no instruction, on group performance and collaboration?'. A conceptual and methodological breakdown leads to four derived research questions:

Do functional roles during CSCL lead to better learning outcomes?

Do functional roles during CSCL lead to a more satisfying collaborative experience?

Do functional roles during CSCL lead to a more efficient group process in terms of communication (coordination and content-focused statements)?

Do functional roles during CSCL lead to fewer dropouts?

Before the research findings can be discussed, it is important to point out that during the course of this thesis it has become apparent that researching CSCL requires triangulation of multiple methods to analyse data from multiple sources (both quantitative and qualitative questionnaire data as well as quantitative analysis of a qualitative source (e-mail) were used).

In order to put the pieces together, it is essential to have an overview of the results obtained from the analysis of various data sources with multiple methods. After the summary of the main results and the findings, triangulation will be discussed in relation to the derived and main research question. Next, further theoretical and methodological considerations will be discussed. This will be followed by some implications of this dissertation for CSCL research in general and CSCL at the OUNL specifically. Also, the limitations of these studies and their outcomes will be addressed. Finally, opportunities for future research will be presented.

8.2 Summary of the main results

Chapter 2 contained a literature review and theoretical framework that was designed to position the use of roles in the broader context of cooperative and collaborative learning. It was argued that interaction is the central process that is studied and therefore any method that aims to support computer-supported group-based learning (CSGBL) should have a conceptualisation of how that method affects interaction. Most designs are based on cooperative or collaborative learning and the common distinction made between them by most researchers is uni-dimensional: cooperation is described in terms of task division and collaboration as a joint activity on a shared task. This distinction is not very informative when it comes to interaction. Group interaction is affected by two well-known mediators of group processes (first applied in research on cooperative learning) – positive interdependence and individual accountability, and both have roots in group dynamics. Positive interdependence is linked to group cohesion and individual accountability is linked to diffusion of responsibility and social loafing. Hence, both are approaches to group-based learning (which explains why the acronym of CSGBL is more applicable than CSCL; at least the meaning of the second 'C' is no longer a subject for debate). Given the conclusion that cooperative and collaborative learning are in fact two sides of the same coin, the literature review proceeded by investigating which characteristics affect the interaction that can occur. Five critical elements were identified – three are conceptualised as dimensions (learning objectives, task type and the amount of pre-structuring) and two as discrete categories (group size and the type of computer support). Combined with a conceptualisation of interaction, a six-step design approach was developed that is process-oriented. It is focused on establishing a setting in which the envisioned interaction – seen as supportive to the attainment of the learning goals – can occur. It is however not certain that the interaction will always occur as planned.

Prior to the literature review roles were regarded as a cooperative learning strategy and it was believed that collaborative learning would not need 'formal' structuring. The dimensional representation provided a theoretical framework to position the use of roles in a collaborative learning context (Roman numeral I in Figure 4, p. 34, Section 2.5.3) as a valid possibility (open skills, an ill-structured task and a relatively high level of pre-structuring). Thus, providing a theoretical argumentation for the use of roles in 'collaborative learning', or rather group-based learning.

Chapter 3 described the first part of the results from the first study that was conducted to investigate the effect of functional roles in a project-based learning environment in higher/distance education. The results in this chapter focused on the variables measured at the intake, the group grades and the evaluation Likert-scale questionnaire data – especially the method used to analyse the evaluation Likert-scales was highlighted – and the analysis of the e-mail communication. No significant correlations were found between the variables (e.g., achievement motivation and passive versus active orientation to group work) measured at intake and grade or the evaluation Likert-scales. None of the variables measured at intake were included as covariates. No difference was found between the research conditions for the group grade. Principal axis factoring of several Likert-scales in the evaluation questionnaire revealed a latent variable that was interpreted as 'perceived group efficiency' (PGE). It was argued that the assumption of independence between the scores of members of the same group is violated – ruling out the use of ANOVA and in the case of OLS regression the residual are not independent. Multilevel modelling (MLM) pays attention to interdependency between scores while retaining the variance at the individual and the group level. MLM appeared to be the best suited technique. A comparison of both research conditions, either using a random intercept model or a random slope model, did not reveal significant differences.

A closer examination of the data was undertaken guided by the theoretical possibility that the roles could increase, as well as, decrease group efficiency. PGE estimates were predicted for all groups in both research conditions using a random intercept and random slope model. A comparison of PGE predictions estimates for both models showed that the predictions of PGE estimates become less extreme for the role groups (move closer toward zero), whereas the predictions of estimates for the nonrole groups become more extreme (move further from zero). In other words, the MLM analysis indicates that the students in role groups appear to be more aware of the groups' efficiency than the students in nonrole groups, as revealed by more extreme ratings (positive or negative).

In addition to the Likert-scale questionnaire data results, the outcomes of the analysis of the e-mail communication was reported. As hypothesised, more task-content statements were observed in the role condition. However, the assumption that this would be due to a decrease in the amount of coordinative statements was not confirmed. In fact, the amount of coordinative statements also increased in the role condition. Apparently, roles stimulated coordination, and as a result, task-content statements increased as well.

Chapter 4 provided an elaborate description of the developmental process of the content analysis method that was designed to investigate predominantly the amount of coordination and content-focused statements during collaboration. It was shown that the reliability of segmentation in units of analysis is as important as the reliability of the coding categories. Especially in the case of quantitative content analysis – where the communication is coded, summarised and the frequencies/percentages are used for comparisons and/or statistical testing – the reliability is of the utmost importance. In addition, the development of our content analysis procedure was used to illustrate the importance of the unit of analysis and that reliance on accepted practice turned out as misleading rather than helpful. The initial procedure that was developed to analyse the e-mail communication failed because of the unit of analysis (unit of meaning) chosen, which led to what was termed 'unit boundary overlap': a similar communication excerpt being assigned two mutually exclusive codes by two different coders. A 'unit of meaning' appeared inappropriate to investigate the questions of interest. In retrospect four contextual constraints could be identified that affect the applicability of a unit of analysis: research objective, nature of communication, collaborative setting and the technological communication tool used.

An alternative unit of analysis was defined as 'a sentence or part of a compound sentence that can be regarded as 'meaningful sentence' in itself, regardless of the meaning of the coding categories'. Subsequent testing of this segmentation procedure revealed that it was reliable. The reliabilities were on average .82, .89, and .87 for the cross-validation, all above the minimum of 80% (cf. Riffe, Lacy, & Fico, 1998). Coding of these segments resulted in satisfactory reliabilities, on average .60 on subcategory level (satisfactory) and .70 on main category level (substantial) (cf. Landis & Koch, 1977). All in all, developing the segmentation and coding procedures has revealed that content analysis methodology – and methodology in a more general sense – should be given a more pivotal position in the scientific CSCL discourse. It is after all the methodology, by which the data is gathered and analysed, that determines for a large part the outcomes that are reported; be they as hypothesised or not.

Chapter 5 investigated an alternative interpretation for the observed differences in PGE (reported in Chapter 3). It was hypothesised that the groups in the role condition might have been more susceptible to conflict and/or drop out. Perhaps the self-reliance in nonrole groups had provided them with more flexibility to cope with changes in the organisation and in the coordination of activities. Students' responses to the open-ended evaluation questions (six categories: general issues, functional roles and task division, collaboration progress, coordination impact, assessment and supervision, and reflection) were investigated with cross case matrices for evidence that supported or refuted this interpretation. Analysis of the open-ended questions revealed a higher level of dropout – in terms of the combined total of students that quit during the collaboration or did not finish the course – in the nonrole groups.

Other results revealed that students in nonrole groups were more prone to use traditional communication modes (e.g., telephone and face-to-face meetings), the students in the nonrole condition indicated that they hardly experienced any supervision, reported more free-riding behaviour, and they tended to organise collaboration by splitting the task (policy report) into several smaller components that were handled individually (or in dyads). Surprisingly, the students in both research conditions considered the use of a group grade an 'accepted practice', because the report is a group product and individual contributions simply vary (as one student put it: sometimes you do most of the work and sometimes you benefit from others doing it for you). Apparently the idea of 'partnership' takes precedence over grade differentiation. Students in the role groups considered the roles not to be equal in terms of effort that had to be invested, however, the role instruction was more guiding than coercive and thus it gave students some room for an individual interpretation on how they actually performed their role. The analysis of the 'collaboration progress' and 'coordination impact' categories reveals that the nonrole groups were not more flexible or more able to cope with changes in the organisation and coordination. Moreover, the results for the 'coordination impact' category showed that non-compliance to the agreements made, with respect to tasks or deadlines, is seen as the principal cause for lack of collaboration progress in both research conditions.

Chapter 6 reported the results of the second study. Preliminary analysis of the first study showed a considerable amount of dropout during the course. Several preconditions were identified that – if controlled for – might decrease or even prevent dropout, such as students' preference for a practice assignment, slow or fast study pace, setting up of a time schedule, establishing a communication discipline and externalising expectations regarding effort prior to collaboration. Also, controlling these preconditions could ensure a more evenly matched comparison of the research conditions.

Similar to Chapter 3, the results in this chapter focused on the variables measured at the intake, the group grades, the evaluation Likert-scale questionnaire data, the analysis of the e-mail communication, but also the analysis of the cross case matrices. None of the variables measured at intake correlated significantly with either grade or the evaluation Likert-scales and they were not included as covariates. Again, no difference was found between the conditions for the group grade. Similar to the first study, principal axis factoring of several Likert-scales in the evaluation questionnaire revealed the latent variable 'perceived group efficiency' (PGE). MLM was performed to analyse PGE using a random intercept model. A positive marginal effect was found in favour of the role groups: PGE in most role groups was consistently higher than PGE in nonrole groups. Moreover, an apparent outlier in the role condition, which appeared to result from an increase in awareness of group efficiency by the roles, hampered the statistical significance. Analysis of the open-ended questions supported this interpretation, as two students in the role condition report that the progress in their group was difficult and the agreements did not stimulate progress: both students participated in the outlier group.

Analysis of the e-mail communication illustrated again that roles affected coordination, and similar to the first study the functional roles increased the amount of 'task coordination'. In contrast, however, an increase in the amount of 'task content' communication was not observed in the second study. Apparently the changes in the preconditions appear to have levelled out some of the disadvantages of the nonrole groups.

Similar to the first study, cross case matrices of the open-ended questions revealed that students in nonrole groups used more frequently additional communication channels (e.g., chat, telephone and/or face-to-face meetings). With respect to 'collaboration progress' the role groups reported more frequently that the progress was fine, compared to students in nonrole groups who report it was difficult or slow. Moreover, progress appeared to be inversely related to the extent that students experienced that they had to wait for other group members. Also, the role groups reported more frequently that the agreements they made about the tasks and deadlines stimulated progress than their counterparts in nonrole groups. Finally, this chapter highlighted the need for triangulation. This will be discussed in relation to both studies in more detail in the next section.

Finally, Chapter 7 addressed the actual performance of the functional roles by students in the role condition and the possibility of spontaneous roles in the nonrole groups for both studies. Moreover, the added value of content analysis was emphasised in relation to the use of the group grade and the Likert-scale evaluation questionnaire; both tend to provide a surface level analysis. The results of the content analysis of the e-mail communication for both studies were included to compare both methodologies (different unit of analysis) and integrate their outcomes.

In order to analyse the groups in both conditions for the level of 'role behaviour' each task belonging to one of the four functional roles was re-worked into a coding category. All role behaviours identified were aggregated on the level of the message, each message receiving one of four codes if role behaviour was performed. In the first study no difference was observed in the total amount of role behaviour between research conditions, but members of the role groups performed role behaviours, associated with their functional role, more frequently than members with a different functional role. In addition, a plausible alternative interpretation for the observed PGE difference in the first study was disproved: the role group with the highest and lowest PGE level did not differ in the extend to which members acted according to their role. Group members in the role group with the lowest PGE level did not act more rigidly according to the functional roles. Yet the variability in functional role behaviour between role groups indicates that the roles acted as a guiding principle rather than a set of coercive descriptions. Two types of role behaviours (project planner and editor) were frequently performed in nonrole groups. They were not bound to a single group member, but distributed. Spontaneous roles emerged in two nonrole groups, but those group members still performed other role behaviours. Finally, the spread of 'editor' behaviours indicates that nonrole groups organised their collaboration by splitting the content of the shared report into (sub)topics which were individually studied, written and assembled (A+B+C+D) in a 'collaborative' report.

In contrast to the first study, the second study revealed a significant main effect for the total amount of role behaviour in favour of the role groups. Compared to the first study, the impact of the preconditions is reflected in the total amount of messages send and role behaviours scored. Similar to study 1, the group members in role groups predominantly performed their functional role behaviours more frequently than group members with a different role: validating the impact of the functional roles. This time three types of role behaviour were observed in nonrole groups (project planner, editor, and communicator) but again not bound to a single group member. Similar to the first study, 'editor' behaviour was spread across all group members of nonrole groups – indicating that these groups tended to split the content in topics that were individually studied. Changing the preconditions – compared to the first study – appears to have controlled for some external sources that may have interfered with the functional roles in the first study.

