Computer–Supported Groups: Coordination and Social Presence

A thesis submitted by

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in fulfilment of the requirements for the award of the degree

DOCTOR OF PHILOSOPHY (Dr. phil.)

June 24th, 2009

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http://archiv.tu–chemnitz.de/pub/2009/0180
ACKNOWLEDGEMENTS

I would like to thank my supervisor, Professor Maria Bannert, for her support and feedback. Her trust in my abilities helped me to finally finish this work. Furthermore, I would like to thank Professor Jörg Zumbach, his ongoing support throughout the years as well as his approach to research have shaped my scientific way of thinking and provided me with a valuable mentorship. I would like to thank Professor Peter Reimann for his timely advice, along a winding road. Furthermore, I would like to thank Professor Peter Goodyear for his guidance and feedback.

Special thanks go to the CoCo research centre team. Without their outstanding social and intellectual support this work would not have been possible. A big thank you goes to Dr. Lina Markauskaite for believing in me, when I could not myself. Her invaluable academic guidance and personal support has assisted in shaping my professional skills, and granted me a great friend. Many thanks to Kate Thompson for her extraordinary help during this thesis and for being a good friend. A special and warm thank you to Nina Hollender, without her ceaseless academic and personal support this thesis would not have been finished. Particular appreciation goes to Dr. Chun Hu and Kathrin Spanner for their support during the data collection.

I would like to extend my thanks to my flatmate, Wencke Lehnert, my friends and Daniel Hofstaetter. They have all patiently listened to the ups and downs of writing a PhD for the better part of the last five years.

Last, and very importantly, I would like to thank my parents and sister, Rebecca. They have always supported me no matter how extraordinary my endeavours and choices might have been. Thank you.
PUBLICATIONS

SUPPORTING THIS RESEARCH


*This poster achieved the “Peoples’ Choice: Best Poster Award”.*
Net-based collaborative learning is increasingly included in the repertoire of teaching and learning methods in higher education. Supporting coordination within distributed learning teams has become a concern for educators and learning designers. While effective communication and meaningful interaction do not occur naturally in online learning, they are essential for group coordination.

The aim of the thesis is to explore the complexity of learning experiences and processes in computer-supported collaboration from the perspectives of group coordination processes and social presence. These two dimensions are particularly important because they represent two problems in net-based collaborative learning: coordination costs and a lacking sense of group feeling.

Compared to face-to-face settings, coordination demands on groups are greater in online settings. Increased demands present the risk of distracting group members from learning goals; coordination demands rapidly turn into coordination costs. Additionally, social presence is required to establish a sense of group feeling and team culture amongst students. Unfortunately, this sense, supporting the social dimension in online settings, is often missing.

This case study–based research analyses the learning processes and experiences of students participating in a blended course in Educational faculties. A subsequent quantitative study further inquired into causal relationships. Students collaborated via various synchronous and asynchronous media: wikis, online chat, etc. Qualitative and quantitative methods were applied, investigating coordination of activities and how social presence was established. Data was analysed at three levels of
Abstract

granularity: single perspective, concept and integrative levels, creating a multi-layered approach.

The findings show, tools, tasks and members influence group coordination, each uniquely contributing to coordination activities. Social presence operates as an enabling context parameter, influenced by media and member characteristics. The thesis describes these findings and delineates their implications for collaborative learning practices in higher education and for further research.
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1 INTRODUCTION

Today, tertiary educational institutions are increasingly developing methods to meet changing demands of their students. One such need is being free of time and place constraints. For example, part-time students with multiple responsibilities, such as work and family, prefer to be able to study when and where their schedule permits. In response to this trend, universities are adding net-based collaborative learning options to their repertoire of teaching and learning delivery methods. These options are developed not only for distance learning, but also as an element of blended learning courses. Additionally, an increasing number of university courses include elements of project-oriented pedagogy: team or group-based learning as the main learning approach, facilitated through internet-based collaboration technologies, such as WebCT\(^1\) or Trac\(^2\). Supporting such distributed learning groups has become a concern for educators and learning designers. How does a university support effective and natural communication and meaningful interaction, in a potentially unnatural setting?

Literature has identified several factors influencing successful collaborative online learning (Fussel et al., 1998; Lou, Abrami & D’Apollonia, 2001). Among these factors are group cohesion and optimised coordination in groups. Gradually, social aspects, such as perception of belonging to a group or trusting group members, move into the centre of attention because they are essential for effective learning. Several pitfalls and obstacles, influencing how groups perform, have been identified (Kreijns, Kirschner & Jochems, 2003). Examples of these obstacles are social loafing

\(^1\) WebCT are Web Course Tools that support the authoring, delivery and management of web based trainings. For further information see [http://webct.com](http://webct.com).

\(^2\) Trac is an enhanced wiki and issue tracking system for software development projects. For further information see [http://trac.edgewall.org](http://trac.edgewall.org).
in virtual groups, coordination complications, establishing and maintaining cognitive as well as social mechanisms.

This thesis addresses two of the main problems in online groups: increased coordination demands compared to face-to-face groups (R. E. Kraut, Fussel, Brennan & Siegel, 2002; Miao, Burgos, Griffiths & Koper, 2007) and a lacking sense of group feeling (Kreijns et al., 2003). Increased coordination demands are associated with the risk of distracting from learning and engaging with the subject matter; such coordination demands rapidly evolve into coordination costs. Establishing a sense of group feeling and team culture amongst students requires social presence supporting online social dimensions in online settings, which does not emerge naturally.

Detailed insight into group coordination processes and social presence provides understanding of how collaborative online learning can be supported better. In order to understand groups’ online learning experiences, research must consider group complexity as an ontological, epistemic and social entity, examining them from multiple perspectives.

1.1 Research Aims, Core Concepts and Theoretical Approach

This thesis has two main aims:

1. to explore the complexity of learning experiences and learning processes in computer–supported collaborative learning environments, from the perspective of group coordination and social presence.
2. to develop suggestions to facilitate more efficient teaching and learning processes, based on the identified processes.

In order to achieve the first aim, this thesis examines group dynamics within two student groups participating in a blended course in an Education Faculty. Coordination and social presence address two of the main problems in net-based collaborative learning: increased coordination demands and establishing a sense of group feeling and team culture among students. Based on the findings of the qualitative findings, a subsequent quantitative study further investigates the reciprocal causal relationship of social presence.

The research project employs a generic framework for examining groups as complex systems, as proposed by Arrow, McGrath and Berdahl (2000). Due to the scope of this research, this thesis will focus only on two of the three proposed elements, i.e. local coordination dynamics and context parameters, to investigate group processes. The framework highlights important aspects to consider when studying coordination dynamics and social presence in CSCL environments and, unlike others, looks at coordination and social presence in the context of technology.

Coordination is “the act of managing interdependencies between activities performed to achieve a goal” (Malone & Crowston, 1990, p. 361). This thesis focuses on coordination activities occurring in online learning groups on a micro-level of behaviour, i.e. local coordination processes. As outlined in the framework, three factors are essential to understand the processes, and are specifically examined in this discussion: tools, tasks and members. Each of these factors contributes to group dynamics in its own specific way:
1 Introduction

**Tools:** a platform manipulated by a user to interact with other users, including mediating artefacts, such as wiki pages.

**Tasks:** activities group members engage in to achieve the learning goal.

**Members:** individual participants that make up a group.

Furthermore, Arrow et al.’s framework highlights the importance of group dynamic context. Social presence is a crucial concept and has recently gained increasing attention (e.g. Rourke, Anderson, Garrison & Archer, 1999; Shih, 2004; Swan, 2002). It describes the degree to which a person is aware of another person in a technology-mediated communication setting. It serves as a context parameter for this study and, therefore, stresses the importance of the social dimension for computer-mediated interaction in groups. The influences of medium and group members largely determine social presence. Its reciprocal nature is further illuminated in a quantitative study.

The subsequent integration of findings provides an in-depth understanding of learning experiences in CSCL environments.

In order to achieve the second aim, suggestions for a more efficient learning and teaching process are derived on the basis of the findings from the quantitative and qualitative studies.

### 1.2 Method and Research Approach

This thesis employs a case-study approach. How students’ coordinate activities and develop social presence is analysed, using mixed qualitative and quantitative methods. Based on the findings, a quantitative study provides further insights on
the reciprocal nature of social presence as well as in-depth insights on the nature of its impact in online settings. A multi-disciplinary, integrative perspective provides a theoretical and methodological framework for the analysis of coordination processes and social presence establishment in learning teams. Theories, concepts, and empirical findings from educational research, psychology of groups and learning, and organisational research are brought together to gain a comprehensive understanding of group learning experiences.

Dynamics in online groups are complex; different factors contribute to group processes at different times in different ways. The multi-layered analytical approach adopted in this study is the thesis' methodological contribution and strength, as it accounts for complex group dynamics. The combined analysis of coordination behaviour and social presence experience, examined from different perspectives on levels of abstraction, provides an integrative view of group dynamics in computer-supported collaborative learning environments. Three abstraction levels, a single perspective level, a concept level and an integrative level, are adopted to portray the complexity of group dynamics, and to help identify factors influencing dynamics.

The smallest unit of analysis is the single perspective level, i.e. the tool, task or member perspective for coordination and the media or member perspective for social presence. The concept level generates an intermediate level of analysis, i.e. coordination behaviour composed of interaction between the three single perspectives or social presence experience as determined by the medium and member. The most abstract level of analysis, integrated level, provides a view of students’ learning experiences, acknowledging the intertwined relationships of all factors involved, i.e. a complex view of coordination as it constitutes local dynamics, and social presence as contextual parameter.
1.3 STUDY CONTEXT

This thesis describes and analyses experiences and perceptions of students participating in a postgraduate blended learning course. The course introduced information technology in education and considered principles of teaching and learning using ICT. It presented an overview of research on the use of ICT in teaching and learning, while focusing on learning from and with hypermedia and multimedia, as well as text-based synchronous and asynchronous discussion.

The course adopted a constructivist learning approach; students studied learning theories and experienced different activities, from both a teacher/facilitator role and a student role. Within the class group, students formed two groups of 3–4 members for all collaborative activities. Students remained in the same groups for most of the activities during the course. The course was taught over 13 weeks, with a blend of face-to-face meetings and online sessions.

A subsequent quantitative study further investigates social presence by pursuing findings from the qualitative study. Sixty participants took part in the study that considered social presence as an independent variable on three levels, high versus low social presence in online settings versus a face-to-face setting. The influence of social presence on the perception of medium, task and members was scrutinized.
1.4 SUMMARY OF FINDINGS, CONCLUSIONS AND CONTRIBUTIONS

1.4.1 Coordination

In the conducted studies, all three proposed factors, i.e. tools, tasks and members, influenced coordination in characteristic ways.

Tools

Different tools triggered unique coordination patterns, i.e. reoccurring sets of coordination actions that form a regularity of some sort. Analysis showed striking differences between synchronous and asynchronous communication media: synchronous media enable a richer variety as well as a larger quantity of coordination compared to asynchronous media. The cost of coordination, when using tools, becomes evident through students’ unsuitable or irrelevant coordination attempts. For example, Synchronisation attempts come at a cost: reiteration of assuring everyone is on track, paying attention, having read the latest contributions or emails. These efforts are an additional strain on students in an online environment. The cost aspect of Synchronisation coordination efforts also becomes evident when students tagged the medium slow and found it frustrating to use if there was ‘a lot to work out’.

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3 Synchronisation is one of eight categories used to classify coordination behaviour. The eight categories are: 1) Goal Identification, 2) Mapping Goals to Activities, 3) Assigning Group Members to Activities, 4) Media Usage for Coordination Purposes, 5) Synchronising Activities, 6) Shared Resource Management, 7) Demanding Activities and 8) Shared Meaning Making. For detailed information see chapter 4.6.1.3 Coding Scheme for Coordination.
Furthermore, coordination costs arise from differences in media dimensions, i.e. parallelism and rehearsability, as proposed by Dennis and Valacich (Dennis & Valacich, 1999). Students’ behaviour was not always congruent with media characteristics. For example, students tried to hold more than one conversation at a time in the chat forum, a medium that has a low ability to hold effective parallel conversations.

**Tasks**

Overall, tasks differed in quantity and quality of coordination attempts. Simple tasks, i.e. discussion tasks, included little coordination and a small variety of coordination attempts, mostly synchronisation and demanding activities efforts. Other, more complex tasks, i.e. concept mapping, wiki page creation and collaborative writing, revealed a higher amount and variety of coordination attempts. Depending on the group and session, coordination efforts were composed of using between four up to all of the eight main coordination categories, with Demanding Activities, Synchronisation and Assigning Group Members to Activities being the most frequent coordination behaviours.

As a task grows more complex, the resulting coordination patterns also increase in complexity.

**Members**

Individual member characteristics contribute to a distinguishable coordination patterns, e.g. prior experience with IT shapes behavioural patterns regarding IT acceptance and interaction with particular mediums. Moreover, students reacted with increased coordination attempts when holding the moderator role, compared to coordination behaviour during the other online sessions.
The complexity of learning experiences becomes evident when considering findings from all three factors simultaneously. For example, synchronous tools trigger more coordination behaviour compared to asynchronous tools, whereas complex tasks need an appropriate platform to develop coordination behaviour. This implies the right mix between task and tool, between interdependencies and triggering mediating environment. Considering only one factor can come at a cost to coordination dynamics in the other.

Describing coordination in terms of cost and gain emphasises the dual nature of coordination in learning groups and provides a powerful point of reference for evaluating group processes in online learning. The educational designer needs to match the pedagogical aim with the choice of tool (e.g. synchronous or asynchronous), particularities of the task (e.g. interdependencies) and members’ needs and characteristics (e.g. media experience and preoccupations).

Overall, the consideration of tools, tasks and members for coordination processes provides a rich and sound basis for exploring the complexity of learning experiences and processes.

1.4.2 Social Presence

The two proposed factors, medium and members, influence social presence. The reciprocal nature of social presence is illuminated by findings that social presence influences the task attitude as well as the evaluation of the medium.
Introduction

Media

Students expressed higher levels of social presence indicators during synchronous communication, compared to asynchronous communication. The impact of social presence across media is more dominant than different levels within a medium. Overall, social presence indicators increased over the semester, as long as students remained in the synchronous communication environment. The social presence decreased during the two last sessions, held in an asynchronous mode. Even though students' engagement might have been influenced to some extent by the end of term, the presented findings go beyond the standard end of term decline and point to the medium's influence in the experience of social presence. The distinct decrease in social presence after changing communication media implies, the medium's impact on social presence is stronger than longitudinal effects emerging as part of the groups' dynamics.

Members

Social presence varies intra- and interindividually. Students expressed varying levels of social presence and individual characteristic patterns. For example, some members did not show a steady increase of social presence, as the above stated longitudinal effects might suggest. Additionally, social presence fluctuated intraindividually from session to session.

These findings indicate, social presence experience varies from individual to individual, alluding to the importance of the medium and the temporal dimension. In general, the longer the individual remains within a certain medium, the more social presence is experienced.
Members experienced the possibility of social exchange as comforting. However, the subsequent reality annihilated that difference and a trend with a favour towards less social presence was revealed.

Promoting the experience of social presence can take up one of various forms, such as choosing a medium with a greater ability to convey social presence, promoting students’ awareness of others’ presence or achieving a balance between social and on-topic actions. The introduction of rules and roles can sustainably change the quality of the social presence experience.

Social presence adds a complex, but crucial, layer to the learning experience.

### 1.4.3 Integration

Each concept, coordination and social presence, contributes to students’ online learning experience. Analysis of coordination illuminates emerging dynamics shaping learning. Social presence analysis provides insight into a powerful enabling factor for effects, such as increased opportunity for common grounding, which in turn shape coordination dynamics.

Increased social presence provides greater opportunity for establishing common ground within groups, which in turn creates a supportive environment for coordination. Synchronous environments enable a stronger sense of social presence; they also provide a rich opportunity for coordination.

The integrated consideration of coordination costs and the social dimension contributes beneficially to students’ online learning experience.
1.5 Outline of this Thesis

The remaining thesis is structured as follows:

Chapter 2 provides an overview of computer-supported collaborative learning literature, as well as research in the field of coordination and social presence. Research on computer-supported collaborative learning presents the basis and framework for the latter two concepts. The chapter elaborates on important aspects to consider when studying online groups, and introduces a view on groups as complex systems.

Chapter 3 outlines the thesis aims. The chapter elaborates on the main research aims and objectives. Furthermore, it links them to respective research findings and considerations.

Chapter 4 illustrates the methodological approach applied to investigate research questions. The chapter elaborates on the methodological framework emerging from the literature review. The contribution of different data types, e.g. coded online data or questionnaire data, and the illumination of the two concepts is described. The multi-layered approach is introduced and elaborated upon, as well as participants and study setting.

Chapter 5 presents findings on coordination and associated discussion. The chapter portrays findings from coded online communication, students’ artefacts, such as wiki pages, as well as questionnaire answers.

Chapter 6 presents findings and the associated discussion on social presence and illuminates the role of social presence as an enabling context parameter in CSCL
environments. It presents findings from coded online communication, other artefacts, such as wiki pages, and questionnaire answers.

Chapter 7 presents a subsequent quantitative study that further inquires into the reciprocal nature of social presence.

Chapter 8 integrates findings on coordination and social presence, and provides a discussion of influences on students' online learning experience. The chapter provides a broader view of learning experience in CSCL settings and suggestions for the improved facilitation of the teaching and learning processes in such settings.

Chapter 9 provides conclusions derived from the previous chapters. Conclusions are presented on three different levels of abstraction: single perspective, concept and integrative level.
2 Theory and Literature Review

The following chapter provides an overview of relevant research into computer-supported collaborative learning groups. Thereby, it also introduces a theoretical framework to elaborate on the two main concepts: coordination and social presence. The first section provides an overarching perspective and introduces the framework. The remaining two sections investigate the two main concepts: coordination and social presence.

The multi-disciplinary perspectives, outlined in each of the respective sections, provide a theoretical and methodological framework analysing coordination processes and social presence in net-based learning teams. Theories, concepts, and empirical findings from educational research, group and learning psychology, computer science and organisational research are brought together to gain a comprehensive understanding of net-based learning.

The literature review’s first section identifies important aspects in computer-based collaborative learning, with special emphasis on complex interrelations within such learning scenarios. The second section investigates coordination, specifically the relationship between collaboration and coordination. Coordination antecedents and effects are addressed as well. Special emphasis is put on coordination costs in net-based collaboration, as they pose a problem in online learning. The third section reviews the connection between social presence and online collaboration, as it relates to group feeling and team culture amongst students. Additionally, the two related concepts, social presence and social awareness, are introduced and delineated. Both concepts are important for the empirical part of this study.
2.1 CSCL GROUPS: RESEARCH AND THEORY

The following section provides an overview of computer-based collaborative learning research, as it is relevant to the studies presented in this thesis. Furthermore, it introduces a framework guiding theoretical and empirical considerations within the thesis.

The presented theories and findings draw from educational research, group and learning psychology, and organisational research. The section mainly focuses on computer-based collaboration research, with a special emphasis on a complex and integrative perspective on online groups. The resulting framework provides a basis for the multi-layered analytical approach taken in this thesis.

This section argues, in order for net-based group learning to take place, a variety of factors, not necessarily directly affecting the learning outcome, have to be considered as well. Group processes play an integral role in facilitating learning; if coordination and communication in a group fail, effective learning is not likely to occur. Hence, collaborative learning and group processes are intertwined. This idea will be elaborated further in the following sub-sections.

2.1.1 Collaborative Learning and Group Processes

This sub-section identifies findings from group research, specifically in the areas of social and educational psychology. The section considers topics relevant to coordination and social presence in net-based group learning, such as the impact of technology on learning and communication as well as basics of computer-supported collaborative learning.
Group learning has become common practice in today's education system. In general, group learning is superior to individual learning in several areas of the learning process, for example it leads to a higher frequency of positive peer interaction leads and appropriate learning, group learning also results in better task strategies and increased student success (Lou et al., 2001).

### 2.1.1.1 Mediating Technologies

Historically, communication, as well as cooperation, have been addressed in teaching and learning scenarios. Mediation devices for teaching have been used since teaching existed, beginning with blackboard and chalk and, more recently, powerpoint slides or mobile devices.

In the 1960s, a new dimension of communication and cooperation was introduced to learning scenarios: computer technology support. The advantages of interacting free of place constraints, for example via video-conferencing, or free of time constraints, e.g. taking part in asynchronous conversations, were revealed. Both the business sector and the educational sector took advantage of this new dimension. Many different learning and teaching mediators emerged, such as overhead projectors, interactive whiteboards and discussion forums.

Technology-mediated learning is characterised by interactions with learning materials and with peers. Furthermore, computer-mediated communication (CMC) is an essential part of collaborative learning (Goodyear, Banks, Hodgson & McConnell, 2004). The following two sub-sections provide a closer look at the technology-mediated aspect of learning, and the role CMC plays in this process.
2.1.1.1 Technology-Mediated Learning

Computers have been present in education since the 1960s (Braun, 1977). Even though computer-mediated learning has been in practice for approximately five decades, research outcomes in that particular area are heterogeneous. There is a need for structured research results.

De Vries (2003) describes seven different functions a computer can take in an educational setting:

a) presenting information,
b) administering exercises,
c) genuinely teaching,
d) providing an information space for exploration,
e) providing an environment for discovering natural laws,
f) providing an environment for discovering the laws of abstract domains, and
g) providing environments for interaction of learners.

Each of these functions is characterised by a dominant theoretical perspective, typical learner activities and specific computer programs: The four dominating theoretical approaches are behaviourist, cognitive, constructivist and situationist perspectives (De Vries, 2003). Learner activities range from reading activities up to manipulating, constructing and discussion activities. Computer programs vary from drill-and-practice programs to microworlds and computer-supported collaborative learning environments. Much of the research around communication and technology was done in the 1970s. A second wave of research, specifically on the fit of task and technology, occurred in the early 1990s. To date, research outcomes in the field have been extremely heterogeneous and sometimes even contradictory.

Several attempts have been made to categorise mediating technologies. One well known categorization has been proposed by McGrath and Hollingshead (1994). They describe a more business-oriented approach and suggest a distinction
between four basic support or mediating systems: systems for intragroup communication, systems for communication with information bases, systems for external communication and structuring group task performance. Systems for intragroup communication refer to electronic systems which provide or modify within-group communication. Support provided by technologies in this category can differ vastly. Popular examples are e-mail technology, videophone technology, workflow systems and group calendars (Olson & Olson, 2003). The diversity of these technologies promotes communication on a variety of channels and modalities. Systems for communication with information bases support information exchange between group members and bodies of information and knowledge, such as the World Wide Web or databases. Usually, depending on the system, support incorporates information access, selection, processing and presentation to users. An example is a search engine on the World Wide Web, where users can search, access and select information.

Furthermore, the didactical design of the scenario shapes the interaction taking place (Rysjedal & Wasson, 2005). An emerging strand of research suggests the representational guidance a medium provides is important to collaborative learning discourse (e.g. Suthers, 2001; Suthers, Hundhausen & Girardeau, 2003; Suthers, Vatrapu, Joseph, Dwyer & Medina, 2006). Suthers’ (2001) initial analysis report insinuates, expressive constraints imposed by representation of salient information may have an important effect on students’ discourse. He defines representational tools as “software interfaces in which users construct, examine, and manipulate external representations of their knowledge” (Suthers, 2001, p. 256). Constraints are viewed in terms of limits on expression, such as a system may provide only a limited ontology of objects, and addresses logical and semantic features of a notation. Salience describes how a representation promotes knowledge processing and focusing on aspects of perception. He found that different representations,
such as graphic, matrix or text, influenced the evidential consideration in collaborative discourse.

In a later study, investigating the representational guidance of asynchronous communication, Suthers et al. (2006) found graph representations advantageous for convergence in collaborative discourse. In a recent study Suthers et al. (2007) found users employing conceptual representations created more hypothesis earlier in the session, compared to threaded discussions. However, they did not find evidence explaining differences in information sharing. Further, Suthers et al. (2007) identified benefits of embedding a shared workspace with task information.

The technologies mediating communication include (non–) interactive video systems, telephone conferences, voice messaging, (non–) interactive computer conferences, decision and process support tools as well as tools assisting with information search. The term “tools” in this thesis describes software interfaces manipulated by the user in order to interact with other users. The software interface can also include mediating artefacts, such as wiki pages.

2.1.1.2 Technology–Mediated Communication

Communication mediates learning in online groups to a certain extent. However, communication itself is subject to the limitations and affordances of the environment it is transferred by. The following section focuses on crucial factors affecting technology–mediated communication in collaborative settings, the technology involved and task to be completed. Most research in this field is derived from an organisational background. Social as well as individual aspects must also be accounted for, as they influence underlying psychological processes.
Many places of innovation in the public and corporate sector have one aspect in common: most tasks involve communication (Galegher & Kraut, 1990). Communication involves cooperation and vice versa. The two have become crucial factors in creating entrepreneurship when meeting the demands of a fast developing, multinational society. Communication has been studied from a variety of research perspectives: sociologists, psychologists, communication scientists, and media scientists.

Dwyer (2002) describes communication as any behaviour that is perceived by some other person. She distinguishes between verbal, nonverbal and graphical communication. Engleberg and Wynn (1997) propose five essential components that influence communication: 1) number of members, 2) interaction between members via verbal or non verbal messages, 3) a common goal or an objective that is of mutual interest for the group, 4) interdependence between group members regarding the fact that they are affected by the actions of the other members, and 5) working in order to pursue the common goal.

Research findings suggest time is an important mediating factor in computer-mediated communication, possibly more important than the medium itself (e.g. Kapur, Voiklis & Kinzer, 2007; Walther & Burgoon, 1992). Birmingham and McCord (2002) identify eight dimensions within which newly formed groups differed compared to older groups: 1) level of trust and attraction to a group, 2) motivation to achieve a goal, 3) willingness to support each other, 4) awareness of peers’ skills and abilities, 5) ability to share information effectively, 6) willingness to disagree, 7) preferred method to solve conflict, and 8) overall ability to complete difficult tasks.

Computer-mediated communication can be asynchronous or synchronous (Ingram & Hathorn, 2003). Asynchronous, text-based communication between two or more people has been studied often (Romiszowski & Mason, 2004; Sproull & Kiesler,
2 Theory and Literature Review

1991), while synchronous communication has been analysed less frequently. This thesis considers both aspects of computer-mediated communication, asynchronous and synchronous.

Technology-mediated communication undergoes change dependant on the newest software and hardware developments, and is therefore difficult to define. Romiszowski and Mason (1996) propose a working definition, describing it as “the process by which people create, exchange, and perceive information using networked telecommunications systems that facilitate encoding, transmitting, and decoding messages” (cited in Romiszowski & Mason, 2004, p. 398).

In further sections, there will be particular emphasis on two issues emerging out of computer-mediated communication research: task–technology fit theories and social needs in CSCL. Task–technology fit theories are elaborated in sub-sections 2.3.3.2.2 Media Richness Theory and 2.3.3.2.3 Media Synchronicity Theory. The focus on task–technology fit theories emphasises particularities of technologies and their impact on communication and continuation on collaboration. Social needs in CSCL are discussed in sub-sections 2.3.3.2.1 Social Presence Theory and 2.3.2 Awareness. Social processes play a special role in distributed learning and will therefore be discussed in more detail. Both areas are well acknowledged within computer-mediated research.

2.1.1.3 Computer Supported Collaborative Learning

Learning in computer–supported groups includes collaboration, computer mediation and distance learning (Stahl, Koschmann & Suthers, 2006). Computer Supported Collaborative Learning (CSCL) responds to multiple educational goals, for example learning at a distance, collaboration and individual learning, educational scenarios from kindergarten to adult learning to informal settings, e.g. in museums.
Researchers from different fields engage in its study, taking an organisational perspective or a social psychological perspective. The diversity of goals and disciplines involved make CSCL a complex field of study.

Research in the field of CSCL emerged in the 1990s (Stahl, 2005). Even though the term implies a common understanding, a variety of approaches and applications are subsumed under it. There is emphasis on technology as well as on group processes. Two major research fields contribute to CSCL findings, cooperative learning and computer-supported collaborative/cooperative work (CSCW) (Lehtinen, Hakkarainen, Lipponen & Muukkonen, 1999). Many tools and principles used in CSCL scenarios were developed in a work context, and transferred to learning settings. Tools range from asynchronous to synchronous support systems. They can promote one functionality, such as an e-mail, or they could incorporate many functionalities, seen in groupware systems (Olson & Olson, 2003).

CSCL environments have proven beneficial for higher order social interaction and deeper understanding of learned content (Lehtinen et al., 1999). However, research outcomes in relation to learning outcomes are uncommon; research that does exist is often heterogeneous. Six out of ten studies report positive effects on learning outcomes (Lehtinen et al., 1999).

Research has also been done on feeding back motivational and emotional measures to the group as a whole (Reimann, 2003; Zumbach, Muehlenbrock, Jansen, Reimann & Hoppe, 2002). Even though impact could not be revealed on emotional information feedback, the authors argue this could be due to time related matters. The investigated groups had not been established for a long time; it may be, emotions were too invariant to be influenced by task or problem-solving processes. This stresses the importance of time in group processes. Reimann (2003) reports on an experimental study investigating the effects of monitoring group performance.
He found small positive effects of mirroring group interaction on ad-hoc groups, formed for only a short amount of time.

Lehtinen et al. (1999) state two major advantages of computer-based scenarios. One is the ability to improve social interactions between group members. The second is, research has shown positive learning effects within such scenarios. However, some reservation exists. It seems important that certain prerequisites are fulfilled. For example, the task must create a need for collaboration, group members should know how to use the tools properly in order to fulfil the task, and the culture supports collaboration. As long as these prerequisites are met, CSCL can provide a rich and nurturing learning environment.

Researchers increasingly criticise existing CSCL research for not considering time as a relevant factor (McGrath, 1990; Reimann, 2007; Walther & Burgoon, 1992). Experiments are usually conducted in laboratories over short periods of time. Therefore, the time factor as it relates to the learning process, might be an important but neglected variable. Findings indicate, if groups exist over longer periods of time no difference exists between computer-mediated groups and face-to-face groups with respect to message exchange rate.

Other researchers acknowledge, dynamics in online groups change over time, but state the influence on learning is unclear. Sweet and Michaelsen (2007) review how group dynamics research can inform small group learning theory and practice. They conclude, group dynamics matter to learning, and group dynamics change over time. It is not clear if it is the change that affects learning.

As previous sub-sections show, a wealth of factors is important in order to understand group processes in CSCL. The following sub-section describes and examines important aspects for group processes in higher education settings with
the help of an overarching framework. The idea of groups as complex systems is introduced and an emerging framework is outlined, providing guidance to the thesis’ empirical section.

2.1.2 CSCL Groups: A Complex Systems View

The following sub-section introduces groups as complex systems. It considers relevant aspects of group dynamics in CSCL within a single emerging framework. Firstly, basic considerations behind such a view are introduced. Secondly, findings shaping the emerging framework are presented; they describe group behaviour as experienced in higher education computer-supported collaborative learning seminars. Many of the findings are derived from research fields other than higher education.

2.1.2.1 Groups as Complex Systems

Research in CSCL is often piecemeal; experimental group research often investigates single factors on learning or knowledge gain or group processes. Ethno–methodologically oriented studies frequently lack concern for theory development and accumulation of findings across studies. Findings are not interpreted from an integrative view, and an increasing body of seemingly heterogeneous findings exists, which cannot be explained satisfactorily. De Laat and Lally (2004) point out, sufficient guidance for researchers is still missing a coherent theoretical framework for CSCL.

The complexity of learning settings becomes evident when looking at the wealth of influencing factors contributing to immediate group behaviour. One can distinguish between micro– and macro levels of analysing behaviour (Engeström & Miettinen,
The micro level emphasises local patterns of action, interaction and knowledge. Activity theory puts forward, any form of local action shapes more general and durable forms, for example when collaboration results in the production of an artefact. A wealth of influencing factors contributes to immediate group behaviour, making it difficult to predict. Such factors include group type, members' and group goals, member action and reaction, positive and negative feedback loops, attitude and many more. Arrow et al. (2000) argue, immediate group behaviour is not predictable. Even though groups may have similar starting conditions, they will quickly develop in different directions (Huysman et al., 2003; Kapur et al., 2007).

Research into collaborative learning, as well as the interaction between theory and praxis in distributed learning communities, are equally complex (De Laat & Lally, 2004). They call for a more complex view on distributed learning settings. They mention four aspects:

- A single framework providing sufficient guidance is missing.
- The research community might not have completely acknowledged the research's complexity in this field.
- Complexity not only applies to the theoretical part of the field. It also extends to interactions in the praxis, as well as to artefacts involved.
- Researchers experience methodological challenges in the field of distributed collaborative learning on various levels, such as suitable methods, or the advantages and disadvantages of specific techniques.

Arrow, McGrath and Berdahl (2000) propose a framework for small groups based on a complex systems view. The framework provides overarching considerations for most types of groups, e.g. from flight crews or task forces in a business environment to clubs forming leisure-type environments. They introduce five propositions as basic elements of their theory.
2 Theory and Literature Review

- Groups are complex, adaptive and dynamic systems. Three levels are important in such a system: the member level, the group level and the context surrounding the group.
- Three levels of causal dynamics are considered: Local, global and contextual dynamics.
  a. Group members’ activities, the rules and procedures determining activities, constitute local dynamics. Viewing group members’ activities from a coordination perspective provides a detailed perspective on activity synchronization, setting and identifying priorities and goals, allocation of resources, as well as other coordination strategies. Thus, the central concept for local dynamics is coordination.
  b. Global dynamics are composed of coherent relations emerging from local realities. However, global and local dynamics are linked and influence each other mutually.
  c. Contextual dynamics result from embedding environmental conditions. They constrain emerging global dynamic patterns over time.
- Groups serve two major functions: 1) completion of the group task and 2) fulfil members’ needs.
- The way the group is structured depends on group members, tasks and tools or resources. These elements are linked through various possible functional networks (see Figure 1). Links are explained in the following network structures:
  a. member network: describes links amongst members,
  b. task network: includes task sequencing or synchronisation,
  c. tool network: describes tool utilisation as well as rules and procedures,
  d. labor network: links members and tasks,
e. role network: links members and resources, and  
f. job network: allocates tools and resources to tasks.

Figure 1: Functional networks between the three structuring elements of groups.

A variety of theories exist focusing on knowledge creation within communities, e.g. Nonaka and Takeuchi’s model of knowledge-creation, Bereiter’s model of knowledge creation and Engeström’s cultural-historical activity theory (Paavola, Lipponen & Hakkarainen, 2004). While the theories have a common goal, i.e. the explanation of knowledge construction in communities, each has a different focus. To this point, few researchers argue for a more complex view on collaboration research. For example, Kapur, Voiklis and Kinzer (2005) describe problem solving interactions between multiple actors, artefacts, tools and environmental structures as a complex adaptive activity. Stating, interactions in distributed learning communities are complex. Cultural–historical activity theory proposes a complex model of behaviour as it occurs between subject, object and community, as mediated by tools, rules and labour division (see Figure 2). At the centre of attention is the object, or task, linking individual actions to group activities (Engeström, 1999, 2001).
Researchers have successfully applied activity theory to computer–supported collaborative learning (e.g. E. Christiansen, 1996; Jonassen & Rohrer–Murphy, 1999). Cultural–historical activity theory puts a strong emphasis on community and views the tool or artefact as a mediator between subject and task. The complex systems framework, as proposed by Arrow et al. (2000), considers similar aspects in the group knowledge construction process. However, the focus is slightly different, putting stronger emphasis on the tool. In Arrow’s framework, the tool is represented on the same level as the task, or object as referred to by cultural–historical activity theory, and the member. The mediating tool is particularly important for computer–mediated learning. Therefore, this thesis will draw more strongly on Arrow et al.’s (2000) framework.

2.1.2.2 Context Parameters

Different researchers emphasise the importance of the learning environment context, e.g. situated cognition (Choi & Hannafin, 1995; Lave & Wenger, 1991) or activity theory (Engeström, 1999). The environment surrounding a group’s action space affects their behaviour. The environment includes everything from the immediate physical or symbolic environment to rules or procedures on a higher organisational level or other groups existing in the same setting.
Often the influence of the context is carried out indirectly, in a way that a change in the surrounding environment results in a different set of limiting parameters for a group. As a result, the group may or may not react on it. For example, participants in a semester’s course are divided into two groups. After some weeks, they establish a level of performance with which they are comfortable. However, a new task emerges matching one member’s field of expertise. This not only changes the group dynamics of the immediate group, it also affects the other group. It might set new performance standards and it might affect the level of performance on which both groups agreed implicitly.

Kirschner et al. (2004) describe computer-supported collaborative learning in education as a unique blend of three different contexts: educational, social and technological. Collaborative learning design shapes the educational setting. A varying range of contacts to fellow students and teachers forms the social context. The technological context links the educational and social contexts. For example, a discussion forum provides students with the means of learning and social exchange. However, the chosen context comes with its own set of rules and constraints and its exploration will be subject to this thesis.

Recently, the social dimension in CSCL has received attention (Kreijns, Kirschner & Jochems, 2002). Social and contextual support is especially important for CSCL, as students have little direct contact with peers or tutors (McLoughlin & Luca, 2006). Social needs are often neglected in CSCL, but are important for success in such settings (Schmidtmann, 2005). Social interaction may help to overcome negative outcomes in group behaviour, such as dysfunctional behaviour or “free-riding”. The existing gap between social needs and technological possibilities has been identified as a central challenge within the field (Ackerman, 2000). The social dimension of communication is constrained by characteristics of the mediating
technology. Kreijns and Kirschner (2001) suggest introducing social affordances into CSCL environments to meet social needs.

This thesis acknowledges, the CSCL context is influenced by factors beyond the social dimension. The educational context in a particular setting is typically unchanging in a course with a predetermined educational goal. However, the social context, mediated by technology, varies. For example, educators might employ different technologies to follow a particular educational rationale. When students engage in an online learning course, they might experience a mix of synchronous and asynchronous communication forms while preparing artefacts. Short, Williams and Christie (1976) first introduced the concept of social presence as a measure of the degree to which a person is aware of another. The level of social presence experienced sets the scope for behavioural variation in computer-mediated settings and is one of the main influencing factors for the CSCL environment. Additionally, the complex systems framework considers contextual parameters.

2.1.2.3 An Research Framework for CSCL Groups as Complex Systems

Elaborating on dimensions uniquely experienced by distributed groups, this thesis illuminates the learning experience and the ‘group experience’ of a learner. The thesis does not attempt to predict group behaviour; the discussion will elaborate on processes occurring within a group, and what type of group has formed. Resta and Laferrière (2007) reviewed research investigating technology supporting collaborative learning. They describe the analysis and comparison of CSCL studies as challenging and characterize collaborative learning as complex and not defined clearly.

CSCL systems have to cater to two problem areas (Lonchamp, 2007): 1) the general complexity of supporting online collaboration and 2) the specific complexity of
constructing a learning situation. Meeting the complex demands of online collaboration requires sophisticated CSCL systems. Several propositions by Arrow et al. (2000) provide a step towards a better understanding of dynamics in CSCL groups in higher education:

- The member, group and context level impact group dynamics in CSCL groups.
- Three levels of causal dynamics affect higher education learning scenarios: member, task and tool level.
- Groups in higher education settings serve proposed functions: task completion and thus course completion, fulfilling member needs and preserving group integrity. Preserving group integrity is a minor interest in higher education settings; the group is established externally and group integrity is ensured through the university setting.
- A group undergoes three distinct stages: formation, operation and metamorphosis. The formation stage of a learning group is mostly determined by administrative or pedagogical considerations. Depending on the teacher’s pedagogical rationale, students can either form their own groups or they are assigned to one. Many different aspects can play a role in the formation of a group, such as expertise, acquaintance, age, prior grades and even coincidence.

The freedom for students to operate as they wish is also determined by pedagogical considerations. The degree of freedom students encounter, the amount of scaffolding they experience etc, influences group actions.

The end of semester usually dictates the metamorphosis phase; when signing up for a course and joining a group, students know the group will cease to exist in a semester’s time. The final session typically addresses any last concerns and then the group dissolves.
Arrow et al.’s (2000) group dynamic framework is formulated on an abstract level. This is advantageous, as it allows extension of its interpretative scope to many different groups, with different development patterns and change contexts. This thesis applies the framework to educational settings and interprets findings from the presented study from a complex systems view.

2.1.2.3.1 Local Variables

Distributed learning utilises tools and resources, e.g. discussion forums or wiki pages, to empower pedagogical belief systems in general. This focus limits the range of applicable and adequate tools and provides an integral part to the learning experience. The task plays a second integral part in the learning experience. Group members arrive with a variety of potential influencing aspects, such as members’ beliefs or the role structure.

Tools

Communication in CSCL-type groups is mediated through tools, i.e. a platform manipulated by the user to interact with other users. Communication can be synchronous, e.g. through chats or video-transmitted interaction, or asynchronous, e.g. through discussion forums, wiki pages, e-mails, etc. Tools can include mediating artefacts, such as student communications via wiki pages instead of a discussion forum. For example, the alternation of editing and commenting on each other’s entries on a wiki page creates an artefact that not only provides evidence of communication but also insight into group processes and knowledge construction.

The potential influence of tool-type has recently attracted attention and undergone substantial research regarding the optimal match of medium and message as elaborated in later parts (e.g. Daft & Lengel, 1986; Dennis & Valacich, 1999). The tools and resources utilised in distributed computer–supported learning scenarios
serve a variety of functions: communication support, task management, task completion and group management.

Technology plays an important role in computer-mediated learning. In order to understand its role better, one has to consider the different perspectives on tools in computer-supported learning scenarios: technology as a medium, resource and a constraint (Suthers, 2005). The medium perspective addresses technology’s communication potential. The resource aspects identify technology’s supporting role in computer-mediated learning. The constraining potential of technology can be applied to intentionally guide the learner. Medium and resource perspectives on technology identify networks’ linking structuring elements of a group, e.g. tool and role networks, as addressed in Arrow et al.’s (2000) framework.

Tools can have many effects on the learning experience. Not only a medium’s constraining potential but also the way it is perceived can have a sustainable impact. For example, students perceive asynchronous media as more reflective (Cheng & Beaumont, 2004). Students felt asynchronous media allowed more time to think about a certain issue. Additionally, existing research points out, students perceive synchronous communication media as slow and inefficient (Pesendorfer & Koeszegi, 2006).

Combining different tools, such as providing a synchronous chat for communication and a whiteboard to display ideas graphically, can be beneficial. For example, using sufficient communication is essential for solving a task with a whiteboard (Pata & Sarapuu, 2003). Research has investigated the influence of regulation and coordination patterns on model composition between 20 teams. The teams could use a chat room for communication purposes, and a whiteboard to compose a model. While constructing a concept map in a whiteboard facility, the coordination through a synchronous chat tool supported group coordination processes (Pata &
Sarapuu, 2006). Researchers found, tutors can be advantageous for guiding students’ activities, both in the chat room and on the whiteboard. Furthermore, they found groups did not communicate via the chat room, using only the whiteboard to create the model. Consequently, students experienced problems with task solutions due to a lack of sufficient communication.

Thus, the tool use also depends on its acceptance and perceived usefulness. Findings show the perceived tool usefulness impacts a user’s acceptance of the technology (Davis, 1989). Davis (1989) developed two different scales for “ease of use” and “perceived usefulness”. In two studies, involving 152 participants overall, Davis was able to validate the scales and establish a link between perceived usefulness and technology acceptance. In both studies, the relative connection between technology usefulness and usage was stronger than ease of use.

Tasks

Tasks play an important role in small group dynamics. There is evidence showing task structure (Schrire, 2004) as well as task type (McGrath, 1991) have an influence on group interaction processes. Schrire (2004) based her learning process analysis on a multiple-case study using asynchronous computer conferences. Results revealed, distinctive interaction patterns within an asynchronous computer conference were associated with the task structure. Therefore, it is important to take a closer look at different tasks.

Zigurs and Buckland (1998, p. 316) define tasks as “behaviour requirements for accomplishing stated goals, via some process, using given information”. This focuses on tasks’ characteristics and points to characteristics shaping the learning process and performance. Simple tasks, problem tasks, decision tasks, judgement tasks and fuzzy tasks, are described by Zigurs and Buckland (1998) in terms of
outcome multiplicity, solution scheme multiplicity, conflicting interdependence and outcome uncertainty. For example, simple tasks have a single desired outcome and a solution scheme with no conflicting interdependence or outcome uncertainty. The more uncertainty involved in a task, the more complex it is. The categorisation for simple and problem tasks in terms of the proposed aggregated task categories is shown in Table 1.