8.3 Analysing CSCL: A need for triangulation

In Chapter 2 it was illustrated that cooperative learning and collaborative learning are two sides of the same coin: group-based learning. Both are different approaches to the organisation of group-based learning and the interaction that takes place, however, one important difference is how the effect of an educational intervention is measured. Cooperative learning still determines the success of an educational intervention in terms of the learning outcomes using standardized quizzes for assessment.

Although Computer-Supported Collaborative Learning (CSCL) shares this main interest for learning outcomes, the actual outcomes are attributed to a variety of processes: internalisation (i.e., individual knowledge gain), interaction (i.e., sharing expertise and distributed expertise) or transformation (i.e., the continuous advancement of shared knowledge) (Lipponen, Hakkarainen, & Paavola, 2004). These processes can be studied in multiple ways with a variety of data sources and analysis methods. In addition, CSCL combines the study of learning, collaboration, support/ scaffolding and computer technology, and each component can be studied with both quantitative and qualitative methods. Yet, whereas theory and instructional support are extensively debated, a methodological debate on research and analysis is relatively missing. Therefore, the Chapters 3, 4, 6 and 7, have given specific attention to the analysis method(s) that were used in relation to the data source and the research questions under investigation. In Chapter 4 it was shown, with respect to the quantitative content analysis of electronic communication, that the research question and data source (among other factors) both determine the unit of analysis that is most appropriate. This can be extended to CSCL research in general: using a sole quantitative or qualitative approach to the analysis of CSCL limits the investigation of the phenomenon under study (e.g., in this dissertation the use of instructional support to increase and sustain participation during CSCL).

Using multiple methods to investigate various data sources requires that the outcomes are combined in a single interpretative perspective that reveals their interrelations. This is referred to as triangulation. Chapter 6 already highlighted the need for triangulation of the research outcomes – obtained with a variety of analysis methods and data sources (e.g., factor analysis and multilevel modelling (MLM) of quantified questionnaire responses, quantitative content analysis of e-mail communication and qualitative analysis of questionnaire responses).

In the next section, the outcomes reported in Chapters 3, 5, 6 and 7 will be combined in a single interpretation of the impact of the functional roles for each study, as well as between both studies. Triangulation not only strengthens the research outcomes obtained with a single method, but in addition a more complete understanding of the effect of functional roles in CSCL emerges.

8.4 Triangulation of research outcomes

In order to answer the main research question and derived questions it is essential that the outcomes that have been reported in Chapters 3, 5, 6 and 7 are integrated into a single perspective. The derived research questions will serve a framework to discuss the integration of these results, followed by an overall interpretation to answer the main research question.

8.4.1 Do functional roles during CSCL lead to better learning outcomes?

It was hypothesised that groups with functional roles would receive a higher group grade than groups working without such roles. Learning outcomes were investigated in terms of the group grades and two essay questions in the evaluation questionnaire. An analysis of learning outcomes in terms of grades between the role and nonrole condition (Chapters 3 and 6) revealed no significant difference in both studies (possible alternative explanations are discussed later). The evaluation questionnaire contained two essay questions asking students to describe what they learned from the course content ('Describe what you have learned from writing a policy report?'), as well as the collaborative process ('Describe what you have learned from collaborating during this course'). Chapter 5 discussed the cross case matrices that were constructed on the group level to compare students' responses within and between both research conditions. Group level matrices were constructed because there was a lot of diversity in students' responses, which is no surprise considering the fact that students in distance education vary considerably in their educational and personal background. Some of the students have a job in the domain of the course, whereas others are studying for a job transition. Hence, some students report that they learned little in relation to the course content (sometimes it is related to previous courses), whereas other students report that they learned a lot. Regarding collaborative learning a similar pattern emerges. Some students report that the collaboration confirmed their expectations (mostly negative) towards virtual collaboration, whereas other students report that the experience proved how virtual collaboration can be applied and/or what it takes to get virtual collaboration off the ground and how it can be sustained once the collaboration is in progress. All in all, however, the matrices revealed that, although students in the role condition are not extremely enthusiastic about collaboration in their group, they tend to be more positive about virtual collaboration than students in the nonrole condition who tend to emphasise what they learned from course content or writing the policy report in general. In Chapter 6, the outcomes from the two questions were not included for lack of space given the journal article format. The cross case matrices, however, showed a similar pattern for the second study.

It can be concluded that the functional roles – as investigated in both studies by using the group grade and short essay questions – did not reveal a difference in terms of learning outcomes.

8.4.2 Do functional roles during CSCL lead to a more satisfying collaborative experience?

It was hypothesised that groups with functional roles would have a more satisfying collaborative experience than groups working without such roles. Students' collaborative experience was investigated with quantified questionnaires (Likert-scales) and a collection of open-ended questions addressing: general issues (i.e., technology and group size), functional roles and task division, collaboration progress, coordination impact, and assessment and supervision.

Analysis of questions rated with either a Likert-scale or ten-point scale in the evaluation questionnaire revealed medium to high correlations in both studies between the variables 'team development', 'group process satisfaction', 'intra-group conflict', 'task strategy' and 'quality of collaboration'. Principal axis factoring revealed in both studies a latent variable: perceived group efficiency (PGE). In both studies standardised factor scores were computed for PGE and further investigated with multilevel modelling (MLM). In the first study PGE was investigated using either a random intercept or random slope model, but no significant differences were found. A comparison of PGE prediction estimates, however, revealed that students in role groups appear to be more aware of the groups' efficiency than the students in nonrole groups, as shown by more extreme ratings (positive or negative). In the second study, a positive marginal effect was found using the random intercept model. PGE in most role groups is consistently higher than in nonrole groups. Moreover, an apparent outlier in the role condition, resulting from increased awareness of group efficiency, hampered the statistical significance. Responses with respect to the open-ended questions on collaboration progress and whether agreements stimulated progress show that two students from the same role group report that progress was difficult. Roles appear to affect PGE in two different ways – *increased awareness of PGE* and *increased level of PGE* – but an increase in awareness of group malfunctioning can potentially cancel out the difference in the level of PGE.

Results from the analysis of the open-ended questions in both studies reveals that students in the nonrole groups are more prone to use additional communication channels (e.g., meeting face-to-face, or using telephone or chat). With respect to functional roles and task division, students in both conditions considered the functional roles to be unequal in terms of effort that had to be invested in them. Nevertheless, analysis of e-mail communication regarding functional role behaviour showed that students in role groups predominantly performed their functional role behaviours more frequently than group members with a different role: validating the impact of the functional roles. With respect to the question about task division, the nonrole groups in both studies tended to organise collaboration by splitting the task (policy report) into smaller components that are then handled individually (or in dyads). Analysis of e-mail communication for emergent spontaneous role behaviour confirmed this pattern. In both studies, students in nonrole groups performed two types of role behaviour spontaneously, but they were distributed across all group members and not bound to a single group member.

Regarding collaboration progress, the studies showed different outcomes. In the first study no clear difference was observed between both conditions for questions that addressed ‘overall progress’, ‘waiting for other group members’ and ‘equality of contributions’. In the second study students in the role condition reported more frequently that their progress was fine, compared to students in nonrole groups who reported it was difficult or slow. Moreover, progress appeared to be inversely related to the extent that students experienced that they had to wait for other group members. Regarding coordination impact again different outcomes emerged. In the first study the students in both conditions report free-riding, but the students in the nonrole groups are more forthcoming about apparent free-riders. This seems to indicate that the functional roles level out the negative experiences associated with free-riders. No differences were found, however, for the questions addressing the kind of agreements made nor whether these agreements affected progress. In the second study, the role groups reported more frequently that the agreements they made about tasks and deadlines stimulated progress, as compared to nonrole groups. Finally, regarding assessment and supervision, the results from both studies reveal that students in both conditions consider the use of a group grade an accepted practice: the idea of ‘partnership’ takes precedence over grade differentiation. Yet, with respect to supervision the results of both studies reveal that the role groups contacted their supervisor more often than nonrole groups. Moreover, students in the nonrole groups indicated that they hardly experienced any supervision, expressing a higher need for supervisor feedback and reporting that it was either not there or insufficient. Although it was likely that the communicator role might have amplified this difference in the first study, the outcomes of the second study – in which nonrole groups also handed in a progress report – confirmed the difference between the conditions regarding their perception of supervision.

It can be concluded that the functional roles lead to more awareness of the collaborative experience (Study 1) and a higher level of satisfaction with their experience (Study 2) – in terms of perceived group efficiency. The second study showed that role groups were more satisfied as expressed by the degree of overall progress and that agreements made stimulated progress. Both studies showed that nonrole groups tended to have been less satisfied and experienced a stronger need for supervisor involvement.

8.4.3 Do functional roles during CSCL lead to a more efficient group process in terms of communication (coordination and content-focused statements)?

It was hypothesised that functional roles would decrease the amount of coordinative statements in favour of content-focused statement. To investigate whether the functional roles affected collaboration in terms of the communicative statements all e-mail communication was analysed and quantified for statistical comparison. Developing a quantitative content analysis appeared to both difficult and laborious: a separate segmentation and coding procedure had to be developed (see Chapter 4) before the communication could be analysed. Each unit of analysis (segment) was coded with one of eighteen subcategories and these were aggregated at the level of five main categories: ‘task coordination’, ‘task content’, ‘task social’, ‘non task’ and ‘non-codable’.

General measures of communication revealed a different communication pattern in both studies. In the first study, a significant difference was found for the amount of segments coded, but not for amount of messages sent: students in role groups contributed longer e-mail messages. In the second study this finding was reversed, a significant difference was found for the number of messages send in role groups but not for the number of segments: students in role groups wrote shorter e-mail messages but interacted more frequently.

Analysis of the e-mail communication in the first study revealed significantly more content-focused statements in the role condition. However, this was not caused by a decrease in the amount of coordinative statements – the amount of coordinative statements increased as well. This was underlined by a positive correlation between coordination and content-focused statements, revealing that role groups clustered predominantly in the high performance quadrant. Analysis of the e-mail communication in the second study also showed significantly more coordinative statements in the role condition, but no difference was found regarding the amount of content-focused statements. In addition, the first study found a significant difference for ‘task social’ statements (expressing either a positive or negative evaluation or attitude in general, toward the group or an individual group member) underlining that the students in the role group were more aware of their groups’ efficiency, regardless whether they performed well or poor.

It can be concluded that functional roles increase the amount of coordinative statements. In a relatively uncontrolled environment the amount of content-focused statements and ‘task social’ statements increase as well. Finally, functional roles apparently result in a different interaction pattern in a relatively uncontrolled (Study 1) and controlled (Study 2) learning environment.

8.4.4 Do functional roles during CSCL lead to fewer dropouts?

It was hypothesised that functional roles would decrease the level of dropout. In the first study there appeared to be no difference between both conditions in the number of students that quit during the collaboration. However, a comparison of the total number of students that dropped out during the course or did not finish the course, revealed a significant difference to the disadvantage of the nonrole groups. Student reflection on what they learned from the collaboration during the course (Study 1) supports this interpretation: students in the role condition appeared to be more positive about their collaborative experience than students in the nonrole groups. Given the level of dropout in nonrole groups the general course design was examined and several preconditions were identified that – if controlled for – could decrease or prevent dropout in nonrole groups: students' preference for a practice assignment, a slow or fast study pace, setting up of a time schedule, establishing a communication discipline and externalising expectations regarding effort prior to collaboration. No significant difference was found regarding dropout in the second study.

It can be concluded that functional roles decrease dropout in an uncontrolled learning environment (Study 1) and controlling general preconditions decreases dropout in the nonrole condition as well (Study 2).

8.4.5 What is the effect of a prescribed functional roles instruction, as compared to no instruction, on group performance and collaboration?

Overall it can be concluded that a prescribed functional roles instruction affects collaboration, as the students in role groups performed role behaviours, associated with their functional role, more frequently than members with a different functional role (Chapter 7). Performance in terms of a group grade is not affected, but performance appears to be better reflected in the level of perceived group efficiency (PGE). However, perceived group efficiency differed in both studies, which appears to be caused by the level of control exerted in terms of preconditions. In an uncontrolled environment roles increase students' *awareness* of their perceived group efficiency (PGE), whereas in a controlled learning environment the *level* of PGE is increased as well. Students in the role groups appear to be more satisfied in general – more prevalent in a controlled learning environment (Study 2) – as revealed by their opinions regarding collaboration progress, coordination impact, and assessment and supervision. Functional roles increase the amount of coordinative statements – contrary to the hypothesis – and in an uncontrolled environment the content-focused statements increase as well. Similarly, the learning environment affects e-mail communication in role groups on a general level: the amount of communication in a message (content) is higher in an uncontrolled environment, whereas the frequency of e-mail messages is higher in a controlled environment.

Controlling for these preconditions has ensured a more evenly matched comparison of both research conditions – as reflected by the differences in PGE and content-focused statements – but simultaneously revealing some persistent effects, such as the latent PGE variable, the difference in the amount of coordinative statements and the role behaviour execution. Finally, controlling for preconditions facilitated the comparison of two qualitatively different CSCL environments: the first study can be an example of how functional roles could support a group in a learning community that only exists for the period of their self-selected project and the second study showing how functional roles support a group in an institutionalised (and more controlled) educational environment.

8.5 Methodological considerations and limitations

In the introduction it was highlighted that explicit attention would be paid to methods for analyses of the various data sources. Although, in general, these methods have proven to be appropriate and effective, they have their limitations.

8.5.1 Analysis of group grades

Chapter 3 and 6 have shown that the use of group grades is insufficient to investigate the learning benefits. This seems to be primarily due to the lack of variation (grades varied between 6 and 8.5 on a 10-point scale). Some groups were given the opportunity to revise the report that they had submitted for grading in order to arrive at a satisfying level, which of course decreased the variance in the final grades. Also, there seems to be a trend that supervisors tend not to give a group a failing grade in a similar way as they would do toward an individual. It should be noted, however, that grade differentiation is difficult and laborious. Taking an individual's contribution to the collaboration and shared report in account would require a supervisor to read all e-mail communication. Given the limited time for supervision and the number of groups this is not feasible. Yet, computer-supported language processing might lessen the burden involved and expand the opportunities for assessment.

8.5.2 Analysis of quantitative questionnaires data

The results obtained with quantitative questionnaire data were also reported in Chapters 3 and 6. In most cases questionnaires – especially Likert-scales – provide a surface level analysis of actual behaviour. Furthermore, questionnaires are self-report measures and therefore a certain degree of the measurement bias is located within the instrument. Chapters 3 and 6 used multiple Likert-scales to investigate constructs that related to collaborative learning. Obviously, the Likert-scales were selected for their applicability toward CSCL, but in addition they were selected for a high internal reliability (Cronbach's alpha) which had to be .80 or higher (an exception is the active/ passive scale (.78) that was specifically developed for this dissertation). The choice was based on the relative small number of participants in CSCL, as research designs in general do not exceed 20 participants (see Stahl, 2002). Such a small number of participants will in general result in an unstable internal reliability, and thus a minimum required reliability for further analysis – which is generally set at .60 – might not be obtained if scales with an internal reliability of less than .80 were used. The results reported in Chapters 3 and 6 supported this decision: most Likert-scales were sufficiently reliable given a small numbers of participants in both research designs (Study 1, N = 33; Study 2 N = 41).

Principal axis factoring of several of the Likert-scales – in both studies – revealed a latent variable (PGE) and standardised factor scores were computed in both studies and analysed with multilevel modelling (MLM). Chapter 3 explained that MLM pays attention to interdependence between scores, and MLM is more suited than OLS regression or ANOVA as the assumption of independence was violated. Nevertheless, MLM is not often used with less than 50 participants. Moreover, the design used in both studies was skewed (i.e., the number of observations on Levels 1 (group) and 2 (individual) are not balanced (5 × 5, 10 ×

10), and such a design is less efficient in the so-called random component on both levels. In other words, statistical power is decreased.

The results of both studies, however, must be treated with some caution. Given the small sample size – which is typical for most ecologically valid educational settings, as it depends on the number of students that register for a course – it can be argued that a significance level of $.05 < p < .10$ is justified. In addition, perceptions in the nonrole condition are also affected by so-called free riders (i.e., group members that abstain from any effort to participate in collaboration), but these members tend to rate their perception of collaboration as a very positive one. Moreover, an apparent outlier in the role condition, resulting from an increased awareness of group efficiency, hampered statistical significance in the second study. Overall, MLM appeared to be the most applicable technique to analyse the Likert-scale data. Nevertheless the results should be treated with some caution and further exploration of this technique in CSCL research is needed.

8.5.3 Analysis of qualitative questionnaire data

The evaluation questionnaire also contained several open-ended questions. Similar to the quantitative Likert-scales they suffer from a self-report bias, however, cross case matrices can be used to construct aggregated representations of their collaboration experience at the group level and the level of the research conditions. The results in Chapters 5 and 6 show both the similarity and the diversity in student responses. Often studies will report summaries of student responses and illustrative student remarks to warrant the interpretation, however, often the selection is not supported with argumentation and the remarks appear to have been chosen idiosyncratically. In response to this practice, the number of students and the number of different groups is stated explicitly in the comparisons at the level of conditions in Chapters 5 and 6.

8.5.4 Analysis of e-mail communication

Apart from the questionnaires, the second data source used was e-mail communication. It was assumed that e-mail would be a sufficient representation and an approximation of the actual collaboration. As shown by the responses to open-ended questions about the use of additional technology, the students used the telephone and occasionally a face-to-face meeting or chat. Obviously, some data have been lost that might have affected the comparison; however, the fact that nonrole groups reverted to alternative communication means illustrates that they could not achieve collaboration only through e-mail communication.

The quantitative content analysis of e-mail communication proved to be complicated. In the course of developing an analysis procedure it became apparent that the applicability of a unit of analysis varies. Segmentation proved to be essential and an alternative unit was developed to analyse the e-mail communication (see Chapter 4). Additionally, a different unit of analysis was used for the content analysis procedure reported in Chapter 7. Overall, the development and the analyses reported in Chapters, 3, 4, 6 and 7 underline that researchers should make their choices made in the development of a content analysis procedure (segmentation and coding categories) explicit. Furthermore, the use of Cohen's kappa and the interpretation of this statistic should be discussed and alternatives should be considered (see for example the use of Krippendorf's alpha by De Wever, Van Winckel, & Valcke, 2004). A scientific discourse is needed on this topic (which could evolve from introducing conventions for systematic reporting of coding and segmentation reliabilities and procedures) and Chapter 4 can serve as a point for departure.

8.5.5 Functional roles

The functional roles used were based on role descriptions in reports by Johnson, Johnson and Johnson-Holubec (1992), Kagan (1994) and Mudrack and Farrell (1995). The descriptions were integrated and adapted in collaboration with the course supervisors for implementation in a project-based learning environment. Although the functional roles proved to affect collaboration in both studies, the development of these roles could have been more systematic. A Delphi study involving experts in project-based learning and working could have provided an even stronger instructional support, or roles that even more closely resemble a professional work context. Chapter 7 revealed that nonrole groups tended to organise their collaboration by splitting the task in individual contributions, which is very similar to a professional context. Such expert roles can indeed have a positive effect on the amount of information shared (see Stasser, Stewart, & Wittenbaum, 1995), however, it should be noted that none of the students can be regarded an expert in a professional sense. Such a performance view of collaboration underlies the task role distribution theory (Stempfle, Hübner, & Badke-Schaub, 2001): the aim of task role distribution is to increase performance and efficiency based on the individual performance indicators. From a learning point of view optimising task performance is not the most important objective of group-based leaning. Moreover, it is very likely that the group members tend to be assigned tasks that they have mastered. Functional role distribution based on performance would inhibit students' learning opportunity (note that Stempfle et al. tested their theory in a learning context).

8.6 Theoretical considerations

Since the introduction of the concept 'collaborative learning' in the late 1980s and early 1990s, research and practice of (computer-supported) group-based learning has suffered from the dichotomy between 'cooperative learning' and 'collaborative learning'. This posed difficulties in relation to the research reported in this dissertation. Cooperative learning was seen as a highly structured form of group-based learning. Roles were a part of this approach and thus they had no place in a collaborative learning perspective. As shown in Chapter 2 the design of CSCL should not be grounded on subjective decisions regarding tasks, pedagogy and technology, or concepts such as 'cooperative learning' and 'collaborative learning'. Instead, multiple collaborative environments exist and no CSCL environment is universally applicable (Kirschner, Martens, & Strijbos, 2004). The problem is to find out when an environment works and elicits the interaction between students that enhances learning.

If learning is the principal process in CSCL, then the design of CSCL environments has to follow the reverse order of the acronym, as argued by Strijbos, Kirschner and Martens (2004a). A theoretical framework for such process-oriented

– i.e. focused on the interaction – design was described. This view is also in line with perspectives that argue that the actual communication (electronic or face-to-face around a computer) – instead of counting messages and whether or not these were read by other group members – should be analysed (Stahl, 2001). Dillenbourg (1999) states that CSCL “describes a situation in which particular forms of interaction among people are expected to occur” and “there is no guarantee that the expected interaction will occur” (p. 5). However, the probability that the interaction might occur can be increased through systematic design of CSCL that focuses on the alignment of the learning objectives, the desired collaboration processes, the kind of support best suited to facilitate collaboration and the applicability of the CSCL-ware or technology used (Strijbos, Kirschner, & Martens, 2004b).

Regarding the functional roles that were studied in this in the dissertation, one important theoretical advancement is that such roles increase coordination instead of decreasing it. Clearly, this was not expected, but this finding was consistent in both studies and the mediating influence of functional roles – and perhaps even roles in general – should be revisited. The functional roles not only appear to assist in coordination, but they stimulate awareness of both the collaborative process (e.g., resulting in PGE) and expected contributions by other group members (e.g., more progress and group members keeping to the agreements in Study 2). Conceptualising functional roles as an awareness tool is closely related to a recent suggestion by Caroll, Neale, Isenhour, Rosson and McCrickard (2003) that ‘activity awareness’ is needed to synchronise collaborative activity. In addition to the general finding that roles can increase effectiveness in terms of coordination, the impact of awareness through roles enhances the usefulness of functional roles for collaboration.

Another advancement of the functional roles is the theoretical foundation of these roles. Naturally they are based on ‘positive interdependence’ and ‘individual accountability’, but as was shown in Chapter 2 these mechanisms relate to phenomena (e.g., group cohesion, diffusion of responsibility and social loafing) in small group dynamics, a discipline in social psychology that specifically studies behaviour in small groups. Social psychology and specifically small group dynamics can offer much to CSCL research and practice by helping answer questions such as: How can we deal with pseudo-groups where members are assigned to do something together, but have no interest in doing so? How can we take advantage of groups that have a long history and tradition as well as established forms of collaboration? What is the influence of status and its relationship with equity in collaboration? Note that the Jigsaw method (Aronson, Blaney, Stephan, Sikes, & Snapp, 1978) was originally developed by social psychologists in an attempt to reduce prejudice towards minorities in classrooms, and the increase of academic performance of minority students was actually a positive side effect. Another opportunity to benefit from the domain of social psychology and group dynamics could be the application of the five stages of group development – i.e., orientation, conflict, cohesion, performance and dissolution (Tuckman 1965; Tuckman & Jensen, 1977) – to analyse interaction in terms of the succession of stages.

Finally, the educational context appeared to be an important determinant for the actual collaborative interaction. Overall, students in role groups appear to have been more engaged in the collaboration, as reflected by either the longer e-mail messages (study 1) or frequency of messages (study 2), as compared to the nonrole groups. Depending on the degree of control exerted over preconditions, the use of roles affects either the awareness of perceived group efficiency (PGE) or PGE level and the amount of communicative statements increases as well. This provides some indirect support for the interrelatedness of cognitive, motivational and social competencies in CSCL, but it should be noted that no mediating effect was found for the social and motivational orientation in the studies reported in this dissertation (also these relationships were only marginally explored in this dissertation). More importantly, however, the impact of the preconditions underlines that multiple collaborative environments exist and the effect of a single instructional approach to support collaborative learning can vary in different educational environments.

8.7 Practical implications

The aim of this dissertation was to investigate whether roles – and more specifically functional roles – can be an effective form of instruction to support CSCL in distance education. In the introduction it was illustrated that asynchronous CSCL in a distance education context requires that students feel the need to engage in sustained interaction with other students, before we can even expect that an effective knowledge building discourse develops.

The results for both studies in the dissertation have shown that functional roles can make a valuable contribution to CSCL in terms of participant engagement in interaction and sustaining the collaboration. Unequivocally, a group grade has not been a useful indicator for performance. Hence, designers, teachers and practitioners should not depend solely on grades to assess the educational effectiveness of (computer-supported) collaborative learning. The short essays by students on what they learned from the course content and collaboration show the variety of learning that took place; which is a specific aspect of distance education. In distance education students have a varied educational as well as personal background. Although they share the learning context, the learning is far less similar than that of students collaborating in a more traditional university setting. Designers and practitioners in higher and distance education should take these differences into account when determining the effectiveness of a CSCL environment.

At present the possibilities, to include each students' contribution to the collaborative process (communication) and the collaborative report in the overall assessment, are limited. Here, computer-supported tools might also make a difference. One application that provides some degree of automated assessment support is the Analytic ToolKit® (ATK) included in Knowledge Forum©. Reflection reports or portfolios can be other useful strategies to assess the collaborative learning process (Chan & van Aalst, 2004). Similarly, peer assessment can be used to enhance the visibility of the collaborative learning that took place (Sluijsmans, 2002; Prins, Sluijsmans, Kirschner, & Strijbos, in press).