Table 1: Aggregated task categories as proposed by Zigurs and Buckland (1998)

<table>
<thead>
<tr>
<th></th>
<th>Simple Tasks</th>
<th>Problem Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outcome Multiplicity</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Solution Scheme Multiplicity</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Conflicting Interdependence</td>
<td>No</td>
<td>Yes or no</td>
</tr>
<tr>
<td>Outcome Uncertainty</td>
<td>Not applicable</td>
<td>Low to high</td>
</tr>
</tbody>
</table>

Depending on the pedagogical rationale, tasks in online learning environments are often composed of argument constructions (Guzdial & Turns, 2000; Pena–Shaff & Nicholls, 2004), concept mapping (Chiu, Huang & Chang, 2000; Komis, Avouris & Fidas, 2002), collaborative construction of models (Reimann, Thompson & Weinel, 2007) or artefacts, e.g. written work (Erkens, Jaspers, Prangsma & Kanselaar, 2005) and wikis (Augar, Raitman & Zhou, 2004). Herrington, Reeves & Oliver (2006) propose implementing authentic tasks to promote synergy between tasks, learners and technology in online environments. McAlpine (2000) found, current online courses realise a combination of collaborative learning through online discussion. Students expressed the need for a balance of discussion, group work and individual tasks. The online course investigated in this thesis is a typical of a course held at an Australian university, and similar to McAlpine’s work.

A variety of factors influence how groups accomplish a task. The required steps and stages are affected by past success or failure (Shaw, 1981). If a group has succeeded in the past, they are more likely to adopt a more difficult task, than if
they failed. Additionally, if a second group performs better this will also result in the first group adopting difficult tasks.

Paulus (2005) argues, task type influences the way groups interact. The study investigated 10 small groups and found, generally, groups chose to cooperate rather than collaborate in application tasks. During synthesis tasks, groups preferred a collaborative approach.

Furthermore, research has established a link between perceived task difficulty and the technology used for this task: Perceived task difficulty varies depending on the medium used (Bradner & Mark, 2001). Bradner and Mark (2001) compared perceived task difficulty for the same task distributed in a collaborative scenario within a video condition, an application sharing condition and a “no medium present” condition. Participants estimated task difficulty level highest for the video condition, next for application sharing condition and least difficult for the no medium condition. Thus, it is important to bear in mind, when students engage in online tasks, the used tool will have an influence on the task completion process.

Members

The postgraduate student body in higher education in Australia is mainly constituted of two large groups: recent undergraduate and mature aged students. Those two groups differ in age, level of subject matter expertise, prior experience with distributed and collaborative learning, ICT literacy, motivation to complete a degree or course, self-directed learning skills, learning goals, etc. A wealth of different possible member characteristics exists in literature. This thesis will emphasise role and technology appropriation to influence coordination dynamics in net-based learning groups. These are particularly important in online groups, and their dynamics investigated in this thesis.
In new groups, it can be beneficial to introduce the moderator role, point out its importance, and impact on the group’s dynamics. Previous research suggests the instructor’s prior experience could influence the group’s interaction patterns (Mortera-Gutierrez, 2002). He conducted a case study to investigate current instructional strategies and interaction in distance education at the Texas A&M University (TAMU). Findings showed, experienced instructors were more effective in interacting with students at a distance than those with less experience.

Maldonado et al. (2007) investigated group dynamics of 38 students, participating in groups of 3–5 members, and their effects on technology appropriation and artefact creation. Researchers handed out laptops and digital pens, which served as the platform for collaboration. They found students’ use of collaborative tools increased when they believed their peers were equally engaged.

ICT constitutes an integral part of distributed learning, therefore attitudes towards its usage are important.

2.1.2.3.2 Context Variables

Context parameters might not directly influence a group’s behaviour. However, embedded context sets limits and provides enabling conditions in which a group can act and react. A context change will trigger a group reaction and adjustment to surrounding conditions. Again, an agreed and fixed set of context parameters does not exist in the research literature. Rather, any context parameter can be a potential influencing factor in research, depending on the research question and theory in question.

Computer–supported collaborative learning groups are embedded in an educational setting. This carries some implications, derived from this thesis and relevant literature:
• Task performance is graded; the grade is the prevailing motivator for many students.
• Depending on the grading system, a mixture of individual contributions and collaborative efforts will be evaluated.
• The group runs the risk of nurturing a social loafer\(^4\). The social loafer might receive the same grade as the group.
• If the majority of the group is content with a ‘pass’-grade, individual goals might not have much power to change it. Thus, a particular group’s behaviour and attitude may develop its own dynamics, different from an individual member’s goals or expectations.
• The main aim is the learning process. Students are supposed to produce an artefact and learn in the process. Thus, the task should place them beyond their “comfort zone”.
• It is accepted practice to make mistakes and to ask questions in an educational environment.
• Group members in an education setting expect more scaffolding than in a work surrounding.

A distributed setting also bears an additional context parameter: the level of mutual presence group members perceive. Findings illustrate, the amount of social presence encountered in a group influences group dynamics as it provides the basis for a range of effects that are important for successful online learning (Bente, Rüggenberg & Krämer, 2005), e.g. promote coordination through establishing common ground (Barron, 2000; Clark & Brennan, 1991).

Researchers have traced the amount of social presence to the mediating tool type (Bente et al., 2005; Short et al., 1976). Others predict a change of social presence

\(^4\) Social loafers are described as individuals putting less effort in doing a task in a group situation than they would on their own (Hare, 1994).
over time (Picciano, 2002). Even though some of the influence of social presence could be due to personal perception, the decision on the mediating tool type is often not in the hands of the individual. Therefore, in summary, social presence constitutes a powerful context factor, which should be considered by educational designers.

2.1.3 Summary and Concluding Remarks

The previous section provided an overview of computer-based collaborative learning research, as it is relevant to the studies. Furthermore, it introduced a framework, which guided theoretical and empirical considerations in this thesis.

The section argued, for successful learning to take place in net-based groups, group processes have to be considered. They play an integral role facilitating learning. If coordination and communication fail in a group, the learning process is impeded. Hence, collaborative learning and group processes are intertwined.

The first sub-section stressed the influence of technology in learning and communication in net-based settings. The mediating technology plays an important part in shaping communication and learning in net-based groups. Different processes are influenced through technology use, e.g. content-related behaviours as well as social processes.

The second sub-section placed special emphasis on a complex and integrative perspective of online groups. The resulting framework provides the basis for the study’s multi-layered analytical approach. It suggests two main factors, coordination and social presence, for understanding and describing group dynamics, which in turn are influenced by tools/media, tasks and members.
Coordination is an important variable in group dynamics on a local behaviour level. Unnecessary or failing coordination can impose additional demands on online groups. Thus, it is important to investigate coordination processes in online groups in order to reduce such ‘costs’. Social presence serves as a context parameter enabling communication and consequently learning. It is important to consider this context parameter, as net-based learning groups often lack a sense of group feeling, which in turn impacts the collaborative learning process.
2.2 COORDINATION

The second section of the literature review addresses coordination issues in groups, drawn from computer science, organisational research, psychology and management science. Coordination can come at a cost to a group. Unnecessary coordination can impose additional demands on groups, particularly on online groups. This section investigates coordination processes in online groups and addresses the reduction of such ‘costs’ without disassembling the group as a social and cognitive unit. Coordination in face-to-face and computer-supported learning groups is examined, with an emphasis on its importance for CSCL.

2.2.1 What is Coordination?

Many disciplines have studied coordination, therefore the nature of existing research is eclectic. There is little common understanding of what coordination is (Malone & Crowston, 2001). However, elaborations on coordination by Malone and Crowston (1990, 1994, 2001) are referred to by many researchers (e.g. Espinosa, Lerch & Kraut, 2004; Espinosa & Pickering, 2006; Mentzas, 1993; Weigand, van der Poll & de Moor, 2003b).

Malone and Crowston (1990) describe coordination as “the act of managing interdependencies between activities performed to achieve a goal” (p. 361). Two or more actors have to be involved in goal-directed activities. These activities are characterised by interdependencies. Such interdependencies can be: common objects that are part of two or more activities, time as a constraining factor or the outcome of one activity being required for another activity. The authors establish a framework for coordination in which they illustrate different components of
coordination. Their Coordination Theory framework (Malone & Crowston, 1994) has been cited in nearly 300 scientific publications and has been applied to a variety of research fields, such as software engineering, systems design, business processes, supply chains and organisational simulations (Crowston, Rubleske & Howison, 2006).

Besides providing a definition of coordination, it describes a modelling framework and presents a typology of dependencies and coordination mechanisms (Crowston et al., 2006). Coordination Theory assumes four coordination processes: goal identification, mapping goals to activities, selecting actors and the management of interdependencies. Each of the processes is associated with one component of coordination (see also Table 2). Furthermore, they subdivide interdependencies into generic and domain-specific. Generic interdependencies consist of prerequisites, shared resources and simultaneity. Domain-specific interdependencies depend on the task domain at hand. The authors put forward an example in a company, where customer relations are described as a domain-specific interdependency and are identified as dependent on the service and the sales department alike.

Table 2: Components of coordination as described in Coordination Theory (Malone & Crowston, 1990, p. 360 ff.).

<table>
<thead>
<tr>
<th>Components of coordination</th>
<th>Associated coordination processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goals</td>
<td>Goal identification</td>
</tr>
<tr>
<td>Activities</td>
<td>Mapping goals to activities</td>
</tr>
<tr>
<td>Actors</td>
<td>Selecting actors and assigning activities to actors</td>
</tr>
<tr>
<td>Generic Interdependencies</td>
<td>Management of interdependencies</td>
</tr>
<tr>
<td>Prerequisite</td>
<td>Output of one activity is required by the next activity.</td>
</tr>
<tr>
<td>Shared resources</td>
<td>Multiple resources require one particular resource.</td>
</tr>
<tr>
<td>Simultaneity</td>
<td>Time at which more than one activity must occur.</td>
</tr>
</tbody>
</table>

The detailed description of coordination components and the associated coordination processes in the framework allows researchers to identify coordination
dynamics in a group at hand. Furthermore, it provides researchers with the appropriate tools to identify problems and suggest improvements.

2.2.2 Coordination and Collaboration

Collaborative approaches require discourse to fulfil task requirements. Group members depend on each other in order to complete the task (Paulus, 2005). The interdependence in such forms of interaction requires coordination between members, activities and resources. Coordination is crucial for collaborative tasks, where members cannot act independently of each other (Barron, 2000; Erkens, 2004). Understanding coordination management, and consequentially the dynamics of interaction, is crucial for a researcher to comprehend net-based learning (Erkens, 2004).

Many different aspects of coordination in groups have been studied, e.g. strategy coordination (Espinosa et al., 2004), expertise coordination (Samer & Sproull, 2000), tacit coordination in anticipation of task completion (Wittenbaum, Stasser & Merry, 1996), coordination in decision-making and routine tasks (Mentzas, 1993), implicit vs. explicit coordination (Espinosa et al., 2004). For example, Espinosa et al. (2004) distinguish between explicit and implicit coordination mechanisms. They consider purposeful coordination actions as explicit coordination. Actions that might not be intentionally aimed at coordination but fulfil the purpose, i.e. shared knowledge about tasks or other members, are regarded as implicit.

2.2.2.1 Coordination in Face-to-Face Groups

A vast body of research has examined face-to-face groups interacting synchronously (Espinosa et al., 2004). Arrow et al. (2000) view coordination in
groups from a broader angle, placing it in the centre of a framework describing group dynamics from a complex systems perspective. Members, tasks and tools constitute the coordination network.

Group behaviour changes over time, giving way to temporal patterns (Arrow, Poole, Henry, Wheelan & Moreland, 2004). They mention three different coordination phases for groups, as time passes: elaborating the coordination network, enacting and maintaining the coordination network and modifying the network through feedback and learning; these phases are interdependent and iterative.

Arrow et al. (2000) argue, coordination behaviour characteristics shape local group dynamics. For example, the moderator knows some members might not have done the preliminary work for the task, and starts by asking who has done what over the week. This results in member accountability and synchronises the group. The three components – members, tasks and tools – influence coordination in groups. However, interaction of the three components poses such complex mechanisms that coordination patterns, such as a reoccurring set of coordination actions forming a regularity, cannot be predicted on a local level. Not every moderator might facilitate the communication and the task completion process in the same way. Not all groups, even though seemingly operating under the same conditions, will react in the same way. In fact, groups do not operate under the same conditions. While groups might be similar in terms of context and performance goal, they will be composed of different members with different skills. Furthermore, group members will interpret information in idiosyncratic and dynamically changing ways.

Depending on dynamics occurring in early group work cycles, groups will develop strategies and interaction routines resulting in different coordination behaviour on a local level. Kapur, Voiklis and Kinzer (2007) emphasise the importance of early stages in online learning groups, and the relation to group performance. They argue
that pre-existing group characteristics, such as group size or ability, influence later success and behaviour during the early stages of a group’s life. They analysed online communication from 60 high school students during a problem solution process. The analysis revealed participation inequity, such as one member contributing more than others, along a timeline. Furthermore, it showed the impact of member contributions to the group performance, e.g. in terms of contributing to the solution of the problem or drawing away, over time. They found high quality contributions during earlier stages benefited the group’s performance more than during later stages. Similarly, low quality contributions harmed the group’s performance more during these earlier stages.

### 2.2.2.2 Coordination in Computer-Supported Learning Groups

#### 2.2.2.2.1 Why is coordination important for CSCL?

Using Information Technology (IT) introduces a new dimension to today’s learning environments. How does coordination in IT enhanced environments differ from traditional learning scenarios? Substantial research exists in the field of computer-supported collaborative work (CSCW) (e.g. Espinosa & Pickering, 2006; Kling et al., 2001; Mentzas, 1993; Samer & Sproull, 2000; Urquijo, Scrivener & Palmen, 1993).

Coordination patterns in learning environments differ from those in work environments, specifically goal expectations, group composition structures or task composition. Additionally, goal expectations in work surroundings might be more product than process oriented. For example, in an educational environment, every member is expected to gain knowledge, and reach learning goals stated for the task. Thus, tasks with a learning purpose will be accomplished differently compared to tasks in a work setting and coordination is affected accordingly.
Groups with a hierarchical structure will have different decision mechanisms, resulting in different coordination patterns. In learning environments, students enter a group with all members being equal. Typically, groups in work environments strive to solve complex problems with only a few resources. In learning environments, students often enter the problem space with a relatively well-defined problem and a defined set of available resources. Of course, one can find ill-defined scenarios in education, depending on the pedagogical rationale, as well as there will be well-defined problems in the working sector. Coordination in learning settings might include most of the issues important for work environments but it might put different emphasis on them. For example, managing shared resources might have different priorities in these two settings.

Time and place play an important role in team cognition (Espinosa et al., 2004). Collaboration in computer–supported groups is different from collaboration in face–to–face groups and thus the nature of coordination changes respectively with time and place settings.

Another important factor for coordination processes is the task itself. Espinosa et al. (2004) point out that not all aspects of coordination are equally important in achieving task accomplishment. Each task has its own specific coordination patterns. In order to match coordination process and task in an appropriate way, one has to understand the interdependencies specific to a particular task.

### 2.2.2.2 Coordination and Different Tools

Much of the research on CSCL, as related to technology and coordination, concerns group support systems aiming to provide global solutions to coordination problems. Few researchers have considered stand–alone technologies implemented in educational settings and their influence on coordination.
As mentioned earlier, Suthers and colleagues suggested the importance of representational guidance, a medium facilitating collaborative learning discourse (e.g. Suthers, 2001; Suthers et al., 2003; Suthers et al., 2006). They put forward that expressive constraints as well as the salience of information, imposed by representations, effect students’ discourse. Constraints are viewed in terms of limits on expressiveness, e.g. a tool may provide only a limited ontology of objects. Salience describes how representations focus on aspects of perception. Different representations, such as graphic, matrix or text, influence the evidential consideration in collaborative discourse (Suthers, 2001).

Representational guidance can be a valuable concept when explaining the connection between coordination and technology. Depending on the guidance offered by a certain tool, coordination efforts change accordingly. For example, a synchronous chat tool offers different coordination affordances compared to a whiteboard. While the chat tool only allows for textual references, the whiteboard includes a graphical interface. Compared to a chat tool, the usage of a versioning writing tool offers more powerful coordination affordances. Both tools are text-based, but transfer different information. The writing functionality provides salience within longer pieces of text, while a chat tool only supports short comments.

Another possible way to assess coordination in groups is through the actual coordination efforts undertaken by a group, and the congruence with affordances offered by the tool. Such affordances can be described in terms of media characteristics as proposed by Dennis and Valacich (1999). The match between media characteristics and behaviour shown can help estimate coordination costs in online groups. For example, discussion forums do not offer opportunities for synchronising. Thus, if students insist on synchronising actions, this will come as a

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5 Media characteristics as proposed by Dennis and Valacich (1999) are explained in chapter 2.3.3.2.3 Media Synchronicity.
cost to the group, in form of additional coordination. In the case of the group wanting to synchronise, they should change the tool.

### 2.2.2.2.3 Coordination and Different Tasks in CSCL

Within the CSCL discussion, research relating to the fields of discussion, concept mapping and collaborative writing will be presented. The thesis places special emphasis on these tasks, as they are primary students’ tasks during the qualitative study presented in this thesis.

Generally, tasks can be categorised into simple tasks, e.g. discussion tasks, and problem tasks, e.g. concept map construction and collaborative writing (Zigurs & Buckland, 1998). Simple tasks have a single desired outcome and a solution scheme with no conflicting interdependence or outcome uncertainty. Problem tasks incorporate multiple possible solution schemes and students have to identify the appropriate solution scheme. During such a task, students might encounter a fair amount of uncertainty. The more complex a task is, the more uncertainty it contains. Coordination plays a special role with complex tasks, e.g. decision-making tasks, as a prerequisite for group effectiveness in relation to complex tasks (Kolbe & Boos, 2009).

**Discussion**

Research investigating coordination as a crucial process in discussion tasks has not been conducted so far. However, discussion tasks are frequently used in online learning and thus, coordination processes as well as accompanying costs are of interest to instructors and educational designers. Previous research can be employed to shed more light on coordination issues in discussion tasks, even though coordination is addressed only marginally at times.
A sustained discussion contributes to learning as it accumulates over time many entries and perspectives, presents evidence, revises and explores questions. Active and broad participation, with emphasis on the aspect of contributing in terms of writing, is another important factor. While Guzdial and Turns (2000) point to the importance of participation, they also acknowledge, discussion forums with broad and frequent participation can easily become unmanageable. It is unclear how much participation actually constitutes effective learning. The third goal, on-topic discussion, stresses, that learning is concerned with not only the quantity of contributions but also the quality (Lipponen, Rahikainen, Lallimo & Hakkarainen, 2001). While discussing off-topic issues contributes favourably to group dynamics (Kreijns et al., 2003), talking about the topic is a good indicator that students will learn something about the subject matter.

Munneke et al. (2007) report on the effects of synchronous and asynchronous computer-mediated collaboration in interactive argumentation. They analysed discussions from 39 dyads, choosing between a synchronous communication form, i.e. chat, or an asynchronous form, i.e. discussion boards. As hypothesised, discussions in a synchronous environment were more elaborated, due to feedback immediacy. Contrary to their hypothesis, asynchronous discussion produced more accurate statements. They argue, the immediacy of feedback in synchronous environments can be valuable and foster broader and deeper discussions compared to asynchronous environments.

However, broad and deep discussions do not necessarily lead to accurate statements. Veerman, Andriessen and Kanselaar (1999) report on a study comparing discussion in synchronous and asynchronous communication media; discussions in both media were highly argumentative. They found that characteristics of the task and affordances of the communication media interacted. While a moderator as well as graphical structuring aids both supported meaningful
discussion, the interaction between task and tool determined the discussion more than a moderator (Veerman et al., 1999). However, research findings point to the importance of contributions from a moderator. Guzdial and Turns (2000) linked the frequency of student contributions to the moderator’s participation in the course.

While the joint knowledge construction through discussion poses many advantages, it also raises some challenges (Guzdial & Turns, 2000; Lipponen et al., 2001). Potential problems are: students 1) not contributing to the discussion forum, e.g. not initiating questions, not reading others’ responses or not responding to contributions, or 2) not engaging in critical or constructive discussions. In order to address such issues in discussions, Janssen et al. (2007) developed a tool providing visualisations of agreement and discussion during the collaboration. They hypothesise that such visualisations will help students overcome typical discussion problems in online environments.

Another potential problem arises when the discussion diverts from the intended topic. Guzdial and Turns (2000) argue, for learning to occur during discussion, sustained on-topic discussion and broad participation is important.

**Concept Mapping**

Joint knowledge construction is an important process in collaboration (Erkens, Prangsma & Jaspers, 2006). Coordination and discussion of the subject matter improve the quality of the final artefact.

The term concept map is used to describe a wide range of knowledge representations (Gaines & Shaw, 1995). Novak (1990) defines concept maps as “representations of meaning or ideational frameworks specific to a domain of knowledge, for a given context of meaning” (p.28). Different concepts are linked
and labelled to form propositions. A person illustrates his or her meaning of a concept by producing all the propositional linkages they can think of.

Most research is concerned with individual concept map construction. A growing body of research exists regarding computer-based concept map construction (Chiu et al., 2000). Computer support offers some advantages for concept mapping, such as enhanced visual appearance, active usage of map and easy management of big maps (Gaines & Shaw, 1995).

Generally, concept mapping has a positive effect on knowledge acquisition and attitude (Horton et al., 1993). Performance in collaborative computer-mediated concept mapping is correlated to the frequency of interaction and cooperation (Chiu et al., 2000). Coordination processes in computer-based collaborative concept map construction have not been targeted so far.

Steketee, Oliver and Herrington (2001) report on preliminary findings with computer-mediated collaborative concept mapping in a preservice teacher course. Some of these findings relate to coordination issues: The discourse showed passages of negotiation of meaning, when participants tried to find a consensus on a new concept. Furthermore, participants also chose to collaborate synchronously instead of dividing the labour and work in an asynchronous mode. The discoveries by Steketee, Oliver and Herrington (2001) resemble findings in this thesis.

Collaborative Writing

In order to write collaboratively, groups have to divide the labour and assign interdependent parts to group members to produce a jointly written text. In CSCL scenarios, they are distributed in the sense that they are separated by time and/or by place (Neuwirth, Kaufer, Chandhok & Morris, 2001). Other forms of collaborative
writing exist, such as individual written texts resulting from collaboration or peers’ providing feedback in the writing process. Collaborative writing can also be used to establish a common goal.

Advantages of collaborative writing compared to individual writing are the possibility of immediate peer feedback and explicit processes verbalisation in activities (Erkens, 2004; Erkens et al., 2006). Collaborative writing poses a coordination challenge, as heterogeneous background knowledge and skills often lead to different interpretations. Establishing common ground in order to achieve a shared goal and task strategy is crucial for the writing process (Erkens, 2004). However, different interpretations might lead to difficulties establishing common ground, shared knowledge or shared goals.

The writing process can be divided into three different phases: planning, drafting and review (Erkens et al., 2006; Neuwirth et al., 2001).

- Coordination challenges exist during the planning phase. For example, authors need to know who is doing what and when. Intermediate drafts have to be usable by co-authors, and communicating plans, goals and constraints might improve understanding (Neuwirth et al., 2001). Repeated communication is essential, as initial goals are often prone to changes during this phase and intermediate versions of the draft influence later versions. Then again, unnecessary communication can be distracting and impede performance.

- Two characteristics determine the drafting phase: changing goals and the intermediate draft itself (Neuwirth et al., 2001).

- The reviewing phase consists of evaluating and revising the written piece at hand (Neuwirth et al., 2001). Often, coordination problems regarding changing parts of the written work occur, as it is sometimes easier to change parts of the text than to describe what it is that has to be changed and why.
The modality of the feedback might play an influential role in collaborative writing, as writers judge their reviewers more positively when feedback is perceived in audio-format compared to written annotations (Neuwirth et al., 2001).

Posner and Baecker (1993) describe four writing strategies: single writer, scribe, separate writers or joint writing. The writing strategy imposes different levels of interdependence on writers. Of the strategies, joint writing results in the largest interdependence level, as every writer has the power and right of decision and opinion at every stage. The separate writer strategy is often the first choice when members have no prior experience with collaborative writing (Mitchell, Posner & Baecker, 1995). In this thesis’ study, groups had no experience with collaborative online writing, and the group chose a separate writing strategy. Groups only adopt other strategies after a certain amount of experience with collaboration and similar tasks (Mitchell et al., 1995).

Furthermore, Posner and Baecker (1993) established a relationship between the writing strategy and document control. They identified four types of control: 1) centralised control, one person controlling the document throughout the whole process, 2) independent control, each person controlling their section, 3) relay control, one person controlling the document at a time or 4) shared control, everyone having access to the document all the time. They reported, writers using joint writing strategies either used shared, relay or independent control. Independent control showed to be the least effective document control type with that writing strategy.

Erkens’ et al. (2006) analysis of online chat implemented to support collaborative writing shows only 8% of argumentative episodes related to subject matter. However, content-related discussion and coordination issues improved the final
artefact’s quality. Overall, students discussed writing planning more frequently than content-related matters, but discussing planning issues did not seem to be associated with performance. In fact, discussing planning issues seemed to show, coordination was not working well. Argumentative episodes seemed to serve as indicators for failing coordination.

Writers in computer-mediated environments seem to encounter more difficulties than writers collaborating face-to-face (Galegher & Kraut, 1994). Galegher and Kraut (1994) found that the communication modality itself did not influence collaborative writing performance. However, restriction to computer-mediated communication resulted in decreased satisfaction regarding own and others’ work, and increased difficulty to complete the task. Consequently, groups in CSCL environments took longer to complete a task compared to face-to-face groups.

Noël and Robert (2004) interviewed 33 individuals about the ideal collaborative writing tool. Participants named synchronous access as the most important feature, followed by version control and easy communication. They also found the most frequent communications were e-mail, face-to-face meetings and the phone. Chat was used with less frequency. The three most frequent communication channels were used for different writing task stages, e.g. discussing the document’s content was done most often by email, while discussing document’s structure was done most often in a meeting. Kraut et al. (1992) found leaner communication, i.e. smaller ability to convey cues, had a strong negative effect on perceived coordination during computer-supported collaborative writing.
2.2.3 Coordination Antecedents

Single group members have an influence on coordination. Their skills, goals and needs as well as the role they might hold are introduced as potential antecedents impacting coordination.

2.2.3.1 Coordination Skills

Individual member characteristics can influence group coordination dynamics and consequently group performance (Arrow et al., 2000). When members lack necessary coordination skills, such as the ability to develop an adequate action plan or the ability to communicate feelings and intentions adequately, it impairs coordination dynamics (Larson & Schaumann, 1993).

The ability to adapt one’s behaviour to technology might be another influencing factor for coordination (Galegher & Kraut, 1994). They report on a study comparing coordination in face-to-face groups with computer-based groups. Even though computer-based groups reported more coordination difficulties, they adapted their behaviour to the medium and did not show any differences in performance.

2.2.3.2 Member Needs and Goals

Arrow et al. (2000) mention how individual goals and needs influence group coordination. Members experience needs, such as affiliation, achievement, power or resources, to shape group behaviour. Generally, needs are pursued through member actions or through negotiations with the group (Arrow et al., 2000). In either case, they will affect the member’s behaviour and consequently the group.

Group roles provoke different expectations regarding behaviour in face-to-face roles (Brown, 2000). In a CSCL environment, roles are most relevant for goals
requiring division of labour, coordination and integration of different activities (Strijbos, De Laat, Martens & Jochems, 2005).

2.2.4 Coordination Effects

Group performance as well as goal-negotiations have an affect on overall coordination.

2.2.4.1 Coordination and Performance

Fussel et al. (1998) establish a link between process measure coordination and performance outcome. Participants reported on coordination and answered questions like “Tasks were clearly assigned.” Fussel et al. (1998) found, better coordination resulted in better performance. Good coordination allowed group members to integrate individual activities more easily, enabling them to make good decisions about their next moves. Team performance benefits from improved communication, and consequently improved coordination, through increased group efficiency (Macmillan, Entin & Serfaty, 2004; Stone & Posey, 2008).

Barron (2000) considers three important coordination components: mutual interaction, joint attention focus and shared task alignment. For each of the three components, she identified low and high markers respectively. Barron (2000) reports, failure to reach high markers in one of the dimensions resulted in problematic interactions and concludes that even though high markers on each of the three dimensions might not necessarily result in better outcomes.

Larson and Schaumann (1993) proposed that coordination problems on the group and individual member levels impact overall group performance. They argue that on
a group level, greater independencies are more likely to cause coordination problems, such as incorrect, untimely or duplicate responses. Coordination problems on an individual member level are likely to affect motivational processes, which in turn affect the goal achievement process (Larson & Schaumann, 1993).

However, research findings show, the association between coordination and performance might not be so straightforward. Different types of coordination might be important to consider (Espinosa et al., 2004).

Furthermore, Espinosa et al. (2004) imply, not all task interdependencies are equally important at all times, and interdependencies might have to be matched to coordination mechanisms. Espinosa et al. (2004) analysed coordination in decision teams. Teams with poor task activity coordination did not perform well during software development processes. Good task activity coordination did not prove to be sufficient for good performance. One explanation could be, some interdependencies are more important to good performance outcomes than others (Espinosa et al., 2004), such as successful integration of functional sub-strategies and according strategy coordination for software development processes. Groups successfully coordinating and managing interdependencies is crucial for task success.

Galegher and Kraut (1994) suggest that tasks with more interdependencies are more difficult to coordinate. However, if group members experience restrained communication channels for coordination, they often adapt to such restrained conditions. This implies that not only the communication channel, but also the individual members’ ability to adapt, play an important role in actual group coordination behaviour.
Faraj and Sproull (2000) identify the importance of expertise coordination in a team, and its strong link to software design team performance. Expertise coordination might be more important in knowledge and skill dependant tasks than in general discussion tasks.

Crowston and Kammerer (1998) also report on software development teams. They name coordination as one of the major problems affecting productivity and quality of outcomes. We all have an intuitive understanding of what we think coordination is. However, we often only take notice of coordination processes when they are performed exceptionally well or poorly.

### 2.2.4.2 Coordination and Goal Negotiations

The ability to coordinate goal-directed activities can determine the goal-setting effectiveness of a group (Larson & Schaumann, 1993). They report on research findings that specific and more difficult goals lead to better performance compared to intangible, easy goals. Specific goals are favourable, while difficult goals are more likely to reveal performance deficits, which in turn trigger increased efforts (Larson & Schaumann, 1993).

Larson and Schaumann (1993) point out, tasks with simple forms of interdependence can be carried out with the help of action plans. Such plans are predetermined and describe behavioural routines. However, tasks with complex interdependencies do not allow for predetermined action plans. Consequently, groups have to monitor their behaviour and constantly adjust their behaviour during the performance process. Larson and Schaumann (1993) point out that coordination difficulties on an individual member level can affect motivation processes that are important for goal achievement.
2.2.5 Coordination Effectiveness

2.2.5.1 Coordination Costs

Espinosa and Pickering (2006) define coordination effectiveness as "the resulting outcome in which all key dependencies among activities in a task have been well managed" (p. 25.2). While effective coordination contributes to performance, any coordination itself draws attention away from the task. Therefore, coordination can also be viewed in terms of cost (Espinosa & Carmel, 2003). They argue, coordination costs can be divided into four components: communication costs, costs of delay, clarification costs and re-work costs.

Some costs are inevitable, e.g. asynchronous communication contains a certain amount of delay compared to synchronous communication. Other costs could be avoided, e.g. delay could be minimised by subscribing to a discussion forum and receiving an alert when a group member contributed.

Table 3: Components of coordination costs (table taken from Espinosa and Carmel (2003), p. 256).

<table>
<thead>
<tr>
<th>Cost components costs</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication costs</td>
<td>Costs involved in maintaining communication links and sending and receiving messages.</td>
</tr>
<tr>
<td>Delay costs</td>
<td>Costs incurred because one actor is waiting for another to complete the task.</td>
</tr>
<tr>
<td>Clarification costs</td>
<td>Additional cost of communication and delay because of miscommunication.</td>
</tr>
<tr>
<td>Rework costs</td>
<td>Additional costs of production because of miscommunication.</td>
</tr>
</tbody>
</table>

Different communication media have different coordination demands. IT usage can solve many coordination problems. However, more complex coordination problems can require increasingly complex tools to scope with these problems (Kling et al., 2001). Asynchronous communication necessitates less procedural coordination compared to synchronous communication media (Pesendorfer & Koeszegi, 2006).
However, asynchronous communication media encompass less coordination demands (Strijbos et al., 2005). Group members have the freedom to contribute to asynchronous communications at anytime, while still having to meet deadlines. This results in a higher demand for coordination support in asynchronous communication forms (Benbunan–Fich & Hiltz, 1999).

Synchronous media produce a higher level of cohesion compared to asynchronous media (Burke, Aytes & Chidambaram, 2001). Synchronisation and intimate contact bring many advantages, such as supporting a feeling of belonging to a group. However, synchronisation has also disadvantages, viewed in terms of communication costs (Espinosa & Carmel, 2003). This thesis presents observations in online communication where coordination comes at a cost, e.g constant reiterations to assure everyone is on track and pays attention. Such actions put additional demands on students. In this study, the cost of synchronisation becomes evident, when students label the medium slow and find it frustrating to use if there is a lot to work out. This type of coordination cost relates to Espinosa and Carmel’s (2003) notion of cost of delay, determined by the delay time a response takes, and clarification costs, which are determined by additional communication.

Another cost in online learning groups can be the lack of disagreement, as mentioned by Bonk et al. (2004). For example, students might be inclined to agree with task completion procedures that do not necessarily lead to the intended goal. Bonk et al. (2004) suggest techniques, such as role introduction, e.g. “the pessimist”, to liven up communication. Another possible technique could be pairing up students as “critical friends” to make disagreement more acceptable.

Espinosa and Carmel (2003) propose a framework by linking coordination costs to the effects of time separation. Their research supports the following hypotheses:
1) Asynchronous communication media are less cost intensive than synchronous media.

2) Time separation can either reduce or increase delay costs, depending on timing and organisation of activities, e.g. different time zones can be used favourably by handing over activities at the end of the day.

3) Clarification costs increase with time separation.

4) Re-work costs increase with time separation.

Cataldo et al. (2006) argues that congruence between coordination requirements and coordination activities influences development time in design teams. Productive designers changed the communication medium during the development cycle to establish congruence. Organisational research states, variations in environment impact coordination processes (Camacho, 1996). Thus, a change in any environmental factors, or even task dependencies, would lead to necessary adjustments in coordination routines. Such considerations point to the temporal aspect in coordination processes, implying that changing coordination requirements during the task completion process might accrue coordination costs in terms of altering coordination strategies and adjusting established routines.

### 2.2.6 Summary and Concluding Remarks

The previous section demonstrated the importance of coordination in computer-based learning groups and addressed coordination issues in such groups. It argued, coordination can come at a cost to a group and unnecessary coordination can impose additional demands on groups, particularly in online groups.

The above-stated discussion proposes, tools can support or amplify coordination problems and thus determine coordination activities to some extent. Additionally, a
close relationship exists between task and coordination. Different tasks require
different behaviours and thus different types of coordination. Further, members
have their own impact on group coordination, depending on skills, needs and goals.

Coordination effects in net-based collaboration and their link to performance and
goal negotiations present a potential problem for online learning. These problems
can be related to costs, resulting from causes such as incongruence between user
behaviour and tool affordances or missing resources, such as non-verbal cues.
Coordination can impose demands on a group, which might be difficult to meet.
Thus, it is favourable to minimise such costs and support successful coordination in
online groups.
2.3 SOCIAL PRESENCE

The third section reviews the second main concept, social presence, as well as the related concept of awareness. Both concepts concern the often-neglected social dimension in net-based learning groups. Social presence, as a context parameter, enables communication and consequently learning. Awareness, when implemented graphically in form of visualisations, feeds back information about group processes and its members to the group and consequently supports group processes. Both concepts address the social dimension in online learning and play an important role for the online learning experience of students, specifically developing a sense of group feeling and team culture amongst students. This sense is often lacking in online environments.

2.3.1 Two related concepts: Awareness and Presence

Research points out that computer–supported collaborative learning environments do not completely live up to expectations regarding interactive group learning, acquisition of competencies and shared understanding (Kreijns & Kirschner, 2001). For example, some research suggests that computer-mediated communication leads to depersonalisation due to missing social cues (Walther & Burgoon, 1992).

The lack of attention to social dimensions and processes within such environments can be identified as playing a major role in these shortcomings. Kreijns et al. (2002) point out two pitfalls related to social interaction in computer–supported collaborative learning environments. One is to take social interaction as given in such an environment. Another pitfall is to neglect the social dimension of interaction. The research stresses the importance of social aspects in online
learning environments. One possible way to address such aspects is to provide feedback on this dimension to the group (Reimann & Zumbach, 2003; Zumbach, Hillers & Reimann, 2003).

Within the social dimension, social presence and social awareness are important concepts. Both concepts describe similar phenomena. Rettie (2003) argues that both concepts are related to each other but are not identical. Awareness is the somewhat broader concept, embracing social presence. Often, the distinction between those two terms is not clear in the research literature. Even the term “presence awareness” is sometimes used (Tyman & Huang, 2003), stressing that system users are aware of another’s presence.

Presence research is conducted often within virtual realities and video mediated environments. The main concern within this type of research is conveying a sense of presence through video or software mediated environments that are as realistic as possible. However, virtual realities are only minimally applied in learning environments.

Awareness research is more concerned with social processes and coordination in task related environments. Awareness itself is viewed on a more abstract level and is not concerned with conveying information through a medium. Rettie (2003) argues, awareness occurs without experiencing social presence. A person might be aware of someone’s activities while receiving an e-mail in an online environment, but not of their immediate social presence. Being aware of co-members’ activities, knowledge level, workload commitment, and motivational state of mind might convey a sense of presence in a more figurative sense. Still, the term awareness includes more and broader information than just the social presence of a member, such as the aspects mentioned above. Thus, social presence constitutes a subset of awareness. Therefore, in some instances the two concepts may be used to refer to
the same phenomena, and be used interchangeable and in other situations the two concepts are quite distinct.

2.3.2 Awareness

Awareness and its link to learning settings are introduced in the following. Different possibilities exist to implement awareness in learning settings. This thesis emphasises one way of awareness integration with the help of visualisations.

2.3.2.1 What is Awareness?

According to Christiansen and Maglaughlin (2003) awareness can be divided into four broad areas: workplace awareness, availability awareness, group awareness and context awareness. Workplace awareness describes task knowledge within an online environment. Availability awareness addresses people’s or objects availability. Group awareness relates to the extent a person feels he belongs to a group. Contextual awareness focuses on the mental, physical or social environment of a person.

Awareness can be facilitated through external representations. Graphical interfaces have been developed for this purpose, in an effort to support task awareness (Erickson, Huang, Danis & Kellogg, 2004), presence awareness (Tyman & Huang, 2003), and common resources awareness, along with past and current activity of group members (Nova & Dillenbourg, 2004).
Gross et al. (2003) point out three core requirements for implementing awareness in online environments:

a) social awareness about co-members' presence and availability has to be addressed,

b) awareness information has to be relevant to the user's current task, and

c) information presentation and processing should result in no additional effort.

The above mentioned requirements are considered when integrating awareness devices into the online learning environment.

2.3.2.2 Visualisations

It has been argued, in order to improve existing online environments one has to implement visualisations reflecting group member presence and activity (Erickson, 2004). Tyman and Huang (2003) notice that visual mapping can be intuitive as well as effective for providing presence information.

Three different approaches to visualising social cues can be identified: realistic, mimetic and abstract approaches (Erickson & Kellogg, 2000). The realistic approach implements social information, just the way it can be experienced in real life. This has been done with videoconferencing systems. Negative aspects of realistic approaches are expensive equipment as well as technology limits such as image resolution and transmission delays. The mimetic approach mimes real life social cues as closely as possible. This is being done through avatars, pedagogical agents and virtual reality systems. Usually, transmission delays are minimised but another problem has emerged: social cues have to be applied consciously. Previously, group members could automatically generate and react to social cues. Now, a person must attribute them to an agent in a conscious and deliberate way. This results in assigning more cognitive work capability to these processes, distracting from the
actual task. A third possibility of implementing social information is to visualise it in an abstract way, which has no direct commonalities with real life appearances. This approach has been pursued by Erickson et al. (1999). Since most abstract approaches only take advantage of basic textual and/or graphical functions, there are no bandwidth issues to be considered. Moreover, social cues do not have to be considered on a conscious level, social information is implicitly implemented in the system.

Interesting work has been done in the field of external representations by establishing different awareness visualisations (Erickson, 2004; Gross et al., 2003; Zumbach, Reimann & Koch, 2006). Vogiazou and Eisenstadt (2004) state, symbolic cues, like colour based team membership, in online environments can enhance complex social behaviours. Moreover, they conclude one of the main challenges in designing such environments is capturing and supporting human interaction behaviours, such as spontaneity and vitality.

One approach to supporting a sense of presence and to promoting awareness of others’ activity through external visualisations has been captured in a theoretical framework by Erickson and Kellogg (2000). In their concept of social translucence they address the kinds of information that should be made perceptible to online group members. Originally, social translucence addressed three aspects: visibility, awareness and accountability. Visibility points to the fact that socially important information has to be made visible. Furthermore, mutual awareness, “me being aware of others and being aware of the fact that they are aware of me”, should result in a sense of being held accountable for actions.

Kellogg and Erickson (2002) expand the original scope of this concept and incorporate aspects of collective awareness. They posit, knowledge of task states or activity contexts is important for collaboration success. This provides an
environment facilitating greater accountability and more easily coordinated actions within computer mediated online collaboration. Kellogg and Erickson (2002) state, mutual collaborative awareness is a crucial aspect in supporting collaboration. It results in a feeling of accountability and thereby supports vital group functions such as staying focused, coordinating actions and interacting smoothly. They state, three properties are important to socially translucent systems: socially important information has to be visible and both awareness and collective awareness have to be implemented.

In such environments, one often-raised issue concerns impression management and privacy (Patil & Kobsa, 2005). Activity disclosure results in a tension between the need for awareness and the individual’s need for privacy. An additional problem is that a common understanding of privacy does not exist. It seems to vary depending on an individual’s point of view and the displayed context.

Patil and Kobsa (2005) propose a system design allowing the user to decide to what extent they want to disclose personal information. An inverse relationship exists between privacy and awareness: the more privacy in an online environment exists, the less awareness can be established and vice versa. Conversation content as well as the way a conversation is held depends heavily on who and how many people are present (Kellogg & Erickson, 2002). The extent of privacy in such an environment influences behaviour by enhancing particular reactions and inhibiting others.

Erickson et al. (1999) put the theory of socially translucent systems into practice, developing the ‘Babble’ system. Babble was built to support collaborative actions within IBM Labs. The system shows socially important information implicitly. A big circle represents the chatroom. Smaller and different coloured dots represent users. The current activity of a user is expressed by the symbol’s relative distance to the circle’s centre. The closer a user dot is to the centre, the more active that person is.
User dots outside the circle symbolise non-present members (see Figure 3). Another group member, chat facilitator or teacher can judge immediately who is present and how active everyone is.

![Figure 3: Social proxy as developed by Erickson et al., user activity is symbolised by relative distance of a dot to the centre (picture from Erickson (2004), p. 7).](image)

Reimann and Kay (2005) report on a study where they successfully used similar adaptive visualisations supporting group coordination processes. Furthermore, in a continuative study Kay, Yacef and Reimann (2007) describe using “Wattle” diagrams portraying complex interactions in a content management system for programming teams. For each team member, such diagrams show for example wiki related behaviour, amount of programming contributions or open as well as finalised tasks. Additionally, they implemented “social network” graphs visualising who interacted with whom and how much. A case-study approach followed 44 students’ experiences during a semester-long project. They found students were generally enthusiastic about visualisations and considered them helpful for the different roles assigned in the groups, e.g. group manager or tracker.

Kreijns et al. (2002) propose a similar visualisation scheme in order to promote group awareness. They argue for a circular display divided into segments, each segment displaying different kinds of awareness information, such as group members engaged in task-related discussion forum or online presence of each individual member. Each segment itself is subdivided into smaller segments, representing one member per subdivision. Active engagement is displayed by a
coloured bar within the corresponding segment, the closer the bar to the outer rim, the more recent the action. The axis within the circle is logarithmic, older participation information is displayed with less detail and importance but is still visible (see Figure 4).

Kreijns et al. (2002) call their visualisation a group awareness widget (GAW). In comparison to the approach of Erickson et al. (1999) this approach has the advantage of providing information on member discussion history. It provides the users with information on the important dimension of time and displays more than one type of awareness information. The availability of the right mix of awareness information is a crucial factor in such environments (Espinosa et al., 2000).
Other work shows group members’ pictures, through PeopleMap software, or a shared workspace overview through DocumentMap software (Gross et al., 2003). McCarthy and Meidel (1999) mention a tool called ActiveMap visualising a certain persons’ location, conveying a sense of location awareness to users. Bergole, Tang, Smith and Yankelovich (2002) developed a system called Awarenex, visualising users’ activity information down to the minute. The data had been collected over a 10 months time period. They focus on work rhythms within and between individuals, pointing out the importance of time related patterns.