The effect of the functional roles as reported in Chapters 3-7 underlines that instructional support in general – and the use of functional roles specifically – has a significant impact on participation during CSCL. In addition, the impact of functional roles in the specific OUNL education context underlines that CSCL requires a careful orchestration of the learning environment. As argued in Chapter 2, the key elements need to be aligned. The pre-structuring chosen – in this dissertation functional roles – should be aligned with the learning objectives (i.e., open skills), the envisioned interaction (i.e., networked), the task (i.e., ill-structured), group size (i.e., three to five) and mode of communication/technology (i.e., e-mail). The six-step design method that was introduced in Chapter 2 focused on designing for interaction, but the design of a CSCL environments implies that 'assessment' and 'supervision' are considered as well. In fact, both assessment and supervision should be aligned with each of the six elements of the six-step method. The method has been expanded to a six by eight matrix and compiles 75 design questions. More importantly, it specifically focuses on the alignment of (now) eight components. The usefulness of this matrix for the design and evaluation of CSCL courses will be investigated among practitioners in higher education in Spain and primary school teachers in Australia. These data are currently collected.

In the introduction it was illustrated that CSCL resides on the combined and interrelated cognitive, motivational and social characteristics of all participants. Indicators for motivational and social characteristics were included in the intake questionnaire to explore such relationships (e.g., achievement motivation and active/passive orientation to group work). In both studies, no significant correlations were found between the motivational and the social characteristics and the perception of collaboration measured in the evaluation questionnaire nor between these and the participation in the e-mail communication (amount of messages).

The comparison of these studies has revealed that preconditions have a significant impact on the effect of the instructional support. Changes in the preconditions were beneficial for both research conditions: decreasing dropout in the nonrole groups and controlling for aspects that confounded the effect of functional roles in the first study (i.e., the lack of clarity about time schedules, a lack of communication discipline and/or externalisation of expectations and norms regarding input of group members prior to collaboration). A dynamic systems perspective – as described in the introduction – could theoretically account for the mediating influence of the work and home environment on CSCL in a distance context.

Nevertheless, the feasibility of strong preconditions may vary for different CSCL environments. Communities of practice or learners are loosely structured: it is conceivable that functional roles are provided to students as a component of a large set of instructional support techniques that a group *may* utilise, but the decision to use the support is ultimately left to the group. CSCL environments vary in the degree of teacher control versus student control, thus a designer or practitioner should take this into account when implementing CSCL and instructional support techniques should be provided. As illustrated by Järvelä, Häkkinen, Arvaja and Leinonen (2004), various forms of instructional support (i.e., social, cognitive, motivational or increasing the authenticity) can be applied, and these methods are not mutually exclusive.

8.7.1 Specific implications for the OUNL

The OUNL distance education context affected the collaboration in the groups. In general the OUNL employs an individual learning model and the students' decide when and how often they study. This amplifies the tension that was described in the introduction for asynchronous communication between a maximum of flexibility and planned group activities. Kreijns (2004) reported that this tension had negative effects on participation during CSCL in distance education, and it resulted in a high level of dropout. A similar effect was observed in the first study reported in this dissertation: events taking place in the work and home environment occasionally had a considerable influence on collaboration. Two preconditions were specifically implemented to address the problem. An examination of the e-mail transcripts during the first study showed that students operated on different study schedules and the amount of effort that could be invested – as well as expectations about the effort by other students – was not made explicit. In the second study students were asked to explicate the amount of time they could invest in the collaboration. In addition, students were asked whether they preferred a practice assignment, which was tied to a slow study pace, or the final assignment that was associated with a fast study pace. The decrease in dropout that was reported for the second study underlines that the design of CSCL in distance education should not only focus on instructional support for collaborative learning, but it should also be designed to cope with unforeseen events such as individual differences in study time and effort that they can contribute to the collaboration.

Given the tension between collaboration and the general OUNL study policy, the OUNL should adopt – or modify – its study policy from 'independent individual' to 'mostly independent individual, sometimes in collaboration'. Moreover, the emphasis on individual freedom to study at the OUNL requires developing a 'culture of collaboration' (Hakkarainen, Järvelä, Lipponen, & Lehtinen, 1998). As argued in the introduction, collaboration does not develop spontaneously, and thus the institution should develop practices that support the implementation of such models, as well as adoption of such educational models by the students. Assuming that the OUNL will continue to organise their education according to a competency-based model – which includes to some extent collaboration – students should be informed in advance that collaboration is a part of a course or a degree program. At present, students are often surprised (and sometimes irritated, but who can blame them) when they find out that a course involves collaboration. Implementing CSCL in distance education will also require a substantial effort at the institutional level, so that students will enter at least as 'informed' participants in a course.

8.8 Future research

8.8.1 Guidance versus coercion

First of all, the delicate balance between guidance and coercion should be addressed. Dillenbourg (2002) has argued that we should be careful not to over-script CSCL. Although he states that over-scripting occurs when natural interaction is disturbed, it is not made explicit what we should look for. Moreover, in essence the goal of every script is to disturb 'natural interaction' – in terms of the interaction processes that students are familiar with – and substitute these with practices that are believed to be beneficial for the attainment of the learning objectives. In sum, the questions as to when over-scripting occurs (for instance with instructional support such as functional roles), what we should observe, and the balance between guidance and coercion are open for investigation. A possible direction is to investigate whether collaboration breakdowns could also be ascribed to a conflict between the pedagogical model enforced through the learning environment and 'naïve' theories or collaboration models that participants have internalised. The 'Cognitive Evaluation Theory' (Ryan & Deci, 2000) predicts social and task factors that hinder or promote intrinsic motivation to learn. A higher degree of competence with, and control over the pedagogical model could increase the level of intrinsic motivation to collaborate.

8.8.2 Roles in small groups and communities

Recently the concept of roles has attracted more attention in CSCL research. For example the use of roles in the form of instructional support (De Wever, Winckelmans, & Valcke, 2004; Pilkington & Walker, 2003; Schellens & Valcke, 2004), and applying computer-software support to increase student awareness of the roles (De Laat & Lally, in press-b) or provide assistance by having students plan a process workflow prior to the collaboration (Herrmann, Kienle, & Menold, 2004). It is apparent, however, that the shape of (functional) roles and their impact differs for the various learning environments.

Regarding CSCL research in general, this dissertation provides part of the groundwork for a further investigation of (functional) roles in a digital collaborative context. The functional roles reported in this dissertation are applicable to other project-based learning settings (presumably also in face-to-face settings – although this should be investigated), but any use beyond a project-based learning setting will likely require certain modifications. Extending their application is not just limited to educational environments, but this can also include Computer-Supported Cooperative Work (CSCW) environments. Furthermore, although role rotation was not studied in this dissertation, it could be included in future research to further explore the effect of roles. Finally, a community perspective on CSCL (regardless whether it concerns a community of learners or practice) reveals a multitude of roles that can be played by the participants (Hermann, Jahnke, & Loser, 2004; Pilkington & Walker, 2003). Roles could be used as a community development tool, but further research is needed.

8.8.3 CSCL as design research

Design research is a view on educational science that has recently gained more attention in the research community. Design research is characterised by several consecutive iterations, in which an educational environment is gradually refined – in interaction with all actors involved (e.g., students, teacher, policy makers, etc.). Collins, Joseph and Bielaczycs (2004) provide an elaborate overview of guidelines for carrying out design research. An important characteristic, which applies to CSCL as well, is the fact that an enormous amount of data is gathered (often more than can be analysed). Moreover, Collins et al. (2004) argue that "designs in education can be more or less specific, but never be completely specified" (p. 17) and continue saying that “The effectiveness of a design in one setting is no guarantee of its effectiveness in another setting” (p. 18). This is similar to the argument set forth in Chapter 2. Constructing an overview of the kinds of environments that can exist, and their effects in a specific setting, is essential. The six step design methodology presented in Chapter 2 (and the expanded version) can be applied to identify and classify current environments to construct such an overview, for example in a shared repository of collaborative learning environments that is electronically accessible; such as the collection of design patterns for networked learning that is constructed in the E-LEN project (2004) (yet, the patterns need to be combined in CSCL designs and the specific alignment of CSCL patterns is currently not specifically addressed).

8.8.4 Prospective versus retrospective research

Most research in CSCL focuses on a specific CSCL setting in which a single instructional guidance method or computer support is provided and their effects are studied. Although the initial focus on determining the effect of a single independent variable was replaced by studies of how several independent variables interact (Dillenbourg, Baker, Blaye, & O’Malley, 1995; Kirschner, 2002), most current CSCL research presents either exploratory studies or anecdotal evidence for outcomes. Although ‘interpretative analyses’ can provide valuable insights in the relationship between interaction and the outcomes, it is questionable whether such settings can be reproduced because, usually, they were not planned. As little or nothing is said about the interaction that was expected prior to CSCL, the observed outcomes could be ascribed to other factors or the observed outcome or process may in a new, analogous, situation never occur.

Prospective and retrospective approaches to the analysis of CSCL should not be treated as polarised paradigms. Prospective research approaches can take significant findings of retrospective analyses to the test and see whether these instances of ‘collaborative learning’ (or hypotheses) can be systematically reproduced. Similarly, data gathered for initial quantitative comparison can be also be analysed in a qualitative way, which can reveal interesting findings that a rigorous and reliable – but necessarily reductive – quantitative (prospective) approach may have overlooked. Design research does not explicitly include or exclude specific analytic methodologies, but this does not mean that anything goes. Any method applied should be applicable in the light of the research question asked and the data sources used; although the methods and procedures are also still debated in design research (Kelly, 2004).

8.9 In closing

This dissertation has presented and discussed the effects of the implementation of instructional support (functional roles) in asynchronous project-based and computer-supported collaborative learning course in distance education. Most importantly this dissertation has revealed that interaction and sustaining interaction are at the core of any collaboration (be it computer-supported or not). Furthermore, viewing the learning process as a fundamentally socially shared practice, implies that learning can no longer be measured adequately with short ‘learning intervals’ (i.e., two hour laboratory settings using standardised tests to assess ‘learning’).

CSCL provides the rationale to treat educational research for what it in essence is: a human science. Perhaps even educational psychologists should reconsider a sole reliance on tests for statistical significance and embrace the full complexity of ecologically valid research settings. Embracing this complexity implies acceptance of alternative research methods (dare we say qualitative?) to supplement and expand conventional approaches toward ‘quisitive research’ (Goldman, Crosby, Swan, Shea, 2004) – and cater for the advancement of our understanding of learning as a social practice.

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Summary

Problem Description: Sustaining interaction

In the past five years most educational institutions abroad and in the Netherlands have implemented forms of computer-mediated or 'Networked learning' – and particularly in distance education. At the Open University of the Netherlands (OUNL) students control both the content and pace of their learning: they decide whether they enter in a degree program or only study a couple of modules. Most students – whether they aim for professional development or transition – have a job and a family; study is most of the time restricted to written materials and the opportunities to meet other students (and sanction or reify your learning or knowledge) are very limited. Martens (1998) argues that Information and Communication Technology (ICT) can play an important role in overcoming these specific disadvantages in distance education.

Computer-Supported Collaborative Learning (CSCL) is a new discipline in the educational sciences that combines the notion of group-based learning and the potential of (communication) technology to support these practices. CSCL has attracted many researchers from a wide variety of disciplines (Koschmann, 1996). This diversity is reflected in both the topics, as well as the methodologies by which CSCL is studied: from communities of practice that involve a large group of people that share a common interest (Renninger & Shumar, 2002), to the interplay between theory and praxis in a community of learners (De Laat & Lally, 2003), and the fine grained analysis of the interaction between middle school students around a computer software artifact (Stahl, 2004).

The introduction of CSCL in Dutch university education started in the 1990's and gave rise to studies into the use of CSCL and the instrumentation (Veerman, 2000; Veldhuis-Diermanse, 2002). Asynchronous communication technology (i.e., time and place independent) appears to be a natural choice in distance education, but it has disadvantages such as the lack of immediate feedback. In addition, during collaboration coordination conflicts are more likely to occur in asynchronous computer-mediated communication (CMC) settings compared to face-to-face settings (Benbunan-Fich & Hiltz, 1999). Thus, for any collaboration to develop it is essential that students feel the need to engage in sustained interaction before we can even expect that the students engage in an effective knowledge building discourse. This problem is addressed in this dissertation.

Problem solution: Instructional support

One approach to stimulate collaboration and sustain student involvement during CSCL is instructional support, i.e. a pedagogical method that structures (or scripts) the collaboration in a way that is believed to be more efficient and effective (Dillenbourg 2002; Weinberger, 2003). One form of such instructional support is the use of roles. Although the use of roles is often advocated, they are in many cases part of an overall implementation of instructional support (see for example Bielaczyc, 2001): rarely is their effect studied in isolation. Yet, in order to determine the added value of roles, it is important to single-out the roles and investigate them.

Many different interpretations of the role concept can be found in reports. In general, roles can be defined as more or less stated functions, jobs, duties or responsibilities that guide individual behaviour and regulate group interaction (Hare, 1994). Mudrack and Farrell (1995) describe three different dimensions – task roles, maintenance roles and individual roles – and each group member can play roles of each dimension simultaneously. Several pedagogical approaches, that have been developed for cooperative learning use roles to support coordination and group interaction (Johnson, Johnson, & Johnson-Holubec, 1992; Kagan, 1994). These roles are either content-focussed – facilitating knowledge acquisition through individual knowledge differences using 'Jigsaw' (e.g., Bielaczyc, 2001), 'scripted cooperation' (O'Donnell & Dansereau, 1992), or 'prompting scripts' (Weinberger, 2003), or process-focussed roles regarding the coordination (e.g., Kynigos, 1999). Most roles developed for cooperative learning settings, however, comprise one single job, task or duty; mainly because they were developed for face-to-face collaboration in primary education. In addition, their effect has not been investigated systematically in both higher/distance and primary education.

In this thesis the effect of functional roles on CSCL during project-based learning in higher distance education was investigated. The functional roles are based on role descriptions by Johnson et al. (1992), Kagan (1994) and Mudrack and Farrell (1995). The role descriptions were integrated and adapted (in collaboration with the course supervisors) for implementation in project-based learning where the students would collaborate in small groups of four persons using CMC (e-mail). The roles were designed to give each student an individual responsibility for the group process, but at the same time all roles were interdependent, i.e. essential to the collaboration. The functional roles that were implemented were: project planner, communicator, editor and data collector (for a detailed description see the Appendices A and B of Chapters 3 and 5). Two studies were conducted and data obtained with questionnaires and the electronic communication was analysed with a variety of analysis methods.

Research questions

This dissertation addressed the following main research question: 'What is the effect of a prescribed functional roles instruction, as compared to no instruction, on group performance and collaboration?'. This leads to four derived research questions:

Do functional roles during CSCL lead to better learning outcomes?

Do functional roles during CSCL lead to a more satisfying collaborative experience?

Do functional roles during CSCL lead to a more efficient group process in terms of communication (coordination and content-focused statements)?

Do functional roles during CSCL lead to fewer dropouts?

Analysing CSCL: triangulation of research outcomes

In Chapter 2 a theoretical framework was presented to illustrated that interaction is the central process that is studied and therefore any method that aims to support CSCL should conceptualise how that method affects interaction. Five critical elements were identified that affect the interaction that can occur: learning objectives, task type, pre-structuring, group size and computer support. A six step process-oriented design methodology was developed that focuses on establishing a setting in which the envisioned interaction – seen as supportive to the attainment of the learning goals – can occur. Although, cooperative learning and collaborative learning are both approaches to group-based learning, one important difference is how the effect of an educational intervention is measured. Cooperative learning still determines the success of an educational intervention in terms of the learning outcomes using standardized quizzes for assessment, whereas in CSCL research the outcomes are attributed to a variety of processes: internalisation (i.e., individual knowledge gain), interaction (i.e., sharing expertise and distributed expertise) or transformation (i.e., the continuous advancement of shared knowledge) (Lipponen, Hakkarainen, & Paavola, 2004). These processes can be studied in multiple ways with a variety of data sources and analysis methods. In addition, CSCL combines the study of learning, collaboration, support/ scaffolding and computer technology, and each component can be studied with both quantitative and qualitative methods. Yet, whereas theory and instructional support are extensively debated, the methodological debate on research and analysis is relatively missing. Therefore, the Chapters 3, 4, 6 and 7, have given specific attention to the analysis method(s) that was used in relation to the data source and the research questions under investigation (e.g., factor analysis and multilevel modelling (MLM) of quantified questionnaire responses, quantitative content analysis of e-mail communication and cross case matrices of open-ended questionnaire responses).

Using multiple methods to investigate various data sources requires that the outcomes are combined in a single interpretative perspective that reveals their interrelations. This is referred to as triangulation, which not only strengthens the research outcomes obtained with a single method, but in addition a more complete understanding of the effect of functional roles in CSCL emerges.

Do functional roles during CSCL lead to better learning outcomes?

It was hypothesised that groups with functional roles would show a higher group performance than groups working without such roles. Learning outcomes were investigated in terms of the group grades and two essay questions in the evaluation questionnaire. An analysis of learning outcomes in terms of grades between the role and nonrole condition (Chapters 3 and 6) revealed no significant difference in both studies (possible alternative explanations are discussed later). The evaluation questionnaire contained two essay questions asking students to describe what they learned from the course content, as well as the collaborative process. Chapter 5 discussed the cross case matrices that were constructed on the group level to compare students responses within and between both research conditions. Group level matrices were constructed because there was a lot of diversity in students' responses, due to variations in educational and personal background. Some students reported that they learned little in relation to the course content, whereas other students reported that they learned a lot. The matrices revealed that, although students in the role condition are not extremely enthusiastic about collaboration in their group, they tend to be more positive about virtual collaboration than students in the nonrole condition who tend to emphasise what they learned from the course content or writing the policy report. In Chapter 6, the outcomes from the two questions were not included for lack of space given the journal article format. The cross case matrices, however, showed a similar pattern for the second study.

It can be concluded that the functional roles – as investigated in both studies by using the group grade and short essay questions – did not reveal a difference regarding learning outcomes.

Do functional roles during CSCL lead to a more satisfying collaborative experience?

It was hypothesised that groups with functional roles would have a more satisfying collaborative experience than groups working without such roles. Students' collaborative experience was investigated with quantified questionnaires (Likert-scales) and a collection of open-ended questions addressing: general issues (i.e., technology and group size), functional roles and task division, collaboration progress, coordination impact, and assessment and supervision.

Analysis of questions rated with either a Likert-scale or ten-point scale in the evaluation questionnaire revealed medium to high correlations in both studies between the variables 'team development', 'group process satisfaction', 'intra-group conflict', 'task strategy' and 'quality of collaboration'. Principal axis factoring revealed in both studies a latent variable: perceived group efficiency (PGE). In both studies standardised factor scores were computed for PGE and further investigated with multilevel modelling (MLM). In the first study PGE was investigated using either a random intercept or random slope model, but no significant differences were found. A comparison of PGE prediction estimates, however, revealed that students in role groups appear to be more aware of the groups' efficiency than the students in nonrole groups, as shown by more extreme ratings (positive or negative). In the second study, a positive marginal effect was found using the random intercept model. PGE in most role groups is consistently higher than in nonrole groups. Roles appear to affect PGE in two different ways – increased awareness of PGE and increased level of PGE – but an increase in awareness of group malfunctioning can potentially cancel out the difference in the level of PGE.

Results from the analysis of the open-ended questions in both studies reveals that students in the nonrole groups are more prone to use additional communication channels (e.g., meeting face-to-face, or using telephone or chat). With respect to functional roles and task division, students in both conditions considered the functional roles or their task division to be unequal in terms of effort that had to be invested by them. Nevertheless, analysis of e-mail communication regarding functional role behaviour showed that students in role groups predominantly performed their functional role behaviours more frequently than group members with a different role: validating the impact of the functional roles. With respect to the question about task division, the nonrole groups in both studies tend to organise collaboration by splitting the task (policy report) into smaller components that are then handled individually (or in dyads). Analysis of e-mail communication for emergent spontaneous role behaviour confirmed this pattern. In both studies, students in nonrole groups performed two types of role behaviour spontaneously, but they were distributed across all group members and not bound to a single group member.

Regarding the collaboration progress, the studies showed different outcomes. In the first study no clear difference was observed between both conditions for questions that addressed 'overall progress', 'waiting for other group members' and 'equality of contributions'. In the second study students in the role condition reported more frequently that their progress was fine, compared to students in nonrole groups who reported it was difficult or slow. Moreover, progress appeared to be inversely related to the extent that students experienced that they had to wait for other group members. Regarding coordination impact again different outcomes emerged. In the first study the students in both conditions report free-riding, but the students in the nonrole groups are more pronounced about apparent free-riders. This seems to indicate that the functional roles level out the negative experiences associated with free-riders. No differences were found, however, for the questions addressing the kind agreements made nor whether these agreements affected progress. In the second study, the role groups reported more frequently that the agreements they made about tasks and deadlines stimulated progress, as compared to nonrole groups. With respect to supervision the results of both studies reveal that the role groups contacted their supervisor more often than nonrole groups. Moreover, students in the nonrole groups indicated that they hardly experience any supervision, expressing a higher need for supervisor feedback. It can be concluded that the functional roles lead to more awareness of the collaborative experience (Study 1) and a higher level of satisfaction with their experience (Study 2) – in terms of perceived group efficiency. The second study showed that role groups were more satisfied as expressed by the degree of overall progress and that agreements made stimulated progress. Both studies showed that nonrole groups tended to have been less satisfied and experienced a stronger need for supervisor involvement.

Do functional roles during CSCL lead to a more efficient group process in terms of communication (coordination and content-focused statements)?

It was hypothesised that functional roles would decrease the amount of coordinative statements in favour of content-focused statements. To investigate whether the functional roles affected collaboration in terms of the communicative statements all e-mail communication was analysed and quantified for statistical comparison. Developing a quantitative content analysis appeared to be both difficult and laborious: a separate segmentation and coding procedure had to be developed (see Chapter 4) before the communication could be analysed. Each unit of analysis (segment) was coded with one of eighteen subcategories and these were aggregated at the level of five main categories: 'task coordination', 'task content', 'task social', 'non task' and 'non-codable'.

General measures of communication revealed a different communication pattern in both studies. In the first study, a significant difference was found for the amount of segments coded, but not for amount of messages sent: students in role groups contributed longer e-mail messages. In the second study this finding was reversed, a significant difference was found for the number of messages send in role groups but not for the number of segments: students in role groups wrote shorter e-mail messages but interacted more frequently.

Analysis of the e-mail communication in the first study revealed significantly more content-focused statements in the role condition. However, this was not caused by a decrease in the amount of coordinative statements – the amount of coordinative statements increased as well. This was underlined by a positive correlation between coordination and content statements, revealing that role groups clustered predominantly in the high performance quadrant. Analysis of the e-mail communication in the second study also showed significantly more coordinative statements in the role condition, but no difference was found regarding the amount of content-focused statements. In addition, the first study found a significant difference for 'task social' statements (expressing either a positive or negative evaluation or attitude in general, toward the group or an individual group member) underlining that the students in the role group were more aware of their groups' efficiency, regardless whether they performed well or poor.

It can be concluded that functional roles increase the amount of coordinative statements. In a relatively uncontrolled environment the amount of content-focused statements and 'task social' statements increase as well. Finally, functional roles apparently result in a different interaction pattern in a relatively uncontrolled (Study 1) and controlled (Study 2) learning environment.

Do functional roles during CSCL lead to fewer dropouts?

It was hypothesised that functional roles would decrease the level of dropout. In the first study there appeared to be no difference between both conditions in the number of students that quit during the collaboration. However, a comparison of the total number of students that dropped out during the course or did not finish the course, revealed a significant difference to the disadvantage of the nonrole groups. Student reflection on what they learned from the collaboration during the course (Study 1) supports this interpretation: students in the role condition appeared to be more positive about their collaborative experience than students in the nonrole groups. Given the level of dropout in nonrole groups the general course design was examined and several preconditions were identified that – if controlled for – could decrease or prevent dropout in nonrole groups: students' preference for a practice assignment, a slow or fast study pace, setting up of a time schedule, establishing a communication discipline and externalising expectations regarding effort prior to collaboration. No significant difference was found regarding dropout in the second study.

It can be concluded that functional roles decrease dropout in an uncontrolled learning environment (Study 1) and controlling general preconditions decreases dropout in the nonrole condition as well (Study 2).

What is the effect of a prescribed functional roles instruction, as compared to no instruction, on group performance and collaboration?

Overall it can be concluded that a prescribed functional roles instruction affects collaboration, as the students in role groups performed role behaviours, associated with their functional role, more frequently than members with a different functional role (Chapter 7). Performance in terms of a group grade is not affected, but performance appears to be better reflected in the level of perceived group efficiency (PGE). However, perceived group efficiency differed in both studies, which appears to be caused by the level of control exerted in terms of preconditions. In an uncontrolled environment roles increase students' awareness of their perceived group efficiency (PGE), whereas in a controlled learning environment the level of PGE is increased as well. Students in the role groups appear to be more satisfied in general – more prevalent in a controlled learning environment (Study 2) – as revealed by their opinions regarding collaboration progress, coordination impact, and assessment and supervision. Functional roles increase the amount of coordinative statements – contrary to the hypothesis – and in an uncontrolled environment the content-focused statements increase as well. Similarly, the learning environment affects e-mail communication on a general level: the amount of communication in a message (content) is higher in an uncontrolled environment, whereas the frequency of e-mail messages is higher in a controlled environment.

Controlling for these preconditions has ensured a more evenly matched comparison of both research conditions – as reflected by the differences in PGE and content-focused statements – but simultaneously revealing some persistent effects, such as the latent PGE variable, the difference in the amount of coordinative statements and the role behaviour execution. Finally, controlling for preconditions facilitated the comparison of two qualitatively different CSCL environments: the first study is an example of how functional roles could support a group in a learning community that only exist for the period of their self-selected project, and the second study shows how functional roles support a group in an institutionalised (and more controlled) educational environment.

Implications

Chapter 8 presents a general overview of the research reported in this thesis and discusses the limitations, implications and opportunities for future research. The results for both studies in the dissertation have shown that functional roles can make a valuable contribution to CSCL in terms of participant engagement in interaction and sustaining the collaboration.

Unequivocally, a group grade has not been a useful indicator for performance. Hence, designers, teachers and practitioners should not solely depend on grades to assess the educational effectiveness of (CS)CL. Here, computer-supported tools for assessment might also make a difference. Similarly, portfolios (Chan & van Aalst, 2004) and peer assessment can be used to enhance the visibility of the collaborative learning that took place (Sluijsmans, 2002; Prins, Sluijsmans, Kirschner, & Strijbos, in press).