### 2.3.2.3 The Impact of Awareness

Research indicates that groups using awareness tools converge faster and agree on solutions in a shorter amount of time (Espinosa et al., 2000). However, groups not using an awareness tool came closer to the correct solution. This implies, findings might not be straight forward and the relationship might not be as simple as, “more awareness = better performance.”

Espinosa et al. (2000) suggest that awareness information not only influences group performance in relation to the task, but also the mere amount of awareness information is influential. Not providing enough information might be useless, but providing too much might result in a cognitive overload. More details have to be revealed about the relationship between quantity and quality of awareness information during communication processes and their impact on task measures.

Major research considers the question how awareness is established in online environments. Conversely, the way awareness affects learning scenarios has barely been considered. Chen and Gaines (1997) propose three evaluation dimensions for chronological awareness in collaboration: locus of responsibility, method of locating change and complexity of user interaction. Their study to compare different
2 Theory and Literature Review

awareness systems constitutes just a first step. They point out that there is still a need for further research in the area and stress the fact of missing research in the area of mutual awareness.

There has not been systematic research comparing awareness visualisations and their effects on distributed collaborative learning environments. There is no experimental evidence revealing superiority of one visualisation type over another. Not only the visualisation of awareness misses a research base, but also what types of awareness provided in an environment have an impact on performance. Espinosa et al. (2000) address the difficult trade-off between general awareness tools and the ones establishing a specific kind of awareness. Moreover, they argue awareness has to be matched carefully to the task type and group communication mode.

It is beneficial to include various aspects of online environment awareness in order to reach sufficient results. Members of a collaborative setting need to have information about their environment (Gross et al., 2003; Zumbach & Reimann, 2003). Gutwin et al. (1995) state that a major problem in computer-mediated communication is the group members’ general knowledge about each other’s learning activities. The implementation of awareness is a crucial factor for the success in computer supported collaboration (Dourish & Bellotti, 1992). Such functionalities deliver information on knowledge sharing, group and individual activity and group coordination support. This is a beneficial contribution to collaborative online environments.

2.3.3 Presence

While there are many elements within the social dimension, this thesis emphasises social presence. Among researchers, presence is considered a crucial part of online
environments (Whitelock, Romano, Jelfs & Brna, 2000). But, what exactly is presence? Approached from a variety of perspectives, there are many ways of understanding presence in online environments. To some extent, it is similar to awareness. Both concepts describe neighbouring phenomena. However, the concepts have been investigated from different angles and related to different mediums.

### 2.3.3.1 What is Social Presence?

Trying to promote a sense of presence through interface design is often called social proxys (Erickson et al., 2004). Research has found, a feeling of presence is closely tied to the extent of processing that is carried out by a group member: it is highly subjective. The individual estimation of the duration of the online experience can be enhanced through the extent of experienced subjectivity (Holmgren & Rimbark, 2001).

A major part of the research concerning presence has been conducted with regards to virtual reality (Ijsselsteijn & Riva, 2003; Knudsen & Naeve, 2001; Riva, Molinari & Vincelli, 2001; Whitelock & Jelfs, 1999). Research in this area attempts to establish a sense of presence in virtual reality. Additionally, it considers which factors influence presence and how much information is needed to constitute a sense of presence.

Immediacy of behaviour is an important factor to influence social presence (Danchack, Walther & Swan, 2001; Swan, 2002). Research in traditional face–to–face classrooms found that immediacy in behaviour decreases the felt distance between group members, creating a feeling of closeness (Pelowski, Frissel, Cabral & Yu, 2005; Swan, 2002). In online communication, feedback immediacy can also be viewed as an “immediacy” behaviour (Walther & Tidwell, 1995). In this sense, asynchronous discussion allows less immediacy behaviour compared to
synchronous discussion. Thus, asynchronous discussions should generally produce a smaller experience of social presence. Findings from the present study support this view.

Albuquerque et al. (2003) propose a framework outlining parameters affecting presence and relationships among those parameters. Four parameters influencing presence are identified: 1) media characteristics, 2) individual characteristics, 3) various types of presence conceptualised and 4) causes and effects resulting in the mediated experience.

Lombard and Ditton (1997) define presence as, "illusion of experiencing a mediated environment as non-mediated". They identify six distinct categories, each disclosing a different aspect of presence. The categories are: presence as social richness, presence as realism, presence as transportation, presence as immersion, presence as social actor within medium and presence as medium as social actor. Not all categories are equally relevant for technology mediated collaborative environments. Mainly aspects of social richness and viewing the medium as a social actor are of importance.

Social richness addresses presence by the extent to which a medium is able to transmit social cues in interactions. Realism stresses accurate representations with respect to real life. Transportation relates to aspects of transporting users to another place, transporting another place to the users place, or transporting more than one user to a common shared place. Immersion describes the extent to which senses are immersed in the environment. The medium is treated as a social actor in viewing presence, resulting in users not realising the medium and wanting to interact with it. The last aspect of presence examines the cues the medium provides.
2.3.3.2 Social Presence

Social presence is viewed as a context parameter for CSCL environments. Major parts of the empirical examination of the case study presented in this thesis draw from this concept.

2.3.3.2.1 Social Presence Theory

Presence within technology-mediated communication was addressed as early as the 1970s. One widely acknowledged theory is the Social Presence Theory, introduced in 1976 by Short et al. (1976). It defined social presence as the degree to which a person is aware of another person in a technology-mediated communication setting. They describe social presence as a quality of the medium. In addition, they hypothesise the mediums’ ability to convey this sense has an impact on interaction. Users are aware of the sense of social presence and choose a medium for its ability to meet interaction needs. Short et al. (1976) stress the crucial importance of this concept to understand technology-mediated communication.

Since the first description of social presence as a concept in 1976, it has been integrated into many different considerations on mediated communication. For example, Danchack et al. (2001) propose an integrated social presence model for technology-mediated communication. They describe intimacy level as a function of bandwidth and immediacy of behaviours, and emphasise the medium’s capacity to convey emotional information. Furthermore, they point out, online learners have the ability to adjust to the environment, e.g. e-mail might have a low bandwidth, but learners include emoticons in their messages to increase the amount of emotional information transmitted.
2.3.3.2.2 Media Richness

Research in matching task and technology in order to receive optimal outcomes has built on the concept of social presence. A widely researched theory is Media Richness Theory (Daft & Lengel, 1986). It originates mainly in organisational research, building on the idea of presence. It states, technologies able to convey many social cues are rich media, enabling a sense of social presence as opposed to lean media. The richer the media, the better it conveys specific information.

Media Richness Theory assumes that organisations process information for one of two reasons: either to reduce task uncertainty or to reduce equivocality (Daft & Lengel, 1986). Task uncertainty describes the situation in which there is not enough information for the task to be accomplished. The greater the amount of information, the more uncertainty decreases. Task equivocality is similar to this concept but not quite the same. Sometimes getting more information results in more uncertainty, since the information can be interpreted in different ways. The term equivocality refers to ambiguity of information.

In general, organisations provide support for information processing in the form of technology. Technologies can be characterised by their ability to carry different levels of information richness (Daft & Lengel, 1986). Information richness relates to the number of cues inherent in the data transported, e.g. a video-conferencing system provides the user with very rich data since all the verbal and paraverbal cues are still immanent in the information presented. Information processing via e-mail, on the other hand, provides less rich information since it carries just the textual information. Lengel and Daft (1986) argue, there is a suitable information technology richness matching the task characteristics: Task uncertainty is best met by information technologies using less rich information transportation. Task ambiguity is best met when technologies provide users with as many cues as possible, enabling debate and consensus.
In order to provide evidence for this theory, a series of studies were conducted in the late 1980s and early 1990s. These studies mostly involved a closer look at managerial media choices, executing a certain task (Lengel & Daft, 1988; Russ, Daft & Lengel, 1990; Trevino, Lengel & Daft, 1987; Trevino & Webster, 1992).

2.3.3.2.3 Media Synchronicity

Dennis and Valacich (1999) criticise the Media Richness Theory, extending it to their Media Synchronicity Theory. Their criticism addresses two crucial aspects of Media Richness Theory: the concept of richness as well as the concept of task.

They argue, the richness of a medium is not only related to the extent of social presence but also to information processing capabilities. One important aspect of communication is, sender and receiver have the same understanding of the conveyed message. Dennis and Valacich (1999) suggest five media characteristics to influence communication: immediacy of feedback, symbol variety, parallelism, rehearsability, and reprocessability.

*Immediacy of feedback* describes the extent to which users give quick feedback. *Symbol variety* incorporates the medium’s ability to transmit information in a variety of different channels and ways. This aspect accounts for Daft and Lengel’s multiplicity of cues and language variety. *Parallelism* refers to the number of conversations taking place at one time effectively. *Rehearsability* relates to the extent users rehearse the message before sending. Thus, rehearsability is often in opposition to immediacy of feedback. *Reprocessability* addresses the opportunity to reexamine a message after it has been sent.

Dennis and Valacich (1999) argue, no medium has high values in all dimensions and therefore reject Daft and Lengel’s (1986) richness continuum. Additionally, they
oppose ranking media due to impracticality. It is possible for one medium to have more than one value on the same dimension, depending on how the continuum is used. For example, e-mail can be used as a text-only functionality but can also convey video information via attachments.

In relation to the task concept, Dennis and Valacich (1999) suggest that conveyance and convergence are important within equivocality as well as task uncertainty. Conveyance describes the distribution of information from many resources, in order to get as much information as possible. After all gathered information is shared among group members, the convergence phase takes place. The group has to agree on a shared meaning of this information and must attempt to understand each others individual interpretation. Dennis and Valacich (1999) define Media Synchronicity as the extent to which media enable members of a group to work together simultaneously.

Dennis and Valacich (1999) state, low media synchronicity is preferred for conveyance and high media synchronicity is best for convergence. If media characteristics match the communication process, it leads to better performance. Symbol variety will only affect performance if the crucial symbol is not present. A high degree of rehearsability is beneficial to both communication processes and will lead to better performance. A high ability to reprocess the sent message is important for both processes if the group's actions involve negotiation. Since negotiation follows any conveyance stage, but not necessarily any convergence stage, higher reprocessability will lead to better performance for conveyance processes.

Finally, Media Synchronicity theory addresses group development over time as well: Newly formed groups will benefit more from high synchronicity media than
established groups, and will prefer media providing symbol variety with greater social presence.

2.3.3.3 The Impact of Presence

Social presence mediates the effect of computer-mediated communication input, e.g. media richness, on the output, e.g. task performance (Suh & Shin, 2007). The impact of social presence in mediated communication environments has been analysed widely by comparing the ability of various technologies to convey a sense of presence (e.g. Bente et al., 2005). Studies successfully using social presence frameworks to account for differences in social presence include technologies such as voice mail and e-mail (Keil & Johnson, 2002) and shared virtual environments (Knudsen & Naeve, 2001). Contradictory evidence states no difference in perceived social presence by comparing application sharing and video scenarios (Bradner & Mark, 2001). Danchack et al. (2001) conclude, students make up for missing affective channels in text-based communication by using immediacy indicators. They found a great number of such indicators in online discussions.

Within the field of technology-mediated communication, a range of studies operationalise social presence as a variation of using either e-mail, presenting a low social presence factor, or using video-conferencing functions or even face-to-face meetings, incorporating a high social presence factor. Whitelock et al. (2000) found audio feedback may have a positive impact on the sense of presence, but found it does not increase learning outcomes. However, most studies focus on asynchronous rather than synchronous computer-mediated communication (Park & Bonk, 2007).

The mere promotion of social presence in an online learning environment is not sufficient. Research suggests, the way the concept of social presence has been varied in former experiments might indeed lead to contradictory results (Cress,
Research hints that social presence is highly dependent on individual perception and user characteristics (Ijsselsteijn, de Ridder, Freeman & Avons, 2000; Picciano, 2002). For example, prior experience with online courses and computer-mediated communication proficiency predict social presence (Mykota & Duncan, 2007). Social presence influences students' course perceptions and learning experience (Richardson & Swan, 2003; Shih, 2004) as well as satisfaction within the learning environment (Gunawardena & Zittle, 1997).

Through a meta-analysis, Guerin (1986) found evidence for effects of mere presence only when there is some uncertainty relating to behaviour. Participants appear to have a tendency to conform to social norms when another person is present. Evidence shows that being watched or evaluated influences behaviour (Guerin, 1986). Not much research focuses directly on effects from increased presence (Lombard & Ditton, 1997) and few studies have been conducted concerning task performance. The small number of existing studies report contradictory results. Bradner and Mark (2001) report on a study showing no differences in task performance for different media. In addition, they point to the superiority of a no-mediating-technology-present condition compared to a mediating-technology-present condition with regard to task performance.

The variety of approaches and applications stated above reflect the problems concerning the measurement of presence. Presence can be measured with subjective and objective methods. Subjective measures can be questionnaires administered during or after the treatment. Objective measures include physiological responses or social response measurement, wherein nonverbal cues are used to determine the extent of presence felt. In both cases, participants have to estimate the sense of presence felt (Holmgren & Rimbark, 2001). Witmer and

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6 Bradner and Mark (2001) introduce this term in order to describe the experimental condition.
Singer (1998) developed a questionnaire to determine the sense of presence as a subjective measure.

Content analysis has been applied commonly to determine social presence in online communication. Rourke et al. (1999) developed a coding scheme measuring social presence based on three different aspects: affective, cohesive and interactive responses. This coding scheme has successfully been applied in further research (Richardson & Swan, 2003).

Furthermore, Rourke et al. (1999) propose a measure, social presence density, allowing for an easy group comparison. This concept will also be reported on in this study. This measure sums the number of instances per social presence indicator and divides them by the total number of words. Thus, social presence density indicates the number of occurrences of a particular social presence indicator per 1000 words. The measure is well validated and therefore a good basis of comparison. Rourke et al.'s (1999) study recruited students from a graduate-level course, participating in asynchronous discussion. They investigated two groups with 14 students each. Group 1 revealed 362 social presence instances and group 2 showed 145, with group 1 also posting twice as many messages compared to group 2.

Presence is a complex phenomenon and incorporates different facets (Holmgren & Rimbark, 2001). Nevertheless, extensive research on the concept indicates, some form of presence in distributed environments is important.

2.3.3.4 Social Presence as a Context Parameter

Social presence, as encountered by a group, can be viewed as an enabling context parameter from a ‘groups as complex systems perspective’ (Arrow et al., 2000).
Social presence contributes to environmental surroundings, forming the basis for other effects crucial for successful online learning (Bente et al., 2005). It influences members’ learning experience perceptions (Richardson & Swan, 2003; Shih, 2004), and thus shapes the range within which a group can act and react.

A medium has a certain potential to convey social presence (Bente et al., 2005; Short et al., 1976). This does not necessarily mean one particular group or a particular member is going to utilise it. Groups are complex systems and as such, many factors shape a medium’s potential. However, a change in such a potential will be noticed by a group and will raise a need for adjustment. According to Arrow et al. (2000), adjustment can take place in various ways:

- Groups can change the composition of members, tools or tasks.
- Groups can change the networks linking these elements.
- Groups can change the characteristic pattern of activity.

Learning groups, however, have a limited repertoire of behaviour from which to choose. The repertoire depends on the degree of freedom they encounter in their learning environment. Typically, in such groups, membership composition as well as tool or task adjustment, are only negotiable to a certain extent, if at all. Often lecturers strive to keep tool, task or membership conditions stable in order to preserve fairness and equality among learning groups. The three elements constitute the cornerstones for group action in a learning setting. However, each group makes its own choices about the utilisation of elements and the establishment of rules and procedures.

However a group meets their need for adjustment, social presence constitutes a powerful enabling factor in such environments and the channelling of such processes can promote learning dynamics favourably.
2.3.4 Summary and Concluding Remarks

The previous section examined the second main concept, social presence, as well as awareness. Social presence and awareness are of importance for the empirical part of this thesis, with a stronger emphasis on social presence. Both are important factors in CSCL environments. Both concepts address the social dimension in online learning and play an important role in students’ online learning experience.

Awareness is used to describe a wide variety of phenomena, including not only being aware of another person but also being aware of their competencies and skills, their knowledge and their past activities in the online space. Often, in online settings, a graphical display is used to visualise one or more aspects of awareness and to support group processes, such as coordination. The empirical part in this thesis implements such visualisations and investigates user perception and usage.

Social presence describes the degree to which a person is aware of another person in a technology-mediated communication setting. Research shows a connection between social presence and online collaboration. One way to describe social presence is as a powerful enabling context parameter for collaborative online learning. Different theoretical considerations, such as the Social Presence Theory or the Media Synchronicity Theory, describe the relationship between technology and social processes. Social presence can have a significant impact on net-based learning groups.

2.4 Summary and Conclusions

This PhD project focuses on groups in higher education and their learning experiences in CSCL environments. The previous chapter introduced a complex
systems perspective, which guides the methodological approach in this thesis and leads to a closer investigation of coordination and social presence.

Many disciplines have contributed to the investigation of groups and the way they function. While some research findings apply to a range of groups, such as the influence of group size, diffusion of responsibility or reward schemes, one consistent distinguishing factor is the influence of technology. Technology mediates communication and learning in computer-supported groups, thus inherent characteristics shape group processes. For example, if technology does not allow group members to display ideas graphically, they will have difficulties with visualisation tasks. One rationale for choosing Arrow et al.'s (2000) framework to guide this research, is its ability to illuminate the special position technology takes in computer-mediated collaboration.

Special emphasis was put on a complex and integrative perspective on online groups. This framework guides the exploration of the complexity of learning experiences and processes in computer-supported collaborative environments. Furthermore, the complex systems perspective allows integration of findings and considerations from different disciplines. The framework highlights two important concepts necessary to understand group dynamics as they occur in online learning groups: coordination and social presence. Each of the two concepts addresses potential problems in online learning groups. Coordination processes can come at a cost to online groups, and such groups can often lack a sense of group culture, which is promoted by experience of social presence.

Coordination plays an important role in computer-based collaborative learning. It shapes group dynamics and, whether performed well or poorly, affects the groups' performance accordingly. As proposed by Arrow et al. (2000), this thesis explores coordination from three aspects: tools, tasks and members. The tool diminishes or
amplifies coordination problems, thus determining coordination activities. A close relationship exists between task and coordination. Different tasks require different kinds of behaviour, thus different coordination. Finally, individual members have their own impact on group coordination, depending on their skills, needs and goals.

Special emphasis is put on the fact that coordination can come at a cost and then poses a problem to online groups. Coordination in online groups can inflict demands on a group which might be difficult to meet. For example, it might be difficult to coordinate members’ actions effectively at a distance, when jointly producing an artefact within a certain time. Members might be more compliant regarding milestones and “their share of the work” when they see each other face-to-face and experience higher accountability. Such negotiations can result in additional efforts. Thus, it is favourable to minimise costs and support successful coordination in online groups.

Furthermore, the framework also emphasises contextual parameters. A major influencing contextual factor in technology-mediated environments is social presence. It describes the degree to which a person is aware of another person in a technology-mediated communication setting.

Two aspects are important to explore social presence: medium and members. The sense of presence conveyed in an online environment is strongly linked to the medium used. Possibly more important, not every individual experiences the same amount, and quality, of social presence in a given environment. Their experience depends on how the individual perceives social presence.

The social dimension in online collaboration is often neglected. Considering important aspects of group processes, such as the availability of group members, this thesis uses the concept of awareness. It is the broader term compared to social presence; graphical displays are often chosen to visualise one or more aspects of
awareness. While both concepts, i.e. social presence and awareness, are important for empirical considerations, a stronger emphasis is placed on social presence as a context parameter.

To sum it up, theories, concepts and findings from three different research areas, i.e. computer-supported collaborative learning, coordination and social presence, are presented, exploring the complexity of learning experiences and processes.

Overall, this thesis emphasises a complex systems view on groups. It points to the fact that many factors and aspects have to be considered to provide an integrative understanding of the online learning experience. Clearly, it outlines the importance of coordination and social presence for the description and understanding of computer-based collaborative learning. Furthermore, it focuses on specific aspects, i.e. tools/media, tasks and individual members, as important units of analysis. This provides the basis for a multi-layered analytical approach, which will be explained in later chapters in detail.
3 AIMS OF THIS STUDY

This thesis serves two aims: Firstly, to provide a detailed insight into the processes that shape the online learning experience of groups. Secondly, based on the identified processes, to develop suggestions for the improvement of learning and teaching processes in computer-mediated groups.

3.1 FIRST AIM

The first aim of the thesis is as follows:

1. To explore the complexity of learning experiences and learning processes in computer-supported collaborative learning environments.

Central CSCL research efforts are concerned with the promotion of learning processes and performance outcomes in computer-based collaboration. Two concepts, coordination and social presence, were chosen to illuminate students' experiences with online communication media and the processes involved in online learning. This refines the overarching research aim into two objectives:

1.1 How can group coordination processes illuminate the complexity of learning experiences and processes in computer-supported collaborative learning environments?

The concept of coordination is linked to the learning process and group performance (Erkens, 2004). Goal identification and associated activities are crucial
during coordination in online collaboration (Erkens et al., 2006). Espinosa et al. (2004) point out that coordination might not be equally important for every kind of task. Tasks that can be solved independently by one member benefit less from coordination than tasks requiring collaborative group effort. In computer-mediated environments, coordination takes place through the mediating means of online communication. Research has identified a lack of findings on how communication supports coordination (Weigand, van der Poll & De Moor, 2003a).

The second objective is as follows:

1.2 How can the concept of social presence describe and explain the complexity of learning experiences and processes in computer–supported collaborative learning environments?

An important and often neglected aspect in computer–supported collaborative learning is the social dimension (Kreijns et al., 2002). Kreijns et al. (2002) point to the positive relationship between social interaction and learning performance as well as learner satisfaction (Gunawardena & Zittle, 1997). One crucial concept closely linked to experiencing social aspects in computer–mediated environment is the perception of social presence in such environments (Bente et al., 2005). Picciano (2002) reports on a study which links social presence to students’ performance in written assignments. Weaver and Albion (2005) link social presence to motivation for participation. However, detailed research is missing regarding the impact of social presence on online collaboration (Bente et al., 2005).
3.2 SECOND AIM

Supporting distributed learning teams has become a concern for educators and technical experts. The two concepts, i.e. coordination and social presence, present main problems in collaborative online learning. The second aim builds on the elaborated link between coordination and social presence for the learning and teaching process and addresses the improvement of support for online learning settings.

2. How can the identified characteristics be adjusted to facilitate more efficient teaching and learning processes?

Separate consideration of coordination and social presence results in two objectives.

2.1 How can group coordination processes be supported better to promote the learning and teaching process?

2.2 How can social presence be supported better in computer-mediated learning environments?
4 METHOD

The following chapter describes the method used in the empirical part of this thesis.

It elaborates on the methodological framework emerging from the literature review and introduces impacting aspects of coordination and social presence. A variety of different data types contribute to the examination of the two concepts: coded online data, instrument data and online contributions, such as reflections, assignments and wiki pages.

Expected findings are formulated on two levels: a local dynamic level and a complex systems level. The levels portray the multi-layered approach forming the basis for analysis in this thesis. The design is a key strength of this thesis.

The involved participants and the study setting are described. The chapter also introduces the pedagogical rationale of the course and describes the tasks, communication media and awareness visualisations as used by the participants.

The qualitative approach is portrayed and criteria for analysis are illustrated. Coding schemes for coordination and social presence and the rationale behind the decision for choosing such schemes are introduced. Furthermore, coding procedures and instruments are described in detail.
4.1 Methodological Approach

This thesis investigates the online units that took place as part of a blended learning course at the University of Sydney, Australia. The recorded online communication transcripts from the course, as well as the contributions to the online learning space, such as wiki pages or written assignments, serve as the basis for analysis. The online communication transcripts allow insights into students’ activity, while reflections in the form of a written assignment provide information on students’ perceptions of their learning experience.

A content analysis of the online communication transcripts, with the help of coding schemes, provides detailed insight into the constructs in question. This approach presents an appropriate practice for the current research aim (e.g. Jonassen & Kwon, 2001; Marra, Moore & Klimczak, 2004; Pelowski, Frissell, Cabral & Yu, 2005; Rourke et al., 1999). The analysis will go beyond quantification of qualitative data (Chi, 1997), by considering the online communication and other contributions as specified above.

In order to analyse the data, a complex systems view of groups will be adopted. This approach allows an integrative analysis of group dynamics. The analytical framework, based on Arrow et al.’s (2000) groups as complex systems view, is chosen for its flexibility and generic applicability. The framework allows technology to take the special position it has in computer– supported learning groups and supports the investigation into coordination and social presence. These concepts address crucial problems in online groups, such as coordination costs and lack of team culture.
4.1.1 Coordination

A coding scheme for coordination in groups with a level of detail, yet applicable across different tasks or tools, does not exist. Therefore, a coordination coding scheme was developed as part of this work. The coding scheme is guided by the works of Malone and colleagues (Malone & Crowston, 1990, 1994; Malone & Crowston, 2001). Their theory on group coordination has been widely acknowledged and applied (i.e. Espinosa et al., 2004; Espinosa & Pickering, 2006; Malone & Crowston, 1990, 1994; Mentzas, 1993; Weigand et al., 2003b).

As outlined in the theory, Arrow et al. (2000) describe three different structuring elements of groups in online environments: tools, tasks and members. These elements serve as the basis for the analytical framework. Researchers studying computer-mediated collaboration have adopted similar frameworks incorporating these elements in some form (Carroll, Neale, Isenhour, Rosson & McCrickard, 2003; Espinosa et al., 2004; Herrington et al., 2006; Olson & Olson, 2001; Urquijo et al., 1993).

This thesis presents an integrative view on coordination by providing an in-depth elaboration of coordination in each of the three elements, which contribute to behavioural variation in groups. The effectiveness of coordination depends on the degree to “which all key dependencies among activities in a task have been well managed” (Espinosa & Pickering, 2006, p. 25). This definition stresses, different aspects of coordination are not equally important for different tasks (Espinosa et al., 2004), coordination efforts have to aim at key dependencies among activities. Learning and communication in CSCL environments is tool-mediated, therefore the tool will be considered another factor contributing to the goodness/quality of fit of coordination effort and task dependency. A third part is the influence of group members.
Coordination costs, as well as the importance of coordination for team performance, leads to the conclusion that a balance between coordination and task-related behaviour is desirable. At this point, existing research does not provide detailed information on specifications of this ratio. It can, however, offer guidance to which factors might influence the link between coordination and task-related behaviour.

Research hints to the fact that frequency and nature of team communication, such as task-related or process-related matters, affect the quality of coordination (Fussel et al., 1998). Due to a lack of existing evaluative nomenclature in relation to coordination in an educational CSCL background, this work will use the terms “relevance” and “suitability” to evaluate coordination. Relevance refers to the overall amount of coordination in relation to task-related behaviour and describes the “quantity” of contributions. Suitability describes the “quality” of coordination utterances and thus evaluates their appropriateness in a particular instance.

The concept of costs operates on a higher level of granularity than the coding scheme. The estimation and evaluation of necessary or unnecessary costs cannot be measured on the basis of single contributions, but has to consider larger units of analysis. Cost quantification, if possible at all, first requires an understanding of quantitative aspects, such as relevance and suitability of coordination.

### 4.1.1.1 Tools

The tool perspective focuses on two aspects: the kind of coordination arising in the tool used and coordination occurring across different tools. When analysing coordination occurring in different tools, communication data will be segmented into parts in which students used the same communication tool. This results in segmentations relating to synchronous and asynchronous communication tools.
Synchronous communication tools can be divided into further subcategories: chat only sessions, synchronous communication including writing functionality or synchronous communication including whiteboard functionality. The subdivision is based on the features that a certain communication tool holds. A similar technology classification was undertaken by Zigurs and Buckland (1998) who identified group support systems according to features they offered and type of support they would deliver.

The mediating environment changes as soon as its features change to allow for different functions or usage. For the purpose of this work, a tool is considered to be the mediating agent through which students collaborate and communicate.

Base–level functionalities and features enable synchronous communication mediated by the “chat only” tool. Nevertheless, when writing a joint paper, the group encountered a new tool. The tool partly consisted of features and functionalities the chat only tool brought forward, and partly consisted of additional features and functionalities enabling the joint writing process. The chat and wiki technology tool is a special form of the chat only condition. Students did not have the wiki technology integrated into one window, as was the case with whiteboard and writing tools.

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7 This is the basic tool used. Other features, such as concept mapping or writing, are added to it as needed.
Table 4: Tools and the description of the functionalities as encountered in the course

<table>
<thead>
<tr>
<th>Tool</th>
<th>Description of functionalities as encountered in the course</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Synchronous Chat Only Tool</strong></td>
<td>• Window to enter your comments.</td>
</tr>
<tr>
<td></td>
<td>• Entry history window.</td>
</tr>
<tr>
<td></td>
<td>• Box with agenda items and box with links to interesting resources.</td>
</tr>
<tr>
<td></td>
<td>• Awareness radar displaying who is logged in and who is contributing how much.</td>
</tr>
<tr>
<td><strong>Chat and Wiki Technology</strong></td>
<td>• Functionalities as described in the chat only tool section.</td>
</tr>
<tr>
<td>(N.B.: special form of “Chat Only”- condition)</td>
<td>• Creation, deletion and linkage of wiki pages with the help of the CamelCase conventions, which is the original wiki convention for creating hyperlinks.</td>
</tr>
<tr>
<td><strong>Chat and Whiteboard Technology</strong></td>
<td>• Functionalities as described in the chat only tool section.</td>
</tr>
<tr>
<td></td>
<td>• Creation, deletion and editing of rectangles or other geometrical shapes as well as arrows and written text, allowing for the creation of concept maps.</td>
</tr>
<tr>
<td><strong>Chat and Writing Functionality</strong></td>
<td>• Functionalities as described in the chat only tool section.</td>
</tr>
<tr>
<td></td>
<td>• Timer functionality to keep track of time.</td>
</tr>
<tr>
<td></td>
<td>• Window to create, delete, highlight and edit written pieces of text.</td>
</tr>
<tr>
<td></td>
<td>• Versioning function to view the history of a certain piece of text.</td>
</tr>
<tr>
<td></td>
<td>• Facility to take the exclusive right to write and to give it back to the group.</td>
</tr>
<tr>
<td><strong>Asynchronous Discussion Forum</strong></td>
<td>• Ability to create, delete, edit and reply to threads.</td>
</tr>
</tbody>
</table>

Furthermore, the tools can be described in terms of their characteristics, as described by Media Synchronicity theory (Dennis & Valacich, 1999). This enables a closer and more detailed investigation of the tools' influence on coordination dynamics (Table 5). Such characterisation implies the two conditions, chat with integrated whiteboard technology and chat with integrated writing functionality, represent the richest medium, followed by the discussion forum and the chat only tool as the leanest medium.
Table 5: Characterisation of the media used in this study according to Dennis and Valacich’s (1999) five media characteristics.

<table>
<thead>
<tr>
<th>Media Characteristics</th>
<th>Tool</th>
<th>Chat Only Tool</th>
<th>Chat and Whiteboard Technology</th>
<th>Chat and Writing Functionality</th>
<th>Discussion Forum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immediacy of Feedback</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>Symbol variety</td>
<td>↓</td>
<td>↑</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>Parallelism</td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>Rehearsability</td>
<td>↓</td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>Reprocessability</td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
</tr>
</tbody>
</table>

Please note, ↑/↓ indicates the relative extent to which a medium holds a particular characteristic. ↑ indicates a large extent and ↓ a smaller extent.

4.1.1.2 Tasks

The coordination analysis regarding particular tasks isolates and evaluates communication passages concerned with only that designated task. During most online sessions, students were assigned to a range of two to three different activities. Activities ranged from chat maintenance and peer feedback to completing an assigned learning task, such as writing a joint paper or discussing a topic.

This thesis is only concerned with the analysis of task-related activities concerning learning tasks of different complexity. The analysed tasks are discussions about readings, concept mapping activities, joint wiki page construction and collaborative paper writing. A task is viewed as an activity based on a certain pedagogical strategy, such as discussing a topic or constructing a concept map. While discussing two different topics represent two different assignments, it is considered as the same task or activity based on the same pedagogical strategy.

This work focuses on task characteristics and points to shaping the learning process and performance. For more information on the hierarchy that Zigurs and Buckland’s (1998) task description imposes on the tasks encountered in this course, see Table 6.
### Table 6: Task hierarchy in terms of Zigurs and Buckland’s (1998) definition of tasks.

<table>
<thead>
<tr>
<th>Task*</th>
<th>Task complexity*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Discussion of different readings</td>
<td>A discussion task can be identified as a simple task in Zigurs and Buckland’s (1998) sense. It has the desired outcome of depicting different opinions and perspectives and in its current form did not have any outcome uncertainty.</td>
</tr>
<tr>
<td>2. Concept mapping activities</td>
<td>Typically, there are multiple ways to portray a certain aspect of knowledge and students have to decide on one possible solution that best fits the concepts and their relationships at hand.</td>
</tr>
<tr>
<td>3. Collaborative writing of a paper</td>
<td>The desired outcome was stated as a joint paper, but students had the freedom to perform this task in different modes, i.e. cooperative or collaborative. Students were given a certain underlying structure for their paper, such that it has to be composed of introduction, main part, conclusion, and thus the solution scheme had to be within the limits of the proposed structure.</td>
</tr>
<tr>
<td>4. Joint construction of wiki pages</td>
<td>Even though technical format is given, the desired outcome did not have one particular format and the structure of the content could be in one of multiple ways. In addition, the solution scheme could be done in one of multiple ways.</td>
</tr>
</tbody>
</table>

*The table displays tasks with increasing complexity.

### 4.1.1.3 Members

The role a member incorporates provokes different expectations regarding behaviour and therefore also influences coordination dynamics (Brown, 2000). However, specific roles, such as the moderator role or the leadership role, lead to different behavioural norms. The moderator role includes opening a meeting or keeping an eye on time and session goal. While roles are often assigned to group members, they also emerge naturally in groups with no predetermined group structure (Brown, 2000). Research findings show members in CSCL groups with assigned roles reveal more coordination related statements compared to groups with no assigned roles (Strijbos et al., 2005). They also found, individuals with assigned roles act stronger in their role compared to individuals taking on a naturally emergent role in such an environment.
This work also considers that individual member characteristics, such as gender or reading comprehension skills, form a distinguishable pattern (Prinsen, Volman & Terwel, 2007).

4.1.2 Social Presence

The second concept, social presence, emphasises another important dimension in online learning, the often neglected social dimension (Kreijns et al., 2002). From a ‘groups as complex systems’ perspective (Arrow et al., 2000) social presence contributes to the environmental surroundings because it forms the basis for other effects crucial for successful online learning (Bente et al., 2005).

In order to illuminate the experience of social presence in the current course, the media type and user characteristics are considered.

4.1.2.1 Contextual Dynamics

A content analysis of online communication data was conducted to explore social presence. A slightly modified version of the social presence coding scheme, introduced by Rourke et al. (1999), was used. It distinguishes three different response types: affective, interactive and cohesive responses.

The analysis elaborates on characteristics and dynamics of social presence as indicated by the response types. In order to shed detailed light on the influence of media and members, the data set was subdivided into the appropriate units of analysis. Through this method, social presence is described in quantitative measures, as offered by the coding of the online communication transcripts. It is also described in qualitative terms as it was experienced throughout the course.
This clarifies the link between social presence and teaching and learning processes in CSCL scenarios.

The perceived social presence influences the perception of learning and instructor satisfaction (Richardson & Swan, 2003). Thus, it can be viewed as an enabling context factor, i.e. a mediator, for students in an online learning environment. An in-depth evaluation of perceived social presence in the CSCL environment provides a further insight into group dynamics, delivering a powerful enabling factor that can purposefully and successfully be integrated into the online teaching process.

This PhD project focuses on different enabling conditions embedded in CSCL environments. Arrow et al. (2000) do not propose a specific analytical approach to determine contextual parameters, as those depend on many situational influences, e.g. competing groups, changes in technology due to updated versions and so on. Often researchers adopt a descriptive approach to analyse the educational context and to portray the conditions they encounter (e.g. Pena–Shaff, Martin & Gay, 2001; Zigurs & Munkvold, 2006).

Similarly, this thesis considers two different units of analyses to shed some light on the dynamics in the experience of social presence: media and members. Some of the research in the field of social presence is concerned with the influence of media type. This concept is closely related to the term “tool” in earlier parts of this work. The chapter on social presence, however, uses the label “media” for the format of the mediating environment, as this is the nomenclature used in the research literature.
4.1.2.2 Contributing Factors: Media and Members

4.1.2.2.1 Media

The type of sensory information provided will have an impact on social presence experience (Bente et al., 2005). Short et al. (1976) view social presence as a characteristic of a communication medium. They argue that different media vary regarding their level of social presence.

Bente et al. (2005) report on clear differences between text chat and other modes of communication, including audio and video. Research suggests, the immediacy of behaviour might have an influence on the social presence experience (Swan, 2002). The current course included text-based forms of synchronous chat, and therefore the analysis level is established on a synchronous – asynchronous communication basis. Synchronous and asynchronous media have inheritly different opportunities for immediacy of behaviour.

Thus, the data set is subdivided into parts relating to synchronous and asynchronous communication media. Quantitative and qualitative content analyses are conducted, as well as a contrasting analysis between the two media types.

4.1.2.2.2 Members

The second analysis targets members as individuals. It investigates the data set in relation to single members’ contributions. Analysis focuses on differences between members, possible distinguishing characteristics and roles members occupy.

Social presence might not be a stable experience, varying across time for each individual user (Picciano, 2002). Research also proposes, two different types of students engage in online courses (Rourke & Anderson, 2002). One group embraces the notion of independence, another body of students longs for the social
exchanges they are used to in face-to-face settings. Rourke and Anderson (2002) propose the moderator should seek a balance between social and on-topic discussion. This work focuses on the social presence experience of a single member as the course proceeds and content and media type change. The development of social presence over time provides a time perspective valuable for improving the teaching and learning process.

Building on the link between social presence and learning and teaching processes, this work suggests how support for social presence in computer-mediated learning environments could be improved.

4.1.3 Contribution to the Research Aim

Coordination and social presence are chosen to illuminate the complexity of learning experiences and processes in computer-supported collaborative groups. Based on these two constructs, this work suggests how characteristics inherent in computer-mediation can be better adjusted to the teaching and learning process.

The coordination analysed through task and tool lenses differs on some points. Firstly, the task data set is a subset of the tool data set. While more data qualify for tool analysis, only some parts of the online exchange that took place actually related to one particular task. Furthermore, while the analysis of coordination from a tool perspective emphasises activities and adopts a ‘how to’ angle on coordination, the analysis of tasks focuses on content-related contributions and adopts a ‘what’ angle on coordination.

The analysis of a single perspective might not provide definite evidence for coordination patterns to be solely attributed to one of the structuring elements, i.e.
task, tool or members. Therefore, the comparison of the three analyses will shed further light on the joint influence. It will also provide guiding information on where and how to start the efforts to improve support. Social presence analysis contributes to the estimation of contextual parameters.

The analysis provides a comprehensive overview of social presence experienced in the course, and considers major influencing factors. In addition, the evaluation emphasises a longitudinal view. It investigates the development and formation of social presence as other factors evolve in the group’s life and students’ perceptions are observed as conditions change.

The careful and detailed consideration of the influences of the two different major factors, i.e. media and members, sheds light on the social presence experience. This allows for detailed suggestions regarding appropriate support in CSCL scenarios.

4.2 EXPECTED FINDINGS

This work considers findings on different levels of granularity. On a more tangible level, it investigates dynamics as they occur in groups. In a later step, the fine-grained view is integrated into a bigger picture to illuminate the complex interrelationships as they occur in online learning groups.
4.2.1 Local Dynamic Level

4.2.1.1 Coordination

It is expected that coordination patterns differ across tools, tasks and members. Separate and partially fragmented research hints to the importance of understanding dynamics concerning these three factors in computer-supported collaborative learning environments.

Malone and Crowston (2001, p. 10) describe coordination as “managing dependencies between activities”. This implies, different tasks with different dependencies require different coordination patterns. It is expected that more dependencies in a task pose more complex coordination patterns.

While research points to the importance of single members’ influence on dynamics in CSCL environments (e.g. Flor & Finger, 2006; Hartley & Bendixen, 2001; Prinsen et al., 2007), little research has been concerned with the identification of the main aspects of individuals’ influence on coordination dynamics. Thus, the current research will take an exploratory approach to the members’ analysis.

4.2.1.2 Social Presence

It is expected that students will experience social presence differently in different media. Social presence studies generally compare communication media with varying abilities to convey sensory information, e.g. text-based vs. audio-mediated chat. Some of the research argues that a reduced ability to convey affective information results in decreased social presence (Daft & Lengel, 1986; Short et al., 1976). Other research suggests more factors, such as immediacy of behaviour or bandwidth, have to be considered to explain the relationship between media characteristics and social presence (Danchack et al., 2001).
The current study compares two forms of chat, synchronous and asynchronous, that do not differ regarding the type of sensory information they convey. However, they differ according to the immediacy of feedback they allow. Synchronous media allow for a higher immediacy of feedback, and thus provide less opportunity for reflection compared to asynchronous media (Swan, 2002). Differences in the two communication media are expected to impact social presence. Increased immediacy of feedback should also produce a higher experience of social presence.

Furthermore, it is expected that longitudinal effects will play a role in social presence experience. As students get to know each other better and as they feel more comfortable working with the medium, social presence should increase.

The social presence experience is not a static encounter, and individuals react differently (Richardson & Swan, 2003). Even though some researchers suggest there should be interindividual variations in the students’ perception as well as over time, they do not provide information on the nature of such variations. Thus, it is expected that the quality and quantity of social presence will vary intra- and interindividually.

### 4.2.2 Complex Systems Level

The multi-layered coordination analysis will illuminate emerging dynamics shaping the learning process. Each factor, i.e. tools, tasks and members, is expected to impact coordination in its own characteristic ways. Only the concurrent analysis of all three factors will provide the complete picture of coordination as experienced in CSCL-type learning settings.
The careful consideration and evaluation of social presence as expressed during the course will provide context-layer information about the students' experience in the online learning environment. Differences in the social presence experience will provide additional insights into trends and behavioural changes.

Coordination as a means to describe local dynamics in CSCL groups, and social presence as an enabling context factor, are two powerful concepts describing students' online learning experience. The integrated analysis of both concepts will provide a broad picture.

4.3 Design

4.3.1 Multi-layered Design

This work employs a case-study approach in describing and analysing the seven students’ experience and perceptions. The students are divided into two groups and participate in a blended teacher education course.

One main strength of this work is the multi-layered analytical approach adopted to describe the learning process. Group coordination processes and social presence experience are analysed from different perspectives and levels of abstraction (Figure 5):

I. The single perspective level, made up of tool, task or member perspective for coordination processes, and of media or member perspective for social presence. This perspective forms the smallest unit of analysis.

II. The concept level generates an intermediate level of analysis. Investigation of coordination behaviour composes interaction between the three single
perspectives as well as interrelations between the two single perspectives for social presence.

III. The most abstract level of analysis provides an integrative view of students’ learning experience, acknowledging the intertwined relationships of all factors involved, e.g. a complex view of coordination as constituting local dynamics and social presence as contextual parameter.

![Diagram showing three levels of analysis: Integrative View, Concept Level, Single Perspective Level]

**Figure 5: Overview of the three levels of conclusions and their relationship.**

To gain a better insight into time-related dynamics, different instruments were provided online on a regular basis, i.e. weekly, monthly and after the course, and online communications were analysed chronologically. To capture participants’ subjective perspective, students completed reflective assignments about their learning experience in the course.

The analysis considers online communication data, but also other artefacts and behavioural data, as they occurred in the online environment. This provides adequate triangulation of the data.
4.3.2 Limitations

The data retrieval from a naturalistic field study yields several advantages, e.g. authenticity, as behaviour is studied in its natural context, or emphasis on the process view (Bryman, 2001). Nevertheless, limitations have to be taken into account. Such a setting does not allow for complete control of all variables. One such variable is the full extent of communication and interaction that takes place within a group. The course is constructed in a blended learning mode. It cannot be guaranteed that students did not communicate with each other by other means than those provided through the groupware. Possible further communication channels are additional face to face meetings, e-mails, phone calls and using SMS. Such information would be lost and cannot be considered in the analysis.

4.4 PARTICIPANTS

Students’ age ranged between 23 and 45 years, with an average of $M = 31.14$ $(SD = 7.67)$. Four of the participants were female and three male. Both teachers were female.