If learning is the principal process in CSCL, then the design of CSCL environments has to follow the reverse order of the acronym, and the learning environment should be carefully orchestrated (Strijbos, Kirschner, & Martens, 2004). The pre-structuring chosen – in this dissertation functional roles – should be aligned with the learning objectives (i.e., open skills), the envisioned interaction (i.e., networked), the task (i.e., ill-structured), group size (i.e., three to five) and mode of communication/ technology (i.e., e-mail). The six-step design method that was introduced in Chapter 2 has been expanded to a six by eight matrix with 75 design questions. The usefulness of this matrix for the design and evaluation of CSCL courses is currently being investigated among practitioners in higher education.

The comparison of these studies has revealed that the changes in the preconditions were beneficial for both research conditions: decreasing dropout in the nonrole groups and controlling for aspects that confounded the effect of functional roles in the first study. Nevertheless, the feasibility of strong preconditions may vary for different CSCL environments. CSCL environments vary in the degree of teacher control versus student control, thus a designer or practitioner should take this into account when implementing CSCL.

Given the tension between collaboration and the general OUNL study policy, the OUNL should modify its study policy from ‘independent individual’ to ‘mostly independent individual, sometimes in collaboration’. As argued in the introduction, collaboration does not develop spontaneously, and thus the institution should develop practices that support the implementation of such models, as well as adoption of such educational models by the students.

Future research

First of all, the delicate balance between guidance and coercion needs to be studied in more detail. Dillenbourg (2002) has argued that we should be careful not to over-script CSCL. Although he states that over-scripting occurs when natural interaction is disturbed, it is not made explicit what we should look for. A possible direction is to investigate whether collaboration breakdowns could also be ascribed to a conflict between the pedagogical model enforced through the learning environment and ‘naïve’ theories or collaboration models that participants have internalised.

The concept of roles attracts more attention in CSCL research. For example the use of roles in the form of instructional support (De Wever, Winckelmans, & Valcke, 2004; Pilkington & Walker, 2003; Schellens & Valcke, 2004), and applying computer-software support to increase student awareness of the roles (De Laat & Lally, in press-b) or provide assistance by having students plan a process workflow prior to the collaboration (Herrmann, Kienle, & Menold, 2004). It is apparent, however, that the shape of (functional) roles and their impact differs for the various learning environments. Extending their application can include Computer-Supported Cooperative Work (CSCW) environments or the use of roles as community development tools (Hermann, Jahnke, & Loser, 2004; Pilkington & Walker, 2003).

Most research in CSCL focuses on a specific CSCL setting in which a single instructional guidance method or computer support is provided and their effects are studied. Although, the initial focus on determining the effect of a single independent variable was replaced by studies of how several independent variables interact (Dillenbourg, Baker, Blaye, & O’Malley, 1995; Kirschner, 2002), most current CSCL research presents either exploratory studies or anecdotal evidence for outcomes. Although ‘interpretative analyses’ can provide valuable insights in the relationship between interaction and the outcomes, it is questionable whether such settings can be reproduced because, usually, they were not planned. As little or nothing is said about the interaction that was expected prior to CSCL, the observed outcomes could be ascribed to other factors or the observed outcome or process may in a new, analogous, situation never re-occur. Prospective and retrospective approaches to the analysis of CSCL should not be treated as polarised paradigms. Prospective research approaches can take significant findings of retrospective analyses to the test and see whether these instances of 'collaborative learning' (or hypotheses) can be systematically reproduced.

In closing

This dissertation has revealed that interaction and sustaining interaction are at the core of any collaboration (be it computer-supported or not). Furthermore, viewing the learning process as a fundamentally socially shared practice, implies that learning can no longer be measured adequately with short 'learning intervals' (i.e., two hour laboratory settings using standardised tests to assess 'learning'). CSCL provides the rationale to treat educational research for what it in essence is: a human science. We must embrace the full complexity of ecologically valid research settings. This implies the acceptance of alternative research methods (dare we say qualitative?) to supplement and expand conventional approaches toward 'quisitive research' (Goldman, Crosby, Swan, & Shea, 2004) and cater for the advancement of our understanding of learning as a social practice.

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Samenvatting

Probleembeschrijving: stimuleren van interactie

De afgelopen vijf jaar hebben de meeste onderwijsinstellingen in het buitenland en in Nederland een vorm van computer-gemedieerd of ‘ge-netwerkt leren’ geïmplementeerd. Dit geldt in het bijzonder in het afstandsonderwijs. Studenten aan de Open Universiteit Nederland (OUNL) bepalen zowel de inhoud van hun programma als het tempo waarin zij studeren: zij bepalen of ze deelnemen aan een geheel opleidingsprogramma of slechts enkele modules volgen. Voor de meeste studenten geldt – of hun studie zich nu richt op professionele ontwikkeling of op een transitie – dat zij al een baan en een gezin hebben. Het onderwijs bestaat doorgaans uit schriftelijk studiemateriaal en de mogelijkheden om andere studenten te ontmoeten (en hun kennis of het geleerde te toetsen) zijn zeer beperkt. Martens (1998) bepleit dat Informatie en Communicatie Technologie (ICT) een belangrijke rol kan spelen om deze specifieke beperkingen van afstandsonderwijs te overwinnen.

Computerondersteund Samenwerkend Leren (CSCL) is een nieuwe discipline in de onderwijswetenschappen. CSCL combineert de notie van groepsgebaseerd leren met het potentieel van (communicatie-) technologie om deze praktijk te ondersteunen. CSCL heeft onderzoekers aangetrokken uit verschillende disciplines (Koschmann, 1996). Deze diversiteit is zichtbaar in zowel het onderwerp als in de methodologie waarmee CSCL wordt onderzocht. Van ‘praktijkgemeenschappen’, die bestaan uit een grote groep mensen met een gedeelde interesse (Renninger & Shumar, 2002), tot de wisselwerking tussen theorie en praktijk in een ‘gemeenschap van lerenden’ (De Laat & Lally, 2003) en de microanalyse van de interactie tussen middelbareschoolleerlingen rondom een computersoftwareproduct (Stahl, 2004).

CSCL is omstreeks 1990 geïntroduceerd in het Nederlands hoger onderwijs en gevolgd door studies naar het gebruik ervan en de benodigde instrumentatie (Veerman, 2000; Veldhuis-Diermanse, 2002). Ofschoon asynchrone communicatietechnologie (i.e. tijd- en plaatsonafhankelijk) een vanzelfsprekende keuze lijkt voor afstandonderwijs, heeft deze vorm ook specifiek nadelen zoals het gebrek aan rechtstreekse feedback. Bovendien is er een verhoogde kans op conflicten met betrekking tot coördinatie als samenwerking plaatsvindt met behulp van asynchrone computergemedieerde communicatie (CMC) in vergelijking tot directe aanwezigheid (Benbunan-Fich & Hiltz, 1999). Bijgevolg kan worden gesteld dat het essentieel is om ervoor te zorgen dat studenten een onafgebroken interactie aan gaan, voordat we zelfs maar kunnen verwachten dat studenten deelnemen aan een effectieve ‘kennisopbouwende dialoog’. Dit probleem wordt behandeld in deze dissertatie.

Probleem oplossing: ondersteuning door instructie

Een benadering om samenwerking en de betrokkenheid van studenten te stimuleren tijdens CSCL is ‘instructieve ondersteuning’. Dat is een onderwijsmethode die de samenwerking structureert (of regisseert) op een manier waarvan wordt verondersteld dat het efficiënter en effectiever is (Dillenbourg 2002; Weinberger, 2003). Een uitwerking van deze vorm van ondersteuning is het gebruik van rollen. Ofschoon het gebruik van rollen vaak wordt bepleit, zijn zij doorgaans een onderdeel van de algehele implementatie van 'instructieve ondersteuning' (zie Bielaczycs, 2001). Zelden is het effect van rollen op zich bestudeerd. Desalniettemin is het belangrijk om de rollen afzonderlijk te bestuderen om de meerwaarde van rollen te kunnen bepalen.

Onderzoeksrapportages tonen verschillende interpretaties van het concept 'rol'. In het algemeen kunnen rollen worden gedefinieerd als min of meer vastgelegde functies, taken, verplichtingen of verantwoordelijkheden die individueel gedrag leiden en groepsinteractie reguleren (Hare, 1994). Mudrack en Farrell (1995) beschrijven drie verschillende dimensies – taakrollen, onderhoudsrollen and individuele rollen – en ieder groepslid vertolkt simultaan rollen van ieder dimensie. Verscheidene onderwijsmethoden die zijn ontwikkeld voor coöperatief leren maken gebruik van rollen om coördinatie en groepsinteractie te ondersteunen (Johnson, Johnson, & Johnson-Holubec, 1992; Kagan, 1994). Deze rollen zijn enerzijds gericht op de onderwijsinhoud – ondersteuning van kennisverwerving, door te kapitaliseren op individuele verschillen, met behulp van methodes zoals 'Jigsaw' (e.g., Bielaczyc, 2001), 'scripted cooperation' (O'Donnell & Dansereau, 1992), of 'prompting scripts' (Weinberger, 2003) – anderzijds zijn zij gericht op de coördinatie (e.g., Kynigos, 1999). De meeste rollen die zijn ontwikkeld voor coöperatief leren bestaan echter uit één specifieke functie, taak, of verplichting: hoofdzakelijk doordat zij zijn ontwikkeld voor een klassikale leeromgeving in het lager onderwijs. Bovendien is het effect van deze rollen niet systematisch onderzocht in zowel hoger- en afstandonderwijs als in lager onderwijs.

In het kader van deze dissertatie is het effect van functionele rollen op CSCL gedurende projectgebaseerd onderwijs in hoger afstandsonderwijs onderzocht. De functionele rollen zijn gebaseerd op rolbeschrijvingen van Johnson et al. (1992), Kagan (1994) en Mudrack en Farrell (1995). De rolbeschrijvingen zijn geïntegreerd en aangepast (in samenwerking met de cursusteamleiders) voor implementatie in projectgebaseerd onderwijs waarin de studenten samenwerken in kleine groepen van vier en gebruik maken van CMC (e-mail). De rollen zijn ontworpen om iedere student een individuele verantwoordelijkheid te geven voor het groepsproces, maar tegelijkertijd zijn zij wederzijds afhankelijk, i.e. essentieel voor de samenwerking. De volgende functionele rollen zijn geïmplementeerd: projectplanner, communicator, rapporteur en dataverzamelaar. (Voor een gedetailleerde beschrijving zie de Appendices A and B van Hoofdstuk 3 en 5.) Twee studies zijn verricht en de gegevens, die zijn verzameld met vragenlijsten, en de elektronische communicatie zijn geanalyseerd met verschillende analysemethoden.

Onderzoeksvragen

Deze dissertatie richt zich op de volgende onderzoeksvraag: "Wat is het effect van voorgeschreven functionele rollen, in vergelijking tot de afwezigheid van deze instructie, op de groepsprestatie en de samenwerking?". Deze vraag resulteert in vier afgeleide onderzoeksvragen:

Leiden functionele rollen tijdens CSCL tot hogere leerprestaties?

Leiden functionele rollen tijdens CSCL tot een bevredigender ervaring van de samenwerking?

Leiden functionele rollen tijdens CSCL tot een efficiënter groepsproces wat zichtbaar is in de communicatie (coördinatieve en inhoudelijke uitingen)?

Leiden functionele rollen tijdens CSCL tot minder studentuitval?

Analyse van CSCL: triangulatie van onderzoeksresultaten

Hoofdstuk 2 presenteert een theoretisch raamwerk om te illustreren dat interactie de kern vormt van het proces dat wordt bestudeerd en derhalve dat iedere methode die beoogt CSCL te ondersteunen een beeld vereist van de wijze waarop die methode de interactie beïnvloedt. Er zijn vijf kritieke elementen vastgesteld die de potentiële interactie beïnvloeden: leerdoelen, taaktype, voor-structuring, groepsgrootte en computerondersteuning. Een procesgerichte ontwerpmethode is ontwikkeld die zich richt op het bewerkstelligen van een onderwijsomgeving waarin de voorgestelde interactie – waarvan wordt verwacht dat deze het verwerven van de leerdoelen ondersteunt – kan ontstaan. Hoewel coöperatief en collaboratief leren allebei benaderingen zijn van groepsgebaseerd leren, is een belangrijk onderscheid de wijze waarop het effect van een educatieve interventie wordt vastgesteld. Coöperatief leren maakt nog immer gebruik van standaardtesten om de leeropbrengst te bepalen. In CSCL-onderzoek daarentegen wordt de leeropbrengst toegeschreven aan verschillende processen: internalisatie (i.e. individuele leeropbrengst), interactie (i.e. het delen van expertise en ‘verdeelde expertise’) of transformatie (i.e. de voortdurende vooruitgang in gedeelde kennis) (Lipponen, Hakkarainen, & Paavola, 2004). Deze processen kunnen worden bestudeerd op verschillende wijzen en met verscheidenheid aan onderzoeksgegevens en analysemethoden. Bovendien combineert CSCL de studie van leren, samenwerking, ondersteuning en computertechnologie en elke component kan worden bestudeerd met zowel kwantitatieve als kwalitatieve methoden. Evenwel, waar over theorie en instructieve ondersteuning uitgebreid is gedebatteerd, ontbreekt relatief gezien een debat rondom onderzoeks- en analysemethodologie. In de Hoofdstukken 3, 4, 6 en 7 is derhalve expliciet aandacht besteed aan de analysemethode(n) die zijn gebruikt in relatie tot de onderzoeksdata en de gestelde onderzoeksvragen (zoals factoranalyse and multilevel modellen (MLM) van de kwantitatieve vragenlijstgegevens, kwantitatieve inhoudsanalyse van de e-mail communicatie en ‘cross case matrices’ van de openvragengegevens).

Het gebruik van meerdere methoden om verschillende onderzoeksdatabronnen te bestuderen vereist dat de resultaten worden gecombineerd tot een enkelvoudig interpretatief perspectief dat de wederzijdse relaties blootlegt. Dit wordt ook wel triangulatie genoemd. Dit kan niet alleen de onderzoeksuitkomsten van de specifieke analysemethoden verstevigen, maar als gevolg daarvan komt ook een vollediger beeld van het effect van functionele rollen op CSCL naar voren.

Leiden functionele rollen tijdens CSCL tot hogere leerprestaties?

De hypothese was dat groepen met functionele rollen een hogere groepsprestatie zouden hebben dan groepen zonder deze rollen. De leeropbrengsten zijn onderzocht met behulp van het groepscijfer en twee open vragen in de evaluatievragenlijst. De analyse van de leeropbrengst in vorm van groepscijfers (Hoofdstuk 3 en 6) toonde geen significant onderscheid tussen de condities met rollen en zonder rollen (mogelijke alternatieve verklaringen worden verderop besproken). De evaluatievragenlijst omvatte twee open vragen gericht op het inventariseren van wat studenten hadden geleerd van zowel de cursusinhoud als het samenwerkingsproces. Hoofdstuk 5 belichtte de ‘cross case matrices’ die zijn geconstrueerd op het groepsniveau om de antwoorden van de studenten ‘binnen’ en ‘tussen’ de condities te kunnen vergelijken. De matrices zijn geconstrueerd op groepsniveau omdat er sprake was van een grote diversiteit in de antwoorden van de studenten; veelal door het onderscheid in zowel hun onderwijs- als persoonsgebonden achtergrond. Enkele studenten gaven aan dat ze weinig hadden geleerd van de cursusinhoud, andere studenten gaven echter aan dat zij veel hadden geleerd. De matrices toonden aan dat, ofschoon de studenten in de rollenconditie niet extreem enthousiast zijn over de samenwerking in hun groep, zij geneigd zijn meer positief te staan ten opzichte van virtuele samenwerking dan de studenten in de conditie zonder rollen, die sterker benadrukken wat zij al dan niet hebben geleerd van de cursusinhoud of het schrijven van de gezamenlijke beleidsrapportage. In hoofdstuk 6 zijn de resultaten van beide vragen niet ingevoegd wegens de beperkingen die tijdschriften opleggen aan artikelen. De ‘cross case matrices’ zijn echter wel geconstrueerd en zij vertonen voor de tweede studie een vergelijkbaar patroon.

Het kan worden geconcludeerd dat niet kan worden aangetoond dat de functionele rollen – zoals in beide studies onderzocht met behulp van een groepscijfer en open vragen – hebben geleid tot een significant onderscheid tussen de condities ten aanzien van de leeropbrengst.

Leiden functionele rollen tijdens CSCL tot een bevredigender ervaring van de samenwerking?

De hypothese was dat groepen met functionele rollen een bevredigender ervaring van de samenwerking zouden rapporteren dan groepen zonder deze rollen. De ervaring van de samenwerking is onderzocht met behulp van kwantitatieve vragenlijsten (Likert-schalen) en een verzameling open vragen die zich richtte op verscheidene aspecten: algemene kwesties (i.e. technologie en groepsgrootte), functionele rollen en taakverdeling, samenwerkingsvoortgang, coördinatie-impact, en beoordeling en supervisie.

De analyse van de Likert-schaalvragen en de tien-puntsschaalvraag uit de evaluatievragenlijst resulteerde in gemiddelde tot hoge correlaties in beide studies tussen de variabelen ‘teamontwikkeling’, ‘groepsprocessatisfactie’, ‘intra-groepsconflict’, ‘taakstrategie’ en ‘kwaliteit van de samenwerking’. Een principale componentenanalyse onthulde in beide studies een latente variabele: ervaren groepsefficiëntie (‘perceived group efficiency’ of PGE). In beide studies zijn gestandaardiseerde factorscores berekend voor PGE en deze zijn verder onderzocht met multilevel modellen (MLM). In de eerste studie is PGE onderzocht met een ‘random intercept’- en ‘random slope’-model. Er werden echter geen significante verschillen gevonden. Een vergelijking van de PGE schattingen voor beide condities bracht aan het licht dat de studenten in de rollengroepen zich meer bewust waren van de efficiëntie in hun groep dan de studenten in groepen zonder rollen; wat zichtbaar werd in extremere beoordelingen (positief of negatief). In de tweede studie werd een positief marginaal effect gevonden voor het 'random intercept'-model. PGE was in de meeste rollengroepen consistent hoger dan in de groepen zonder rollen. De rollen blijken aldus PGE te beïnvloeden op twee wijzen: enerzijds verhogen rollen het 'bewustzijn' van de ervaren groepsefficiëntie en anderzijds het niveau van de ervaren groepsefficiëntie; echter een verhoogd bewustzijn als gevolg van een disfunctionele groep kan een onderscheid in het niveau van PGE verhullen.

De resultaten van de analyse van de open vragen in beide studies tonen aan dat de studenten in groepen zonder rollen sterker geneigd zijn om aanvullende communicatiekanalen te benutten (zoals persoonlijke ontmoetingen, gebruik van de telefoon of chat). Met betrekking tot de functionele rollen en de taakverdeling gaven de studenten in beide condities aan dat de functionele rollen of hun taakverdeling onevenredig was, gegeven de inzet die van hen werd vereist. Desalniettemin bracht de analyse van het rolgedrag aan de hand van de e-mailcommunicatie aan het licht dat studenten in rollengroepen zich overwegend frequenter volgens de voorgeschreven rol hebben gedragen dan de groepsleden met een andere rol; hetgeen de impact van de functionele rollen valideert. Met betrekking tot de vraag over de taakverdeling geven de groepen zonder de rollen in beide studies aan dat zij de samenwerking voornamelijk hebben georganiseerd door middel van het opsplitsen van de taak (beleidsrapportage) in componenten die individueel zijn verwerkt (of in tweetallen). De analyse van de e-mailcommunicatie met betrekking tot spontaan rolgedrag in de groepen zonder rollen bevestigde dit patroon. In beide studies vertoonden de studenten in groepen spontaan twee typen rolgedrag, echter dit gedrag was verdeeld over de groepsleden en niet gebonden aan een specifiek groepslid.

Ten aanzien van de samenwerkingsvoortgang vertoonden beide studies verschillende uitkomsten. De eerste studie toonde geen duidelijk onderscheid aan tussen de condities voor wat betreft de vragen over 'algehele voortgang', 'wachten op andere groepsleden' en de 'gelijkwaardigheid van de bijdragen'. In de tweede studie rapporteerden studenten in de rollenconditie frequenter dat de voortgang van de samenwerking goed was, terwijl de studenten in de groepen zonder rollen vaker aangaven dat de samenwerking moeizaam of langzaam verliep. Voorts bleek de mate van voortgang omgekeerd evenredig te zijn aan de mate waarin de studenten aangaven dat zij op andere groepsleden moesten wachten. Ten aanzien van de coördinatie-impact werden wederom verschillende uitkomsten gevonden. In de eerste studie rapporteerden studenten in beide condities 'meeliftgedrag', echter de studenten in de groepen zonder rollen waren hierover meer uitgesproken. Dit geeft aan dat de functionele rollen de negatieve ervaring van meelifters lijken uit te vlakken. Geen verschillen werden daarentegen gevonden met betrekking tot de typen afspraken die werden gemaakt, noch ten aanzien van de mate waarin deze afspraken de voortgang beïnvloedden. In de tweede studie geven de groepen met rollen, in vergelijking tot de groepen zonder rollen, frequenter aan dat de afspraken rondom taken en deadlines de voortgang stimuleerden. Met betrekking tot de supervisie tonen de resultaten van beide studies aan dat de groepen met rollen vaker contact hebben gezocht met de begeleider dan de groepen zonder rollen. De studenten in groepen zonder rollen gaven bovendien aan dat zij nauwelijks enige supervisie hebben ervaren en uitten een grotere behoefte aan feedback van de begeleider.

Er kan worden geconcludeerd dat de functionele rollen leiden tot een groter bewustzijn van de ervaring samenwerking (Studie 1) en een hogere mate van tevredenheid ten aanzien van hun ervaring (Studie 2) – in de zin van ervaren groepsefficiëntie. De tweede studie toonde aan dat groepen met rollen tevredener zijn hetgeen zichtbaar is in de mate van algehele vooruitgang en het feit dat zij aangeven dat de afspraken de voortgang stimuleerden. Beide studies toonden aan dat groepen zonder rollen minder tevreden zijn en een sterkere behoefte hebben aan betrokkenheid van de zijde van de begeleider.

Leiden functionele rollen tijdens CSCL tot een efficiënter groepsproces wat zichtbaar is in de communicatie (coördinatieve en inhoudelijke uitingen)?

De hypothese was dat de functionele rollen de mate van coördinatieve uitingen zouden verminderen in het voordeel van taakinhoudelijke uitingen. Om te onderzoeken of de functionele rollen de samenwerking beïnvloedden in de vorm van communicatieve uitingen, is de onderlinge e-mailcommunicatie geanalyseerd en gekwantificeerd voor statistisch vergelijking. Het ontwikkelen van een procedure voor de kwantitatieve inhoudsanalyse bleek lastig en bewerkelijk: een afzonderlijke segmentatie- en codeerprocedure moest worden ontwikkeld (zie Hoofdstuk 4) voordat de communicatie kon worden geanalyseerd. Iedere analyse-eenheid (segment) is vervolgens gecodeerd met één van achttien subcategorieën en deze zijn weer geaggregeerd op het niveau van vijf hoofdcategorieën: taakcoördinatie, taakinhoud, taaksociaal, niet-taak and niet codeerbaar.

Algemene communicatiematen toonden een verschillend communicatiepatroon in beide studies. In de eerste studie werd een significant verschil gevonden in de hoeveelheid gecodeerde segmenten, maar niet in de hoeveelheid verzonden berichten: student in groepen met rollen schreven langere berichten. In de tweede studie werd het omgekeerde effect gevonden, een significant verschil in de hoeveelheid verzonden berichten maar niet in het aantal segmenten: studenten in groepen met rollen schreven kortere berichten maar communiceerden frequenter.

De analyse van de e-mailcommunicatie in de eerste studie bracht naar voren dat studenten in de groepen met rollen significant meer taakinhoudelijke uitingen maakten. Dit onderscheid werd evenwel niet veroorzaakt door een daling in de hoeveelheid coördinatieve uitingen – de hoeveelheid coördinatieve uitingen steeg eveneens. Dit werd benadrukt door de positieve correlatie tussen de coördinatieve- and taakinhoudelijke uitingen; deze toonden aan de groepen met rollen hoofdzakelijk clusteren in het hoogpresterende kwadrant. De analyse van de e-mailcommunicatie in de tweede studie resulteerde eveneens in significant meer coördinatieve uitingen in groepen met rollen, maar ditmaal werd er geen onderscheid gevonden voor de hoeveelheid taakinhoudelijke uitingen. Daarnaast werd in de eerste studie een significant verschil gevonden voor taaksociale uitingen (positieve of negatieve attitudes of evaluatieve uitdrukkingen in het algemeen, ten aanzien van de groep of een individuele groepslid) hetgeen benadrukt dat de studenten in de groepen met rollen zich meer bewust waren van de ervaren groepsefficiëntie, onafhankelijk of de groep nu goed of slecht functioneerde.

Er kan worden geconcludeerd dat functionele rollen de hoeveelheid coördinatieve uitingen verhogen. In een relatief ongecontroleerde omgeving stijgen de mate van taakinhoudelijke uitingen en taaksociale uitingen eveneens. Afsluitend kan worden gesteld dat functionele rollen ogenschijnlijk leiden tot een verschillend interactiepatroon in een relatief ongecontroleerde (Studie 1) en gecontroleerde (Studie 2) leeromgeving.

Leiden functionele rollen tijdens CSCL tot minder studentuitval?