Some implications result from the characteristics of this sample. Participants were recruited from a university course, randomisation regarding prior knowledge of the content domain, computer literacy, distributed learning experience, already established relationships between group members, cultural background and the like did not take place. These aspects were taken into consideration by retrieving information on relevant moderating variables with the help of distributed instruments, and a personal profile established by the participants themselves.
4.5 STUDY SETTING: A BLENDED TEACHER EDUCATION COURSE

This work examines the experience of seven students and their teachers in a postgraduate course, taught in a blended format. All names and student records have been anonymised after retrieval for the purpose of this study.

4.5.1 Pedagogical Rationale and Course Outline

The course provided an introduction to information technology in education, considering principles of teaching and learning as models for ICT implementation. It presented an overview of research on the use of ICT in teaching and learning, while focusing on learning from and with hypermedia and multimedia as well as text-based synchronous and asynchronous discussion. Different learning theories and their implications for designing ICT-mediated instruction were discussed. By merging ICT tools as part of assignments and activities, students worked collaboratively to gain knowledge and first-hand experience on the impact these tools could make on teaching and learning. The main objective of the course was to examine contributions from scientific research towards understanding the potentials and pitfalls comprising ICT usage for teaching and learning. Research studies were analysed from varying views of specific theories and frameworks. In addition, students practiced some basic research methods and at the same time learned about underlying theories.

Course goals included acquisition of a basic understanding of the impact of learning theories on ICT-mediated teaching and learning design as well as critical evaluation of research studies in that field. The course also aimed at the understanding of
pedagogical potential of various ICT tools, and how they can be used as tools in the teaching and learning process.

The course adopted a constructivist teaching approach. Students studied learning theories and experienced different activities, from both a teacher/facilitator role and a student role. Students formed two different groups, which remained the same during course duration, with 3–4 members each for all collaborative activities.

The course was taught over 13 weeks, with a blend of face-to-face meetings and online sessions. Out of the 13 sessions, 8 were held online and 5 in a face-to-face format.

Face-to-face sessions served social purposes: orientation, peer presentation or reflection. The first session provided an orientation for the course content. Two presentation sessions (session 5 and 8) occurred in the middle of the course, a topic overview lecture towards the end (session 11) and a wrap-up session served as a further face-to-face session. During presentation sessions, students were asked to collaboratively present a chosen multimedia/hypermedia topic to the class.

Means of communication included synchronous chat sessions as well as asynchronous discussion forum sessions. Out of the eight online sessions, six were conducted in a synchronous mode (session 2, 3, 4, 6, 7, 9) and two were conducted in an asynchronous mode (session 10, 11).

### 4.5.2 Collaboration

Communication media in the online part of the course mostly consisted of synchronous chat, as well as an asynchronous discussion forum. The chat
environment was introduced in the beginning of the course. After students felt comfortable with the synchronous environment, asynchronous communication was introduced into the course. Students had access to all forms of communication media throughout the course. However, students also used additional communication means such as SMS and mobile phones.

Teachers facilitated discussion during the first three chat sessions. After students were oriented, the course established a rotating system putting students in the moderator role. Within the discussion forums, a moderator rotation was established as well. Moderators established discussion threads, monitored the discussion during the week’s course. Typically, moderators would start a thread and students had the opportunity to reply. In general, teachers just logged into the forum and checked the discussion progress, commented on the quality of threads or the interaction frequency. In general, the teachers provided feedback on a meta-cognitive level with regard to emerging group dynamics, as well as on a task content level.

An agenda accompanied each chat session, in order to provide structure. Furthermore, behavioural rules for chat rooms were introduced. Students did not follow those rules at all times, especially when they got “carried away” by a discussion. However, the rules provided a good foundation for communication and structured the discussion sufficiently to offer a basis for effective work.

### 4.5.3 Tasks

Tasks were composed of collaborative wiki page and concept map creation, joint group paper writing as well as the discussion of, and feedback about, other group members’ contributions. The tasks allowed for a certain degree of freedom, as they
typically asked for specific final products. For example, such a product could be a concept map to be achieved collaboratively, but the means of coordination and collaboration were left up to the group.

Discussions usually included peer feedback and reflection. Typically, students had to comment on previous assignments they had uploaded to the learning space, or they commented on scientific articles they had read. Reflection was aimed at students’ beliefs or practices and procedures encountered as part of the course group work.

Concept mapping sessions consisted of the collaborative concept map creation with the help of a whiteboard facility.

For collaborative wiki page construction, students could choose a topic from a list of multimedia and hypermedia related research articles. They had to divide the work amongst group members, and produce a page properly linked to a range of subtopics. They had to master the learning content and familiarize themselves with wiki construction. Similarly, joint paper writing consisted of a chosen topic. Students used the chat environment with a versioning facility to write a joint paper. During the asynchronous discussion forum sessions, students had to formulate questions from previous readings and post them in thread format in the online space. They also had the task of commenting on replies and trying to keep the discussion going.

4.5.4 Communication Media

Groups collaborated through the content management system, Plone®, during online sessions. Synchronous interaction between participants mostly took place in a chat
environment developed at the CoCo Research Centre, University of Sydney (Ullman, Peters & Reimann, 2005). The simple chat environment provides users with a chat history, agenda items for structuring the online session, the possibility to share links and a member monitoring display, showing who is present as well as how much they contribute at a particular moment (see also Figure 6).

During some sessions, the chat environment was enhanced with additional functionalities to better support different tasks. One “add-on” to the environment was a whiteboard facility, which allowed students to draw. Another add-on was a collaborative writing facility, allowing students to create several notes and collaboratively write on a note. A versioning option helped tracking different writing stages.

Students also used an asynchronous discussion board, implemented in the Plone® environment. The discussion forum allowed students to create and edit threads as well as to reply to their posts. Furthermore, they could use a range of emoticons and text structuring aids (see also Figure 7).
Students used the whiteboard facility with incorporated chat for the concept mapping tasks. The facility allowed students to draw rectangles, label them with text, produce connecting arrows and label them. All students had the right to create and delete objects at all times. This meant they had to coordinate their actions through the adjacent chat functionality.

For collaborative writing, we introduced a versioning facility allowing students to jointly produce written work. Students were able to create notes and edit them. Each student could create as many notes as desired. However, only one student could edit a particular note at a time. This required students to organize and coordinate their actions to produce a joint product.
4.5.5 Awareness Visualisations

In order to support the social dimension within online communication different visualisations were implemented into the groups’ learning space.

A “radar” visualisation conveyed a sense of presence awareness amongst group members in the synchronous chat sessions. Visualisations have been described, and successfully implemented, by Erickson et al. (1999). This visualisation consists of a large circle, in which a different coloured dot symbolizes each group member entering the chat. This dot initially appears at the outer rim of the circle. The more a member contributes, the more his dot moves towards the centre. This allows participants to have an overview of who is present, and how much someone is contributing to the discussion. The radar visualisation is located on the lower left corner of the chat window. For a detailed view of the synchronous chat environment see Figure 6.

A contribution bar chart visualised participants’ contribution behaviour and facilitated task awareness (see also Figure 8). The contribution bar chart was part of the learning space. Students’ accessed it from session four onwards. It shows the overall amount of contributions a group member has made within the workspace. This is not related to one task, but shows the overall contribution behaviour. By clicking on the number underneath each member’s name, each single contribution is listed. Members have the opportunity to look at them, and the benefits of its usage were explained, but it is not required.
During the last two discussion forum sessions, students were provided with various graphs on their interaction behaviour: a “wattle tree graph” and a “social network graph” as well as a “radar graph”. This type of visualisation was only included in the synchronous environment (e.g. Kay et al., 2007; Reimann & Kay, 2005).

The wattle tree graph visualised specific actions in relation to time. A stem growing over time presents each group member (see Figure 9). When a member either initiates a thread or contributes to a chat session, the stem develops a ‘leaf’ to the left of the stem, which is symbolized through a red coloured dot. If this member replies to a posting, a blue coloured dot to the right of the stem symbolizes his action. The more postings made on a particular day, the bigger the dot. The number of words posted during a day determines the size of the dot. Once a member has logged on for the first time, the member stem turns green. This indicates the active phase of a participant. The wattle tree visualization allows group members to monitor other members’ behaviour on several levels, as well as to compare their own behaviour to that of others. For instance, if one member posts all the information needed close to the due date, this will be evident through the

![Contribution Bar Chart](image)

**Figure 8: Contribution Bar Chart (names shown in figure are anonymised).**
visualisation. This person might have done the work, but might not have shown a good example of collaboration. Only one dot around the due date indicates, this person has contributed only once during the week. Likewise, group members who worked on a constant basis can be identified (Figure 9). Numerous dots, in a more continuous fashion, indicate this person has contributed throughout the week, in Figure 9 this would be Kathryn (names anonymised).

![Wattle tree visualisation](image)

**Figure 9: Wattle tree visualisation.**

The social network graph (Figure 10) shows communication patterns within the group. Each member is represented by a different coloured dot. These dots are arranged in a circle. If an interaction has taken place between any two members, this will be shown through a line connecting the two dots. The thicker the line the more interaction has taken place between those two members (Figure 10). A social network graph provides a detailed view of communication patterns. If one person only has a few connections to others, this might indicate that this person does not wish to take part in the group communication or feels isolated. In any case, it calls for action within the group.
The radar graph shows the amount of contributions a member made in relation to everyone else's contributions (see also Figure 11). The graph provides participants with a comparison between their own contribution behaviour and others.
The visualisations were posted as a thread in the discussion forum. Additionally, information on how to interpret the dots and distances was given to the students and they were asked to comment on the graphs.

4.6 Analysis

The multi-layered analysis was approached through a variety of methods. The instruments’ analysis provides a quantitative elaboration of group processes and performance. Synchronous and asynchronous communication content analysis presents a rich framework. Sequential analysis targets behavioural patterns related to time and employs qualitative as well as quantitative considerations.

Before analysing data, the online communication data was downloaded and saved in a spreadsheet. Ethical considerations were applied: the data set was anonymised and identifiers applied in order to allocate corresponding data sets over time.

4.6.1 Quantitative Content Analysis

4.6.1.1 Criteria for analysis

Different analysis criteria are proposed by different authors. The nature of the content analysis will be descriptive, as adopted in most studies employing quantitative content analysis (Rourke, Anderson, Garrison & Archer, 2001). Rourke et al. (2001) point out four criteria to be considered while undertaking quantitative content analysis: objectivity, reliability, replicability and systematic coherence. Murphy and Ciszewska-Carr (2005) propose reliability, discriminant capability,
feasibility and identifiability as important criteria for a unit of analysis. Objectivity, reliability, replicability and feasibility are the most outstanding and commonly adopted ones.

Objectivity describes the extent to which the analysis is independent of the coder (Mulaik, 2004). Inter-rater reliability is one often-mentioned form of reliability in the context of content analysis of distance education (De Wever, Schellens, Valcke & Van Keer, 2006; Rourke et al., 2001). It describes the extent to which two or more raters agree on coding content in the same way. Lombard, Snyder-Duch and Bracken (2002) discuss the usage of percentage of agreement between two coders, Holsti’s Method, Scott’s Pi (π), Cohen’s Kappa (κ) and Krippendorff’s Alpha (α), as different measures for inter-rater reliability of online communication data.

The percent agreement considers the number of codes agreed upon in relation to the number of overall codes. The advantages are that it is relatively simple and it includes more than two raters at once (De Wever et al., 2006). The disadvantage is that it does not account for agreement by chance. Krippendorff’s Alpha (α), Scott’s Pi (π) and Cohen’s Kappa (κ) address this weakness and take agreement by chance into account. The percent agreement measure and Cohen’s Kappa (κ) are the two most commonly reported measures in literature. Lombard et al. (2002, p. 602) suggest a list of minimum information that should be reported in conjunction with inter-rater reliability:

- The size of the reliability sample and the method used to create it, as well as the justification for it,
- the relationship between reliability sample and full sample,
- the number of reliability coders,
- the amount of coding conducted by each reliability and nonreliability coder,
- the indices selected for calculating inter-rater reliability as well as justification,
• the inter-rater reliability level for each variable and for each index selected,
• the approximate amount of training (in hours) required to reach reported reliability levels,
• how disagreements within the reliability sample are resolved in the full sample and
• how detailed information can be obtained regarding coding scheme, procedure and instructions.

This thesis will report on the widely used Cohen's Kappa measure and take the above listed minimum requirements by Lombard et al. (2002) into account.

Replicability is the ability to produce the same results under different circumstances or after some time. Rourke et al. (Rourke et al., 2001) describe it as multiple groups of researchers being able to apply a scheme reliably.

Feasibility refers to the amount of data to be managed in relation to the amount of resources available (Murphy & Ciszewska-Carr, 2005).

Identifiability describes the capability of a unit to be identified using the conventions adopted by group members (Murphy & Ciszewska-Carr, 2005). Identifiability points to an important aspect in online discussion forums. Certain units of analysis are more suitable for one particular data set than others, due to the context the discussion is held in. The choice of medium, as well as the communication convention, impacts the identifiability of a unit.

4.6.1.2 Unit of analysis

The units of analysis were adjusted to the research question and to the level of analysis. Each of the analytical layers served as a unit of analysis. The course as a whole will serve as one unit of analysis; it took 13 weeks. All online sessions were considered in order to detect patterns only showing over time.
The unit of analysis – approach bears the advantage of separating variables such as tool or task.

Different possibilities exist to analyse contributions in online learning environments. Rourke et al. (2001) name the sentence, the paragraph, the message, the thematic and the illocutionary unit as possible levels. Others broadly distinguish between syntactic and semantic units of analysis, subsuming different levels (Murphy & Ciszewska–Carr, 2005). The following section discusses particular advantages as well as limitations, while considering the above-mentioned criteria for analysis.

Using a sentence as a unit of study has the advantage of being easily identifiable and thus reliable. This meets the above-mentioned criterion of objectivity. The feasibility of a sentence unit can be quite difficult. A discussion during a couple of weeks can easily create 1000 sentences. Nevertheless, syntax in asynchronous postings is often not straightforward and resembles a mixture of writing e-mails and casual oral conversations (Rourke et al., 2001). This affects reliability and ease of identifying a sentence or paragraph. One possible solution to this problem could be an apriori instruction to the participants regarding communication conventions (Murphy & Ciszewska–Carr, 2005).

Using a paragraph as a unit of analysis incorporates the advantages stated above for the sentence level regarding reliability, objectivity and ease of identification, assuming that communication conventions have been followed. It is a lot better to apply, since cases will be diminished significantly. However, its capability to discriminate between behaviours might be diminished as well (Murphy & Ciszewska–Carr, 2005). Rourke et al. (2001) mention that with the size of a unit the likelihood increases that this unit includes more than just one variable.
The message as a unit of analysis incorporates the advantage of being easily identifiable and reliable. It produces a comparatively low amount of cases in asynchronous discussions compared to synchronous communication. In synchronous discussions, the number of messages might be higher, depending on the communication convention used. For example, some authors propose the usage of just a few words per message in order to keep the conversation in a chat room flowing (Hines & Pearl, 2004).

A thematic or semantic unit of analysis usually includes only one idea or a single piece of information (Rourke et al., 2001). Blignaut and Trollip (2003) used a thematic unit to retrieve the essence of a communication. They applied more than one label per unit of analysis, thus enabling researchers to address more than one aspect in a specific posting if needed. Employing thematic units has been criticised for its lack of objectivity and reliability. Murphy and Ciszewska-Carr (2005) report, two raters will have different approaches with regards to the coding of messages. A two-staged approach to thematic units coding is proposed (Murphy & Ciszewska-Carr, 2005). Raters should reach a prior consensus with regards to their coding approach, and then in a second step commence coding the units.

The illocutionary unit of analysis is an attempt to improve shortcomings of the thematic unit of analysis. In trying to set a theoretical basis for the thematic unit of analysis, Howell-Richardson and Mellar (1996) ask for the purpose of a specific contribution. They ground their shift of attention in Speech-Act theory. However, this approach is complex and challenging for the researcher (Rourke et al., 2001).

Murphy and Ciszewska-Carr (2005) illustrate advantages and limitations with a study comparing semantic coding vs. syntactic units of analysis within an asynchronous discussion forum. Besides the proposal of a two-staged approach to enhance reliability for semantic units of analysis, they raise further issues, such as
the importance of the discussion context. Feasibility is effected through the number of participants and the duration of the discussions. Most of the studies that analyse online communication are based on asynchronous discussion forums (i.e. Blignaut & Trollip, 2003; Murphy & Ciszewska–Carr, 2005; Pena-Shaff & Nicholls, 2004).

This work includes data from synchronous and asynchronous discussions. Similar analysis approaches are chosen for both forms of communication, allowing comparison across media type. Murphy and Ciszewska–Carr (2005) point out, the decision for a unit of analysis depends on the context of the online communication as well as analysis criteria such as reliability, discriminant capability, feasibility and identifiability. Considering the above stated advantages and limitations, a thematic unit is chosen as the unit of analysis. Following Murphy and Ciszewska–Carr (2005), a two–staged approach to coding will be applied in order to ensure acceptable interrater reliability.

Message length varies significantly between the two forms of online communication. While one contribution within a chat forum might not be constituted of a thematic unit, a message in an asynchronous discussion forum might be composed of more than one. This is due to differing communication conventions within the two different media. In order to keep communication flow going in synchronous chats, participants are instructed to divide their sentence into more than one message, as described by Hines and Pearl (2004). Since participants usually post only one message at a time in an asynchronous discussion forum, such messages will naturally be longer and possibly be composed of more than one thematic unit.
4.6.1.3 Coding Scheme for Coordination

Research literature vividly discusses the advantages of developing a new coding scheme, compared to using an already existing one. Some authors suggest, the uniqueness of each research question can only be addressed through a matching coding scheme. On the other side, authors argue, the validity of existing schemes can only be verified if schemes are applied and evaluated by the scientific community (Rourke & Anderson, 2004).

Considering the unique and complex nature of the processes in question, none of the reviewed coding schemes matched the research questions regarding coordination. Therefore, a new coding scheme was developed, following guidelines proposed by Chi (1997) and Edwards’ (1993) three criteria for category design: categories have to be systematically discriminable, exhaustive and systematically contrastive.

4.6.1.3.1 Development

The coordination processes, as identified in Malone and Crowston’s (1990) coordination theory, served as the theoretical basis for the coordination coding scheme development. The processes are: identification of goals, mapping of goals to activities, selection of actors/assignment of activities to actors and management of interdependencies. Interdependencies management is further segmented into management of more generic aspects: prerequisites, shared resources, simultaneity and domain specific aspects.

Guidelines given by Bakeman and Gottman (1997) were used to establish the framework, including the code for behaviour, category, subcategory, definition and examples. In the first version, a subcategory was added to ‘managing interdependencies’. capturing the media usage for coordination purpose. This served the purpose of capturing differences between face-to-face coordination and
coordination in computer-supported scenarios. The first coding scheme draft was tested against chat data acquired from a previous course.

In order to achieve better consistency with data coding, category definitions were extended. An additional subcategory to ‘managing interdependencies’ was included to capture ‘shared meaning making’. At this stage, the coding scheme was introduced to a second rater.

### 4.6.1.3.2 Description of Categories

The coding scheme is constituted of four overall categories, which aim to identify coordination processes related to goals, activities, actors and interdependency management. The category ‘interdependencies’ consists of five subcategories, addressing communication means, establishing simultaneity, negotiating shared resources, dealing with prerequisites and establishing shared meaning.

As coordination is a mutual activity (e.g. Barron, 2000) and dependent on a co-actor, ‘closure’ categories were established. In order to indicate closure of an action, two additional codes were introduced per category and subcategory respectively. A plus (‘+’) indicates acceptance, elaboration, clarification or reassurance of initiation behaviour. A minus (‘−’) indicates rejection. A detailed description of the categories is given in Table 7.

*Goal Identification* describes behaviour aiming to identify the goal to be accomplished. As most classes have an implicit goal, the definition was altered so that the code also included behaviour on a task level. *Mapping Goals to Activities* concerns behaviour breaking down the overall goal or task to an activity level. *Selecting Group Members* refers to participants assigning tasks either to themselves or to other group members. *Media Usage for Coordination Purposes* aims at the
means of communication in the coordination process. *Synchronising Activities* incorporates activities, intending to bring members up to one level. *Shared Resource* management includes utterances aiming at allocation or discussion of resources. *Prerequisite* codes are allocated to phrases that *Order or Demand Activities*. This could also include discussing the structure or layout of a specific solution. *Shared Meaning Making* aims at coordination behaviours enacted to reach common understanding. See also Table 7 for an overview of the coding scheme.

**Table 7: Overview of the coordination coding scheme.**

<table>
<thead>
<tr>
<th>Code</th>
<th>(Sub-)Category</th>
<th>Definition</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>CG(+-)</td>
<td>Goals</td>
<td>Identifying goals</td>
<td>“Overall, what do we need to do?”&lt;br&gt;– Asks for the overall goals.</td>
</tr>
<tr>
<td>CA(+-)</td>
<td>Activities</td>
<td>Mapping goals to activities (e.g. goal decomposition).</td>
<td>“This is the to do list.”&lt;br&gt;– Tries to map previous stated goals with actual activities.</td>
</tr>
<tr>
<td>CT(+-)</td>
<td>Actors</td>
<td>Selecting group members. Assigning activities to group members.</td>
<td>“I would like to see Ralph put the doc together as a Wiki and Lee does some editing to get uniform style.”&lt;br&gt;– This asks for an actor and not an activity.</td>
</tr>
<tr>
<td>CIC(+-)</td>
<td>Communication means</td>
<td>Media usage for coordination purpose.</td>
<td>“Should we meet face-to-face to discuss this?”&lt;br&gt;– This utterance asks for a means of communication to discuss an assignment.</td>
</tr>
<tr>
<td>CIS(+-)</td>
<td>Simultaneity</td>
<td>Synchronising activities, e.g. Performance monitoring: Are we all up to the same level?</td>
<td>“Have you all read my notes?”&lt;br&gt;– Asks if all members are on the same level of knowledge.</td>
</tr>
<tr>
<td>CIR(+-)</td>
<td>Shared resource</td>
<td>Allocating resources. Discussing Resources, eg. What kind/how many resources do we have?</td>
<td>“Who is in our group for this task?”&lt;br&gt;This utterance does not ask for a specific actor, rather it asks how many people will be available to work on the assignment.</td>
</tr>
</tbody>
</table>

–Table continued on following page–
4.6.1.3.3 Coding Rules

Coders were asked to picture the intention of the person posting an utterance and what purpose the utterance serves. Coders were instructed to find the essence of an utterance and ask if this utterance reveals coordination behaviour. If the answer was yes, then they should code it. If in doubt about a category, they should check if it fits any other category. They were instructed to code more rather than fewer utterances. This resulted in more coordination codes in order to capture a high level of detail.

A behavioural hierarchy was introduced to guide the coding procedure. The level of interest, as well as the level of abstraction, served as a determinant for hierarchy position. Included categories do not necessarily resemble coordination behaviour on the same abstraction level. For example, “Identifying a Goal” is considered to be a higher order activity than “Demanding an Activity”. The order is shown in the order of category appearance from top to bottom in Table 7. If a certain chat utterance
could be coded within two different categories, the higher order code behaviour was preferred.

Also, if a behaviour could be coded either as action closure or behaviour initiation, the initiation behaviour was favoured. Only initial behaviours were coded as ‘closed' and closure loops. The closure of a closure behaviour was neglected.

For an utterance to qualify for coding, the demonstrated behaviour should clearly serve a coordination purpose. This may seem trivial, but it is important. Some chat entries might qualify, for example, as an episode of shared meaning making. If not serving a coordination purpose, then this episode was coded as non-coordination behaviour.

4.6.1.3.4 Coding Procedure

Introducing the coding scheme to the second rater, initial coding was undertaken. A first interrater agreement was estimated and the coding scheme underwent a revision cycle. Training cycles, consisting of coding, agreement and revision were done twice on data not retrieved from the course and once on actual course data. The training phase included about 5 hours of coding, and 5 hours of discussions and elaborations. Subsequently, the second rater coded about 50% of the existing data.

The coding scheme itself works on a complex language level. The coder has to go beyond identifying surface-level language characteristics in order to decide whether a communication entry should be coded in one category or another. The coder has to identify the meaning and purpose behind a chat entry in order to decide on a coding category. The more the purpose and meaning of an entry are taken into account for coding, the more this poses a threat to reliability of the entire coding
process. However, the level of depth considered in the coding offers a richer coding set.

4.6.1.4 Coding Scheme for Social Presence

Research profits from repeated testing and application of existing coding schemes (Rourke & Anderson, 2004). An existing coding scheme was identified to examine the research questions regarding social presence. Rourke et al.’s (1999) model and template was adopted to assess social presence in the online transcripts.

4.6.1.4.1 Development

After an initial coding of the online transcript data, the four categories were altered. The category 'continuing a thread' was omitted. This code referred to asynchronous communication and most of the data at hand was derived from synchronous communication. In order to allow better comparison between the two media types, this category was not necessary for assessing asynchronous communication. One category, 'expressing disagreement' was added. The category 'vocatives' was split into two different categories. Since students were presented with screen names, group members had the chance of either calling them by their given name or by the displayed screen name. Thus, the codes ‘vocatives I’ and ‘vocatives II’ were used for screen name and given name respectively.

4.6.1.4.2 Description of Categories

Overall, the coding scheme codes for three different types of responses, which serve as indicators for social presence: affective, interactive and cohesive responses. Each of the three response types is composed of subcategories.
Affective response codes capture emotional expression, the use of humour and self-disclosure. Interactive responses include quoting and referring to others’ messages, asking questions, complimenting others and expressing agreement as well as disagreement. Cohesive responses include addressing group members by name, either given or screen name, addressing the group with inclusive pronouns, phatics, and salutations. For further details of the categories’ definition and examples, see Table 8.

Table 8: Social Presence Coding Scheme as adopted after Rourke et al. (1999)

<table>
<thead>
<tr>
<th>Code</th>
<th>Category</th>
<th>Definition</th>
<th>Examples</th>
</tr>
</thead>
</table>
| PAE  | Expression of emotions | Conventional expressions of emotion, or unconventional expressions of emotion, includes, repetitious punctuation, conspicuous capitalization, emoticons | “I just can’t stand it when...!!!”  
ANYBODY OUT THERE!”  
“Thank you”  
“I am sorry!” |
| PAH  | Use of humour    | Teasing, cajoling, irony, understatements, sarcasm.                       | “The banana crop in Edmonton is looking good this year.”                                                                            |
| PAS  | Self-disclosure  | Presents details of life outside of class, or expresses vulnerability. Please note that this does not necessarily have to relate to the topic/content. | “Where I work, this is what we do...”  
“I just don’t understand this question.”  
“I am at home at the moment.”  
“My sister helped me with this.” |
| PIM  | Quoting from others’ messages | Using software features to quote others entire message or cut and pasting selections of others’ messages. | Software dependent, e.g.  
“Martha writes:”  
Text preface by less than symbol. |
| PIR  | Referring explicitly to others’ messages. | Direct references to contents of others’ posts. | “In your message, you talked about xy’s distinction between...” |

–Table continued on following page–
<table>
<thead>
<tr>
<th>Code</th>
<th>Category</th>
<th>Definition</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>PII</td>
<td>Referring explicitly to</td>
<td>Direct references to former interactions between members. Please note that these interactions don’t have to take place in the same medium.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>other interactions</td>
<td>(not particularly within the same medium).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Referring explicitly to</td>
<td>Direct references to former interactions between members. Please note that these interactions don’t have to take place in the same medium.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>other interactions</td>
<td>(not particularly within the same medium).</td>
<td></td>
</tr>
<tr>
<td>PIQ*</td>
<td>Asking questions</td>
<td>Students ask other students or the moderator questions.</td>
<td>“Anyone else had experience with WebCT?”</td>
</tr>
<tr>
<td>PIC</td>
<td>Complimenting expressing</td>
<td>Complimenting others’ or contents of others’ messages.</td>
<td>“I really like your interpretation of the reading”</td>
</tr>
<tr>
<td></td>
<td>appreciation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PIA*</td>
<td>Expressing agreement/</td>
<td>Expressing agreement with or acknowledging others or content of others’ messages.</td>
<td>“I was thinking the same thing. You really hit the nail on the head.” “That is ok.”</td>
</tr>
<tr>
<td></td>
<td>acknowledge-ment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PID*</td>
<td>Expressing disagreement</td>
<td>Expressing disagreement with others or content of others’ messages.</td>
<td>“No, I think it would be better if we discuss the layout first.”</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCR*</td>
<td>Vocatives I</td>
<td>Addressing or referring to participants by name, thus using the screen name as displayed in the chat tool.</td>
<td>“I think Mlat made a good point” “Mlat, (what do you think?)”</td>
</tr>
<tr>
<td>PCN*</td>
<td>Vocatives II</td>
<td>Addressing or referring to participants by name, thus using their real name, which is not displayed in the chat tool.</td>
<td>“I think Monica made a good point” “Monica, (what do you think?)”</td>
</tr>
<tr>
<td>PCP</td>
<td>Addresses or refers to</td>
<td>Addresses the group as we, us, our group or group a.</td>
<td>“Our textbook refers to…” “I think we veered off track…”</td>
</tr>
<tr>
<td></td>
<td>the group using inclusive</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>pronouns.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCS</td>
<td>Phatics, salutations</td>
<td>Communication that serves a purely social function; greetings, closures. <strong>Definition 'Phatic': of, relating to, or being speech used for social or emotive purposes rather than for communicating information.</strong></td>
<td>“Hi all.” “That’s it for now.” “We’re having the most beautiful weather here.” “I wish you a good weekend.” “Goodbye.”</td>
</tr>
</tbody>
</table>
4.6.1.4.3 Coding Rules

Coders were instructed to maintain the timeline. In case one utterance had to be coded multiple times, another column in the spreadsheet was used and, under consideration of the timeline, the code was inserted into the next column.

Special coding rules applied to surface level categories, labelled with an asterisk (*) in the coding scheme. If coders were in doubt for a certain coding, and one utterance equally fit in two categories and could not be divided otherwise with regard to the timeline, then coders did not code for the surface level category but for the other matching category.

4.6.1.4.4 Coding Procedure

Two coders applied the coding scheme. A two-staged approach for the coding was adopted (Murphy & Ciszewska–Carr, 2005). In a first step, the coders decided on their coding approach, and in the second step the actual coding took place. After introducing the coding scheme to the second coder, both coders used a different data set to reach a better understanding of, and agreement about, the coded categories. To ensure better coder understanding and agreement, two different coding trial runs on different data and one trial run on the course data, were undertaken. Overall, training the second coder included 1 hour of theoretical introduction to the coding scheme, 3 hours of coding and 3 hours of subsequent negotiations. One coder coded 100% of the data and the second coded 50%.

4.6.1.5 Comparison of the Coding Schemes

The coding schemes act on different language levels. While the coordination coding scheme requires more attention and interpretation regarding purpose and meaning behind an utterance, the social presence coding scheme acts more on a surface
language level. The social presence coding scheme requires less attention regarding semantics; coders can base their coding assessment on decisions such as “Is this utterance a question or not?”. Similarly, Rourke et al. (1999) report a higher reliability for scales that are easily recognizable, e.g. ‘addressing participants by name’.

4.6.2 Descriptive Analysis

After coding the verbal data, the overall total number of event occurrences, their frequency and distribution over time were of further interest. These first few steps provided an initial overview of the data.

4.6.3 Comparative Analysis

The multi-layered approach to analysis provides a more integrative view of the group process. The data is segmented according to the theoretical considerations mentioned earlier in this thesis. Segmentation of the data allows for different perspectives on dynamics occurring in online communication. Elaboration of these perspectives, as well as the comparison across perspectives, provides a detailed insight into dynamics regarding coordination and social presence. The integration of single perspectives, with the help of Arrow et al.’s (2000) complex systems framework, provides an integrative view of students’ online learning experience in the course.

To triangulate findings, artefacts such as assignments and students’ reflections on the course, as well as questionnaire answers, are taken into account.
4.6.4 Instruments

Questionnaires were developed to gather subjective measures from students. Different aspects of their learning experience were captured, such as perceived task difficulty or perceived usefulness of awareness visualisations. The instruments were tested in a pilot study on six participants. The analysis of the piloted instruments resulted in a revised layout.

During the main study, three different instruments were handed out at different times during the course: weekly, approximately monthly and after the course finished.

On a weekly basis, participants were asked about perceived task difficulty and usefulness of information provided by awareness features in the online space, such as the participation chart, the bio page and the radar functionality in the chat.

On a monthly basis, participants filled in questions about the enjoyment of their online work, their feeling as part of the group, and their possible wishes to change the group. Moreover, they rated their task understanding as an individual, and as a group. They were asked if they felt they had an understanding of necessary steps to fulfil the upcoming tasks, and if they met face to face. In addition, they were asked if they felt certain course aspects were too complicated, such as technical applications, tasks or group work activities.

The instrument after course completion asked for demographic information, their level of experience before the course started, and if they felt comfortable working in a group. It also included questions such as whether they knew their class members before the class started, and how similar they would rate the group work to other online work groups. In addition, the instrument considered usage of other
communication media not offered in the online space. It also asked each participant
to rate the competency of each of the other group members.

The complete set of instruments can be found in Appendix A.

4.7 SUMMARY

The previous chapter introduced the methodological framework emerging from the
literature review. The methodological approach addresses impacting aspects, such
as tools/media, tasks and members, for each of the two main concepts,
coordination and social presence. Coordination is described in terms of local
behaviour, while social presence is investigated as a context parameter.

This thesis expects findings on two levels: local dynamic and complex systems
level. The different levels portray the multi-layered approach forming the analysis
basis for this thesis. Coordination patterns are expected to differ across the three
factors: tools, tasks and members. Differences within each should result in varying
coordination quality and/or quantity. In addition, it is expected that social presence
experience will depend on the medium, as well as the individual. The combined
analysis of findings from coordination and social presence is expected to provide an
integrative picture of the complexity of online learning experiences and processes.

To achieve this goal, the research design includes a single layer perspective,
concept perspective and integrative perspective. Separate analysis of each layer
provides the basis for exploring the complexity of learning experiences and
processes. The multi-layered approach contributes sustainably to the body of
research methods, and is one of the key strengths of this thesis.
Special emphasis is put on participants’ information and the study setting. The pedagogical rationale for the course embraces a constructivist learning approach. In the course, students formed two groups, remaining throughout the course. The course was conducted in a blended learning mode, with the majority of sessions held online. The communication tools included synchronous and asynchronous media. In addition, a variety of awareness visualisations were available to students, such as contribution bar charts and wattle tree visualisations. Tasks ranged from simple discussion to more complex collaborative writing activities.

The multi-layered analysis was approached through several methods, including quantification of qualitative data, qualitative analysis of online contributions and analysis of questionnaire data. The online communication analysis constituted the majority of the analytical approach. However, triangulation and further analysis was carried out through questionnaire answers and further online contributions, such as reflections, assignments and wiki pages.

Analysis emerged two coding schemes, one for coordination and social presence respectively, and quantified qualitative online contributions. While an appropriate coding scheme for measuring social presence was available, a coding scheme for coordination had to be developed. The coordination coding scheme included not only coordination of task aspects, it also captured the impact of technology use. The development, as well as the coding, followed sound procedures as outlined in previous research. In addition, instruments were developed as part of this thesis. They targeted mainly task difficulty, perception of awareness features and measures of group culture, such as group cohesiveness.

Based on these methods, the following chapters present findings and discussions.
5 COORDINATION

RESULTS AND DISCUSSION

This chapter presents findings and associated discussion on the first main concept, coordination. The majority of findings are derived from the analysis of coded online communication. In addition, various artefacts, e.g. assignments in the form of wiki pages and questionnaire answers are presented, to illuminate coordination dynamics.

The presentation of findings and subsequent discussion follows the framework emerged from the literature review and consolidated in the methods chapter (Figure 5, page 106). Tools, tasks and members are investigated in separate sections. Each section provides a detailed investigation of coordination, as it is experienced under different conditions, e.g. different tools or tasks.

The tools and tasks, described in the next two sections were used at different points during the course. Table 9 provides an overview of when certain tools were used in combination with which tasks.

Overall, coordination coding revealed 3628 codes for group A (3524 for synchronous and 104 for asynchronous communication) and 2475 codes for group B (2319 for synchronous and 156 for asynchronous communication). The difference in codes is due to the fact that group A conducted additional voluntary chat
The coding achieved a satisfactory Kappa measure with $\kappa = .77$ (Banerjee, Capozzoli, McSweeney & Sinha, 1999).

Table 9: Overview of the various tools and tasks and their combined implementation in the different sessions.

<table>
<thead>
<tr>
<th>Tools</th>
<th>Chat only</th>
<th>Chat with Whiteboard</th>
<th>Chat with Collaborative Writing</th>
<th>Discussion Forum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discussion</td>
<td>Session 2</td>
<td>Session 6</td>
<td>–</td>
<td>Session 10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Session 12</td>
</tr>
<tr>
<td>Concept Mapping</td>
<td>–</td>
<td>Session 3</td>
<td>Session 4</td>
<td>–</td>
</tr>
<tr>
<td>Wiki Page Creation</td>
<td>Session 6</td>
<td>Session 7</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Collaborative Writing</td>
<td>–</td>
<td>–</td>
<td>Session 9</td>
<td>–</td>
</tr>
</tbody>
</table>

Please note, the data segments used for coordination processes analysis in tools and tasks are not identical. For more information see Chapter 4.1 Methodological Approach.

5.1 TOOLS

The following section analyses coordination in relation to tools employed during the course. Class sessions 2,3,4,6,7 and 9 served as synchronous sessions: Within these sessions, tools ranged from simple chat rooms for discussion to chat rooms with add-ons. Such add-ons were, for example, whiteboard facilities for drawing purposes or a writing space with a versioning option to track different writing stages within a group. Sessions 10 and 12 were reserved for asynchronous communication via discussion forums.

Findings and associated discussion of each tool are presented in separate sub-sections. The findings are presented for each of the two groups, followed by a

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8 When extracurricular communication was required, group A conducted voluntary online sessions in two instances, while group B met face-to-face.
comparison between the two groups. When applicable, findings across sessions are also presented.

The section concludes with a comparison and discussion of coordination across the different tools.

5.1.1 Chat Only

(Sessions 2, 5*, 6, 6* and 7)\(^9\)

The following sub-section presents findings and associated discussion regarding the use of the chat only tool. Figure 12 shows a screenshot of the tool used. Please note, the screenshot does not portray an actual conversation during the course.

\[\text{Figure 12: Screenshot of the chat only tool as experienced in the course.}\]

\(^9\) Asterisks (*) indicate voluntary sessions.
5.1.1.1 Findings

The simple chat room was used during five sessions (session 2, 5*, 6, 6*, 7). Group A conducted two additional, voluntary sessions, one during week 5 and one during week 6. These sessions are marked with an asterisk (*).

The quantitative analysis of chat logs revealed, the first chat, which was a combined session for group A and B, included 18.0% coordination behaviour. For group A, the coordination rate during the following chat only sessions ranged between 40% and 66% coordination. For further detail see Table 10.

<table>
<thead>
<tr>
<th></th>
<th>Session 2 (combined)</th>
<th>Session 5 (Voluntary)</th>
<th>Session 6 (Voluntary)</th>
<th>Session 6 (Voluntary)</th>
<th>Session 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coordination (%)</td>
<td>Group A</td>
<td>18.0</td>
<td>56.2</td>
<td>40.8</td>
<td>47.2</td>
</tr>
<tr>
<td>Coordination (%)</td>
<td>Group B</td>
<td>--</td>
<td>31.4</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

For the most part, either synchronising or demanding activities made up the coordination behaviour. An overview of the most frequent coordination behaviours is shown in Table 11.

Some Non–Coordination semantic units were made up of names. The table above provides an overview of the percentage of non–co-ordination, due to names and discourse. The following analysis considers the total non–co-ordination measure.
Table 11: Most common coordination codes during the chat only sessions for group A and group B.

<table>
<thead>
<tr>
<th>Coordination (%)</th>
<th>Session 2</th>
<th>Session 5*</th>
<th>Session 6</th>
<th>Session 6</th>
<th>Session 6*</th>
<th>Session 7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group A &amp; B</td>
<td>Group A</td>
<td>Group A</td>
<td>Group B</td>
<td>Group A</td>
<td>Group A</td>
</tr>
<tr>
<td>Identifying Goals</td>
<td>CG]</td>
<td>--</td>
<td>1.0</td>
<td>.4</td>
<td>--</td>
<td>2.2</td>
</tr>
<tr>
<td>Positive Closure</td>
<td>CG+</td>
<td>--</td>
<td>.5</td>
<td>--</td>
<td>--</td>
<td>1.4</td>
</tr>
<tr>
<td>Mapping Goals to Activities</td>
<td>CA]</td>
<td>--</td>
<td>.5</td>
<td>.4</td>
<td>--</td>
<td>1.7</td>
</tr>
<tr>
<td>Positive Closure</td>
<td>CA+</td>
<td>--</td>
<td>.5</td>
<td>--</td>
<td>--</td>
<td>.3</td>
</tr>
<tr>
<td>Negative Closure</td>
<td>CA-]</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>.6</td>
</tr>
<tr>
<td>Synchronisation</td>
<td>[CIS]</td>
<td>3.5</td>
<td>9.5</td>
<td>11.3</td>
<td>9.6</td>
<td>8.4</td>
</tr>
<tr>
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*voluntary sessions

-Table continued on following page-
### Table continued

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*voluntary sessions

### 5.1.1.1 Group A

Synchronisation entries were usually concerned with bringing everyone in the group up to the same level of information. The excerpt below shows typical synchronisation passages including closure responses regarding the group knowledge level. Squared brackets at the end of an utterance indicate the assigned coordination code.

Lecturer 2: “everyone knows what emoticons are?” [CIS]
Sabine: “emotional icons?” [CIS+]
Jane: “yes” [CIS+]
Dave: “not sure” [CIS-]
Lecturer 2: “emoticons are :) ;) :0” [CIS+]

Excerpt 1 taken from session 2, group A and B.
Synchronisation [CIS] comments concerned the current member status. The exchange below shows a student’s apology for entering the chat room late.

Jane: “!-sorry guys, was trying to finish 1 more comment” [CIS]
Sandra: “thats ok. we are starting now” [CIS+]

Excerpt 2 taken from session 6, group A.

Synchronisation [CIS] behaviour showed a peak during session 6. The lowest amount of synchronisation behaviour was shown during voluntary sessions. Generally, synchronisation behaviour was shown from 3.5% to 11.3% of chat entries, with closures ranging between 1.9% and 7.0%. The nature of Synchronisation [CIS] chat entries did not seem to differ between the different sessions.

The second most frequently observed coordination behaviour was Demanding Activities [CIP]. This can take the form of negotiating or elaborating on a topic.

Eric: “why don’t we read it and then meet?” [CIP]
Sandra: “thats a great idea [name]!” [CIP+]

eric [NNC]
Sandra: “i havent downloaded it yet [name]” [CIS]
susan [NNC]
Sandra: “how about we all read it asap
Sandra: and meet sometime next week?” [CIP]
...
Sabine: “good idea [name]” [CIP+]
Sandra [NNC]

Excerpt 3 taken from session 6, group A.

Demanding an Activity [CIP] can also be concerned with information transfer from one activity to the next. In the following example, the student pointed out that
inserting the name of the person a particular chat log refers to, would help with the communication smoothness.

Eric: “make sure, we’ll write the name of the person we are replying to” [CIP]

Excerpt 4 taken from session 2, group A and B.

Generally, Demanding Activities [CIP] ranged between 3.3% and 10.5% during the various sessions. Session 7 showed a peak in activity demanding with 10.5%.

Students’ comments on Media Usage for Communication Purposes [CIC] are another part of coordination behaviour that is of special interest to this thesis.

Sandra: “how about we all read it asap
Sandra: and meet sometime next week?” [CIP]
…
Sandra: “is tuesaday good for everyone?” [CIP]
…
Sandra: “where – chat room
Sandra: ?” [CIC]
…
Sabine: “we need first to meet and outline our wiki” [CIP]
Sandra: “lets meet in the seminar room on tuesday arvo” [CIC]
Jane: “? - sandra
the seminar room or the group room” [NNC]
Sandra: “ok seminar room.. by then we have read it already” [CIC+]

Excerpt 5 taken from session 6, group A.

The following excerpts show exchanges occurring while reflecting about chat experience during session 2. Even though the excerpts are not concerned with
coordination, they illustrate the members’ perception of the communication medium.

Dave: “difficult because you had to respond quickly or the conversation move on”  [NNC]
... 
Eric: “it’s like having a conversation where you have 2 secs to give your answer”  [NNC]

Excerpt 6 taken from session 2, group A and B.
Lecturer 2 (Susan): “Any suggestions how we can make it easier & may be better next time?”  [NNC]
... 
Dave: “and maybe it is a matter of us developing the skills of chatting online”  [NNC]

Excerpt 7 taken from session 2, group A and B.

After a couple weeks, students’ perception changed, and they felt the ‘chat’ medium was too slow for an effective conversation.

Eric: “it’s so slow doing stuff in chat”  [CIC]
Sandra: “i agree, [name]!”  [CIC+]
    eric  [NNC]
Sandra: “its kinda frustrating and SUPER SLOW.”  [CIC]
Eric: “if there is not much to say chat is ok, but ..
    Eric: if there is a lot to work out it will take all night...”  [CIC]
Eric: “can you guys look at a program called Skype ..
    Eric: it’s free and it’s like making a conference phone call ..
    Eric: you need peakers (headphones) and a microphone...
    Eric: and prbly broadband ..”  [CIC]
Sandra: “is it a wiki page?
Discussing Media Usage for Communication Purposes [CIC] showed a wide range of occurrence between 0.6% and 10.0%. During sessions 2, 6* and 7 it was relatively low, between 0.6 and 3.4%, and peaking during session 5* and 6 with 10.0% and 4.6% respectively. The above excerpts, from session 6, display two passages where students talk about “where to meet next” and the importance of audio in online sessions, as well as using Skype™ instead of the text-based chat rooms.

In group A, Assigning Members to Activities [CT] ranged between 0.7% and 5.5%. The voluntary session 5* showed a high occurrence of 5.5% and session 6 showed a low of only 0.7%. Closure rates were relatively low, ranging between no closure and 0.9%. The following excerpt shows members from group A Assigning Members to Activities [CT].

Assigning activities in the first chat included more utterances directed towards others, than one’s self. This resulted in increased closure\textsuperscript{10} behaviour. As the course

\textsuperscript{10} Closure behaviour is defined as a direct response to a previous chat entry. It has to serve the sole purpose to close an entry; otherwise it was coded as initiation behaviour.
proceeded, students increasingly engaged in volunteering for a task. In terms of assigning activities, this was literally understood as assigning an activity to one's self. This resulted in fewer closures.

Sandra: “hey guys, im not quite sure how to start a wiki page... so i will need to read up on it”  

Excerpt 10 taken from session 6*, group A.

Finally, session 7 shows an increase in Assigning Members to Activities [CT], when group A used the chat to jointly create a wiki page.

Meaning Making [CIM] behaviour was not shown frequently. It was only used during session 6 and the voluntary session 6*. The following excerpt shows the passage during the voluntary chat session 6*.

Eric: “by raster surface they just mean computer screen don’t they?”  
Eric: “sabine  
- what’s the difference between the raster and visualisation”  
Eric: “isn’t it about the same thing?”  
Jane: “!-guys, if you look at the assignment details, we are to create a wikipage on Design of multimedia/hypermedia instrnal msgs, so i suppose it’s computer”  
Sabine: “its more on landforms?  
Sabine: does map comes with it  
Sabine: like google maps?”  
Jane: “!-sabine  
the paper’s using geography as its basis”  
Eric: “the theory applies to any multimedia resource”
5 Coordination: Results and Discussion

Sabine: “aok…” [NNC]
Eric: “that conveys detailed info using animation etc” [CIM]

Excerpt 11 taken from session 6*, group A.

Positive closure, such as acknowledgement, elaboration or agreement, showed a relatively large range from only a few initiations closed, to almost all initiations closed. Negative closure, such as disagreement, was almost not existent and showed only in a few instances.

Sabine: “so wer do we go from here?” [CIS]

...

Jane: “!-sabine,
i have no idea” [NNC] [CIS-]

Excerpt 12 taken from session 6*, group A.

5.1.1.1.2 Group B

As mentioned above, session 2 was combined for group A and B. Group B did not participate in any voluntary sessions and did not hold a chat session during week 7. During session 6, group B showed 31.4% coordination and 68.6% non-coordination related behaviour during their chat. Their chat behaviour consisted of Synchronisation and Demanding Activities (compare Table 11). Overall, coordination behaviour for group B consisted of just four different initiation behaviours during session 6.

Synchronisation [CIS] behaviour increased from 3.5%, during combined session 2, to 9.6% during session 6 for group B. It was Mark’s first time as a session moderator, and he utilized Synchronisation [CIS] as a means of moderation.
Sabine: “! – so what do we do now?”  
Mark: “would you guys bear with me because this is  
my first time moderating?”  
Sabine: “! – no worries”  
Jessica: “! – sure.”  

...  
Mark: “We will start by talking about the papers  
we read.”  
Mark: “Is that okay?”

Excerpt 13 taken from session 6, group B.

Group B did not meet online during session 7. Rather, they decided to meet face-to-face to accomplish the task.

Group B developed a habit of repeating questions, even though the fact was already stated before (see Excerpt 14). Although they could just scroll up and view what was said earlier, they rather asked a second time, as if in a face-to-face session. The following excerpt shows an exchange where students ask multiple times for the wiki creation task content. This results in redundant chat entries.

Jessica: “first  
Jessica: when is the presentation”

...  
Mark: “it is not a presentation. we just have to  
create our own wiki page, if i understand  
correctly.”

...  
Mark: “Is it on the wiki page, [name]?”

anne

...  
Lecturer 1(Anne): “yes, jessica, we are talking  
Lecturer 1 (Anne): about group wiki page  
Lecturer 1 (Anne): on motivation.”

...  
Jessica: “!- so we have to create a Wiki page”
5.1.1.1.3 Comparison Group A and B

This chapter focuses on session 6, as this is the only session both groups participated separately in online communication. Session 2 was a combined plenary chat session and online communication for sessions 5*, 6* and 7 was only conducted by group A.

Some differences exist between group A and B regarding coordination patterns for session 6. A Kolmogorov–Smirnov test for normality showed a non-significant Kolmogorov–Smirnov Z statistic ($Z = 1.19, p = .12$), indicating the distribution is not normal and non-parametric tests have to be conducted. A Mann–Whitney test revealed a significant difference ($p < .01$) between the two chat sessions for group A and B.

Group A showed a wider range of coordination (sub-) categories than group B during session 6. While group A’s chats showed eight different initiation behaviours, group B’s chat included only four. However, the two most frequently
shown behaviours, Synchronisation [CIS] and Demanding Activities [CIP], are shown with nearly equal percentages. Differences show in discussing Media Usage for Communication Purposes [CIC]: group B showing a slightly smaller percentage than group A. Furthermore, group B shows a higher percentage of assigning members to activities and more closure behaviour.

5.1.1.2 Discussion

Students using the chat only functionality not only revealed a different pattern within each chat session, but also between sessions as well as between groups.

5.1.1.2.1 Patterns within Sessions

Patterns within sessions can be identified. Even though overall coordination rates ranged between 18% and 66%, distribution of most coordination subcategories did not vary as much. Synchronisation behaviour was almost always the most common coordination behaviour, followed by Demanding Activities. These two sub–groups made up between 30–50% of the coordination behaviour.

The closure rates for Synchronisation [CIS] stabilized around 30–50%. The first chat session showed almost as many closures as initiations regarding synchronisation. The second chat revealed a gap between initiation and closure behaviour. After introducing the chat protocol, students did not just reply to any question or remark, rather they tried to stay focused (e.g. Excerpt 6 and Excerpt 7, Excerpt 17 and Excerpt 25).

The first chat session during week 2 presents an exception for several reasons. First of all, for many students, it was their first chat experience in an educational setting (Table 32, Excerpt 36). It was the only session to be completely held in a plenary
format. In terms of collaboration, it showed a particularly small amount of coordination behaviour. Students realised that the chat was chaotic and felt it was hard to follow. Thus, a chat protocol was established. Students realised, increased coordination and following of rules was accompanied by clarity and increased chat quality (Excerpt 25). As a result, overall coordination rates increased from 18% to at least 40% in group A (session 6) and 30% in group B (session 6), compare Table 11.

However, there seems to be an upper limit to the perceived usefulness of regulating mechanisms such as chat protocols and coordination activities enhancing chat quality. Students described chats as slow and the pace being inefficient. They felt it had a negative effect on task completion and said, conference calls might be a more efficient alternative when there is ‘a lot to work out’ (Excerpt 8).

Discussing Media Usage for Communication Purposes [CIC] ranged between 4.6% to 7.1% of all chat utterances. It showed an exceptional peak during session 5* for group A with 17.7%. During that session, students discussed how to coordinate their first group presentation for the following week’s face-to-face session. This was the first time during the semester they had to prepare for a face-to-face session, and as a group they had to find a way to prepare for such presentations. The assignment guidelines did not suggest any such procedures. However, on a more general basis, it seems talking about communication media usage is an ongoing need and is discussed during almost all sessions.

Additionally, students’ perception of synchronous communication media being slow and inefficient (Excerpt 9 and Excerpt 35) conforms with existing research (Pesendorfer & Koeszegi, 2006). Pesendorfer and Koeszegi (2006) mention, asynchronous communication media produce higher satisfaction amongst participants.
5.1.1.2.2 Patterns across Sessions

Patterns across sessions can be identified. Chat only sessions showed a higher coordination rate than others, voluntary sessions from group A depicting the highest. The nature of content discussed, and the intention of a particular session, can account for variations across sessions. Voluntary sessions, for example, served a coordination purpose discussing division of labour and the next steps on the current project. Session 7 posed an exception to other chat only sessions, students used the chat tool to coordinate the collaborative wiki page construction. For example, during session 7 it seemed to be more important to close Activity Demands [CIP] than in other sessions. This session also shows more instances of Assigning Members to Activities ([CT], Table 11).

Assigning members to activities ranged from 1.7% to 10.3%. During session 6, group A did not engage in the discussion of labour division for the next assignment, rather they postponed it to the next session. The session was completely composed of discussing online resources, and thus there was no need for assigning members to activities.

5.1.1.2.3 Patterns across Groups

Patterns across groups are also evident. Session 6, the single chat only session been held by both groups separately during the same week, reveals significant differences for each of the groups.

First of all, group A and B show different levels of coordination rates during the chats (40.8% for group A vs. 31.4% for group B). Researchers point to an important sensitive early period and its influence on the developing dynamics (Arrow et al., 2000; Kapur et al., 2007). Even though the two groups might have had similar starting conditions, they might have experienced different initial events. Such
differences led to different coordination patterns and resulted in a smaller coordination ratio. One reason for such differences might be different acceptance levels of online communication. Depending on the nature of students' sceptical, inexperienced or even resistant attitudes towards online communication and learning, it might be beneficial for later group dynamics to discuss belief systems and possibilities, as well as willingness to change them.

The nature of coordination differs between the two groups. While group A used a variety of coordination responses, group B only used four coordination actions; Synchronisation, Demanding Activities, Assigning Actors to Tasks and Discussing Media Usage for Communication Purposes as well as the closure of all of the above (Table 11). While it is not unfavourable to only incorporate four initiation behaviours, missing crucial coordination behaviours is disadvantageous. Goal-oriented behaviour, such as identifying goals or mapping goals to activities, was not shown. Since this aspect is only based on the observation and comparison of one chat session, the behaviour comparison using other tools is of interest.

Differences in the two groups' local dynamics support Arrow et al.'s (2000) elaborations on groups as complex systems. Even though both groups seem to have equal conditions and work in the same environment, they develop different dynamics specific to that group, e.g. regarding initiation–closure behaviour or the overall amount of coordination.

### 5.1.2 Chat with Whiteboard (Session 3 and 4)

The following sub-section presents findings and the associated discussion regarding the use of the chat tool with a combined whiteboard. Figure 13 shows a screenshot of the tool used. Please note, the screenshot does not portray an actual conversation during the course.
5.1.2.1 Findings

The chat room with whiteboard facility was used during two consecutive weeks, session 3 and 4, when students collaboratively produced concept maps. The following section provides a detailed evaluation of the coordination percentages in each of the sessions as shown by group A and B, respectively (Table 12).

Table 12: Percentage of all coordination codes during the chat and whiteboard sessions 3 and 4 for group A and group B respectively.

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---Table continued on following page---
## 5 Coordination: Results and Discussion

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<th>Session 3</th>
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<td>57.9</td>
<td>62.4</td>
<td>56.2</td>
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<td>12.5%</td>
<td>15.8%</td>
<td>12.3%</td>
<td></td>
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<tr>
<td>Total</td>
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<td>100</td>
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</tbody>
</table>
5 Coordination: Results and Discussion

5.1.2.1.1 Group A

The three most frequent initiation utterances in group A were, in descending order, Synchronisation [CIS], Demanding Activities [CIP] and Assigning Members to Activities [CT]. Excerpt 15 shows a typical interaction between group A members, including all three of the above stated coordination behaviours.

Susan (Lecturer 2): “who would like to start?!” [CT]
Jane: “? – shall i start first?” [CT+]
Sabine: “!- would it be ok if we agree first on the subject?” [CIP]
Susan (Lecturer 2): “yes, jane” [NNC]
Sabine: ! – ok [name] so that we’ll be guided” [CIP+]
jane [NNC]
Susan (Lecturer 2): "The subject is the role of teacher knowledge and learning experience" [CIP+]
Jane: “! - i'm done” [CIS]
Susan (Lecturer 2): "sabine, do you want to go next?” [CT]
Sabine: “! ok” [CT+]
Sabine: “! - am confused... are we talking about the case studies about the 4 teachers?” [NNC]
Susan (Lecturer 2): “we want to set up a concept map about the content of the article”
Susan (Lecturer 2): “the case studies are just one part of it” [NNC]
Sabine: “!-ok so can i change it?” [CT]
Susan (Lecturer 2): “Sure, go ahead sabine” [CT+]
Sabine: “! - ok! whew!” [CIS]
Susan (Lecturer 2): “What do you think [name]? do you want to add something?” [CT]
Eric [NNC]
Eric: “!-yes” [CT+]

Excerpt 15 taken from session 3, group A.
Group A also engaged in goal-related coordination behaviour (Identifying Goals [CG] and Mapping Goals to Activities [CA]) during the session (Excerpt 16). Susan, the second lecturer and moderator for that session, was the initiator.

Susan (Lecturer 2): “Your task will be to construct – collaboratively – a concept map on the Hughes et al article!”

Susan (Lecturer 2): “later on, after you feel confident using the whiteboard!” [CG]

Susan (Lecturer 2): “Please feel free to ask questions if you do not know how to use something” [CIP]

... Susan (Lecturer 2): Do you want to set up a rule on how to go about your task?”

Susan (Lecturer 2): “there are several options:

Susan (Lecturer 2): 1) everyone can just start at once

Susan (Lecturer 2): 2) you take turns” [CA]

Susan (Lecturer 2): “What do you prefer?” [NNC]

Erik: “?-susan” [NNC]

Susan (Lecturer 2): “yes, eric” [NNC]

Sabine: “! – i think its ok if we take turns” [CA+]

Eric: “!-susan-

what is the task?” [NNC]

Jane: ”! – taking turns will be less chaotic on the whiteboard i think” [CA+]

Lecturer 2 (Susan): “The task is to build a concept map on the Hughes et al article you read at home” [CG]

Excerpt 16 taken from session 3, group A.

During session 4, group A showed 37.6% coordination behaviour, using the full range of initiation utterances (Table 12). The three most frequent utterances remained the same compared to session 3: Synchronization [CIS], Demanding
Activities [CIP] and Assigning Members to Activities [CT], listed in descending order of occurrence. Additionally, they used all possible coordination utterances. This resulted in a wider variety of coordination utterances, with a smaller overall frequency of more common coordination behaviours.

Jane, the session moderator, initiated some of the goal–related behaviour (Excerpt 17). Susan, the second lecturer, posted the remainder of the goal–related utterances.

Jane: “! are we going in rounds?” [CIP]
Sandra: “! whos next?” [CIS]
Jane: “****** can we stop for a while?”
Jane: “! i need to remind you something” [CIP]
Sabine: “ok” [CIP+]
Sandra: “! Listening” [CIP+]
Jane: “once you think you have completed your
share on the whiteboard, please inform the
group so that the next one is ready to go. Is
that all right with you?” [CA]
Sandra: “! sounds like a great plan [name]” [CA+]

Excerpt 17 taken from session 4, group A.

Group A also Discussed Media Usage for Communication Purposes [CIC] (Excerpt 18).

Sabine: “if ever we run out of time for the
decision can we, have forums for this?” [CIC]
Jane: “! sure, why not? but that would mean we
have to actively check the forum this week” [CIC+]
Sandra: “yes I thinkn we might have to” [CIC+]

Excerpt 18 taken from session 4, group A.
Meaning Making [CIM] passages were directed towards the content of the map (Excerpt 19).

Jane: “? what do you mean by ‘classes’ ” [CIM]
...
Sabine: “i.e. semantic org tools, dynamic modelling tools, etc?” [CIM+]
Sandra: “? what classes are we talking about?” [CIM]

Excerpt 19 taken from session 4, group A.

5.1.2.1.2 Group B

During session 3, Group B employed Demanding Activities [CIP], Synchronization [CIS] and Assigning Members to Activities [CT] to create their concept map, listed in descending order of occurrence. They did not engage in goal–related behaviour during that session. Examples of typical coordination exchanges in group B are shown in Excerpt 20. The concept mapping creation started without much difficulty. However, the group experienced confusion as soon as they started working on the whiteboard and the moderator intervened to guide the process of the map construction (Excerpt 20).

Sandra: “!sorry guys i think I messed it up a bit”
Sandra: “! Still trying to get use to it” [CIS]
Mark: “me too” [NNC]
Jessica: “?- Anne [NNC]
you can see me???” [CIS]
Dave: “maybe we just need to spread the boxes around” [CIP]
Mark: “can’t figure out how to connect lines with the boxes” [NNC]
Jessica: “?-when ever i aske you a question you are not replying??” [CIS]
Anne (Lecturer 1): “******please hold on for a minute” [CIP]
Sandra: “? how do we move the boxes?” [NNC]
Anne (Lecturer 1): “****let’s get this organized a bit before we continue” [CIP]
Mark: “yes. good idea” [CIP+]
Sandra: “good idea” [CIP+]
Anne (Lecturer 1): “****is everything we have necessary?” [CIP]

Excerpt 20 taken from session 3, group B.

During session 4, the ranking of the three most frequent coordination utterances remained similar to session 3 for group B. They are, in descending order, Demanding Activities [CIP], Synchronisation [CIS] and Assigning Members to Activities [CT]. Additionally, they showed unusually frequent instances of Discussing Media Usage for Communication Purposes [CIC], which was initiated as frequently as Assigning Members to Activities [CT] with 5.5% during the session. Excerpt 21 and Excerpt 22 both show instances of Discussing Media Usage for Communication Purposes [CIC]. Excerpt 21 is not related to whiteboard use, but is concerned with the moderators’ rotation for future sessions, thus concerning chat maintenance.

Anne (Lecturer 1): “we need someone for wk4” [CT]
Sandra: “are we expected to facilitate for more than once? – anne” [NNC]
Anne (Lecturer 1): “let’s talk about this via email” [CIC]

Excerpt 21 taken from session 4, group B.

Sandra: “eric – think we need to ask all our quesitons in forum” [CIC]
...
Eric: “sandra – yes!” [CIC+]
Susan (Lecturer 2): “forum is the right place – good idea” [CIC+]
Group B experienced less confusion and stayed on track during the activity in session 4. First, they talked about a strategy for how to organize the concept map construction. This time they were much more hesitant to begin drawing on the map compared to session 3. They waited for the moderator to prompt map construction, following the moderator’s instructions more closely (compare to Excerpt 20).

Anne (Lecturer 1): “before we start, shall we have some agreement on the protocols?” [CIS]
Dave: “could we discuss how we are going to do it first” [CIP]
...
Dave: “should UPS be our starting point?” [CIP]
Anne (Lecturer 1): “yes” [CIP+]
Mark: “k” [CIP+]
Jessica: “yes” [CIP+]
Anne (Lecturer 1): “i know the other group” [NNC]
Mark: “then we should have the 3 phases” [CIP]
Dave: “maybe we add to the map as we discuss on chat” [CIP]
Anne (Lecturer 1): “talked while drawing the map” [NNC]
Anne (Lecturer 1): “shall we do the same?” [CIP]
Mark: “k” [CIP+]
Jessica: “yes” [CIP+]
Dave: “yes!!” [CIP+]
Anne (Lecturer 1): “let’s talk about where we shall start?” [CIP]
Mark: “UPS”
Mark: “?” [CIP+]
Anne (Lecturer 1): “technologies or pedagogies?” [CIP]
Jessica: “can we start with the value of computer” [CIP]
Goal–related behaviour shown during this session was uttered in relation to the following week’s task (Excerpt 24).

Excerpt 24 taken from session 4, group B.

5.1.2.1.3 Comparison Group A and B

Overall, both groups showed similar amounts of coordination behaviour during session 3 (43.1% for group A and 42.1% for group B). The nature of coordination during the session was also similar, with the exception of goal–related behaviour (Identifying Goals [CG] and Mapping Goals to Activities [CA]), which was only shown in group A, and one instance of discussing ‘Shared Resources’ [CIR] in group B.

Both groups showed a moderate variety of coordination behaviour during session 3. The three most frequent initiation utterances in both groups were Synchronisation [CIS], Demanding Activities [CIP] and Assigning Members to Activities [CT]. However, ranking order differed. Instances of other initiation codings were below the 1%–point mark for both groups.

Additionally, at the end of the session both groups discussed their concept mapping experience and tool use in a plenary forum (Excerpt 25). The passage illustrates the frustration and confusion students experienced during the session, as well as their thoughts on how they could improve during future concept mapping sessions.
Mark: “for a first time use, it was not bad. the important thing is we all understood the idea of a concept map and how it can be organised.” [NNC]

Anne (Lecturer 1): “the most important thing is to listen to each other” [NNC]

Dave: “that is probably the biggest challenge in here” [NNC]

Sandra: “yes but it didn’t seem that I got my questions answered” [NNC]

Jane: “!- and we can expect the same to happen to our students if we use this in the classroom” [NNC]

Dave: “sandra?”

Dave: “why do you think that is?” [CIS]

Eric: “ppl aren’t taking turns in the discussion” [NNC]

Eric: “and there are more than one conversation going on at the same time” [NNC]

Sandra: “well all I wanted to know was how to use the arrows to connect the boxes” [NNC]

Sandra: “never got an answer” [NNC]

Anne (Lecturer 1): “hold on, one at a time” [NNC]

Mark: “that’s true [name]..that’s why it would be nice to understand the tool before teaching it to students” [NNC]

jane [NNC]

Excerpt 25 taken from session 3, group A and B.

In session 4, group A showed 37.6% and group B 43.8% coordination behaviour during the chat tool and whiteboard usage.
Both groups used the full range of initiation utterances during session 4 (Table 12). Again, the three most frequent utterances remained the same, with different ranking orders in the two groups. Discussion of Media Usage for Communication Purposes [CIC] ranked third in group B, equally as frequent as Demanding Activities [CIP].

5.1.2.2 Discussion

During session 3 and 4, students collaboratively constructed a concept map in each of the sessions and used the chat tool, positioned in the same window, to coordinate their actions. During both sessions, students revealed characteristic coordination patterns. Pattern differences occurred across the two sessions and between the groups.

5.1.2.2.1 Patterns within Sessions

Both groups revealed a moderate variety of coordination behaviour during session 3, and the full range of possible coordination behaviour during session 4. The three most frequent coordination behaviours were Synchronisation [CIS], Demanding Activities [CIP] and Assigning Members to Activities [CT], not necessarily in that order. Almost all other coordination initiation behaviours remained under the 1% mark.

Generally, the groups used Demanding Activities [CIP] utterances to discuss content or display the concept map. They used Synchronisation [CIS] utterances to let other group members know they were done with their share of map construction. They used Assigning Members to Activities [CT] coordination utterances to ask for volunteers for the next step of construction, or to volunteer an activity (Excerpt 15, Excerpt 21 and Excerpt 23). Thus, actual concept map construction in the
whiteboard was coordinated through the synchronous chat (Pata & Sarapuu, 2006), mainly through a mixture of these three coordination behaviours in both groups.

5.1.2.2.2 Patterns across Sessions

Both groups increased the variety of coordination in session 4. While they used only a moderate variety of coordination during session 3, they employed the full range of coordination in session 4.

During session 3, students felt confused and frustrated. Much of the frustration was due to the fact that group members did not know how to use the tool (e.g. Excerpt 20). They also seemed to be overwhelmed by the situation as they repeatedly asked the same questions, such as ‘how to create an arrow’ or ‘how to select a box’. This was explained during the chat session, instead of scrolling up to view chat history or trying it out, they asked the moderator repeatedly. Sufficient communication is essential for solving a task with a whiteboard (Pata & Sarapuu, 2003). The repetition of identical questions hints to an insufficient coordination strategy. This comes as a cost since additional resources have to be put towards communication.

During the plenary forum, at the end of session 3 (Excerpt 25), students discussed their frustration and confusion. The raised issues concerned adequate synchronous chat use, and consequently the chat protocol, as well as using the whiteboard. In the following session 4, students in both groups experienced less confusion and frustration. They minimised coordination costs through the usage of a chat protocol and a coordination strategy for concept map construction.
5.1.2.2.3 Patterns across Groups

One difference between the two groups concerns the goal-related behaviour employed during the combined chat and whiteboard sessions. Group A used goal-related behaviour during both sessions. A behavioural pattern was established in this group, supporting research from Arrow et al. (2000). They argue, groups form unique patterns of interaction during the early stages of group formation. Such patterns can be different for each group and are distinct for a particular group. Once established, they are hard to change (Arrow et al., 2000).

Group B only showed goal-related behaviour during session 4 (Excerpt 24). It was initiated by one of the group members and not in relation to using the whiteboard or the week’s task. The utterances were quite often someone’s ideas and were stand-alone statements. Often, they did not trigger a response and consequently did not necessarily lead to goal-related action. This caused frustration, which students mentioned during the session 3 plenary. This interaction pattern changed during session 4 (Excerpt 23). However, the discussion still contained utterances that might have been suitable, but since group members did not respond, they lost their relevance, e.g. see some of the Demanding Activities [CIP] utterances in Excerpt 23. Such behavioural patterns come as a coordination cost to the group.

5.1.3 Wiki Pages (Session 7)

During session 7, group A used synchronous chat in addition to Plone®, to create a wiki page. Group B chose to coordinate the wiki page creation face-to-face. Therefore, coordination data does not exist for this session for group B11. The

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11 Group A conducted the session online, and the interaction has been analysed in earlier parts of this chapter.
synchronous chat has been analysed in the ‘chat only’ section since the tool used during the wiki-creation task differed from the whiteboard and writing devices. The latter two devices were integrated in the same window display and students could see all the features in the same window. Students created wiki pages in the Plone® environment. This was not integrated with the chat window and students had to switch windows, which resulted in a cooperative working style. Students divided the work so that they each could create their part independently and only relied on chat to coordinate how to put it all together.

5.1.4 Chat with Writing Function (Session 9)

A screenshot of the chat tool with writing function is shown in Figure 14. Please note, the screenshot is an example and does not portray an actual conversation during the course.

![Screenshot of the chat with writing function tool as experienced by the students.](image)
5.1.4.1. Findings

During session 9, students used a combined synchronous chat and a writing device tool. Both functionalities were accessible through the same window; they could chat in the lower part and simultaneously write in the upper part of the window.

The online collaboration system, which served as a platform for the online communication, provided students with the resources, but presented some difficulties during the session. The system was periodically inaccessible, creating confusion and frustration among course participants. Consequently, students discussed the systems’ technical stability and their coping strategies during the beginning of the chat session.

Overall, Group A showed 45.1% coordination and group B 50.8% coordination during the combined chat and writing device session. For detailed information on single coordination codes, see Table 13.

Table 13: Overview of coordination code percentages for both groups during session 9, which used a combined chat and writing tool.

<table>
<thead>
<tr>
<th>Coordination (%)</th>
<th>Session</th>
<th>Session 9 Group A</th>
<th>Session 9 Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identifying Goals</td>
<td>CG[ ]</td>
<td>.5</td>
<td>.3</td>
</tr>
<tr>
<td>Positive Closure</td>
<td>CG[+]</td>
<td>.3</td>
<td>–</td>
</tr>
<tr>
<td>Mapping Goals to Activities</td>
<td>CA[]</td>
<td>.3</td>
<td>.3</td>
</tr>
<tr>
<td>Positive Closure</td>
<td>CA[+]</td>
<td>.3</td>
<td>.3</td>
</tr>
<tr>
<td>Synchronisation</td>
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<td>10.8</td>
<td>16.2</td>
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<tr>
<td>Positive Closure</td>
<td>CIS[+]</td>
<td>6.0</td>
<td>4.3</td>
</tr>
<tr>
<td>Negative Closure</td>
<td>CIS[-]</td>
<td>1.8</td>
<td>.7</td>
</tr>
<tr>
<td>Demanding Activities</td>
<td>CIP[]</td>
<td>6.0</td>
<td>9.2</td>
</tr>
<tr>
<td>Positive Closure</td>
<td>CIP[+]</td>
<td>4.8</td>
<td>3.3</td>
</tr>
<tr>
<td>Negative Closure</td>
<td>CIP[-]</td>
<td>.3</td>
<td>.7</td>
</tr>
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5 Coordination: Results and Discussion

<table>
<thead>
<tr>
<th>Coordination (%)</th>
<th>Session</th>
<th>Session 9 Group A</th>
<th>Session 9 Group B</th>
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</thead>
<tbody>
<tr>
<td>Media Usage for</td>
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<td>Communication Purposes</td>
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<td>1.7</td>
</tr>
<tr>
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<td>CIC+</td>
<td>.3</td>
<td>.3</td>
</tr>
<tr>
<td>Negative Closure</td>
<td>CIC-</td>
<td>.3</td>
<td>.3</td>
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<tr>
<td>Assigning Group Members to Activities</td>
<td>CT</td>
<td>5.5</td>
<td>8.9</td>
</tr>
<tr>
<td>Positive Closure</td>
<td>CT+</td>
<td>3.9</td>
<td>4.0</td>
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<tr>
<td>Negative Closure</td>
<td>CT-</td>
<td>.5</td>
<td>.3</td>
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5.1.4.1.1 Group A

Group A encountered technical difficulties during session 9. The group members had to log out of the current room and into another to commence with the writing assignment. Some students got lost in the process, which caused confusion and delay during the session (Excerpt 26).

Sandra: “we have wasted so much time” [NNC]

...Jane: “sandra, we were just talking about getting consensus on the issue of the paper” [CIS]
Sandra: “ok” [CIS+]
Sandra: “what did you come up with?” [CIS]
Jane: “can you scroll up to see?” [CT]

Excerpt 26 taken from session 9, group A.
Even with difficulties, group A used the complete range of possible coordination initiations. They showed an overall of 45.1% coordination utterances. The three most frequent initiation utterances in group A were, in descending order, Synchronisation [CIS], Demanding Activities [CIP] and Assigning Members to Activities [CT]. Besides Discussing Media Usage for Communication Purposes [CIC] none of the other initiation utterances exceeded the 1%-point mark.

Collaboration through the chat, in the writing session, was dominated by the three most frequently used coordination behaviours, i.e. Synchronisation [CIS], Demanding Activities [CIP] and Assigning Members to Activities [CT]. Group members used Assigning Members to Activities [CT] utterances to volunteer for activities (Excerpt 27). They used Synchronisation [CIS] utterances to let the group know they had completed their work (Excerpt 28). Demanding Activities [CIP] concerned either writing device handling (Excerpt 27) or written artefact content (Excerpt 28).

Jane: “i shall start on the first note then. to put the issue up in the writing board” [CT]
Sandra: “ok” [CT+]
Sabine: “ok” [CT+]
Jane: “you should be able to see a note on “issue” now, go check it” [CIP]
Sandra: “i see it” [CIP+]

Excerpt 27 taken from session 9, group A.

Jane: “ok gals, i’m done… can you see the note” [CIS]
Sabine: “the “issue”? yes” [CIS+]
Jane: “how about the content? sabine” [CIP]
Sandra: “yes” [NNC]

Excerpt 28 taken from session 9, group A.
Group A Identified Goals [CG] and Mapped Goals to Activities [CA] during session 9 (Excerpt 29).

Sandra: “well i wasn’t quite sure
Sandra: about
Sandra: whether it is
Sandra: 500 words for the group or individual
Sandra: ?” [CG]

... 
Sabine: “so its says its 500 hundred words” [CG]
Jane: “yes” [CG+]
Sabine: “so how do we divide the tasks?” [CA]
Jane: “i would think that we need to get consensus
of the issue mentioned in the paper first” [CA+]
Jane: “then we can have a direction for our
writing” [CA]
Sabine: “alright...” [CA+]

Excerpt 29 taken from session 9, group A.

The Meaning Making [CIM] during that session concerned the paper writing process (Excerpt 30).

Sabine: “by definition, does that mean summary of
the paper?” [CIM]
Jane: “!- we don’t have to finish the paper today,
but at least we should know the outline and the
research paper thoroughly enough to complete it
by next wed” [CIS]
Sandra: “i agree –
jane” [CIS+]
NNC
Sabine: “ok.. which means to say that we’ll be
working on it the entire week until wed?” [CIM]
Sandra: “thats what i already wrote up” [CIM+]
Jane: “!-no [name], i think the definitions mean
things like what is science inquiry skills,
what is collaborative learning... etc” [CIM-]
sabine [NNC]

Excerpt 30 taken from session 9, group A.
They discussed Media Usage for Communication Purposes [CIC] mainly to arrange the next extracurricular meeting, during which they could finalize the task.

5.1.4.1.2 Group B

Group B showed an overall of 50.8% coordination utterances during the session. They used a moderate variety of coordination initiation utterances (Table 13). The three most frequent initiation utterances in group B were, in descending order, Synchronisation [CIS], Demanding Activities [CIP] and Assigning Members to Activities [CT] (Table 13). Besides Discussing Media Usage for Communication Purposes [CIC], which was used with a frequency of 1.7%, they also revealed goal-related behaviour (.3% Goal Identification [CG] and .3% Mapping Goals to Activities [CA]).

During session 9, discussion concerned the content of the written artefact. However, coordination was dominated by one of the three frequently used coordination behaviours, i.e. Synchronisation [CIS], Demanding Activities [CIP] and Assigning Members to Activities [CT]. Group B used coordination utterances similarly to group A.

The moderator for that session, Dave, initiated all of the goal-related behaviour (Goal Identification [CG] and Mapping Goals to Activities [CA]) during that session (Excerpt 31).

Dave: “right! we need to think about the structure of our work” [CG]

... Dave: “So we define: Groups. Then look at issues of function and modes etc”

Dave: “then looking at the issue of natural and artifical groups” [CA]
Group B discussed Media Usage for Communication Purposes [CIC] only in relation to contacting each other prior to the current session or the next session.

5.1.4.1.3 Comparison between Group A and B

Group A engaged in a chat twice as long as group B’s chat (621 entries for group A vs. 303 entries for group B). The difference is partially due to the fact that group A encountered technical difficulties, and had to change chat rooms. However, group B also engaged in a different communication style and task coordination strategy.¹²

Group A used the full range of coordination initiations, whereas group B used only some of them. Group B did not engage in the Discussion of Shared Resources [CIR] and did not use Shared Meaning Making [CIM] as a means of coordination.

Out of all coordination responses, group A showed a 56.8% initiation-rate and a 43.2% closure-rate. In group B, 72.1% of all coordination utterances were initiations and 27.9% closures.

5.1.4.2 Discussion

During the usage of a writing device, students revealed a characteristic pattern of coordination utterances. Some differences in patterns can be noticed across the two sessions and between the groups.

¹² Evaluated in more detail in the section concerning the influence of tasks on coordination.
5 Coordination: Results and Discussion

5.1.4.2.1 Patterns within Sessions

The nature of coordination behaviour was similar in both groups. The three most frequent coordination initiation behaviours were, in descending order, Synchronisation [CIS], Demanding Activities [CIP] and Assigning Members to Activities [CT]. Both groups employed goal-related behaviour and discussed Media Usage for Communication Purposes [CIC].

The frequent usage of Synchronisation [CIS] confirms findings from Noël and Robert (2004). Participants in their study named synchronous access as the most important feature for the ideal collaborative writing tool, followed by version control and easy communication. Coordination problems can be due to delayed communication, again emphasizing the importance of simultaneity in the collaborative writing process (R. Kraut et al., 1992).

5.1.4.2.2 Patterns across Groups

Group A showed a wider variety of coordination behaviours than group B. Furthermore, as in previous sessions, group A revealed a different pattern of initiation – closure behaviour than group B. Group A employed more closures in relation to initiations than group B (group A: 56.79% initiations and 43.21% closures, group B: 72.07% initiations and 27.92% closures). This points to different interaction styles in the two groups. Group B uttered more initiations, which were not necessarily responded to by group members. This coordination behaviour came at a cost to the group: The generally suitable coordination behaviour became irrelevant, as group members did not notice it.

Initiation–closure behaviour describes the ratio between chat entries initiating an action and those directly responding to such an action.
5.1.5 Discussion Forum (Session 10 and 12)

A screenshot of the discussion forum used is shown in Figure 15.

![Screenshot of the chat tool with whiteboard function as experienced by the students.](image)

Figure 15: Screenshot of the chat tool with whiteboard function as experienced by the students.

5.1.5.1 Findings

Students participated in an asynchronous discussion forum during sessions 10 and 12. The session’s moderator initiated most of the threads, group members not holding the moderator role did not initiate threads (compare Table 14). Students showed a general tendency towards less contribution and interactivity during session 12. This might be due to the fact that this was the second last unit for this semester, and students were increasingly busy studying for their final exams.

Table 14: Descriptive statistics for group A and group B during session 10 and 12, held in an asynchronous mode.

<table>
<thead>
<tr>
<th></th>
<th>Session 10 Group A</th>
<th>Session 12 Group A</th>
<th>Session 10 Group B</th>
<th>Session 12 Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Threads Overall</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Number of Replies Overall</td>
<td>21</td>
<td>7</td>
<td>24</td>
<td>20</td>
</tr>
<tr>
<td>Word count Overall</td>
<td>2129</td>
<td>1081</td>
<td>2318</td>
<td>1667</td>
</tr>
<tr>
<td>Number of Semantic Units Overall</td>
<td>72</td>
<td>32</td>
<td>101</td>
<td>58</td>
</tr>
</tbody>
</table>
An analysis of asynchronous discussion forum data, with regard to coordination behaviour, reveals a high percentage of utterances not related to coordination (Table 15). The only initiation of coordination behaviour shown during the asynchronous discussion forums are Synchronisation [CIS] and Demanding Activities [CIP].

Table 15: Overview of coordination code percentages for both groups participating in asynchronous discussion forums during sessions 10 and 12.

<table>
<thead>
<tr>
<th>Coordination (%)</th>
<th>Session</th>
<th>Session 10</th>
<th>Session 12</th>
<th>Session 10</th>
<th>Session 12</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Group A</td>
<td>Group A</td>
<td>Group B</td>
<td>Group B</td>
</tr>
<tr>
<td>Synchronisation</td>
<td>[CIS]</td>
<td>--</td>
<td>--</td>
<td>13.3</td>
<td>--</td>
</tr>
<tr>
<td>Demanding</td>
<td>[CIP]</td>
<td>--</td>
<td>3.1</td>
<td>2.0</td>
<td>--</td>
</tr>
<tr>
<td>Activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non - Coordination Of it:</td>
<td>NNC]</td>
<td>100.0</td>
<td>96.9</td>
<td>84.7</td>
<td>100.0</td>
</tr>
<tr>
<td>Names</td>
<td></td>
<td>4.2%</td>
<td>--</td>
<td>5.1%</td>
<td>8.6%</td>
</tr>
<tr>
<td>Discourse</td>
<td></td>
<td>95.8%</td>
<td>100%</td>
<td>94.9%</td>
<td>91.4%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

5.1.5.1.1 Group A

Group A showed no coordination during session 10, and only 3.1% Demanding Activities [CIP] utterances during session 12 (Table 15). One posting during session 12 served a coordination purpose (Excerpt 32). Jane, a regular group member, initiated the coordination utterance.

Re: How do Communication and Technology researchers study the internet? (Posted by Jane)
I suppose what we are doing now in this course, eg. mindtools, chat, discussion forum, has a lot to do with interactivity, some of the sessions are successful, some are not so (different opinions from individuals on this of course). Perhaps we can look into this? [CIP]

Excerpt 32 taken from the discussion forum during session 12, group A (thread 1).
5.1.5.1.2 Group B

Group B showed 13.3% Synchronisation [CIS] and 2.0% Demanding Activities [CIP] during session 10 (Excerpt 33 and Excerpt 34), and no coordination during session 12 (Table 15). The following excerpt shows postings coded as coordination behaviour during session 10. Jessica, the session moderator, initiated the two coordination purpose postings. A posting was naturally longer than a chat entry and usually contained more than one semantic unit.

Re: Barriers (Posted by Jessica)

... Before we close our discussion let me summarize some of the barriers which was mentioned by our group: [CIS]

... Re: Barriers (Posted by Jessica)

As summary, group B members prefer using discussion forum for learning rather than the chat for the following reasons: [CIS] Paul feel that: It is more beneficial to use the forum for reflective educational discussion. [CIS]

... Re: Barriers (Posted by Jessica)

Let’s change our direction in this discussion from being a student to act as a teacher ... [CIP]

Excerpt 33 taken from the discussion forum during session 10, group B (thread 1).

Re: Reflection (Posted by Jessica)

One of the barriers which was mentioned in the paper is the participation of the group members, low participation will lead to inactive collaborative discussion. So lets participate in this discussion and think of more barriers in order to make you discussion very active... [CIP]

[emoticon smiley] [NNC]
Re: Reflection (Posted by Jessica)

As this is the first experience for our group in using the forum, i would like to give some guidelines for participating in online discussions. Hope these guidlines are helpful. [CIS]

Excerpt 34 taken from discussion forum during session 10, group B (thread 2).

5.1.5.1.3 Comparison between Group A and B

Considering the fact that group B had one less group member, they showed an overall higher average word count per member compared to group A (group A: \( M = 671.8, SD = 437.0 \); group B: \( M = 1158.0, SD = 598.1 \)). This is true for each asynchronous sessions, even though students contributed less during session 12 (Table 16).

<table>
<thead>
<tr>
<th></th>
<th>Session 10 Group A</th>
<th>Session 12 Group A</th>
<th>Session 10 Group B</th>
<th>Session 12 Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Word count overall</td>
<td>1907</td>
<td>793</td>
<td>2086</td>
<td>1388</td>
</tr>
<tr>
<td>Average word count per member</td>
<td>476.8</td>
<td>198.3</td>
<td>695.3</td>
<td>462.7</td>
</tr>
</tbody>
</table>

Group A showed only some coordination behaviour in the second discussion forum and none in the first. Group B showed some coordination in their first discussion forum, but none during the second unit (Figure 16).

The nature of coordination behaviour is relatively similar. Both groups employed only initiations and no closures. Furthermore, they used only Synchronisation [CIS] and/or Demanding Activities [CIP] coordination.
5.1.5.2 Discussion

During session 10 and 12, students used asynchronous discussion forums. They revealed a characteristic pattern of coordination utterances.

5.1.5.2.1 Patterns within Sessions

During the asynchronous discussions, very few coordination utterances were shown. Some sessions did not reveal any coordination utterances at all. This confirms findings that asynchronous communication necessitates less procedural coordination compared to synchronous communication media (Pesendorfer & Koeszegi, 2006). However, asynchronous communication media still enclose coordination demands (Strijbos et al., 2005). Group members have the freedom to contribute anytime they like but still have to meet a certain deadline. This results in a demand for coordination support in asynchronous communication forms (Benbunan-Fich & Hiltz, 1999).
The few coordination utterances used were solely composed of Synchronisation [CIS] and Demanding Activities [CIP] attempts. None of them were closed. The nature of the coordination responses was similar to the conversation style used during the chat sessions. All Synchronisation [CIS] entries were initiated by group B's moderator to sum up the discussion (see Excerpt 33 and Excerpt 34). This was a strategy adopted directly from the synchronous sessions. While this can be a favourable strategy, in this case the discussion was manageable. If participants wanted a reminder of what was said, they could look up earlier discussion threads. Thus, coordination attempts from the moderator were neither suitable nor relevant and therefore came at a cost.

5.1.5.2.2 Patterns across Groups

Group B participated more actively than group A. They showed a higher word count per member during both sessions and higher coordination frequencies during session 10, due to how the moderator summarized the discussion.