De hypothese was dat de functionele rollen studentuitval zouden verminderen. In de eerste studie bleek er geen verschil te bestaan tussen beide condities in de mate waarin studenten zijn uitgevallen tijdens de opdracht. Een vergelijking van het totale aantal student dat is uitgevallen en/of de cursus niet heeft beëindigd toonde een significant verschil in het nadeel van de groepen zonder rollen. De reflecties door de studenten ten aanzien van hetgeen zij hadden geleerd van de samenwerking tijdens de cursus (Studie 1) ondersteunt deze interpretatie: studenten in groepen met de rollen bleken positiever gestemd over de samenwerking die zij hadden ervaren dan studenten in de groepen zonder rollen. Gegeven de mate van studentuitval in groepen zonder rollen werd het algemene cursusontwerp geëvalueerd, hetgeen een aantal randvoorwaarden aan het licht bracht die – indien gecontroleerd – uitval zouden kunnen verminderen of voorkomen in de groepen zonder rollen: de voorkeur van studenten voor een oefenopdracht, een laag of hoog studietempo, het opzetten van een tijdsplanning, instellen van een communicatiediscipline en het inventariseren van verwachtingen ten aanzien van ieders inzet voorgaand aan de samenwerking. In de tweede studie is geen significant onderscheid gevonden met betrekking tot studentuitval.

Er kan geconcludeerd worden dat functionele rollen studentuitval verminderen in een ongecontroleerde leeromgeving (Studie 1) en indien wordt gecontroleerd voor randvoorwaarden, verminderd eveneens de studentuitval in de conditie zonder rollen (Studie 2).

Wat is het effect van voorgeschreven functionele rollen, in vergelijking tot de afwezigheid van deze instructie, op de groepsprestatie en de samenwerking?

In het geheel genomen kan worden geconcludeerd dat een voorgeschreven functionele-rolleninstructie de samenwerking beïnvloedt, aangezien de studenten in groepen met rollen het rolgedrag dat is geassocieerd met hun functionele rol vertonen dan groepsleden met een andere functionele rol (Hoofdstuk 7). Prestatie in de vorm van een groepscijfer wordt niet beïnvloed. De prestatie komt echter beter tot uitdrukking in de mate van ervaren groepsefficiëntie (PGE). Een verschil in ervaren groepsefficiëntie was zichtbaar in beide studies, hetgeen lijkt te zijn veroorzaakt door de mate waarin voor randvoorwaarden wordt gecontroleerd. In een ongecontroleerde leeromgeving verhogen de rollen het bewustzijn van de studenten ten aanzien van de ervaren groepsefficiëntie (PGE), terwijl in het niveau van PGE eveneens stijgt in een gecontroleerde leeromgeving. Studenten in de groepen met rollen blijken in het algemeen meer tevreden te zijn – hetgeen nadrukkelijker naar voren komt in een gecontroleerde leeromgeving (Studie 2) in hun opinies ten aanzien van samenwerkingsvoortgang, coördinatie-impact en beoordeling en supervisie. De inzet van functionele rollen verhoogt de hoeveelheid coördinatieve uitingen – in tegenstelling tot de verwachting (hypothese) – en in een ongecontroleerde omgeving stijgen de taakinhoudelijke uitingen eveneens. Op een zelfde wijze beïnvloedt de leeromgeving de e-mailcommunicatie op een algemeen niveau: de hoeveelheid communicatie in een bericht (inhoud) is hoger in een ongecontroleerde omgeving, terwijl de frequentie van e-mailberichten hoger is in een gecontroleerde omgeving.

Door te controleren voor de randvoorwaarden is een gelijkwaardigere vergelijking van de onderzoekscondities bewerkstelligd – hetgeen zichtbaar is in de verschillen in PGE en de taakinhoudelijke uitingen. Maar het heeft tegelijkertijd aangetoond dat een aantal effecten constant zijn, zoals de latente variabele PGE, het onderscheid in de hoeveelheid coördinatieve uitingen en de uitvoering van rolgedrag. Afsluitend kan worden gesteld dat het controleren voor randvoorwaarden de vergelijking van twee kwalitatief verschillende CSCL-omgevingen mogelijk maakt: de eerste studie is een voorbeeld van de wijze waarop functionele rollen een groep in leergemeenschap zouden kunnen ondersteunen die enkel bestaat voor de duur van een project; de tweede studie toont hoe functionele rollen een groep kunnen ondersteunen in een geïnstitutionaliseerde (en meer gecontroleerde) onderwijsomgeving.

Implicaties

Hoofdstuk 8 geeft een algemeen overzicht van het onderzoek dat is gerapporteerd in deze dissertatie en bespreekt de beperkingen, implicaties en suggesties voor toekomstig onderzoek. De resultaten van beide studies in deze dissertatie hebben aangetoond dat functionele rollen een waardevolle bijdrage kunnen leveren aan CSCL in vorm van de betrokkenheid van de deelnemers in de interactie en het stimuleren van samenwerking.

Ondubbelzinnig is gebleken dat een groepscijfer geen bruikbare indicator is om de prestatie vast te stellen. Ontwerpers en docenten zouden er derhalve goed aan doen om niet enkel te vertrouwen op cijfers om de onderwijseffectiviteit van (CS)CL te bepalen. Computerondersteunde methodes voor beoordeling kunnen hier een verschil maken. Op een zelfde wijze kunnen portfolio’s (Chan & van Aalst, 2004) en ‘beoordeling door gelijken’ (peer assessment) worden ingezet om de zichtbaarheid van het resultaat van samenwerkend leren te verhogen (Sluijsmans, 2002; Prins, Sluijsmans, Kirschner, & Strijbos, in press).

Indien leren het voornaamste proces is binnen CSCL dan dient het ontwerp van de CSCL-omgeving in de tegengestelde volgorde plaats te vinden dan het acroniem, en de leeromgeving dient zorgvuldig te worden georganiseerd (Strijbos, Kirschner, & Martens, 2004). De verkozen voorstructurering – in deze dissertatie het gebruik van functionele rollen – dient in overeenstemming te worden gebracht met de leerdoelen (i.e. open vaardigheden), de voorgestelde interactie (i.e. genetwerkt), de taak (i.e. slecht gestructureerd), groepsgrootte (i.e. drie tot vijf) en communicatie wijze/technologie (i.e. e-mail). De zes-staps procesgerichte ontwerpmethode die is geïntroduceerd in Hoofdstuk 2 is uitgebreid tot een zes bij drie matrix met in totaal 75 ontwerpvragen. De bruikbaarheid van deze matrix voor het ontwerp en de evaluatie van CSCL-cursussen wordt op dit moment onderzocht onder docenten in het hoger onderwijs.

Een vergelijking van beide studies heeft aangetoond dat de wijzigingen in de randvoorwaarden een positief effect hadden voor beide onderzoekscondities: een vermindering in studentuitval in de groepen zonder de rollen en controle over aspecten die het effect van functionele rollen in eerste studie verstoorden. Desalniettemin kan de toepasbaarheid van sterke randvoorwaarden verschillen tussen CSCL-omgevingen. CSCL-omgevingen onderscheiden zich in de mate van docentcontrole versus studentcontrole en een ontwerper of docent dient dit in beschouwing te nemen wanneer CSCL wordt geïmplementeerd.

Gegeven de spanning tussen samenwerking en het algemene OUNL-studiebeleid, dient de OUNL haar studiebeleid te wijzigen van ‘onafhankelijk individueel’ in ‘meestal onafhankelijk individueel, soms in samenwerking’. Zoals beargumenteerd in de introductie ontstaat samenwerking niet vanzelf, derhalve dient het instituut praktijken te ontwikkelen die implementatie van deze modellen ondersteunen en ook de acceptatie van deze onderwijsmodellen door de studenten.

Toekomstig onderzoek

Allereerst dient de delicate balans tussen ‘leidraad’ en ‘dwang’ nader te worden bestudeerd. Dillenbourg (2002) heeft bepleit dat we ervoor moeten zorgen dat CSCL niet wordt over-geregisseerd. Ofschoon hij aangeeft dat over-regie ontstaat als natuurlijke interactie wordt verstoord is het geenszins duidelijk hoe dit zou kunnen worden geobserveerd. Een mogelijke richting is door te onderzoeken of het falen van de samenwerking toegeschreven zou kunnen worden aan een conflict tussen het onderwijsmodel, dat wordt opgelegd door de leeromgeving, en de ‘naïeve’ theorieën over samenwerking die de groepsleden hebben geïnternaliseerd.

Het concept ‘rollen’ heeft de laatste tijd meer aandacht gekregen in CSCL-onderzoek. Bijvoorbeeld het gebruik van rollen in vorm de van ‘instructieve ondersteuning’ (De Wever, Winckelmans, & Valcke, 2004; Pilkington & Walker, 2003; Schellens & Valcke, 2004), en het toepassen van computersoftwareondersteuning om het rolbewustzijn van studenten te verhogen (De Laat & Lally, in press-b) of het geven van ondersteuning door studerenden voorafgaand aan de samenwerking een werkplan te laten maken (Herrmann, Kienle, & Menold, 2004). Desondanks is het duidelijk dat de vorm van (functionele) rollen en hun impact verschilt voor diverse leeromgevingen. De inzet van rollen kan worden uitgebreid naar omgevingen voor Computerondersteund Samenwerken (CSCW) of het gebruik van rollen als instrument voor het creëren van een gemeenschap (Hermann, Jahnke, & Loser, 2004; Pilkington & Walker, 2003).

Het meeste CSCL-onderzoek richt zich op een specifieke CSCL-omgeving waarin één specifieke instructieve methode of vorm van computerondersteuning wordt aangeboden en het effect wordt onderzocht. Hoewel de oorspronkelijke focus in onderzoek naar één onafhankelijke variabele is verruild voor studies naar de wijze waarop meerdere onafhankelijke variabelen elkaar beïnvloeden (Dillenbourg, Baker, Blaye, & O’Malley, 1995; Kirschner, 2002), rapporteert het meeste huidige CSCL-onderzoek exploratieve studies of anekdotisch bewijs als uitkomsten. Ofschoon ‘interpretatieve analyses’ waardevolle inzichten kunnen verschaffen in de relatie tussen interactie en uitkomsten, is het twijfelachtig of zulke omgevingen kunnen worden gereproduceerd aangezien zij doorgaans niet waren gepland. Daar weinig tot niets wordt gezegd over de interactie die was verwacht voorafgaand aan CSCL hadden deze uitkomsten even waarschijnlijk kunnen worden toegeschreven aan andere factoren en/of de geobserveerde uitkomsten zouden in een analoge omgeving niet wederom naar kunnen voren komen. Prospectieve en retrospectieve analysebenaderingen voor CSCL dienen niet te worden behandeld als tegengestelde paradigma's. Prospectieve onderzoeksbenaderingen kunnen de belangwekkende uitkomsten van retrospectieve analyses testen en onderzoeken of deze voorbeelden van 'samenwerkend leren' systematisch kunnen worden gereproduceerd.

Ten slotte

Deze dissertatie heeft aangetoond dat interactie en het stimuleren van interactie behoren tot de kern van elke vorm van samenwerking (of het nu computerondersteund is of niet). Indien het leerproces wordt bezien als een fundamenteel sociaal gedeelde praktijk dan impliceert dit dat leren niet meer adequaat kan worden vastgesteld met korte 'leerintervallen' (i.e. twee uur durende laboratoriumomgeving waarin standaardtests worden gebruikt om 'leren' te meten). CSCL geeft een reden om onderwijsonderzoek te beschouwen voor wat het in essentie is: een humane wetenschap. We dienen de volledige complexiteit van ecologisch valide onderzoeksomgevingen te omarmen. Dit impliceert de acceptatie van alternatieve onderzoeksmethoden (durven we te zeggen: kwalitatief?) als supplement en het uitbreiden van conventionele methoden naar 'quisitive' onderzoek (Goldman, Crosby, Swan, & Shea, 2004) om zorg te dragen voor een vooruitgang van ons begrip van leren als een sociale praktijk.

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Curriculum Vitae

Jan-Willem Strijbos was born on the 29th of August 1974, in Millingen aan de Rijn, The Netherlands. He completed his pre-university education at the ‘Willem de Zwijger scholengemeenschap’ in 1993, and started his graduation in Psychology at the Radboud University Nijmegen. He specialised in educational psychology and constructed his own personalised masters programme that focused on the use of collaborative learning and was specifically tuned to adolescents. During his masters research he was introduced to computer support for collaboration and the topic of his masters thesis shifted toward CSCL. Since July 1999 he has been working as a Ph.D. candidate at the Educational Technology Expertise Center (OTEC) of the Open University of the Netherlands (OUNL) on his thesis regarding the use of roles in computer-supported competence-based learning environments. Besides his work as a Ph.D. candidate he edited a volume in the Kluwer CSCL-book series and he has been involved in Ph.D professional organisations at the national (treasurer) and international (JURE pre-conference chair) level. Recently, he visited Drexel University (Philadelphia, USA) where he worked on the ‘Virtual Math Teams Project’ for five months and developed a content analysis procedure for chat-based problem solving communication. He is currently visiting the FernUniversität Hagen (Germany) for two months, where he co-authors a distance learning course on CSCL and is involved in the development of an evalution framework for their digital learning environment. Beginning January 1st 2005 he will start at Leiden University as a researcher on the topic of ‘self-, co- and peer assessment’.

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