5.1.6 Comparison between Tools

5.1.6.1 Findings

Online Discourse

The most striking difference in coordination behaviour, triggered by various tools, can be noticed between synchronous and asynchronous media (Figure 17). Coordination frequency in the chat sessions typically showed between 40% and 56%, with a few exceptions (Table 10). The first chat session during week 2 was a combined session for both groups and included only 18% coordination. Differences between the two groups can be noted. Group A showed an average of 42%
coordination behaviour in synchronous chat logs, where group B showed an average of 37% (Table 10). Asynchronous communication media triggered much less coordination, with an average of 1.6% for group A and 7.7% for group B (Table 15).

![Coordination Percentage per Tool and Group in the Various Sessions](image)

**Figure 17: Coordination percentage per tool and group in the various sessions**

*Voluntary, non-scheduled sessions; numbers in parenthesis indicate the session.

Overall, chat consisted of approximately 60% non-coordination behaviour (Table 17). From the remaining 40%, approximately 60% were composed of coordination initiation, 35% of positive closures and 5% of negative closures (Table 18). Closure behaviour did not differ between groups (Mann–Whitney U test, $U = 87422.500$, $p = .131$). From all closures, approximately 10% were disagreements or rejections, and 90% were due to acceptance, elaborations or clarifications (Table 19).

<table>
<thead>
<tr>
<th>Tools</th>
<th>Group A</th>
<th>Group B</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chat Only (S2)</td>
<td>14.1</td>
<td>13.0</td>
<td>13.6</td>
</tr>
<tr>
<td>Chat Only (+ Wiki, S7)</td>
<td>1.6</td>
<td>1.0</td>
<td>1.3</td>
</tr>
<tr>
<td>Chat Only* (S6)</td>
<td>24.5</td>
<td>23.5</td>
<td>24.0</td>
</tr>
<tr>
<td>Chat &amp; Whiteboard (S4)</td>
<td>59.7</td>
<td>62.5</td>
<td>61.1</td>
</tr>
<tr>
<td>Discussion Forum (S10)</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**Table 17: Frequencies of initiation, closure and non-coordination behaviour in group A and B.**

<table>
<thead>
<tr>
<th>Tools</th>
<th>Positive Closure (%)</th>
<th>Negative Closure (%)</th>
<th>Initiation (%)</th>
<th>Non-coordination (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>14.1</td>
<td>1.6</td>
<td>24.5</td>
<td>59.7</td>
</tr>
<tr>
<td>Group B</td>
<td>13.0</td>
<td>1.0</td>
<td>23.5</td>
<td>62.5</td>
</tr>
<tr>
<td>Overall</td>
<td>13.6</td>
<td>1.3</td>
<td>24.0</td>
<td>61.1</td>
</tr>
</tbody>
</table>

**Table 18: Frequencies of initiation and closure behaviour for the respective groups.**
5 Coordination: Results and Discussion

<table>
<thead>
<tr>
<th></th>
<th>Positive Closure (%)</th>
<th>Negative Closure (%)</th>
<th>Initiation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>35.0</td>
<td>4.1</td>
<td>60.9</td>
</tr>
<tr>
<td>Group B</td>
<td>34.6</td>
<td>2.8</td>
<td>62.6</td>
</tr>
</tbody>
</table>

Table 19: Frequencies of positive and negative closures for coordination behaviour in both groups.

<table>
<thead>
<tr>
<th></th>
<th>Positive Closure (%)</th>
<th>Negative Closure (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>89.5</td>
<td>10.5</td>
</tr>
<tr>
<td>Group B</td>
<td>92.6</td>
<td>7.4</td>
</tr>
</tbody>
</table>

Reflection on the Tools

The course's pedagogical rationale included various reflection passages throughout the chat sessions, as well as an assignment requiring students to reflect on their course experience. The following excerpts illustrate students' appreciation of the learning experience, as well as their prior experience with computer-based collaborative learning settings.

"One of the most difficult things to deal with while doing this course was the lack of F2F contact. I have become very aware of the importance of informal contact. Working online requires the learner to be much more focused, self-reliant and organised, especially as things seem to take much longer to do online. Any instruction that is not expressed clearly, any inconsistencies in the navigation or technical problems place a greater cognitive load on the learner (Moreno) and can quickly lead to frustration."

Excerpt 35, Eric's reflection on the course.

"Prior to enrolling in this course, I was using computers for fun such as using the chat rooms or the discussion forum to chat with my friend,
and exploring the internet to do some product or service search.”

“In the beginning I felt a bit confused, since it was completely new experience to me to work with ICT tools during the learning process. As a learner I must have particular skills to use online materials, including technical and personal expertise, plus adjustment to the transition to online leaning.”

Excerpt 36, Jessica’s reflection on the course.

During their first chat session, in week 2, students felt quite lost and could not easily follow the chat, as mentioned in a reflective passage the week after (Excerpt 37).

Dave: “! I’m just pleased that it is not as chaotic as last week” [NNC]
Lecturer 1 (Anne):”can you elaborate, [name]?” [NNC]
Dave [NNC]
Dave: “well the discussion was going all over the place and branching out
Dave: it was difficult to follow.” [NNC]
Mark: “you can say that again. i was very lost last week..” [NNC]

Excerpt 37 taken from session 3, reflecting on session 2.

Furthermore, during some of the chat sessions repetitive, reconfirming conversation loops occurred, shown in the following excerpt (Excerpt 38).

Eric: “were we just checking out the layout?” [CIS]
Susan: “yes” [CIS+]
Jane: “i think so, we have to design a webpage to talk about ‘visualisation’ ” [CA]
...
Sandra: “i think we were just checking out the layout like Eric mentioned” [CIS]

Excerpt 38 taken from session 6, group A and B.

During the first asynchronous discussion forum, in session 10, one thread of group B’s discussion concerned their perceptions of synchronous and asynchronous collaboration during the course (Excerpt 39).

Re: Reflection (Posted by Dave)
The course has predominantly used synchronous discussion with some asynchronous use. While there is a place for synchronous discussion, I feel it would be more beneficial to use asynchronous discussion for reflective educational discussion. [NNC]

For example, discussion readings would be better in an asynchronous discussion. There is not direct need to be synchronous, and asynchronous discussion allows for reflection and thought. [NNC]

Re: Reflection (Posted by Dave)

... This is not to say that there are no benefits to chat. Chat is a great way of meeting and doing a task where decisions need to be made and ideas pooled. For example, the group construction of text - wikipage and last weeks task. [NNC]

However, to discuss learnings and response to a reading or readings, a discussion forum is more appropriate. There is time to reflect on people’s comments and refer back to the readings or notes. Also response can be considered and reflected on before posting. [NNC]

Re: Reflection (Posted by Dave)

Even after we became familiar with Chat there still seemed to be a very superficial level to
our conversations on articles. While some good points arose during the chats, rarely did we take the conversation to any depth. [NNC]

I wonder if this would have been different if it was a discussion forum. [NNC]

Chat seems to be less productive than discussion forums. [NNC]

Re: Reflection (Posted by Mark)
I also believe discussion forums are a better form of reflective thinking. For starters, we can always go back and add to our ideas and add on the ideas of others. [NNC]

Excerpt 39 taken from discussion forum during session 10, group B (thread 2).

5.1.6.2 Discussion

Generally, coordination behaviour in synchronous and asynchronous tools differs substantially. Synchronous media include a rich variety of coordination utterances, whereas asynchronous media trigger very few coordination responses.

When considering Dennis and Valacich’s (1999) five media dimensions, the one dimension distinguishing synchronous media, as used in this study from the asynchronous discussion forum, is the ability to convey immediate feedback. This is high for all three synchronous tools and low for the discussion forum. This suggests, the immediacy of contact is linked to coordination attempts in groups. The aspect of coordination behaviour that is linked to immediacy of contact are Synchronisation [CIS] attempts (Malone & Crowston, 1991). Most past research has investigated synchronisation in coordination from a task perspective, aiming at interdependencies and time-dependent activities in the task performance process. However, research has not examined synchronisation behaviour in different media from a tool perspective. A few exceptions look at coordination from a systems
perspective (Malone & Crowston, 1994), targeting how widespread use of information technology changes the way people work together.

An integral part of synchronous communication are synchronisation efforts. Synchronous media produce a higher level of cohesion, compared to asynchronous media (Burke et al., 2001). However, synchronisation can come as a cost (Espinosa & Carmel, 2003). The reiteration of assuring everyone is on track, paying attention, having read the latest contributions or mails, comes as an additional strain to students in such an environment, especially since synchronisation makes up between 18 and 30% of all coordination behaviour. The cost of synchronisation becomes evident when students identify the medium “slow” and find it frustrating to use if there is a lot to work out (Excerpt 8). This type of coordination cost relates to Espinosa and Carmel’s (2003) notion of cost of delay. Cost is determined by delayed response rates, and clarification costs, determined by additional communication necessary to make up for misunderstandings.

Different coordination costs can be further investigated via differences in media dimensions, i.e. parallelism and rehearsability, as proposed by Dennis and Valacich (1999). The chat only tool, used in the present study, scores low on both dimensions. This describes the tool’s lacking ability to effectively hold more than one conversation at a time, and to provide students the opportunity to rehearse their message before sending. The discussion forum scores higher on both dimensions. However, students tried to hold more than one conversation at a time in the chat forum and felt pressured during the beginning of the course, due to the speed of the medium. This aspect of the tool, in connection with participants’ behaviour, came as a coordination cost to the group. Both cost aspects were reduced as the course proceeded: 1) by a chat protocol, so students would not try to hold more than one conversation at a time and 2) by accumulated participants’ experience, so they no longer perceived the medium as too fast.
Research by Suthers and others (e.g. Suthers, 2001, 2007; Suthers et al., 2006) suggests differences between tools with different representational guidance ability, i.e. graphic vs. text. Findings from the present study do not support this for coordination dynamics. Even in the synchronous sub-category, including tools with different abilities to convey symbol variety\(^\text{14}\), participants did not show sustainably different coordination behaviour. The chat only tool and chat combined with writing functionality both conveyed textual information. The chat with integrated whiteboard tool was able to portray different symbols, and thus coordination patterns should be distinguishably different. Findings in this case-study do not reveal any differences. One possible explanation could be that students did not actually communicate through the whiteboard, but through the chat tool. Therefore, the means of communication and consequently coordination were text-based.

However, it is not desirable to completely extinguish synchronisation behaviour in online communication. Synchronisation behaviour can be channeled with a few rules, such as agreement on expecting everyone to have read the assigned readings. Accountability, being held responsible for one’s actions, is an important part of social processes (Erickson & Kellogg, 2000). Naturally, accountability in online sessions is not as high as in face-to-face interaction. Having to face the group while admitting one has not done one’s share of work, is more distressing than online. Thus, students find it easier to get away with not reading assigned articles in online environments (Excerpt 65).

In order to introduce students to using chat for education, it might be helpful to point out similarities and differences to other forms of synchronous communication.

\(^{14}\) Symbol variety incorporates the medium’s ability to transmit information in a variety of different channels and ways, see media characterisation by Dennis and Valacich (1999) in sub-section 2.3.3.2.3 Media Synchronicity.
communication, including face-to-face communication. To some extent this was done by introducing a chat protocol. This protocol points out major issues, such as remaining on topic, not interrupting a current conversation, and taking care to insert the person’s name in a reply.

In addition, encouraging the use of the chat history, students can decrease the amount of redundant chat entries, such as asking about issues already tackled. Students did not use the chat history prior to session 9, where the moderator instructed one of the members to “scroll up the window” instead of providing a summary (Excerpt 26). Asking for a discussion summary when absent is a characteristic of face-to-face communication, but is not an effective strategy in online environments.

Generally, online communication does not include much disagreement amongst members (Bonk et al., 2004). This becomes evident through the amount of positive and negative coordination closures (approximately 90% agreement and 10% disagreement). Students seldom criticize or plainly disagree with one another online. Bonk et al. (2004) mention the lack of disagreement as one problem in online learning. It could be useful to introduce a rule enforcing disagreement instead of too much agreement. Introducing productive, purposeful disagreement into online discourse could target repetitive, reconfirming loops, as revealed during chat sessions (Excerpt 38).

5.1.7 Summary and Concluding Remarks

The three different synchronous tools, i.e. chat only, chat with whiteboard, chat with writing function, showed a variety of coordination behaviours, with Synchronisation [CIS], Demanding Activities [CIP] and Assigning Group Members to Activities [CT] as the most common coordination behaviours. Positive closures were shown on a
Coordination clearly puts demands on the groups. The cost of coordination became evident when both groups showed episodes of unsuitable or irrelevant coordination attempts. For example, continuous reiteration of assuring everyone is on track and paying attention comes as an additional strain to the group. Furthermore, some students showed behaviour incongruent to the mediums’ characteristics. Such incongruent behaviour comes as a cost as well.

One way of meeting coordination demands is to introduce a chat protocol to the group. This minimises coordination costs. Another way is the proper tool choice. Asynchronous communication tools trigger much less coordination. The congruence between media characteristics and member behaviour can benefit coordination and minimise coordination costs. However, one has to consider, the communication tool is not the only factor to influence coordination. There are other factors, i.e. tasks and members, which will be investigated in the following two sections of this chapter.
5.2 Tasks

The following section presents coordination behaviour, as expressed within each task. Assigned tasks ranged from discussions to concept map construction and joint wiki page creation, to collaboratively writing a short paper. Except for the discussion task, enacted through two different tool types, i.e. synchronous vs. asynchronous, all other tasks were accomplished with a synchronous tool.

5.2.1 Discussion Task (Session 2, 6, 10 and 12)

The following sub-section presents findings, and associated discussion, regarding discussion assignments. Discussion tasks were enacted during two synchronous sessions (sessions 2 and 6) as well as both asynchronous sessions (sessions 10 and 12). Table 20 provides a short description of the discussion task assignments.

<table>
<thead>
<tr>
<th>Session</th>
<th>Short Task Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session 2</td>
<td>Students were instructed to read and discuss short papers written by their peers. The short papers served as the first graded assignment during that course and elaborated on a chosen learning theory from a pool of designated theories.</td>
</tr>
<tr>
<td>(Synchronous)</td>
<td></td>
</tr>
<tr>
<td>Session 6</td>
<td>Students were instructed to read and discuss short papers handed in by their peers. The short papers served as the third graded assignment during the course. It asked students to identify a web-based multimedia learning resource and to write a critique of the resource by using Cognitive Load Theory. During the following discussion, students had to visit the multimedia learning resources listed in the papers, after reading the papers, and then discuss the paper and the learning resource.</td>
</tr>
<tr>
<td>(Synchronous)</td>
<td></td>
</tr>
</tbody>
</table>

-Table continued on following page-
5 Coordination: Results and Discussion

<table>
<thead>
<tr>
<th>-- Table continued --</th>
</tr>
</thead>
</table>
| **Session 10**  
(Asynchronous) | Students were instructed to discuss CSCL related issues that were raised in the other group’s paper during the previous week. Each of the groups collaboratively wrote a 500-word paper online on an assigned CSCL topic during session 9. They were then asked during the following session to view their peers’ group paper. The assigned moderator had to post questions while the remaining group members discussed the issues. |
| **Session 12**  
(Asynchronous) | Students were instructed to discuss the readings for that session. Three different readings were assigned on the topics of hypermedia and multimedia-based instruction. The assigned moderator generated and posted questions, while group members discussed. |

5.2.1.1 Findings

Session 2

During session 2, the group discussed the match between group specifics, such as member expectations, skills or prior experience, and the course goals. They also discussed their first assignment topics. Every student chose a learning theory, and the assignment was posted online. Afterwards, students compared and discussed the theories.

The discussion was comprised of 216 semantic units for group A and B, as this was a plenary session. Only 9.3% of all chat utterances were coded as coordination behaviour in the discussion. Only four coordination utterances were observed more than once: Demanding Activities [CIP] and the accompanying Positive Closure [CIP+], Assigning Members to Activities [CT] as well as Discussing shared Resources [CIR] (see also Table 21).
Table 21: Coordination codes for group A and B in the respective discussion passages.

<table>
<thead>
<tr>
<th>Coordination (%)</th>
<th>Session 2 Group A &amp; B</th>
<th>Session 6 Group A</th>
<th>Session 6 Group B</th>
<th>Session 10 Group A</th>
<th>Session 10 Group B</th>
<th>Session 12 Group A</th>
<th>Session 12 Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Synchronisation [CIS]</td>
<td>0.5</td>
<td>2.6</td>
<td>3.4</td>
<td>–</td>
<td>13.3</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Positive Closure [CIS+]</td>
<td>0.5</td>
<td>–</td>
<td>2.3</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Demanding Activities [CIP]</td>
<td>1.9</td>
<td>–</td>
<td>3.4</td>
<td>–</td>
<td>2.0</td>
<td>3.1</td>
<td>–</td>
</tr>
<tr>
<td>Positive Closure [CIP+]</td>
<td>1.4</td>
<td>–</td>
<td>3.4</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Media Usage for</td>
<td>0.5</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Communication Purposes</td>
<td>[CIC]</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Positive Closure [CIC+]</td>
<td>0.5</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Assigning Group Members to Activities [CT]</td>
<td>1.9</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Positive Closure [CT+]</td>
<td>0.5</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Negative Closure [CT–]</td>
<td>0.5</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Meaning Making [CIM]</td>
<td>0.5</td>
<td>2.6</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Positive Closure [CIM+]</td>
<td>–</td>
<td>5.3</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Shared Resource [CIR]</td>
<td>0.9</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Non-Coordination Of it:</td>
<td>90.7</td>
<td>89.5</td>
<td>87.4</td>
<td>100.0</td>
<td>84.7</td>
<td>96.9</td>
<td>100.0</td>
</tr>
<tr>
<td>Names</td>
<td>6.0%</td>
<td>9.4%</td>
<td>4.3%</td>
<td>4.2%</td>
<td>5.1%</td>
<td>–</td>
<td>8.6%</td>
</tr>
<tr>
<td>Discourse</td>
<td>94.0%</td>
<td>90.6%</td>
<td>95.7%</td>
<td>95.8%</td>
<td>94.9%</td>
<td>100%</td>
<td>91.4%</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

The coordination behaviour observed was partially tool and partially task related. Tool related coordination was shown when students discussed the current communication media (Excerpt 40 and Excerpt 41.)
5 Coordination: Results and Discussion

Jane: “let me get this right...we are NOT in the discussion forum now, are we?” [CIC]

...Lecturer 2 (Susan): “Hi [name]

Jane

we are in the Chat room [acronym]

:)” [NNC]

Jane: “that does mean that we have to get out of this chatroom to look at the discussion forum later?” [CIM]

Excerpt 40 taken from session 2, group A and B.

Kathryn: Do you know, everyone, this is my first time online. [CIR]

I am very excited.” [NNC]

...Sandra: “same here...first time with an online class” [CIR]

Excerpt 41 taken from session 2, group A and B.

Task related coordination can be observed when students were confused about the current discussion (Excerpt 42) or asked for action on the current topic (Excerpt 43).

Dave: “Susan,

not sure what the chatting is: bios or artificial intelligence???” [CIS]

Excerpt 42 taken from session 2, group A and B.

Eric: “we should follow up this activity with a reflective task – that would be good Constructivist practice” [CT]

Excerpt 43 taken from session 2, group A and B.

After the session discussion, students engaged in a short reflection about their online medium experience. During reflection, one student commented on the chat
content, mentioning he missed reflective comments during the discussion. The lecturer (Susan) asked students if they could name any suggestions regarding how the chat experience could be easier and better next time. Students provided tool and task-related suggestions: to have a stronger focus on the topic and to develop chatting skills.

**Session 6**

During session 6, students provided feedback to each other’s assignments. Their assignment was to pick and critically evaluate an online learning web-resource and post it on a wiki page. Afterwards, the groups met in a chat room to discuss the assignments. The session 6 discussion contains 38 semantic units for group A and 87 for group B.

Group A showed 10.5% coordination behaviour (Table 21), composed of one Meaning Making [CIM] incident, two Positive Closures [CIM+] and one incident of Synchronising Activities [CIS].

Group B showed 12.6% coordination behaviour during session 6. It was composed of three incidents of Synchronisation [CIS] and two incidents of Positive Closure [CIS+] as well as three incidents of Demanding Activities [CIP] and three incidents of accompanying Positive Closure [CIS+] (Table 21, page 193).

The most coordination behaviour related to confusion about what topic to discuss (Excerpt 44).

Mark: “We will start by talking about the papers we read.” [CIP]
Mark: “Is that okay?” [CIS]
Sabine: “ok” [CIP+]
Jessica: “!-yes” [CIP+]

Excerpt 44 taken from session 6, group B.
Sessions 10 and 12

During the discussion forums in session 10 and 12, one assigned moderator had to create two to three questions, typically in relation to the weekly readings. The moderator posted the questions online and group members commented. Group A’s discussion was composed of four threads (72 semantic units) in session 10 and two threads (32 semantic units) in session 12. Group B’s discussion was composed of four threads (98 semantic units) in session 10, and three threads (58 semantic units) in session 12 (Table 14).

Table 22: Semantic units for group A and group B during session 10 and 12, held in an asynchronous mode.

<table>
<thead>
<tr>
<th></th>
<th>Session 10</th>
<th>Session 12</th>
<th>Session 10</th>
<th>Session 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Semantic</td>
<td>72</td>
<td>32</td>
<td>98</td>
<td>58</td>
</tr>
<tr>
<td>Units Overall</td>
<td>Group A</td>
<td>Group A</td>
<td>Group B</td>
<td>Group B</td>
</tr>
<tr>
<td>Semantic Units Thread 1</td>
<td>28</td>
<td>12</td>
<td>19</td>
<td>24</td>
</tr>
<tr>
<td>Semantic Units Thread 2</td>
<td>22</td>
<td>20</td>
<td>41</td>
<td>23</td>
</tr>
<tr>
<td>Semantic Units Thread 3</td>
<td>11</td>
<td>–</td>
<td>28</td>
<td>11</td>
</tr>
<tr>
<td>Semantic Units Thread 4</td>
<td>11</td>
<td>–</td>
<td>10</td>
<td>–</td>
</tr>
</tbody>
</table>

Group A showed no coordination behaviour during session 10, and only one incident of Demanding Activities [CIP] during session 12 (Excerpt 32, page 177).

Group B showed 17.8% coordination behaviour during session 10, and no coordination behaviour during session 12. The coordination behaviour during session 10 was composed of 13 incidents of Synchronisation [CIS] behaviour and two incidents of Demanding Activities [CIP] (Excerpt 34, page 179). All synchronisation passages attempted to bring everyone in the group up to the same knowledge level by summarizing previous discussions. The moderator, Jessica, posted all of the coordination attempts. She posted the questions and used this particular behaviour as a means of introducing a new aspect into the discussion.
Task Difficulty Rating

Students answered a questionnaire regarding perceived task difficulty during discussion sessions. Students rated the discussion tasks during sessions 2, 6 and 10 as easy (compare Table 23). The weekly assignments were composed of identifying a web-based multimedia learning resource, and short paper preparation. The chat session tasks were composed of content-discussion and the division of labour for the next session’s task. The task difficulty for session 12 was perceived easy in group A and not difficult in group B. The assignments during that week were composed of writing a short and a long paper.

Table 23: Average perceived task difficulty* (standard deviation in brackets) during discussion tasks.

<table>
<thead>
<tr>
<th></th>
<th>Session 2</th>
<th>Session 6</th>
<th>Session 10</th>
<th>Session 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>2.75 (0.50)</td>
<td>2.67 (0.58)</td>
<td>3.00 (0.00)</td>
<td>2.00 (0.00)</td>
</tr>
<tr>
<td>Group B</td>
<td>2.00 (0.00)</td>
<td>1.50 (0.71)</td>
<td>2.33 (0.58)</td>
<td>2.67 (0.58)</td>
</tr>
</tbody>
</table>

*The questions were rated on a scale ranging from, very difficult (0), difficult (1), not difficult (2), easy (3) to very easy (4). The questionnaire asked for the perceived task difficulty during the last week.

5.2.1.2 Discussion

Overall, students showed little coordination behaviour during discussion passages. Generally, very few Synchronisation [CIS] and Demanding Activities [CIP] utterances characterized coordination behaviour during discussion. Two distinct patterns became evident in the coordination behaviour analysis during discussion passages: one within each discussion and one across discussion sessions.

Generally, students rated discussion tasks as “not difficult” with a tendency towards “easy”. This suggests, they felt comfortable with the task and did not experience uncertainty.
5.2.1.2.1 Patterns within Sessions

Discussion Session 2

The first chat session, session 2, revealed a wide variety of coordination behaviour, with most of the coordination behaviours occurring once or twice. The coordination behaviour during the discussion passage can generally be allocated to one of two categories: task-related and tool-related coordination.

The discussion passage is characterised by a variety of task-unrelated coordination concerning the communication medium, prior experience or other unrelated difficulties (Excerpt 40 and Excerpt 41).

Some task-related coordination resulted from the characteristics of the communication medium. One example is a member’s demand to move on to the next activity, which is only suitable in synchronous communication environments. Students engaging in asynchronous discussion forums can choose when to move on to the next task.

Mostly, task-related coordination consisted of Synchronising [CIS], Demanding Activities [CIP] and Assigning Members to Activities [CT], including the respective closures. For example, this occurred when students asked for further information on a topic or commented on teaching practices (Excerpt 42 and Excerpt 43).

Viewing coordination in terms of cost (Espinosa & Carmel, 2003), one would like to have as little coordination as possible and the coordination shown should be suitable and relevant. The analysis of discussion passages during session 2 reveals, improvements can be made in order to minimise task-unrelated coordination. To ensure learning on a particular topic, on-topic discussion has to take place (Guzdial & Turns, 2000). Even though discussing other issues, i.e. social, might have a
positive effect on online learning (Kreijns et al., 2002), sustained on-topic discussion can serve as an indicator for knowledge gain, regarding the topic. Naturally, if students continually talk about a topic, it is more likely they will gain knowledge. Additionally, a stronger focus on on-topic discussion would further decrease discussion confusion, for example when students lose the discussion focus, often occurring because different topics were discussed at once (Excerpt 42).

**Discussion Session 6**

The session 6 discussion passage showed a small variety of coordination behaviour. Coordination was mostly task-related, including confusion about the discussion topic (e.g. Excerpt 44).

Both discussions showed suitable coordination utterances. The only coordination behaviour during this session that could be improved was students’ confusion about the discussion topic, which proved an issue for both groups. One suggestion could be clearer and more detailed instructions. One student reflected, missing face-to-face contact made learning more vulnerable to inconsistencies in instructions (Excerpt 35). However, clearer and more detailed instructions cannot guarantee less confusion, as students still might not read instructions properly (Guzdial & Turns, 2000).

**Discussion Session 10**

During discussion in the asynchronous forum both groups showed little coordination behaviour. Group A showed no coordination at all and group B showed only 15.3% coordination. The coordination was entirely task-related and initiated by the moderator. She used coordination as a means of summarizing arguments from earlier replies.
The few coordination responses were suitable but not relevant. While summarizing is a helpful technique in learning processes, it could have been helpful to restrain summary to only a few major points, minimising coordination cost.

**Discussion Session 12**

During the session 12 discussion, group A showed one task-related incident of Demanding an Activity [CIP], while group B showed no coordination. Discussion during this session included very few coordination utterances, the few present were suitable and relevant for the particular instance.

**5.2.1.2.3 Patterns across Sessions**

Comparing discussion passages across different sessions revealed two different findings. The first chat session was different from the following sessions in the variety of coordination behaviour. In general, coordination behaviour differs in synchronous media and asynchronous media.

The discussion during the first chat session showed a wider variety of coordination behaviour than any other discussion, even though it did not show more coordination behaviour overall. This might be due to the introduction of the chat protocol during session 3. The subsequent online communication was more focused. Incidents such as asking topic–unrelated questions during a discussion did not occur after adopting the protocol. The variety of coordination behaviour changed accordingly. The only categories of coordination shown after session 2 were Synchronising [CIS], Demanding an Activity [CIP] and Meaning Making [CIM] as well as their respective closures. Additionally, passages where students mentioned it was their first time online or clarified communication means, were due to the
novelty of the medium (Excerpt 41 and Excerpt 40), and did not occur in the later discussion sessions.

Discussions mediated through asynchronous communication media showed even less coordination behaviour compared to synchronous media. Coordination in the discussion forum was completely task-related while synchronous discussion passages revealed a mixture of tool- and task-related behaviour. Some behaviour was relevant and suitable, while some could be improved. The implementation of a chat protocol can minimise off-topic entries or parallel multiple topic discussion.

5.2.1.2.3 Patterns across Groups

Patterns across groups were not evident, with the exception of the discussion forum in session 10, where group B revealed a higher level of coordination behaviour due to moderator summarizing.

Even though coded differently, groups demonstrated the same uncertainty about the discussion topic. While group A uses a meaning making passage, group B uses Synchronisation [CIS]. Most of the remaining differences in coordination were due to the group B moderator who used Synchronisation [CIS] and Demanding Activities [CIP] as a mean of facilitation.

It becomes evident that the influences of task and tool on the group behaviour of in online environments are intertwined. Both aspects affect coordination dynamics of a group performing in a computer-mediated environment (Arrow et al., 2000). Moreover, individual members can also impact coordination dynamics in a group by their personal facilitation style.
Discussion in a synchronous environment does not ask for much coordination behaviour. If the discussion task is clear and students are not confused about the discussion topic, the only coordination occurring is demanding to further elaborate on particular task aspects, or summarizing to keep everyone on the same level.

One must consider, while some coordination might not be relevant from neither a task nor a tool perspective, it might support other relevant aspects of group dynamics. It might serve a social function in online communication (Kreijns et al., 2002). One example of such behaviour is students admitting they are participating in an online class for the first time (Excerpt 41). It might not be relevant for task or tool interaction, but such a response contributes to the group awareness of members’ expertise and competence. Faraj and Sproull (2000) point out the importance of expertise coordination for tasks that are more knowledge and skill dependant, compared to discussion tasks. However, the group does not change its composition over the semester; students can utilize the knowledge gained from such responses in later tasks.

In conclusion, while some patterns concerning discussions in online communication can be identified, it becomes evident that group dynamics in online environments are complex. No factor can be singled out to account for group dynamics on its own (Arrow et al., 2000).

5.2.2 Concept Mapping Task (Session 3 and 4)

Students engaged in concept map creation during two consecutive synchronous sessions (sessions 3 and 4). Table 24 provides a short description of the assignment during the concept mapping tasks.
### Table 24: Short task description during concept mapping tasks

<table>
<thead>
<tr>
<th>Session 3 (Synchronous)</th>
<th>Create a concept map on one of the two readings for this session. Choose a topic first to practice until you feel comfortable with the whiteboard use.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session 4 (Synchronous)</td>
<td>Create a concept map on one of the two readings for this session. Group A: article 1, group B: article 2.</td>
</tr>
</tbody>
</table>

#### 5.2.2.1 Findings

In each of the two concept mapping sessions, different concept maps were constructed in a whiteboard facility. Students had the opportunity to chat and coordinate their whiteboard actions in the same window. The software allowed all students to draw and manipulate the map at the same time. None of the students had prior experience with concept map construction, neither paper-based nor online. They were introduced to articles explaining the theoretical concept as well as research concerning concept maps.

Overall, coordination ranged between 47.0% and 58.3%. Group A’s chat during the concept mapping task composed of 100 semantic units in session 3 and 184 in session 4. Group B’s chat during the concept mapping task was composed of 155 semantic units in session 3 and 168 in session 4. During the concept mapping activity, a wide variety of coordination behaviour was shown, ranging from a few instances of goal identification [CG], Mapping Activities to Goals [CA], Meaning Making [CIM] and Discussion of Shared Resources [CIR] to more frequent instances of Assigning Members to Activities [CT], Synchronisation [CIS] and Demanding Activities [CIP] (Table 25). Additionally, coordination utterances were often accompanied by the respective closures. Closures were mostly composed of positive acknowledgement or elaboration requests.
Table 25: Coordination codes for group A and B in the respective concept mapping passages.

<table>
<thead>
<tr>
<th>Coordination (%)</th>
<th>Session 3 Group A</th>
<th>Session 3 Group B</th>
<th>Session 4 Group A</th>
<th>Session 4 Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identifying Goals</td>
<td>CG]</td>
<td>3.0</td>
<td>-</td>
<td>0.5</td>
</tr>
<tr>
<td>Positive Closure</td>
<td>CG+]</td>
<td>-</td>
<td>-</td>
<td>0.5</td>
</tr>
<tr>
<td>Mapping Goals to Activities</td>
<td>CA]</td>
<td>1.0</td>
<td>-</td>
<td>0.5</td>
</tr>
<tr>
<td>Positive Closure</td>
<td>CA+]</td>
<td>2.0</td>
<td>-</td>
<td>1.1</td>
</tr>
<tr>
<td>Assigning Group Members to Activities</td>
<td>CT]</td>
<td>10.0</td>
<td>4.5</td>
<td>7.6</td>
</tr>
<tr>
<td>Positive Closure</td>
<td>CT+]</td>
<td>6.0</td>
<td>0.6</td>
<td>3.8</td>
</tr>
<tr>
<td>Synchronisation</td>
<td>CIS]</td>
<td>7.0</td>
<td>7.1</td>
<td>9.2</td>
</tr>
<tr>
<td>Positive Closure</td>
<td>CIS+]</td>
<td>4.0</td>
<td>2.6</td>
<td>3.8</td>
</tr>
<tr>
<td>Negative Closure</td>
<td>CIS-]</td>
<td>-</td>
<td>-</td>
<td>0.5</td>
</tr>
<tr>
<td>Demanding Activities</td>
<td>CIP]</td>
<td>9.0</td>
<td>19.4</td>
<td>8.2</td>
</tr>
<tr>
<td>Positive Closure</td>
<td>CIP+]</td>
<td>5.0</td>
<td>9.0</td>
<td>6.5</td>
</tr>
<tr>
<td>Negative Closure</td>
<td>CIP-]</td>
<td>-</td>
<td>-</td>
<td>0.5</td>
</tr>
<tr>
<td>Meaning Making</td>
<td>CIM]</td>
<td>-</td>
<td>-</td>
<td>1.6</td>
</tr>
<tr>
<td>Positive Closure</td>
<td>CIM+]</td>
<td>-</td>
<td>-</td>
<td>0.5</td>
</tr>
<tr>
<td>Shared Resource</td>
<td>CIR]</td>
<td>-</td>
<td>0.6</td>
<td>-</td>
</tr>
<tr>
<td>Non - Coordination Of it: Names</td>
<td>NNC]</td>
<td>53.0</td>
<td>56.1</td>
<td>54.9</td>
</tr>
<tr>
<td>Discourse</td>
<td>NNC]</td>
<td>9.0%</td>
<td>11.0%</td>
<td>9.8%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

5.2.2.1.1 First Concept Map (Session 3)

Group A

During session 3 group A showed 47% coordination behaviour. The second lecturer, Susan, moderated the chat. The three most frequent coordination behaviours were Assigning Group Members to Activities [CT] with 10%, Demanding Activities [CIP] with 9% and Synchronisation [CIS] with 7%.

While coordinating the concept map creation, members of group A either asked for volunteers (Excerpt 45 and Excerpt 46) or volunteered themselves.

*Lecturer 2 (Susan): “who would like to start?!”*  [CT]
5 Coordination: Results and Discussion

Jane: “? – shall i start first?”  [CT+]

Excerpt 45 taken from session 3, group A.

Sabine: “!-ok so can i change it?”  [CT]
Lecturer 2 (Susan): “Sure, go ahead”  [CT+]

Excerpt 46 taken from session 3, group A.

The moderator, Lecturer 2, initiated most of the utterances related to Demanding Activities [CIP] (Excerpt 47 and Excerpt 48.

Lecturer 2 (Susan): “may be you want to take 5-10 mins to play around with the whiteboard above the chat window?!”  [CIP]
Jane: “! okey dokey”  [CIP+]

Excerpt 47 taken from session 3, group A.

Lecturer 2 (Susan): “Please feel free to ask questions if you do not know how to use something”  [CIP]

Excerpt 48 taken from session 3, group A.

Synchronisation [CIS] aimed at bringing all group members up to one knowledge level (Excerpt 49) or an activity basis (Excerpt 50), i.e. by letting them know that a member is done with their share of constructing the map. Five out of seven Synchronisation [CIS] attempts were aimed at aligning the group on an activity basis.

Lecturer 2 (Susan): “You have all read the info on how to create a concept map.”  [CIS]

...  
Jane: “! yes”  [CIS+]
Eric: “yes”  [CIS+]
Sabine: “!yes”  [CIS+]

Excerpt 49 taken from session 3, group A.
Jane: “!- i’m done”

Excerpt 50 taken from session 3, group A.

They also showed three instances of Goal Identification [CG], and one attempt to Map Goals to Activities [CA]. The second lecturer, session moderator, triggered most of these coordination utterances (Excerpt 16).

Group B

Group B showed 43.9% coordination behaviour during session 3. The three most frequent coordination behaviours were Demanding Activities [CIP], Synchronisation [CIS] and Assigning Group Members to Activities [CT].

Group B focused their chat on discussing the topic, rather than the procedure of concept map construction and they often reported on small steps of their actions towards task completion (Excerpt 51).

Mark: “first-order and second-order barriers as the concept?”
Lecturer 1 (Anne): “that’s a good start”
Jessica: “!- we can add an examples to each of them”
Lecturer 1 (Anne): “maybe we want to change the color of 2nd order barrier?”
Dave: “! could we move the boxes to 2 distinct groups

Excerpt 51 taken from session 3, group B.

Group B did not coordinate their activities before starting the map construction, but tried to organize it afterwards (Excerpt 52).

Lecturer 1 (Anne): “****let’s get this organized a bit before we continue”
Lecturer 1 (Anne): “which should be deleted?” [CIP]
Mark: “the new boxes with nothing in them” [CIP+]
Dave: “! Boxes without text for starters” [CIP+]
Sandra: “the arrows need to be deleted” [CIP+]

Jessica: “the arrows direction need to be change” [CIP]
Mark: “and the mess i made with the arrows should be deleted” [CIP]

Excerpt 52 taken from session 3, group B.

Most Synchronisation [CIS] was aimed at aligning the group with the current activity (Excerpt 53). Only one out of the eleven Synchronisation [CIS] utterances was aimed at the knowledge level.

Dave: “?Ok what now?” [CIS]

Mark: “are we on the right track?” [CIS]

Sandra: “!sorry guys I think I messed it up a bit
Sandra: ! still trying to get use to it” [CIS]

Excerpt 53 taken from session 3, group B.

Generally, Assigning Members to Activities [CT] was used to ask for volunteers or to volunteer for a particular task. Group B showed no goal identification or attempt to map goals to activities. One instance of discussing Shared Resources [CIR] was revealed.

Task Difficulty Ratings
The task difficulty for session 3 and the previous week tended to be perceived as not difficult for group A ($M = 1.75, SD = 0.50$) and difficult for group B ($M = 1.33, SD = 0.58$). The weekly assignment included readings on the topic of teacher’s belief systems and the role of teacher knowledge. The tasks during the chat session included concept mapping and the decision on moderator rotation for future online sessions.

**Reflection on Map Construction**

After constructing the map, both groups met in one chat room and took part in a reflection about their experience (Excerpt 54 and Excerpt 55). Members of both groups perceived the concept mapping experience as unstructured and unsatisfactory. Difficulties became evident concerning task and medium.

Jessica: "!-I did not like it"  
Sandra: "! it was fun but I couldn’t some of the things"  
- Anne  
Jane: "!- it’s alright, although I find that some tools are missing –  
[NNC]  
anne  
Sandra: "! I couldn’t participate that much”  
...  
Dave: "!while there was no real discussion  
Dave: learning the skills was interesting”  
Jessica: “ i think every body was working by himself”  
...  
Dave: “! it is also challenging to work as a group!”  
Eric: “! s very slowe working that way  
Eric: and hard to communicate”  
...
Mark: “everyone has different ideas, and to share and organise them online are little difficult”  
Eric: “without talking” 
... 
Dave: “if we chatted about ideas before putting them on the concept map”  
Sandra: “! It was still pretty confusing even though we had the same focus or topic”  
... 
Eric: “!- i think we need to practise the etiquette”  
... 

Excerpt 54, reflection on concept mapping experience, group A and B.

Both groups suggested points to improve the concept map construction in future sessions (Excerpt 55). Most difficulties were concerned with coordination and communication issues. In addition, the novelty of the medium and the online collaboration, and thus missing behaviour rules, proved a challenge for the group.

Jane: “!- actually, it would be useful if we pay attention to the message board at the bottom while we are typing”  
... 
Jessica: “!- we need to share our ideas”  
... 
Dave: “maybe the focus should be the chat. with some additions to Dave: the map as we chat”  
... 
Mark: “yes. work as a group. more structured next time”  
... 
Dave: “that is probably the biggest challenge in here”  

Excerpt 55, reflection on concept mapping experience, group A and B.
5.2.2.1.2 Second Concept Map (Session 4)

Group A

Coordination frequency during session 4 was 45.1% for group A. Again, group A showed a wide variety of coordination behaviour and utilized all categories. The three most frequent coordination behaviours were Synchronisation [CIS] with 9.2%, Demanding Activities [CIP] with 8.2% and Assigning Members to Activities [CT] with 7.6%.

Again, Synchronisation [CIS] served one of two purposes: bringing the group up to the same knowledge level or providing information on the current activity progress. The latter accounted for the majority of synchronisation entries: 14 out of 17 instances of Synchronization [CIS] were concerned with the current activity progress. Jane, the moderator, initiated 10 out of 15 activity demands.

Assigning Members to Activities [CT] mostly consisted of asking for volunteers for the next step during task completion, or volunteering for it. Only 4 out of 15 instances were directed at a person other than oneself, or a general inquiry for volunteers. The lecturer initiated two of the four instances by handing the moderation over to Jane, Jane initiated another, and one group member initiated the fourth by asking the moderator for help.

Other coordination codes were less frequent. They included passages on Identifying Goals [CG], triggered by Susan, the second lecturer, as well as Mapping Goals to Activities [CA], triggered by the moderator Jane (Excerpt 56 and Excerpt 57).

Lecturer 2 (Anne): “I am not sure, if you remember the topics for your next weeks representation.
Lecturer 2 (Anne): here they are
Lecturer 2 (Anne): 1) Multimedia learning
Lecturer 2 (Anne): 2) Mayer and Moreno cognitive theory of multimedia learning” [CG]
...
Jane: “!- ok, thanks, anne” [CG+]

Excerpt 56 taken from session 4, group A.

Jane: “once you think you have completed your share on the whiteboard, please inform the group so that the next one is ready to go. Is that all right with you?” [CA]
Sandra: “! Sounds like a great plan [name]” [CA+]
jane [NNC]
Sabine: “! sounds good!” [CA+]

Excerpt 57 taken from session 4, group A.

Group B

Overall, group B showed 58.3% coordination during session 4. Almost all of the coordination was devoted to one of three coordination actions: Demanding Activities [CIP] with 17.3%, Assigning Group Members to Activities [CT] with 10.1%, and Synchronisation [CIS] with 7.1% (Table 25). Additionally, one Meaning Making [CIM] exchange occurred. Anne, the first lecturer, moderated this session and initiated approximately two thirds of Activity Demands.

All coordination attempts, aimed at Assigning Members to Activities [CT], asked for volunteers to enact a certain next step in the task completion process, or group members volunteering themselves. Only the moderator allocated other group members to a particular task directly. Synchronisation [CIS] attempts were directed at concept map content, or at the construction process. Five out of 12 of the Synchronisation [CIS] entries were aimed at bringing everyone up to one content level or knowledge basis (Excerpt 58). The remaining 7 aimed at synchronising on
an activity basis (Excerpt 59). One Meaning Making [CIM] passage occurred that concerned the concept map content.

Dave: “How is that?” [CIS]

... 

Jessica: “?- what do you think [name] ?” [CIS]

Anne [NNC]

...

Dave: “I’ve just realised I moved the wrong box” [CIS]

Excerpt 58 taken from session 4, group B.

Lecturer 1 (Anne): “before we start, shall we have some agreement on the protocols?” [CIS]

...

Jessica: “anne are you talking to me?” [CIS]

...

Dave: “what are we up to?” [CIS]

Excerpt 59 taken from session 4, group B.

Task Difficulty Ratings

Task difficulty for session 4 and the previous week was perceived easy for group A ($M = 3.00, SD = 0.00$) and not difficult for group B ($M = 2.00, SD = 0.00$). The weekly assignment included readings about concept mapping and preparing a short paper. The chat session tasks included division of labour for the face-to-face presentation during session 5, as well as moderator rotation for future online sessions (only group B). Some reflective discussions took place, they were concerned with the map topic and the online learning experience.

Reflection on Map Construction

After constructing the map, students met in a chat room and reflected on the experience (Excerpt 60). Overall, it became clear that the experience during session
was perceived better than session 3. Not only due to the sustained enforcement of chat protocol, but also adjustment and refinement of procedures during their online collaboration while constructing the map.

Dave: “! Anne – much better than last week” [CIP+]

Sandra: “! i liked the way we structured it where the moderator
Sandra: is the person we continually refer to” [NNC]
Mark: “! more organised” [NNC]

Mark: “i liked the fact that we discussed things” [NNC]

Sabine: “! – yep n wer more familiar with the whiteboard” [NNC]

Dave: “we all talked through the moderator” [NNC]
Mark: “! yes, experience helped” [NNC]
Jessica: “!– asking before doing anything” [NNC]
Sabine: “! there’s a teamwork actually” [NNC]

Jane: “! i think it’s slower because we were taking turns” [NNC]

Jane: “but actually, once the layering or structure comes out, we can do the add-ins without interrupting others” [NNC]
Sandra: “! i learnt so much more than what I did last week” [NNC]

Excerpt 60, reflection on concept mapping experience, group A and B.

**5.2.2.1.3 Comparison between Tasks**

Generally, behavioural patterns across tasks did not vary much in terms of coordination types utilized. Coordination during concept mapping sessions was
characterised by Assigning Group Members to Activities [CT], Demanding Activities [CIP] and Synchronisation [CIS]. These three coordination behaviours remained the three most frequent actions across tasks.

During the concept map construction in session 4, both groups showed an additional Meaning Making [CIM] passage (Table 25) related to map content.

Overall, both groups employed 45.1% coordination behaviour during concept mapping in session 3 and 51.4% during concept mapping in session 4. The increase in coordination behaviour is completely due to group B. Group A showed a decrease of 1.9%.

Responses to the questionnaires provide some information regarding a decrease in perceived task difficulty from session 3 to session 4. This is supported when comparing reflections on the experience during session 3 and 4 (Excerpt 55 and Excerpt 60). While students perceived the map construction during session 3 as confusing and difficult, their perception improved substantially during concept mapping in session 4.

5.2.2.1.4 Comparison between Groups

While group A showed a relatively stable amount of coordination during both sessions, with only a slight decrease of 1.9% during session 4, group B showed a substantial increase of 14.4% during session 4.

Another striking difference was the employment of Identifying Goals [CG] and Mapping Goals to Activities [CA] of group A during both sessions. Even though the lecturer triggered most of it, the group adopted the behaviour during session 4 and
initiating instances by themselves. Group B did not utilize goal related coordination behaviour during either session.

Even though the three most frequent coordination behaviours remained the same during both sessions for both groups, group B continually showed a much larger amount of Demanding Activities [CIP] during both sessions compared to group A. They showed 10.4% more Activity Demands [CIP] during session 3 and 9.1% more during session 4. Even though both groups used Meaning Making [CIM], as a means of coordination, group A showed two more instances compared to group B.

5.2.2.2 Discussion

Both groups revealed a substantial amount of coordination during the concept mapping activities. Generally, coordination was characterized by a moderate variety of behaviour, which remained fairly stable across the two different concept mapping activities.

Two coordination patterns emerged from activities during concept mapping. A distinctive pattern within each task distinguished concept mapping activities. Additionally, differences in coordination behaviour between groups gave way to a second pattern.

Students rated the perceived difficulty for the concept mapping tasks as difficult during session 3 and as not difficult during session 4. This points to the initial difficulties and the uncertainty they experienced during their first map construction.
5.2.2.2.1 Patterns in Sessions and across Tasks

During both concept mapping activities, coordination behaviour constituted approximately 50% of all utterances. Both concept mapping activities reveal three frequent coordination behaviours: Demanding Activities [CIP], Assigning Members to Activities [CT] and Synchronisation [CIS].

The Synchronisation [CIS] attempts of both groups aimed at aligning groups on an activity basis, rather than a content or knowledge basis. However, the ratio between activity-based and content-/knowledge-based synchronisation varied between groups. One cannot infer the medium–task dimension (i.e. task– or tool–relatedness) based on synchronisation (activity based vs. content–/knowledge–based). While most activity–based synchronisations were clearly related to the specifics of medium, some were task–related. This points to the dual purpose of synchronisation in synchronous media.

Assigning Members to Activities [CT] was mostly related to asking for volunteers or volunteering themselves (Excerpt 45 and Excerpt 46). This did not change with the task assignment, between groups, or moderator rotation. It might be due to the fact that confrontational behaviour, such as disagreement, is usually not shown in online communication. Pointing someone out and allocating him or her directly to an activity, could be viewed as confrontational. Hence, the members’ allocation to activities was done in a more indirect way by asking for volunteers.

Collaboration on concept mapping tasks asks for skill–related and knowledge–related activities. Skill–related activities concern the actual map construction, e.g. drawing boxes or arrows, and collaborative aspects, such as division of labour. Knowledge–related issues concern knowledge structuring during concept map constructing. On the executive level of task completion, such activities are best met by coordination behaviour such as Synchronisation [CIS], Demanding Activities [CIP]
and Assigning Members to Activities [CT]. Goal-directed coordination is preferable to an albeit minor degree.

Additionally, both groups only showed few Meaning Making [CIM] exchanges during session 4 map construction. These exchanges were completely content related. In general, attempts to establish a common understanding of the subject matter are preferable in online collaboration and essential for coordination (Barron, 2000). The amount of Meaning Making [CIM] necessary for a group to develop a shared understanding of current tasks or a subject in question depends on the assignment. The more detailed and rigid an assignment, the fewer Meaning Making [CIM] attempts are necessary and suitable, as it results in less uncertainty for the group members. The task assigned to the students in the course was relatively detailed and rigid, in the respect that it asked for certain predetermined concepts to be included in a concept map. It left participants a certain degree of freedom on how to go about coordinating the collaboration, but not with regards to the task content. Thus, some Meaning Making [CIM] is suitable, but it should not dominate. Considering the level of detail in the task instruction, the amount of Meaning Making [CIM] shown during the concept mapping task seems relevant and suitable. Therefore improvements regarding Meaning Making [CIM] are not necessary.

5.2.2.2.2 Patterns across Groups

Both groups showed a relatively stable pattern of coordination across tasks. Some differences exist in the coordination behaviours employed by the two groups.

Group B showed a much higher level of Demanding Activities [CIP] during both assignments than group A. Their Activity Demands [CIP] were 10.4% higher during the first assignment in session 3 and 9.1% higher during the second assignment in session 4.
The nature of interaction during the first assignment also differed. Group A’s members relatively independently took turns constructing the map. Members in group B generally discussed smaller steps of the task completion (Excerpt 51), repeatedly notifying the group of small task accomplishments. Instead of specifying the cause of a problem, group members rather reported back to the group that they needed help, which is very generic statement and points to the level of overload that was experienced. This behavioural pattern resulted in a higher amount of Activity Demands [CIP]. After group B looked at group A’s concept map and exchanged thoughts during the reflection (Excerpt 54 and Excerpt 55), they changed their strategy for the next concept map assignment. They also took turns discussing in the chat section of the online environment while constructing the map in the whiteboard section. This strategy change, along with the help of sustained chat protocol enforcement, improved perceptions of the online experience substantially (Excerpt 60).

One striking difference between the two groups was the use of goal-directed behaviour. As a possible result of group A’s goal-directed discussion, they employed a different pattern of concept map construction during session 3. This resulted in a more structured and organized outcome during the first task assignment. Group B did not engage in goal-directed discussions. They perceived their concept map as less organized and the experience as unsatisfactory, as expressed during the session 3 reflection (Excerpt 55). This aligns with differences in perceived task difficulty, where group B reported a slightly higher difficulty level.

During session 3, a group member pointed out, he had never used the whiteboard before. This added to competency awareness and was clearly due to the novelty of the tool. After the group practiced the whiteboard usage, such utterances not relevant.
In conclusion, coordination behaviour is relatively frequent in concept mapping tasks. The range of coordination behaviour is moderate, but remains relatively stable across the concept mapping assignments. Some differences between groups exist, pointing to different local dynamics in the two groups (Arrow et al., 2000).

5.2.3 Wiki Page Task (Session 6, 6* and 7)

Students engaged in wiki page creation during two consecutive synchronous sessions (sessions 6 and 7), group A also conducted a voluntary session (session 6*). Table 26 provides a short description of the wiki page creation assignment.

Table 26: Short task description during concept mapping tasks.

<table>
<thead>
<tr>
<th>Session 6 (Synchronous)</th>
<th>Students were instructed to have a look at wiki examples on the web and divide their labour for the wiki page construction that was to take place in session 7.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session 7 (Synchronous)</td>
<td>Students were instructed to create a wiki page Design of Multimedia/hypermedia instructional messages focusing on one of the following topics: 'Visualisation' (Group A) and 'Motivation' (Group B).</td>
</tr>
</tbody>
</table>

5.2.3.1 Findings

The wiki page assignment included collaboratively creating a wiki page on a specified topic. The task included various steps, spread over three different online chat sessions for group A: The division of labour in session 6, the voluntary session 6*, and creating the actual wiki page in session 7.

Group B did not collaborate through online communication, but created the wiki page face-to-face. Thus, only coordination data for group A was retrieved.
5.2.3.1.1 Division of Labour (Session 6 and 6*)

During session 6, group A discussed the wiki page topic, and looked at other wiki pages in order to get a better understanding of a wiki page. They finally decided during session 6, it did not make much sense to divide the topic into subtopics until they had completed the readings on their wiki page topic. They met a week later, in a voluntary session 6*, to divide the labour for the wiki page construction.

Division of Labour Discourse

The initial passage about the division of labour included 108 semantic units and showed 55.6% coordination behaviour. The range of coordination behaviour during the session was moderate, utilizing 13 different coordination behaviours (Table 27). A voluntary session took place a week later, where they decided on the division of labour. This session was composed of 48.2% coordination behaviour, including all the main coordination categories.

Table 27: Coordination behaviour in the respective chat sessions for group A.

<table>
<thead>
<tr>
<th>Coordination (%)</th>
<th>Session</th>
<th>Division of Labour (Session 6)</th>
<th>Division of Labour (Session 6*)</th>
<th>Wiki page creation (Session 7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identifying Goals CG</td>
<td>0.9</td>
<td>2.4</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Positive Closure CG+</td>
<td>-</td>
<td>1.5</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Mapping Goals to Activities CA</td>
<td>0.9</td>
<td>1.8</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Positive Closure CA+</td>
<td>-</td>
<td>0.3</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Negative Closure CA-</td>
<td>-</td>
<td>0.6</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Assigning Group Members to Activities CT</td>
<td>-</td>
<td>2.7</td>
<td>7.1</td>
<td></td>
</tr>
<tr>
<td>Positive Closure CT+</td>
<td>-</td>
<td>-</td>
<td>1.6</td>
<td></td>
</tr>
<tr>
<td>Synchronisation CIS</td>
<td>15.7</td>
<td>7.5</td>
<td>12.1</td>
<td></td>
</tr>
<tr>
<td>Positive Closure CIS+</td>
<td>8.3</td>
<td>6.6</td>
<td>3.3</td>
<td></td>
</tr>
<tr>
<td>Negative Closure CIS-</td>
<td>0.9</td>
<td>0.6</td>
<td>1.1</td>
<td></td>
</tr>
</tbody>
</table>

-Table continued on following page-
The three most frequent coordination behaviours were Synchronisation [CIS] with 15.7%, Demanding Activities [CIP] with 13.9% and Discussing Media Usage for Communication Means [CIC] with 4.6%. Also, goal-directed behaviour was shown in two instances, a Meaning Making [CIM] exchange occurred, as well as Discussing Shared Resources [CIR].

During the voluntary session 6*, group A discussed the outline of the wiki pages, subdivided the topic according to the outline, and allocated the subtopics to each of the members. The division of labour during this session included 332 semantic units. It was composed of 48.2% coordination behaviour. The range of coordination behaviour was large; students employed 20 out of 25 possible coordination behaviours (Table 27).
The three most frequent coordination behaviours were Synchronisation [CIS] with 7.5%, Demanding Activities with 6.6% and Meaning Making [CIM] with 4.5%. Additionally, they engaged in substantial goal-directed coordination, with eight instances of Goal Identification [CG] and six instances of Mapping Goals to Activities [CA].

The passage below shows the division of labour between group members, using the most common coordination utterances (Excerpt 61).

Sandra: “how should we divide the work... any ideas?” [CIP]
...
Jane: “!-someone’s got to start the main page, then all of us can add on the hyperlinks to the 5 principles” [CIP]
Eric: “! Jane - the first page would be an overview?” [CIP]
Jane: “!eric i'm not too sure about that” [CIP-]

Excerpt 61 taken from session 6*, group A.

The passage below shows typical goal-directed behaviour during the voluntary session (Excerpt 62).

Eric: “are we supposed to use hyperlinks to demonstrate concepts or are we just supposed to be learning how to create a web page?” [CG]
Sabine: “i guess hyperlinks included also” [CG+]
Jane: “!-i suppose they want us to try and use the wiki, yes, hyperlinks too” [CG+]
...
Jane: “!-guys, if you look at the details of session 7,...” [CG]
...
Sabine: “aok... i think we need to outline our topic and for every topic we’ll be assigned and do research?”

Eric: “sabine – the five pages sounds pretty simple – it’s probably all we have to do”

Sabine: “i guess so, i think their main concern is for us to know how to do the wiki”

Excerpt 62 taken from session 6*, group A.

Task Difficulty Ratings

Students answered a questionnaire regarding the perceived task difficulty after session 6. The questions were rated on a scale ranging from very difficult (0), difficult (1), not difficult (2), easy (3) to very easy (4). The task difficulty for session 6 tended to be perceived as easy for group A ($M = 2.67$, $SD = 0.58$) and difficult for group B ($M = 1.5$, $SD = 0.71$).

5.2.3.1.2 Wiki Page Creation (Session 7)

The planning phase during session 6 and the voluntary session 6* led to wiki page creation during session 7. Each group member had prepared content for the wiki page. They linked it together during this session.

Wiki Page Construction Discourse

The communication concerning the page creation consisted of 182 semantic units and the group employed 39% coordination during the chat session (see Table 27). The range of coordination behaviour was relatively small, using 9 different coordination behaviours, composed of only four different initiation behaviours with the respective closures.
The three most frequent coordination behaviours were Synchronisation [CIS] with 12.1%, Demanding Activities [CIP] with 9.3% and Assigning Members to Activities [CT] with 7.1%.

**Task Difficulty Ratings**

Students answered a questionnaire regarding the perceived task difficulty after session 7. The questions were rated on a scale ranging from very difficult (0), difficult (1), not difficult (2), easy (3) to very easy (4). The task difficulty for session 7 was perceived overall difficult ($M = 1.57$, $SD = 0.53$). Group A reported a mean of $M = 1.75$ ($SD = 0.50$) and group B reported a mean of $M = 1.33$ ($SD = 0.58$).

**5.2.3.2 Discussion**

Students rated the perceived difficulty for the wiki page construction as difficult, indicating problems with the page construction and their uncertainty concerning the task.

**5.2.3.2.1 Division of Labour (Session 6 and 6*)**

Group A accomplished the division of labour for the wiki page creation during two different sessions, a scheduled and a voluntary session. The sessions revealed similarities and differences. Similarities were due to the overarching session aim. The differences were due to the fact that they had to come back to conduct a second session to finish their activities. This becomes particularly evident when focusing on the frequency with which they assigned group members to activities [CT] during the two sessions. Division of labour naturally is concerned with matching resources, including assigning group members to activities. They did not assign any activities to members during the first session and made up for this shortcoming during the voluntary session. Similarly, the group showed minimal
5 Coordination: Results and Discussion

goal-directed behaviour (‘Goal Identification’ [CG] and ‘Mapping Goals to Activities’ [CA]) during the first division of labour session and increased goal-directed behaviour during the second.

The variety of coordination utterances during division of labour was relatively large. This was due to the fact that they had to accomplish various tasks, such as establishing common ground regarding the task (Excerpt 62), dividing up and assigning subtasks to members (Excerpt 61) and deciding on communication means during that session.

5.2.3.2.2 Wiki Page Creation (Session 7)

During wiki page creation the focus was clearly on page creation. The variety of coordination behaviour was relatively small, consisting mostly of ‘Assigning Group Members to Activities’ [CT], ‘Synchronisation’ [CIS] and the ‘Demanding of Activities’ [CIP]. These three coordination behaviours directly target task execution. The overall increase in non-coordination behaviour hints at an increase in task-related behaviour, indicating that students engaged in task execution.

5.2.3.2.3 Comparison between Division of Labour and Wiki Page

Creation

Creating the wiki page (session 7) did not involve goal-directed utterances. Compared to the division of labour, it involved a higher frequency of ‘Assigning Group Members to Activities’ [CT]. It did not involve ‘Meaning Making’ [CIM] or discussion of ‘Shared Resources’ [CIR]. The focus was clearly on task execution. Thus, the variety of coordination behaviour was much smaller and more directed.
Students perceived the division of labour ($M = 2.67$, $SD = 0.58$) as less demanding than the actual page construction ($M = 1.75$, $SD = 0.71$).

### 5.2.4 Collaborative Writing Task (Session 9)

Students engaged in a collaborative writing assignment during the synchronous session 9. Table 28 provides a short description of the collaborative writing assignment.

<table>
<thead>
<tr>
<th>Session 9 (Synchronous)</th>
<th>Short Task Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Students were instructed to choose a topic from the readings for session 10 and elaborate on arising issues in their paper. They were furthermore instructed that the paper should have a certain structure, e.g. introduction, definition, reasons why they thought this was an issue, conclusion.</td>
</tr>
</tbody>
</table>

### 5.2.4.1 Findings

During session 9, students used a note writing functionality for constructing written passages, while coordinating actions through the chat tool. The chat tool was located underneath the writing pad in the same window. The collaborative writing activity required writing a 500-word paper. All necessary resources were provided, so this could typically be accomplished during a two hour chat session.

Overall, group A showed 46.5% coordination behaviour while group B revealed much more coordination behaviour with 67.3% (Table 29).
Table 29: Coordination behaviour in the respective chat sessions for the collaborative writing activity in group A and B.

<table>
<thead>
<tr>
<th>Coordination (%)</th>
<th>Session</th>
<th>Collaborative Writing Group A (Session 9)</th>
<th>Collaborative Writing Group B (Session 9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identifying Goals [CG]</td>
<td></td>
<td>0.8</td>
<td>0.7</td>
</tr>
<tr>
<td>Positive Closure [CG+]</td>
<td></td>
<td>0.5</td>
<td>-</td>
</tr>
<tr>
<td>Mapping Goals to Activities [CA]</td>
<td></td>
<td>0.5</td>
<td>0.7</td>
</tr>
<tr>
<td>Positive Closure [CA+]</td>
<td></td>
<td>0.5</td>
<td>0.7</td>
</tr>
<tr>
<td>Assigning Group Members to Activities [CT]</td>
<td></td>
<td>6.8</td>
<td>16.0</td>
</tr>
<tr>
<td>Positive Closure [CT+]</td>
<td></td>
<td>4.2</td>
<td>7.3</td>
</tr>
<tr>
<td>Negative Closure [CT-]</td>
<td></td>
<td>0.5</td>
<td>0.7</td>
</tr>
<tr>
<td>Synchronisation [CIS]</td>
<td></td>
<td>10.0</td>
<td>18.0</td>
</tr>
<tr>
<td>Positive Closure [CIS+]</td>
<td></td>
<td>5.2</td>
<td>4.0</td>
</tr>
<tr>
<td>Negative Closure [CIS-]</td>
<td></td>
<td>1.8</td>
<td>-</td>
</tr>
<tr>
<td>Demanding Activities [CIP]</td>
<td></td>
<td>6.8</td>
<td>13.3</td>
</tr>
<tr>
<td>Positive Closure [CIP+]</td>
<td></td>
<td>6.0</td>
<td>4.7</td>
</tr>
<tr>
<td>Negative Closure [CIP-]</td>
<td></td>
<td>0.5</td>
<td>-</td>
</tr>
<tr>
<td>Meaning Making [CIM]</td>
<td></td>
<td>0.5</td>
<td>-</td>
</tr>
<tr>
<td>Positive Closure [CIM+]</td>
<td></td>
<td>0.3</td>
<td>-</td>
</tr>
<tr>
<td>Negative Closure [CIM-]</td>
<td></td>
<td>0.3</td>
<td>-</td>
</tr>
<tr>
<td>Shared Resource [CIR]</td>
<td></td>
<td>0.8</td>
<td>-</td>
</tr>
<tr>
<td>Positive Closure [CIR+]</td>
<td></td>
<td>0.3</td>
<td>-</td>
</tr>
<tr>
<td>Non – Coordination Of it: Names [NNC]</td>
<td></td>
<td>53.5</td>
<td>32.7</td>
</tr>
<tr>
<td>Discourse</td>
<td></td>
<td>7.6%</td>
<td>8.0%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Group A

The three most frequent coordination behaviours for group A were Synchronisation [CIS] with 10.0%, Demanding Activities [CIP] and Assigning Activities to Members [CT] with 6.8%. They also showed goal-directed behaviour to a small extent (0.8% Goal Identification [CG] and 0.5% Mapping Goals to Activities [CA], see also Excerpt 63) as well as a passage concerning Meaning Making [CIM] with 0.5% and Discussing Shared Resources [CIR] with 0.5%.
Excerpt 63 shows the goal-directed behaviour during the session.

Sabine: “so its says its 500 hundred words” [CG]
Jane: “yes” [CG+]
Sabine: “so how do we divide the tasks?” [CA]
Jane: “i would think that we need to get consensus of the issue mentioned in the paper first” [CA+]
Jane: “then we can have a direction for our writing” [CA]
Sabine: “alright…” [CA+]

Excerpt 63 taken from session 9, group A.

Excerpt 64 shows typical interactions during the division of labour for the writing activity. Initially, group A decided to work simultaneously on the activity, collaborating instead of splitting the task into subtasks to be accomplished in parallel. However, they concluded it would take them too long, and decided to coordinate the subtasks separately and bring it all together in the end (Excerpt 64).

Jane: “do you think it is easier for us to edit the notes by sections or lump everything together in 1 page at the beginning and edit from there?” [CIP]
Sabine: “i think since it is not final yet, its ok we have separate notes first”
Sabine: “so that if we are all online then at least we can visit each notes individually and edit it” [CIP+]
Sabine: “what d you think” [CIS]
Jane: “let’s hear from sandra” [CIP]
Sandra: “hmmm…” [NNC]
Sandra: “i think it will take too long if we have it in separate notes
Sandra: because i mean it s really only suppose to be 500 words
Sandra: so maybe we could each focus on one section” [CIP+]  
Sabine: “aok.. sandra means we divide the sections?” [CIP]  
Sandra: “but all end up editing one ‘note’” [CIS]  
Sandra: “yes” [CIP+]  

Excerpt 64 taken from session 9, group A.

Some Synchronisation [CIS] utterances also addressed accountability (Excerpt 65).

Jane: “ok gals, have you read any of the papers yet?” [CIS]  
...  
Sandra: “i tried to read all but too much”  
Sandra: so focussed on Tans” [CIS-]  
...  
Jane: “yeh, me too” [NNC]  

Excerpt 65 taken from session 9, group A.

**Group B**

Group B revealed similar behaviour regarding the nature of coordination. The three most frequent coordination utterances were Synchronisation [CIS] with 18.0%, Assigning Members to Tasks [CT] with 16.0% and Demanding Activities [CIP] with 13.3%. Similarly, they revealed goal-directed behaviour to a small extent (0.7% Goal Identification [CG] and 0.7% Mapping Goals to Activities [CA]).  

The excerpt shown below portrays coordination behaviour during the collaborative writing process (Excerpt 66).

Group B did not discuss the division of labour much. Instead, they divided work into subtasks, as proposed by the moderator, and they accepted the roles and tasks the
moderator assigned (Excerpt 66). They chose a cooperative approach and wrote in parallel. Excerpt 66 shows the initial stage of the writing process. The group established common ground and developed a common understanding of the topic and the task. The excerpt also shows the coordination of labour divisions concerning the subtasks assigned to group members.

Dave: “mark [NNC]
- you write about natural and artificial groups in
  the Introduction” [CT]
Mark: “okay [CT+] dave” [NNC]
Jessica: “! i can see some definition in the
  article” [NNC]
Jessica: “! can i use them” [CT]
Dave: “Jessica [NNC] could you write a clear statement defining
  “groups”” [CT]
Dave: “yes” [CT+]
Jessica: “! sure” [CT+]
Dave: “I will try to look at functions” [CT]
Mark: “okay, i will get started” [CT]
Dave: “does that sound OK.” [CIS]
Dave: “great. Shall write take 20min to do a draft
  and then look at each others?” [CIP]

Excerpt 66 taken from session 9, group B.

The moderator decided to include a revision and feedback cycle after each member finished his or her part. He then assigned revision parts to each group member.

Differences between Groups

Both groups showed similar types of coordination, i.e. coordination categories such as Synchronization [CIS], during the collaborative writing activity. They only deviated in a few discrete instances, such as one instance of Meaning Making [CIM].
The quantity of coordination behaviour varied substantially across groups. Not only did group B show much more overall coordination behaviour (67.3% for group B vs. 46.5% for group A), they also showed a higher frequency of Synchronisation [CIS] (18.0% for group B vs. 10.0% for group A), Assigning Members to Activities [CT] (16.0% for group B vs. 6.8% for group A) and Demanding Activities [CIP] (13.3% for group B vs. 6.8% for group A). Group B showed a 38% closure rate in their utterances (with 73 initiations and 28 closures), while group A revealed a 77% closure rate in their interactions (with 100 initiations and 77 closures). This indicates different communication styles during the chat sessions.

Task Difficulty Ratings

The task difficulty for session 9 was perceived not difficult for both groups (group A: $M = 2.67$, $SD = 1.15$; group B: $M = 2.00$, $SD = 0.00$). The questions were rated on a scale ranging from very difficult (0), difficult (1), not difficult (2), easy (3) to very easy (4).

5.2.4.2 Discussion

Students showed a distinct nature of coordination behaviour during the task completion. Differences in coordination behaviour across groups were revealed. The writing task was rated as not difficult, indicating students felt comfortable with the task.

5.2.4.2.1 Patterns in the Collaborative Writing Task

The task required one two-hour chat session and was too short to allow meaningful coordination evaluation regarding general aspects of collaborative writing, such as role behaviour (Posner & Baecker, 1993) or different writing phases (Erkens et al., 2005).
Both groups revealed a relatively small variety of coordination behaviour during task collaboration. They both showed Synchronisation [CIS], Demanding Activities [CIP] and Assigning Members to Activities [CT] as the most frequent coordination behaviours. The goal-directed behaviour in both groups (Excerpt 63 for group A and Excerpt 65 for group B) was relevant and suitable. Both groups tried to establish common ground when talking about the aim of their activity. Each of the goal identification passages was eventually followed by utterances Mapping Goals to Activities [CA].

Initially, group A chose a joint writing approach (Posner & Baecker, 1993) and authors synchronously collaborated to develop a joint text. However, after a while they decided to work separately on different parts. Posner and Baecker (1993) found a relationship between the writing strategy and the type of document control, with independent control being the most effective document control type.

The document control type in the current course was a mix between relay and independent control. Basically, only one person could edit one section of text, illustrating a relay control type. However, students divided the work in such a way that they first established subtasks and then each group member would create a separate file for their text, which they could edit in parallel. Even though they would technically have been able to edit these private sections of text, there was an understanding, only the person with the assigned subtask would edit that text. Such an arrangement demonstrates independent document control. Similarly, the most effective writing strategy with such a document control type is a separate writer strategy (Posner & Baecker, 1993) which was enforced in both groups.

The amount and nature of coordination shown support considerations that collaborative writing is complex (Noël & Robert, 2004). Writers can take up various strategies to cope with this complexity, such as taking on different roles or
adopting writing strategies (Posner & Baecker, 1993). In this case, students adopted a separate writer strategy. They established a common topic understanding and divided tasks into subtasks that could be written separately. This resulted in the smallest interdependency. Interestingly, group A adopted a strategy to work jointly on the task. However, they soon decided that a separate strategy would be faster (Excerpt 64). This confirms observations in other collaborative writing groups (Mitchell et al., 1995). Groups having no prior experience with this form of writing tend to choose a separate writing strategy, and only adopt other strategies after having gained profound experience (Mitchell et al., 1995).

The small variety of coordination behaviour reflects the writing style and consequently reduced the amount of interdependency in the task.

5.2.4.2.2 Patterns across Groups

The overall amount of coordination in both groups varied substantially. While group A revealed a relatively typical 46.5%-rate for coordination, group B used much more coordination during their chats, revealing a 67.3%-coordination rate.

Even though both groups did not use many different coordination initiation utterances, the frequency of usage varied. Group B initiated many more responses in each of the three most frequently revealed coordination behaviours, Synchronization [CIS], Demanding Activities [CIP] and Assigning Members to Activities [CT]. Group A showed a much higher closure rate compared to group B. This indicates different communication and interaction styles in the two groups. Results showed, group B initiated many more coordination acts, but often did not respond to initiations (e.g. Excerpt 65). In this interaction style, many of the coordination utterances are not relevant and are of the same nature or intent (Excerpt 66). Thus, they are generally suitable as they address issues at hand, but
remain unresponded. A possible intervention could be the establishment of additional rules and draw the moderator’s attention to this deficit.

Group B’s moderator used a more directive moderation style. He did not ask the students’ opinion on how to divide the work, and instead assigned tasks to each member (Excerpt 65). Group A discussed much more and the moderator ensured that each group member had given their opinion on the issue (Excerpt 64).

At first, this circumstance seems to be contradictory: Even though group A discussed issues more, and the moderator employed a less directive style, overall they used fewer coordination utterances during task completion.

In order to compare the collaborative writing process in both groups, one also has to consider that chat for group A contained 381 utterances compared to 150 utterances for group B. Also, group B completed their artefact during the assigned chat session, while group A was not finished at the end of the session. Thus, group B used more coordination during their chats distributed over less chat entries, and finished the task during the assigned time.

5.2.5 Comparison between Tasks

5.2.5.1. Findings

Differences in the quantity and quality of coordination attempts exist between the tasks. Discussion in online communication generally included few coordination attempts and the nature of coordination utterances was relatively limited; most sessions mainly contained Synchronisation [CIS] and Demanding Activity [CIP] utterances. The concept mapping task revealed a high amount of coordination as
well as a wide variety. Almost the complete variety of coordination behaviour was employed during these sessions. The wiki page creation showed similar trends to concept mapping sessions. The division of labour for page creation resulted in many coordination attempts with a wide variety of coordination behaviours. The actual page creation triggered less coordination, and only moderate variety. The writing session presented a somewhat different picture: it resulted in a large amount of coordination in both groups. While group B showed a particularly high amount of coordination, they only showed a moderate variety. Coordination behaviour in group A is comparable to the wiki page and the concept mapping task in terms of overall frequency and variety.

The four discussion tasks utilised synchronous and asynchronous media. Coordination differed in the two media conditions. Discussion tasks carried out in synchronous media included a bigger variety, as well as quantity of coordination attempts, than those carried out in asynchronous media. Asynchronous media only included Synchronisation [CIS] attempts.

5.2.5.1. Discussion

Differences in frequency and nature of coordination behaviour across tasks aligns with considerations that task characteristics shape the learning process (Zigurs & Buckland, 1998). While the discussion task can be categorized as a simple task in terms of Zigurs and Buckland’s (1998) hierarchy, other tasks involved much more uncertainty and thus have to be considered as more complex. Consequently, more complex tasks, e.g. concept map production or collaborative writing, produced higher levels, as well as a wider variety, of coordination behaviour.
Furthermore, students showed differences in coordination behaviour during the discussion task when using different communication media. This points to the additional influence of the medium on group dynamics.

### 5.2.6 Summary and Concluding Remarks

In general, all four tasks triggered Synchronisation [CIS], Demanding Activities [CIP], Assigning Group Members to Activities [CT] and Discussing Media Usage for Communication Purposes [CIC] as the most frequent coordination behaviours. However, tasks differed in the overall amount of coordination behaviour shown. While discussion tasks triggered only approximately 10% coordination behaviour, other tasks triggered up to 60%.

The tasks differed in quantity and quality of coordination attempts. For example, discussions included little coordination and a small variety of coordination attempts. Concept mapping tasks revealed a high amount and variety of coordination attempts. Wiki page construction and collaborative writing showed similar trends to concept mapping. However, some differences existed within these tasks. The actual wiki page creation only showed a moderate variety as opposed to the preceding division of labour. Furthermore, the two groups differed greatly in their coordination attempts during the writing task.

Different tasks inherit different characteristics. The more complex the characteristics are, the more complex the resulting coordination patterns. For example, tasks such as discussion assignments include little uncertainty and require little coordination activity. Other tasks, such as concept mapping assignments, involve a higher degree of uncertainty and require a larger variety and quantity of
coordination activities. This concludes, complex tasks also need a platform enabling complex coordination support.

Coordination observations during the discussion tasks, presented in the first subsection, were of particular interest. The four discussion tasks were carried out with the help of two different media. While there was a general pattern of coordination for discussion, i.e. a moderate variety with generally few coordination attempts, the pattern also differed across the media used. Discussion tasks carried out in synchronous media included a bigger variety and quantity of coordination attempts than those carried out in asynchronous media. Additionally, asynchronous media only included Synchronisation [CIS] attempts. This points to the importance of interrelations between different influencing factors, as both factors contribute to coordination behaviour in their own ways.

The cost of coordination became evident when groups showed episodes of unsuitable or irrelevant coordination attempts. For example, students showed surplus coordination behaviour based on confusion about the task assignment. This could be met by more detailed and precise task assignments. In other instances, the group developed behavioural patterns, failing to react to each other’s utterances. This resulted in additional coordination attempts. Such behavioural patterns can be met by making them explicit and pointing them out to the group.

However, one has to consider, not only tool and tasks influence coordination by themselves, but individual members play an important role in coordination dynamics in a group as well. The following section investigates how individual members influence coordination dynamics in online groups.
5.3 INDIVIDUAL MEMBERS

The following section elaborates on the influence of individual members on coordination dynamics. The development of coordination per member is examined from a longitudinal and an individual perspective. The influence of roles on coordination dynamics is examined as well.

5.3.1 Individual Characteristics

The following sub-section presents findings and associated discussion regarding intra- and interindividual differences in coordination behaviour. It provides an individual and a longitudinal view on the behaviour shown. Prior experience with IT usage is investigated in detail.

5.3.1.1 Findings

In general, intra- and interindividual differences in coordination behaviour can be observed. Characteristics can be viewed from a time perspective, emphasizing developmental aspects, and an individual perspective, focusing on single members. Additionally, the moderator role influence on coordination behaviour is considered.

5.3.1.1 Longitudinal Perspective

Students show a pattern of alternating decreases and increases in coordination behaviour (Figure 18 and Figure 19). Individuals of group A did not show one distinct coordination pattern as the semester proceeded (Figure 18). Each member formed their own individual coordination contribution pattern. The lecturer, Susan,
contributed as a moderator during the first few sessions and then gradually reduced her contributions. Eric started with few contributions and slowly increased his coordination behaviour as the semester progressed. Sandra revealed an increasing coordination trend, with a peak during the voluntary session 5*, and presented an alternating coordination pattern afterwards. Sabine contributed generally at a moderate level, compared to her group members. Jane revealed an alternating pattern from session to session.

![Figure 18: Coordination initiation percentage in relation to overall coordination per individual from group A using synchronous communication means.](image)

*Voluntary sessions; enlarged dots with black circles indicate moderator role, “L” indicates Lecturer

In group B, students showed an equal amount of alternating coordination attempts as the semester proceeded. Jessica started with a relatively high coordination contribution proportion during session 2, and revealed an increasing trend towards the end. Dave and Mark, both showed alternating patterns during the synchronous
chat sessions. Generally, they contributed more when holding the moderator role, as indicated by an enlarged, black-circled dot in Figure 19. During session 10 Jessica, the moderator, was the only member to utter coordination attempts. No coordination was shown during session 12.

![Figure 19: Coordination initiation percentage in relation to overall coordination per individual from group B using synchronous communication means.](image)

Enlarged dots with black circles indicate moderator role, "L" indicates Lecturer.

### 5.3.1.1.2 Individual Perspective

Overall, most members coordinated less during the beginning and end of the semester. In group A, almost all members showed more initiations than closures, with the exceptions of Sandra in session 9, as well as Sabine and Jane in session 2 (Table 30). Some students, e.g. Sabine, contributed to coordination on a generally lower level compared to other students, e.g. Jane. This development seems to be stable across the semester.
Table 30: Coordination initiations and closures (in percent) per student and session in group A (*voluntary sessions).

<table>
<thead>
<tr>
<th>Session</th>
<th>Eric</th>
<th>Sandra</th>
<th>Sabine</th>
<th>Jane</th>
<th>Susan (Lecturer)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Initiation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Session 2</td>
<td>6</td>
<td>2</td>
<td>1</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Closure</td>
<td>1</td>
<td>4</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Session 3</td>
<td>5</td>
<td>6</td>
<td>4</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Closure</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Session 4</td>
<td>–</td>
<td>20</td>
<td>8</td>
<td>25</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Closure</td>
<td>–</td>
<td>10</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Session 5*</td>
<td>–</td>
<td>38</td>
<td>13</td>
<td>26</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Closure</td>
<td>–</td>
<td>7</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>Session 6</td>
<td>9</td>
<td>24</td>
<td>4</td>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Closure</td>
<td>3</td>
<td>10</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>Session 6*</td>
<td>22</td>
<td>10</td>
<td>14</td>
<td>18</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Closure</td>
<td>11</td>
<td>7</td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>Session 7</td>
<td>20</td>
<td>18</td>
<td>15</td>
<td>11</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Closure</td>
<td>10</td>
<td>10</td>
<td>13</td>
<td>3</td>
</tr>
<tr>
<td>Session 9</td>
<td>–</td>
<td>9</td>
<td>9</td>
<td>26</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Closure</td>
<td>–</td>
<td>15</td>
<td>11</td>
<td>11</td>
</tr>
</tbody>
</table>

Table 31: Coordination initiations and closures (in percent) per student and session in group B.

<table>
<thead>
<tr>
<th>Session</th>
<th>Jessica</th>
<th>Dave</th>
<th>Mark</th>
<th>Anne (Lecturer)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Initiation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Session 2</td>
<td>13</td>
<td>7</td>
<td>1</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Closure</td>
<td>5</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Session 3</td>
<td>7</td>
<td>4</td>
<td>7</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>Closure</td>
<td>5</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Session 4</td>
<td>13</td>
<td>14</td>
<td>14</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Closure</td>
<td>8</td>
<td>9</td>
<td>14</td>
</tr>
<tr>
<td>Session 6</td>
<td>14</td>
<td>–</td>
<td>21</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Closure</td>
<td>7</td>
<td>–</td>
<td>12</td>
</tr>
<tr>
<td>Session 9</td>
<td>29</td>
<td>27</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Closure</td>
<td>8</td>
<td>9</td>
<td>6</td>
</tr>
</tbody>
</table>

Inter- and intraindividual differences became evident when looking at the initiation–
closure rates of each of the members (Table 30 and Table 31). In group B, everyone showed
more coordination initiations than closures (Table 31). Generally, Jessica’s
and Dave’s coordination patterns were similar, revealing moderate contributions
during the first sessions and a higher coordination rate in the last synchronous session. Mark showed a coordination peak during session 6, due to his moderator role during that session.

5.3.1.1.3 Prior Experience

The prior experience of group members with collaborative computer–based learning was relatively low. Group members estimated their level of experience with different media prior to the course in a questionnaire. Generally, the answers showed little experience, with the exception of using e-mails and to some extent chat. Group B’s answers showed slightly greater prior experience than group A (Table 32). However, both groups answered, they felt comfortable working with a computer as well as in a group.

Table 32: Average prior experience* and standard deviation (in brackets) for group A and B in the various media (N = 7).

<table>
<thead>
<tr>
<th>Media type</th>
<th>Group A</th>
<th>Group B</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-mail</td>
<td>3.50 (0.58)</td>
<td>3.33 (0.58)</td>
<td>3.43 (0.53)</td>
</tr>
<tr>
<td>Chat</td>
<td>2.25 (1.5)</td>
<td>3.3 (0.58)</td>
<td>2.71 (1.25)</td>
</tr>
<tr>
<td>Whiteboard</td>
<td>0.25 (0.5)</td>
<td>0.00 (0.00)</td>
<td>0.14 (0.38)</td>
</tr>
<tr>
<td>Webcam</td>
<td>1.00 (1.41)</td>
<td>2.00 (1.73)</td>
<td>1.43 (1.51)</td>
</tr>
<tr>
<td>Collaborative Computer–Supported Learning</td>
<td>1.25 (0.96)</td>
<td>1.33 (1.52)</td>
<td>1.28 (1.11)</td>
</tr>
<tr>
<td>Individual Computer–Supported Learning</td>
<td>1.50 (1.73)</td>
<td>1.00 (1.73)</td>
<td>1.28 (1.60)</td>
</tr>
<tr>
<td>Feeling comfortable working with computer</td>
<td>3.50 (1.00)</td>
<td>3.00 (1.00)</td>
<td>3.29 (0.95)</td>
</tr>
<tr>
<td>Feeling comfortable working in a group</td>
<td>3.25 (2.67)</td>
<td>2.7 (1.15)</td>
<td>3.00 (1.00)</td>
</tr>
</tbody>
</table>

*The scale ranged from not at all experienced (0), not very experienced (1), neutral (2), experienced (3) to very experienced (4).

Generally, group members enjoyed the online work with a slight positive trend (Table 33). Group B tended to rate enjoyment slightly lower than group A.
Table 33: Average rating of online work enjoyment* for group A and B (N = 7).

<table>
<thead>
<tr>
<th></th>
<th>Group A</th>
<th>Group B</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>I enjoyed the Online Work (Session 4)</td>
<td>2.75 (0.50)</td>
<td>2.33 (0.58)</td>
<td>2.57 (0.53)</td>
</tr>
<tr>
<td>I enjoyed the Online Work (Session 7)</td>
<td>3.00 (1.00)</td>
<td>2.00 (1.00)</td>
<td>2.50 (1.05)</td>
</tr>
<tr>
<td>I enjoyed the Online Work (Session 12)</td>
<td>3.00 (0.81)</td>
<td>3.00 (0.00)</td>
<td>3.00 (0.58)</td>
</tr>
</tbody>
</table>

*The scale ranged from not at all experienced (0), not very experienced (1), neutral (2), experienced (3) to very experienced (4).

Most tasks were new to the students: None of the students had created a collaborative concept map with the help of a whiteboard before. The experience with wiki pages was also relatively low.

Students reacted differently to the challenge of online collaboration: often the medium’s novelty resulted in frustration. Excerpt 67 depicts an interaction where a student missed instructions about handling software. Instead of scrolling up to view the instructions, she got frustrated and repeatedly asked the same question.

Sandra: “i know it might be a simple question but shouldn’t be ignored” [NNC]
Anne (Lecturer 1): “sandra, do you mind posing your question in the discussion forum” [CIC]
Sandra: “but how do you select the two boxes so that the arrow are in the right place?” [NNC]
Mark: “i tried doing that with the arrows but it never worked as i wanted it to. guess i need more practice” [NNC]
Sandra: “ok will do” [CIC+]

Excerpt 67 taken from session 4, group A and B.

In the following session, the moderator told the same student, who logged in late, to scroll the chat window up in order to catch up with the discussion, instead of asking the group to summarise (Excerpt 25).
Similarly, when the online platform encountered technical difficulties, students reacted with frustration. In other courses, students would use alternative communication media, such as e-mail to cope with the technical problems. Students in this course had less prior experience, and thus only limited coping strategies available to react to unexpected circumstances. Excerpt 68 shows students’ chosen coping strategies in a typical situation where they could not find their group. It took them approximately 20 minutes to locate the appropriate chat room.

```
Jessica: ”where is the class?????”          [CIS]
Jane: “i have no idea”                     [CIS+]
     jessica                                [NNC]
Jessica: “is the class cancelled today ??” [CIS]
Jane: “let me go out and take a look.....” [CT]
...
Jane: “no one’s there
     sabine”                                [NNC]
Jessica: “shall we go out again [name]
Jessica: and search for our friends”      [CIP]
     jane                                  [NNC]
Jane: “ok, come back here later”          [CIP+]
...
Jessica: “i think there something wrong in the larnlab”
Jessica: “i was stuck”                    [CIS]
...
Jane: “seems like the website is having some problems of logging in
Jane: “which is what i was afraid of”      [NNC]
```

Excerpt 68 taken from session 9, group A and B.

Group members were asked in a questionnaire whether they felt technical aspects were too complicated in the course during the last month. Generally, they tended to disagree that technical aspects were too complicated. Group B rated them neutral, with a slight tendency to agreement (Table 34).
5 Coordination: Results and Discussion

Table 34: Average rating of technical aspects* as being too complicated during the last month for group A and B (N = 7).

<table>
<thead>
<tr>
<th></th>
<th>Group A</th>
<th>Group B</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical applications were</td>
<td>1.25</td>
<td>2.00</td>
<td>1.57</td>
</tr>
<tr>
<td>too complicated (Session 4)</td>
<td>(0.50)</td>
<td>(1.00)</td>
<td>(0.79)</td>
</tr>
<tr>
<td>Technical applications were</td>
<td>1.33</td>
<td>2.67</td>
<td>2.00</td>
</tr>
<tr>
<td>too complicated (Session 7)</td>
<td>(0.58)</td>
<td>(0.58)</td>
<td>(0.89)</td>
</tr>
<tr>
<td>Technical applications were</td>
<td>1.25</td>
<td>2.00</td>
<td>1.57</td>
</tr>
<tr>
<td>too complicated (Session 12)</td>
<td>(0.50)</td>
<td>(1.00)</td>
<td>(0.79)</td>
</tr>
</tbody>
</table>

*The scale ranged from not at all experienced (0), not very experienced (1), neutral (2), experienced (3) to very experienced (4).

5.3.1.2 Discussion

5.3.1.2.1 Longitudinal and Individual Perspective

Most students revealed alternating decreases and increases in coordination behaviour as the semester progressed. The alternating behaviour did not follow a particular pattern. It is important to notice that behavioural fluctuations exist and individual student's behaviour is not predictable, at a certain level of granularity. This confirms theoretical considerations from Arrow et al. (2000), group dynamics cannot be predicted on a local level.

Generally, most group members contributed less coordination during the beginning and the end of the semester, with the exception of Jessica and Dave. These two contributed more towards the end. The general trend could be explained by the fact that students did not have experience with the medium in the beginning and were hesitant to take charge and try to coordinate the group's efforts. The coordination decline in the end could be attributed to the semester ending and students became increasingly busy with other assignments.
5.3.1.2.2 Prior Experience

The general low level of prior experience can account for some of the group members' frustration during periods of technical difficulty. For example, instead of scrolling up the chat window to retrieve an already given answer to a particular question, students would be frustrated when their repeated question was not answered (Excerpt 67).

5.3.2 Roles

The following sub-section presents findings and associated discussion regarding the roles a group member holds and how such roles influence coordination behaviour.

5.3.2.1 Findings

During the sessions, individuals initiated more coordination behaviour when they held the moderator role; see Figure 18 and Figure 19 for initiation behaviour and Figure 20 for combined coordination (initiation and closure). There is no comparison available for Jessica, she only held a moderator role during sessions 10 and 12.
During session 3 the moderator, Susan, asked the class about their map construction strategy. During the following session 4, Jane, who held the moderator role for this session, adopted the same approach. Such a development did not emerge in group B. The incident illustrates how local dynamics in groups occur, in this case the adoption of other members’ role strategies.

Interestingly, group A did not appoint a group member to the moderator role during their two voluntary sessions.

5.3.2.2 Discussion

The moderator role influenced coordination behaviour. Group members who held the moderator role generally contributed more coordination behaviour compared to sessions were they acted as a regular group member (Figure 20). This confirms findings from Strijbos et al. (2005) that predetermined roles shape the organisation and coordination of collaboration in computer-based learning settings. Furthermore, such roles act more as guiding principles than behavioural
determinants and there was a general trend for all members to contribute more during their moderator role. However, the overall amount of contribution and other member’s general habits to coordinate in addition to the moderator still varied with the individual involved.

Previous research points to the influence of the instructor’s prior experience on group interaction patterns (Mortera-Gutierrez, 2002). Almost all of the students in the current study had no prior experience with moderation of an online class. The introduction to the moderator role, pointing out its importance and impact on group dynamics, can benefit coordination dynamics.

5.3.3 Perception of Group Members

At different times during the course, students rated different aspects of their online experience.

5.3.3.1 Findings

Students rated the quality of their group experience approximately monthly. They agreed to feeling part of the learning group and did not want to change groups (Table 35).

<table>
<thead>
<tr>
<th></th>
<th>Session 4</th>
<th>Session 7</th>
<th>Session 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Felt as part of a group.</td>
<td>2.71 (0.95)</td>
<td>3.00 (0.63)</td>
<td>2.71 (0.76)</td>
</tr>
<tr>
<td>Would like to change the group.</td>
<td>1.85 (0.38)</td>
<td>2.17 (0.75)</td>
<td>2.0 (0.82)</td>
</tr>
</tbody>
</table>

* Questions were rated on a scale ranging from totally disagree (0), disagree (1), neutral (2), agree (3) to totally agree (4). The questionnaire asked for the experience during the last month.
After the course, students assessed the similarity of the current course to other courses, regarding the online work group, the way the group stuck together, and helped each other. They felt neutral towards the group being similar to other groups ($M = 1.71$, $SD = 0.76$). They rather disagreed that this group was sticking together similarly to other groups ($M = 1.43$, $SD = 0.53$), and were rather neutral about group members helping each other ($M = 1.71$, $SD = 0.48$).

They all agreed they used other means of communication in addition to those offered by the course environment, such as text messaging through mobile phones.

5.3.3.2 Discussion

Generally, questionnaire ratings portrayed a positive picture of group culture within the groups. Students felt part of the group and did not want to change the group.

They rather disagreed with groups being similar to other groups and helping each other out. Interpreting this in the light of other answers, students felt positive about their groups, in terms of support and group culture.

5.3.4 Summary and Concluding Remarks

Individual characteristics were examined from an individual and a longitudinal perspective. The influence of prior IT experience as well as the influence of the role a group member holds was investigated.

Some group members showed a lower tendency to engage in coordination attempts than others. As time proceeded, coordination behaviour underwent intraindividual fluctuations. The prior experience of students with IT in a CSCL setting was
relatively low: none of them had participated in online learning before. This resulted in frustration during the initial stages of the course until students felt comfortable with IT usage in an educational setting. The initial frustration imposed additional coordination demands on the groups. Furthermore, students holding the moderator role showed increased coordination efforts during that particular session.

Generally, participants experienced a positive picture of the group culture. They felt as part of a group and did not want to change.

This leaves to conclude, even though the influence of single members on coordination dynamics is difficult to predict, some influencing factors are explored in more detail, i.e. the role they hold or even their prior experience with CSCL environments.

5.4 Integrative Summary and Conclusions

The chapter presented a separate analysis of three major factors influencing coordination: tools, tasks and members.

Regarding tools, the most striking differences were encountered between synchronous and asynchronous communication media: synchronous media enable a richer variety, as well as a larger quantity of coordination compared to asynchronous media. This could be due to the medium’s ability to convey immediate feedback.

The cost of coordination in relation to the tool became evident when students showed episodes of unsuitable or irrelevant coordination attempts. For example,
continuous reiteration of assuring everyone is on track and paying attention can come as an additional strain to the group. Also, they felt the chat tool was slow, if there is a lot to work on. One possible way to minimise unwanted coordination is proper tool choice; when choosing a medium that enables less coordination behaviour, chances for unwanted coordination are minimised. Also, congruence between media characteristics, such as its ability to convey effective parallel messages, and members’ behaviour, such as trying to stick to a topic if parallelism is low, reduces coordination costs. However, in order to make a fully informed tool choice, one has to consider other influences as well, such as the assigned task and members’ individual characteristics.

Overall, the tasks differed in quantity and quality of coordination attempts. Simpler tasks, i.e. discussion tasks, included little coordination and a small variety of coordination attempts. Other, more complex tasks revealed a higher amount and variety of coordination attempts, i.e. concept mapping, wiki page creation and collaborative writing tasks. The more complex characteristics in tasks are, the more complex the resulting coordination patterns. This concludes, more complex tasks also need complex coordination support.

The cost of coordination in relation to the task became evident when groups showed episodes of unsuitable or irrelevant coordination attempts, triggered by confusion about task assignments or malfunction coordination patterns such as continuously neglecting other’s coordination attempts.

Furthermore, member characteristics influenced coordination, e.g. participants tended to react with increased coordination attempts when they held the moderator role. Furthermore, prior experience with IT was linked to members’ behavioural patterns regarding IT acceptance and might influence interaction through a particular communication medium.
However, it is important to view these findings in an integrated way, the three factors contribute to the coordination dynamics in their own ways.

Generally, coordination can come as a cost to online learning groups. Asynchronous media triggered less coordination, which resulted in a smaller risk for coordination costs. When estimating costs and only considering the tool aspect, one might be inclined to favour asynchronous communication media. However, the task perspective has to be considered as well, complex tasks have a complex coordination demand. This again stresses the importance of an optimal fit between tasks and tools.

In addition, some students voiced a strong preference for asynchronous communication media. This might be due to a low prior experience with IT in learning environments. Asynchronous media might be easier to handle at first. This implied, individual member factors have to be considered for the course design. It might be preferable for students to start a class with an asynchronously mediated discussion task, and then change to other, more demanding media as the course proceeds and experience increases. The implementation of synchronous online communication should come with the provision of clear instructions and the introduction of rules and roles. This seems especially valuable if the general level of prior experience is low.

Online learning groups are embedded in a context, such context factors constitute a further layer of impacting factors on learning experiences. A crucial contextual factor in online learning environments is social presence. In order to enable a deeper insight into students' online learning experience, the following chapter examines social presence and its importance in CSCL environments.
6 SOCIAL PRESENCE

RESULTS AND DISCUSSION

The following chapter presents findings and associated discussions on social presence, illuminating the role of social presence as an enabling context parameter in CSCL environments. The majority of findings are derived from analysing coded online communication and class artefacts. Findings from questionnaire answers are also presented. In addition, the use and perception of awareness features, as implemented in the course, are examined.

The coding scheme captures three different aspects of social presence: affective, interactive and cohesive responses. It is adopted and slightly modified from Rourke et al. (1999).

Excerpts from communication exchanges are presented, illustrating the nature of coordination utterances. The voluminous amount of excerpts and qualitative analysis leads to an extended results presentation. In order to tie the results and discussions closer together, each result presentation is followed by the respective discussion.

The presentation of findings and subsequent discussion follows the framework presented in the literature review, and consolidated in the methods chapter: media and members are investigated in separate sections. The term “media” in this chapter is closely related to the term “tool” presented in earlier parts of this thesis. The label “media”, used in connection with social presence, is the nomenclature commonly used in related research literature.
A longitudinal perspective provides insight into the development of social presence in different media. Social presence density, a measure introduced in other empirical studies (e.g. Rourke et al., 1999), allows for cross comparison.

Two perspectives, individual and longitudinal, emphasize the member's impact on the experience of social presence. While the individual perspective provides an overview of the social presence experienced by each of the participants, the longitudinal perspective emphasizes its development as the course proceeds.

Overall, social presence coding revealed 4201 codes for group A (4091 for synchronous and 110 for asynchronous communication), and 2761 codes for group B (2590 for synchronous and 171 for asynchronous communication). The difference in codes is due to the fact that group A conducted additional voluntary chat sessions. The coding achieved a satisfactory Kappa measure, $\kappa = .86$ (Banerjee et al., 1999).

### 6.1 MEDIA

Social presence was experienced differently in the media used in the course, i.e. synchronous and asynchronous. Sessions 2, 3, 4, 6, 7 and 9 were synchronous chat sessions. Sessions 10 and 12 were asynchronous discussion forum sessions. The sub-section concludes with a comparison of the social presence experience between different media.
6.1.1 Media Perspective

A screenshot of the synchronous online environment as experienced in the respective sessions is provided in Figure 12 (page 139), Figure 13 (page 155), Figure 14 (page 168). Figure 15 (page 176), shows a screenshot of the asynchronous environment.

6.1.1.1 Findings

The following section compares social presence as experienced in the two different media. It also adopts a longitudinal perspective to unveil how social presence develops over time.

The groups showed different levels of social presence during synchronous and asynchronous sessions (Table 36). Synchronous communication triggered around 80% social presence out of all contributions (82.7% for group A and 78.9% for group B). Asynchronous communication triggered only about 45% social presence (43.6% for group A and 48.6% for group B).

Table 36: Social Presence (in %) as shown during synchronous and asynchronous media use in group A and group B.

<table>
<thead>
<tr>
<th>Social Presence (%)</th>
<th>Session</th>
<th>Synchronous Chat Group A</th>
<th>Synchronous Chat Group B</th>
<th>Discussion Forum Group A</th>
<th>Discussion Forum Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expression of Emotions [PAE]</td>
<td>8.2</td>
<td>5.9</td>
<td>10.9</td>
<td>7.0</td>
<td></td>
</tr>
<tr>
<td>Use of Humour [PAH]</td>
<td>.4</td>
<td>.3</td>
<td>--</td>
<td>.6</td>
<td></td>
</tr>
<tr>
<td>Self-Disclosure [PAS]</td>
<td>2.2</td>
<td>2.9</td>
<td>1.8</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>Referring to other’s messages [PIR]</td>
<td>.1</td>
<td>--</td>
<td>1.8</td>
<td>2.9</td>
<td></td>
</tr>
<tr>
<td>Referring to other interactions [PII]</td>
<td>.2</td>
<td>.2</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
</tbody>
</table>

-Table continued on following page-
### 6 Social Presence: Results and Discussion

<table>
<thead>
<tr>
<th>-- Table continued --</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Asking Questions [PIQ]</td>
<td>17.6</td>
<td>17.3</td>
<td>15.5</td>
<td>9.9</td>
</tr>
<tr>
<td>Complementing [PIC]</td>
<td>1.6</td>
<td>2.4</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Expressing Agreement/Acknowledge-ment [PIA]</td>
<td>16.9</td>
<td>16.7</td>
<td>4.5</td>
<td>8.2</td>
</tr>
<tr>
<td>Expressing Disagreement [PID]</td>
<td>1.1</td>
<td>1.1</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Vocatives I [PCR]</td>
<td>2.3</td>
<td>4.2</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Vocatives II [PCN]</td>
<td>15.3</td>
<td>10.7</td>
<td>3.6</td>
<td>5.3</td>
</tr>
<tr>
<td>Refer to group using inclusive nouns [PCP]</td>
<td>11.5</td>
<td>11.4</td>
<td>5.5</td>
<td>13.5</td>
</tr>
<tr>
<td>Phatics, salutations [PCS]</td>
<td>5.4</td>
<td>5.7</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>No Social Presence [NSP]</td>
<td>17.3</td>
<td>21.1</td>
<td>56.4</td>
<td>51.5</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

### 6.1.1.1 Synchronous Media

The groups revealed similar patterns of social presence in online communication (Table 36). During synchronous chat sessions, the three most frequent behaviours displaying social presence were, in the following rank order, Asking Questions [PIQ], Expressing Agreement/Acknowledgement [PIA], Vocatives II [PCN] for group A and Referring to the Group Using Inclusive Nouns [PCP] for group B. Generally, group A used vocatives slightly more often compared to group B. Group A also addressed participants with their real name more often (Vocatives II [PCN]), in relation to addressing them with their screen name (Vocatives I [PCR]).

Excerpt 69 illustrates a typical synchronous interaction during session 4. It depicts social presence indicators as illustrated by the codes.

Jane: "? what do you mean by 'classes'?"   [PIQ]
Sandra: "! how is that guys?"               [PIQ]
Jane: "! - yes... you're right!"           [PIA]
6.1.1.1.2 Asynchronous Media

Social presence patterns during asynchronous discussion differed slightly in the two groups (Table 36). During the discussion, the three most frequent were for group A, Asking Questions [PIQ], Expression of Emotions [PAE] and Referring to the Group Using Inclusive Nouns [PCP]. Group B revealed a slightly different ranking order with Referring to the Group Using Inclusive Nouns [PCP], Asking Questions [PIQ] and Expressing Agreement [PIA]. Excerpt 70 shows a typical interaction as it occurred during session 10 in group A.

Posted by Sabine: Re: Natural Groups
For me, i think it has something to do with conflicts, as one of the four modes of group which in some circumstances occur in the production, member-support, and group well-being function… [NSP]
i was just wondering about the “big-brother thing”… an artificial group right? [PIQ]
[emoticon smiley] [emoticon thinking] [PAE]

Posted by Jane: Re: Natural Groups
i would think the ‘real complexities’ not only include conflicts, but also the members’ attitudes and behaviours. Some members in the natural groups really have bad attitudes towards members who may be slower or lower
abilities than them, blaming them for poor performance of the group, putting them down instead of encouraging them, ignoring their contributions....(the list goes on). The human mind is the REAL complexity. [NSP]

PS: yes sabine, [PCN]
i agree with you, ‘big brother’ looks artificial, [PIA]
haha [PAE]
[emoticon laughing] [PAE]

Excerpt 70 taken from the discussion forum during session 10, group A (thread 1).

6.1.1.1.3 Media Comparison

The quantity and quality of social presence indicators varied between the two different communication media. Synchronous media conveyed a stronger sense of presence compared to asynchronous media. In addition, the variety of social presence indicators was much smaller during the asynchronous forum compared to the synchronous sessions (Table 36). Neither group Referred to Other Interactions [PII] during the discussion forums, and showed no instances of Complementing [PIC], Expressing Disagreement [PID] and Phatics/Salutations [PCS]. However, Referring to Others’ Messages [PIR] increased slightly in both groups when using the discussion forum.

Each discussion forum posting displayed the screen name as well as a picture and real name of the author. Members of neither group employed the screen name when addressing each other. Instead, they used the real names. Overall, they showed fewer instances of vocatives compared to the synchronous chat sessions. Group A also Referred to the Group Using Inclusive Nouns [PCP] with less frequency during discussion forums, whereas group B showed a slight increase. Also, Emotions [PAE] were expressed more frequently during the discussion forum.
compared to the synchronous chat sessions. Both groups showed a decline in Expressing Agreement [PIA] in discussion forums compared to synchronous sessions; group A showed about 75% less, and group B about 50% less agreement.

6.1.1.2 Discussion

The results show, social presence was experienced differently between the two media. Both groups expressed higher levels of social presence indicators during synchronous communication compared to asynchronous communication.

Some research points to different media resulting in varying levels of social presence experience (Bente et al., 2005; Short et al., 1976). Varying levels of conveying affective information result in varying social presence experience. In the current study, both forms of communication media were text-based and thus employed the same sensory channels. Therefore, they inherited the same ability to convey affective information.

Immediacy behaviours are important for experiencing social presence, as they decrease the distance felt between group members (Swan, 2002). Observations from this study support this view, asynchronous communication generally enables a smaller sense of presence. A possible explanation is that asynchronous discussion allows less immediacy behaviour compared to synchronous discussion.

These findings partially oppose the equilibrium model stated by Danchack et al. (2001), because the available affective channels remained the same in the two communication media, but the overall amount of experienced social presence decreases. During asynchronous discussion forums, affective social presence indicators achieved more application in relation to other social presence indicators, compared to synchronous chats. The most frequently expressed social presence
indicators during the synchronous chats belonged to the interactive or cohesive group. This changed during asynchronous discussions. For group A, the three most frequently expressed indicators stemmed from all three groups and for group B the Expression of Emotions [PAE] revealed a relatively frequent usage (Table 36). Even though students expressed more Use of Emotions [PAE], thus affective social presence indicators, during the asynchronous discussion forum, they experienced less social presence overall. This leads to two possible interpretations: a) students might strive for some form of equilibrium but the influence of the medium is stronger or b) students might strive for an equilibrium which is dependant on the medium. In any case, the medium’s impact cannot be ignored.

During asynchronous communication, expression of social presence was much lower compared to synchronous communication (Figure 22 and Figure 23). The decline began when groups switched from synchronous to asynchronous communication media. This supports the fact that groups act within certain developed dynamics (Arrow et al., 2000). Groups tend to act according to the direction developed during their lifespan, and this momentum can be quite resistant. The change in group context, i.e. the communication medium, forces the group to react and develop new patterns of communication. The delay in altering expressed social presence illustrates group resistance to altering the path on which they have set out.

6.1.2 Longitudinal Perspective

6.1.2.1 Findings

A general trend towards increased expressed social presence indicators during synchronous communication exists (Figure 22 and Figure 23). See Figure 21 for
group A. The voluntary session 5* showed a particularly high level of social presence expressions compared to other synchronous sessions.

The higher category analysis of social presence indicators, i.e. affective, cohesive and interactive, provides a collated picture of the group’s social presence development over time. Generally, the two groups showed a smaller percentage of affective statements during all sessions compared to interactive and cohesive indicators (Figure 22 and Figure 23). Affective social presence indicators ranged around 10%, whereas cohesive and interactive indicators ranged between 30–40% during the synchronous sessions. This changed slightly during the asynchronous discussion forum, both groups showing the same amount of affective social presence indicators, compared to previous session; all other indicators, i.e. cohesive and interactive, were lower, so the ratio was only slightly altered. However, this changed during session 12, where affective indicators decreased. Interactive and cohesive social presence indicators showed on similar levels.

Figure 21: Social presence contributions by all four members of group A in each of the synchronous sessions.
During the synchronous sessions a trend towards increasing social presence was portrayed. Both groups showed a clear decrease in social presence during the asynchronous discussions in session 10 and 12 (see Figure 22 and Figure 23).

**Figure 22:** Higher social presence categories shown during the sessions in group A. (*Voluntary sessions; sessions 2–9 are synchronous and 10–12 are asynchronous.)*

**Figure 23:** Higher social presence categories shown during the sessions in group B. (Sessions 2–9 are synchronous and 10–12 are asynchronous.)
6.1.2.2 Discussion

Overall, expression of social presence indicators increased as the semester proceeded and as long as the students remained in the synchronous communication environment. The more students got used to the synchronous environment, the more they felt comfortable working in the group and the more the social presence expression increased. This finding supports theoretical considerations that temporal aspects play a role in the experience of social presence (Picciano, 2002). However, expression of social presence decreased during the two last sessions, held in the asynchronous mode. The decline points to the medium’s impact on the expression of social presence. This impact seems to be stronger than longitudinal effects emerging as part of the groups’ dynamics.

Interactive and cohesive expressions were generally more frequent than affective expressions of social presence during synchronous communication. This provides some support for Danchack et al.’s (2001) considerations that the affective channel plays a special role when experiencing social presence. They suggest bandwidth, immediacy and equilibrium, i.e. the individuals’ tendency to maintain an emotional equilibrium, also play a role in experiencing social presence.

As students switched from synchronous to asynchronous communication, affective indicators initially remained on the same level as previous sessions but dropped during the last session (Figure 21 and Figure 22). Interactive and cohesive indicators had already dropped during the first asynchronous session. This could point to the fact, they are more susceptible than the affective channels. The further decline of affective indicators during session 12 can be explained by noting that the decline in immediacy also results in a decline in affective indicators. This opposes the equilibrium model by Danchack et al. (2001).
6.1.3 Social Presence Density

The social presence density measure has been introduced in other studies (Rourke et al., 1999) to allow for a comparison of social presence across studies.

6.1.3.1 Findings

Social presence density, as proposed by Rourke et al. (1999), is calculated as the total number of social presence indicators divided by the total number of words for the respective session (Figure 23). This figure is then multiplied by 1000.

Table 37: Overall amount of words in the respective sessions.

<table>
<thead>
<tr>
<th></th>
<th>Group A</th>
<th>Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Synchronous Communication</td>
<td>25283</td>
<td>14206</td>
</tr>
<tr>
<td>Asynchronous Communication</td>
<td>3210</td>
<td>3985</td>
</tr>
</tbody>
</table>

Group B showed a slightly higher aggregate social presence density compared to group A. Overall, they showed 143.9 social presence indicators per 1000 words compared to 133.8 for group A. Similarly, group B attained 20.8 instances of social presence indicators per 1000 words during the asynchronous sessions compared to 15.0 instances for group A.

A more detailed analysis of single social presence indicators revealed a similar picture (Figure 24). All social presence indicators revealed a higher density in the synchronous medium, compared to the asynchronous medium.

In the synchronous sessions, group A almost always showed a lower social presence density compared to group B, with the exception of Expressing Emotions [PAE] and Vocatives II [PCN]. Asynchronous sessions revealed similar results.
Overall, Vocatives II [PCN], Addressing or Referring to the Group Using Inclusive Pronouns [PCP], Expressing Agreement [PIA] and Asking Questions [PIQ] achieved the highest densities during synchronous sessions. During asynchronous sessions, Addressing or Referring to the Group Using Inclusive Pronouns [PCP], Asking Questions [PIQ], Expressing Agreement [PIA] and Expressing Emotions [PAE] attained the highest densities. The variety of social presence indicators was much smaller in the asynchronous sessions.

The only social presence indicator achieving a higher density during asynchronous sessions, compared to synchronous sessions, was Referring Explicitly to Other Interaction [PIR]. It accomplished a social presence density of .6 and 1.3 per 1000 words for group A and B respectively during asynchronous discussion, and for a density of .2 in group A and .1 in group B’s synchronous discussion.

Figure 24: Social presence density of all social presence indicators in the respective groups.
6.1.3.2 Discussion

Rourke et al. (1999) employed the social presence density measure to evaluate the social presence expressed during asynchronous communication. Compared to Rourke et al.'s analysis, students in the current study expressed a lower level of social presence indicators during their asynchronous communication. Rourke et al. (1999) reported social presence densities for each of the categories, ranging between 0 and 7 social presence indicators per 1000 words. Indicators such as expressing emotions and the use of humour or even expressing agreement achieved the smallest densities. The use of vocatives and replying, which was excluded in the current coding scheme due to application difficulties to synchronous communication forms, reached the highest densities. Students in the current study revealed social presence density levels up to 6 indicators per 1000 words in asynchronous discussion. The nature of the indicators differs from Rourke et al.'s (1999) findings, the highest densities shown by Questions [PIQ] and Expressing Emotions [PAE].

The quantity and quality of expressed social presence indicators differs between the two studies. Students in the current study showed only a small variety of indicators whereas Rourke et al.'s students revealed a broader range of social presence indicators.

One social presence indicator, Referring to Others’ Messages [PIR], achieved a higher density during asynchronous discussion (Figure 24). Students describe asynchronous discussion media as more reflective (Pesendorfer & Koeszegi, 2006). Findings from the current study confirm such conclusions. Students referring to other messages more often during asynchronous discussion show, they not only perceive it as more reflective but also enact more reflective behaviours.
Most apparently, the social presence density measure confirms differences between the different communication media. Synchronous communication reveals many more social presence indicators than asynchronous communication.

### 6.1.4 Summary and Concluding Remarks

Overall, findings show that social presence was experienced differently with synchronous and asynchronous communication media: students expressed higher levels of social presence during synchronous communication compared to asynchronous communication. Asynchronous discussion allowed for less immediacy behaviour compared to synchronous discussion, and thus produced a smaller experience of social presence.

The three most frequently expressed social presence indicators during the synchronous chats belonged to either the interactive or the cohesive category. This differed during asynchronous discussions: students expressed more affective social presence indicators during the asynchronous discussion forum.

During asynchronous communication, expression of social presence was much lower compared to synchronous communication. The decline was delayed after groups switched from synchronous to asynchronous communication media. The delay in alteration of expressed social presence is an example of group resistance to altering their path.

Overall, expression of social presence indicators increased as the semester proceeded, as long as the students remained in the synchronous communication environment. This supports theoretical considerations that temporal aspects play a role in the experience of social presence. However, the expression of social
presence decreased during the two last sessions, held in an asynchronous mode. The decline points to the fact, the medium’s impact on expression of social presence is stronger than the above-stated emerging longitudinal effects.

While the social presence density measure confirms previous results, it also reveals differences between social presence experienced by students in this study, compared to other studies. Students in the current study showed a smaller variety and quantity of indicators compared to Rourke et al.’s (1999) study.

In order to develop a full picture of social presence as an enabling context factor, one has to consider the individual group member’s role in social presence. This role will be investigated more closely in the next section.
6.2 Members

The following section elaborates on individuals’ experience of social presence in a group. The analysis utilises a static individual perspective and a dynamic longitudinal perspective. The individual perspective provides a static overview of individual characteristics and their influence on the experience of social presence. The longitudinal view investigates how single members experience social presence as the course proceeds.

6.2.1 Individual Perspective

6.2.1.1 Findings

During synchronous communication, almost all members, in both groups, showed a wide variety of social presence indicators (Table 38 and Table 39). However, differences amongst students exist. Some students showed a lower level of social presence indicators, than others. Eric, for example, showed a generally lower level of contributions compared to other group members. His remarks most frequently included the following social presence indicators: Vocatives II [PCN], Asking Questions [PIQ] and Agreement [PIA]. Sabine showed a relatively high frequency of Agreement [PIA] indicators, a medium frequency of Questions [PIQ] and relatively low levels of Vocatives I [PCP]. Jane generally addressed others by their real name (Vocatives II [PCN]) or their screen name (Vocatives I [PCR]), more frequently, compared to her other group members.
Members of group B showed a slightly different pattern of social presence behaviour. For example, Dave expressed Agreement [PIA], Questions [PIQ] and Inclusive Nouns [PCP] most often (Table 39).
Table 39: Social Presence (in %) during synchronous sessions per member in group B.

<table>
<thead>
<tr>
<th>Social Presence Category [Code]</th>
<th>Jessica</th>
<th>Dave</th>
<th>Mark</th>
<th>Anne (Lecturer)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expression of Emotions [PAE]</td>
<td>1.81</td>
<td>0.58</td>
<td>0.50</td>
<td>0.35</td>
</tr>
<tr>
<td>Use of Humor [PAH]</td>
<td>0.08</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Self-Disclosure [PAS]</td>
<td>0.62</td>
<td>0.54</td>
<td>0.66</td>
<td>–</td>
</tr>
<tr>
<td>Referring Explicitly to Others' messages [PIR]</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Referring Explicitly to Other interactions [PII]</td>
<td>0.04</td>
<td>0.15</td>
<td>–</td>
<td>0.04</td>
</tr>
<tr>
<td>Asking Questions [PIQ]</td>
<td>3.17</td>
<td>2.59</td>
<td>3.44</td>
<td>3.20</td>
</tr>
<tr>
<td>Complimenting Expressing Appreciation [PIC]</td>
<td>0.46</td>
<td>0.39</td>
<td>0.62</td>
<td>0.46</td>
</tr>
<tr>
<td>Expressing Agreement [PIA]</td>
<td>2.86</td>
<td>2.66</td>
<td>3.36</td>
<td>1.16</td>
</tr>
<tr>
<td>Expressing Disagreement [PID]</td>
<td>0.35</td>
<td>0.12</td>
<td>0.19</td>
<td>0.08</td>
</tr>
<tr>
<td>Vocatives I [PCR]</td>
<td>0.08</td>
<td>0.93</td>
<td>1.08</td>
<td>0.23</td>
</tr>
<tr>
<td>Vocatives II [PCN]</td>
<td>2.01</td>
<td>1.24</td>
<td>1.00</td>
<td>1.78</td>
</tr>
<tr>
<td>Addresses or Refers to the Group using Inclusive Pronouns [PCP]</td>
<td>1.47</td>
<td>2.32</td>
<td>1.97</td>
<td>2.74</td>
</tr>
<tr>
<td>Phatics, salutations [PCS]</td>
<td>1.24</td>
<td>0.62</td>
<td>0.93</td>
<td>0.50</td>
</tr>
</tbody>
</table>

While all members in group A most frequently included social presence indicators in their contributions, this was reversed for two of the three members in group B: Jessica and Dave most frequently contributed remarks without social presence indicators. Group B did not reveal any instances of Referring Explicitly to Others’ Messages [PIR] during synchronous communication.

During asynchronous communication, the variety of social presence indicators was much smaller (Table 40 and Table 41). Differences between the inclusions of social presence indicators in individuals’ remarks were much bigger.
In general, members in group A most frequently revealed remarks that did not include any social presence indicators (Table 40). Sandra posed an exception as she frequently used Complimenting [PIC] and Questions [PIQ]. Sabine expressed Emotions [PAE] frequently. Jane showed a wide variety of social presence indicators, i.e. Expression of Emotions [PAE], Self-Disclosure [PAS], Inclusive Nouns [PCP], Vocatives II [PCN], Agreement [PIA], Complimenting [PIC] and Questions [PIQ], opposed to Sabine, who used a much smaller variety, i.e. Emotions [PAE] and Questions [PIQ].

Table 40: Social Presence (in %) during asynchronous sessions per member in group A.

<table>
<thead>
<tr>
<th>Social Presence Category [Code]</th>
<th>Eric</th>
<th>Sandra</th>
<th>Sabine</th>
<th>Jane</th>
<th>Susan (Lecturer)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expression of Emotions [PAE]</td>
<td>–</td>
<td>–</td>
<td>7.27</td>
<td>3.64</td>
<td>–</td>
</tr>
<tr>
<td>Use of Humor [PAH]</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Self-Disclosure [PAS]</td>
<td></td>
<td></td>
<td>–</td>
<td>–</td>
<td>1.82</td>
</tr>
<tr>
<td>Referring Explicitly to Others’ Messages [PIR]</td>
<td>0.91</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>0.91</td>
</tr>
<tr>
<td>Referring Explicitly to Other Interactions [PII]</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Asking Questions [PIQ]</td>
<td>1.82</td>
<td>6.36</td>
<td>1.82</td>
<td>3.64</td>
<td>1.82</td>
</tr>
<tr>
<td>Complimenting Expressing Appreciation [PIC]</td>
<td>–</td>
<td>6.36</td>
<td>–</td>
<td>3.64</td>
<td>–</td>
</tr>
<tr>
<td>Expressing Agreement [PIA]</td>
<td>0.91</td>
<td>1.82</td>
<td>–</td>
<td>1.82</td>
<td>–</td>
</tr>
<tr>
<td>Expressing Disagreement [PID]</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Vocatives I [PCR]</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Vocatives II [PCN]</td>
<td>–</td>
<td>0.91</td>
<td>–</td>
<td>2.73</td>
<td>–</td>
</tr>
<tr>
<td>Addresses or Refers to the Group using Inclusive Pronouns [PCP]</td>
<td>0.91</td>
<td>2.73</td>
<td>–</td>
<td>1.82</td>
<td>–</td>
</tr>
<tr>
<td>Phatics, Salutations [PCS]</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>No Social Presence [NSP]</td>
<td>16.36</td>
<td>1.82</td>
<td>0.10</td>
<td>20</td>
<td>9.10</td>
</tr>
</tbody>
</table>
Group B members showed a more similar picture of using social presence indicators during their asynchronous communication (Table 41). They most often used Inclusive Nouns [PCP], Questions [PIQ] and Agreement [PIA], as well as Expression of Emotions [PAE]. The variety of social presence indicators was almost identical between the three group members, with the exception of Dave who additionally used Humour [PAH] in one instance.

Table 41: Social Presence (in %) during asynchronous sessions per member in group B.

<table>
<thead>
<tr>
<th>Social Presence Category [Code]</th>
<th>Jessica</th>
<th>Dave</th>
<th>Mark</th>
<th>Anne (Lecturer)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expression of Emotions [PAE]</td>
<td>2.34</td>
<td>3.51</td>
<td>1.17</td>
<td></td>
</tr>
<tr>
<td>Use of Humor [PAH]</td>
<td>-</td>
<td>0.58</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Self-Disclosure [PAS]</td>
<td>0.58</td>
<td>0.58</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Referring Explicitly to Others’ Messages [PIR]</td>
<td>1.75</td>
<td>0.58</td>
<td>0.58</td>
<td>-</td>
</tr>
<tr>
<td>Referring Explicitly to Other Interactions [PII]</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Asking Questions [PIQ]</td>
<td>1.75</td>
<td>3.51</td>
<td>4.09</td>
<td>0.58</td>
</tr>
<tr>
<td>Complimenting Expressing Appreciation [PIC]</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Expressing Agreement [PIA]</td>
<td>1.75</td>
<td>3.51</td>
<td>2.92</td>
<td>-</td>
</tr>
<tr>
<td>Expressing Disagreement [PID]</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Vocatives I [PCR]</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Vocatives II [PCN]</td>
<td>1.17</td>
<td>2.34</td>
<td>1.75</td>
<td>-</td>
</tr>
<tr>
<td>Addresses or Refers to the Group using Inclusive Pronouns [PCP]</td>
<td>5.26</td>
<td>5.85</td>
<td>2.34</td>
<td>-</td>
</tr>
<tr>
<td>Phatics, Salutations [PCS]</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>No Social Presence [NSP]</td>
<td>17.54</td>
<td>17.54</td>
<td>9.94</td>
<td>6.43</td>
</tr>
</tbody>
</table>

5.2.1.2 Discussion

Findings show, different students expressed different levels of social presence indicators as well as different characteristic patterns, supporting theoretical
considerations (Holmgren & Rimbark, 2001; Picciano, 2002). Even though strong intra- and interindividual fluctuations existed regarding single social presence indicators, e.g. Vocatives [PCR], Complementing [PIC] or Phatics, Salutations [PCS], patterns emerged for some indicators. Questions [PIQ] and Agreement [PIA] were the most frequently used indicators amongst most members.

6.2.2 Longitudinal Perspective

6.2.2.1 Findings

During synchronous discussions, a general trend towards increasing social presence existed (Figure 25 and Figure 26). However, social presence experience expressed via indicators was not stable. Strong intraindividual variations were observed.

In group A, students started at a relatively low level of social presence expression. Sandra, for example, only expressed 4.1% of social presence indicators in all contributions during the first online session, in week 2 (Figure 25, session 2). This gradually increased up to a local peak of 47.3% social presence indicators in the voluntary session during week 5 (Figure 25, session 5*). Then, her social presence expression dropped until the next voluntary session during week 6 (Figure 25, session 6*). Intermediated by a small increase during session 7, her social presence expressions dropped to a final low of 0% during the last asynchronous session.

Jane, on the other side, revealed a different pattern. She also started at a relatively low level of 8.7% during session 2, and her expressions fluctuated during the synchronous sessions. This included a peak in each voluntary session (session 5* and session 6*), and a final high of 37.1% during the last synchronous session in week 9. During the following two asynchronous sessions her social presence expressions remained on the same level.
Students in group B showed a similar general trend towards increasing social presence expression during synchronous communication, with the exception of Mark, whose expressions collapsed during session 9. Generally, students in this group showed less fluctuation. However, they did not conduct any voluntary sessions, which seemed to trigger variations in social presence expression.
During the final two asynchronous sessions, social presence expression patterns change. In the first asynchronous session, session 10, both groups showed a similar level of social presence to the preceding synchronous session. In the subsequent final discussion forum, session 12, most students underwent a dramatic change in social presence expression. Students showed either a strong increase or decrease in social presence, with the exception of Jane, in group A, whose social presence expressions remained similar to previous levels.

For example, Mark expressed relatively little social presence during session 9 (10.6%) and 10 (12.4%). During the second asynchronous session, session 12, his expression of social presence increased to 39.4%. Jessica expressed relatively high levels of social presence during sessions 9 and 10, 40.7% and 46.7% respectively. Her social presence expressions decreased substantially during session 12, where only 9.1% of her contributions showed social presence indicators.
6.2.2.2 Discussion

Strong intra- and interindividual differences showed in the expression of social presence as the course proceeded: Single members did not show a stable pattern. These findings support considerations from Picciano (2002), putting forward that the experience of social presence varies from individual to individual.

Furthermore, the expression of social presence indicators experienced a clear point of change for individuals in both groups, as they switched communication media. While this incision triggered a trend towards less social presence for most group members, some showed either a stable level of social presence or an increase during these sessions (Figure 25 and Figure 26). The incision revealed different influences of the medium on single group members. Thus, the medium's influence might not be as straightforward as the above-mentioned general trend suggests. Contrary to prior research, individuals showing generally high or low expressed social presence in the current study cannot be identified preferring or disliking a certain communication medium.

6.2.3 Summary and Concluding Remarks

Overall, findings showed fluctuating levels of social presence for each of the students.

Strong intra- and interindividual differences in the experience of social presence emerged. Generally, social presence fluctuated from session to session. These findings emphasise the variation of social presence from individual to individual, as well as the importance of the temporal dimension for the experience, reinforcing the medium’s influence.
The switch from synchronous to asynchronous communication media marked a clear point of change for individuals in both groups. This point of change revealed a trend towards less social presence for most group members. However, the medium’s influence is not as straightforward as the general trend suggests. Few students experienced a stable level of social presence, others an increase. This points to differing influences of the medium on single group members.

### 6.3 Awareness Features

The following section investigates students’ perception of the awareness features and information as implemented in the course, i.e. biography information and different visualisations, such as participation chart, radar graph, social network graph and wattle tree graph (see Table 42).

**Table 42: Availability (x) of awareness information in the different sessions during the course.**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Session 2</th>
<th>Session 3</th>
<th>Session 4</th>
<th>Session 5</th>
<th>Session 6</th>
<th>Session 7</th>
<th>Session 8</th>
<th>Session 9</th>
<th>Session 10</th>
<th>Session 11</th>
<th>Session 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biography Information</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Radar Display</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Participation Chart</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Wattle Tree Graph</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Radar Graph</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Social Network Graph</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>
6.3.1 Biography Information

6.3.1.1 Findings

Both groups answered a questionnaire on the usefulness of biography information\(^{15}\) (see Table 43). The biography information was initially rated as relatively useful \((M = 2.9\) in session 2). As online sessions progressed, the perceived value of the information declined \((M = 1.9\) in session 12). Group A had a higher tendency to perceive the biography information as useful (ranging from \(M = 1.25\) to \(M = 3.00\)) compared to group B (ranging from \(M = 0.67\) to \(M = 2.67\)).

<table>
<thead>
<tr>
<th>Session</th>
<th>Mean Group A (SD)</th>
<th>Mean Group B (SD)</th>
<th>Overall mean (STD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>3.00 (1.41)</td>
<td>2.67 (1.53)</td>
<td>2.85 (1.35)</td>
</tr>
<tr>
<td>3</td>
<td>1.75 (0.50)</td>
<td>1.00 (1.00)</td>
<td>1.43 (0.79)</td>
</tr>
<tr>
<td>4</td>
<td>2.00 (1.00)</td>
<td>1.67 (1.53)</td>
<td>1.83 (1.17)</td>
</tr>
<tr>
<td>6</td>
<td>2.33 (0.58)</td>
<td>1.50 (2.12)</td>
<td>2.00 (1.22)</td>
</tr>
<tr>
<td>7</td>
<td>2.33 (0.58)</td>
<td>1.00 (0.00)</td>
<td>1.67 (0.82)</td>
</tr>
<tr>
<td>9</td>
<td>2.67 (1.53)</td>
<td>1.00 (0.00)</td>
<td>1.83 (1.47)</td>
</tr>
<tr>
<td>10</td>
<td>1.25 (0.96)</td>
<td>0.67 (1.15)</td>
<td>1.00 (1.00)</td>
</tr>
<tr>
<td>12</td>
<td>2.00 (1.15)</td>
<td>1.67 (1.5)</td>
<td>1.85 (1.21)</td>
</tr>
</tbody>
</table>

*The scale ranged from not at all useful (0), somewhat useful (1), neutral (2), useful (3) to very useful (4).

6.3.1.2 Discussion

The perceived usefulness of biography information decreased during the course from initially useful to neutral. This is not surprising, biography information is used for primary impression management. As the course proceeded, students had other information, which they relied on for judgment.

\(^{15}\) The biography information was provided during and after session 1.
6.3.2 Radar Display

6.3.2.1 Findings

Both groups answered a questionnaire for the synchronous mandatory sessions regarding perceived usefulness of radar display, i.e. sessions 2, 3, 4, 6, 7 and 9. Group A showed a slightly higher perception of usefulness than group B. Information presented in the radar display chat rooms tended to be perceived as neutral (Table 44) and did not change as the course proceeded.

Table 44: Mean and standard deviation (in brackets) of perceived usefulness of radar display* in the mandatory sessions for group A and B (N = 7).

<table>
<thead>
<tr>
<th>Session</th>
<th>Mean Group A (SD)</th>
<th>Mean Group B (SD)</th>
<th>Overall mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2.50 (0.58)</td>
<td>2.00 (1.73)</td>
<td>2.28 (1.11)</td>
</tr>
<tr>
<td>3</td>
<td>2.00 (1.15)</td>
<td>1.67 (0.58)</td>
<td>1.86 (0.90)</td>
</tr>
<tr>
<td>4</td>
<td>3.00 (1.00)</td>
<td>1.33 (1.53)</td>
<td>2.16 (1.47)</td>
</tr>
<tr>
<td>6</td>
<td>3.00 (1.00)</td>
<td>1.50 (0.71)</td>
<td>2.40 (1.14)</td>
</tr>
<tr>
<td>7</td>
<td>2.67 (0.58)</td>
<td>1.67 (0.58)</td>
<td>2.16 (0.75)</td>
</tr>
<tr>
<td>9</td>
<td>3.67 (0.58)</td>
<td>0.67 (0.58)</td>
<td>2.16 (1.72)</td>
</tr>
</tbody>
</table>

*The scale ranged from not at all useful (0), somewhat useful (1), neutral (2), useful (3) to very useful (4).

The true usefulness of the radar display was revealed in the chat entries (Excerpt 71 and Excerpt 72).

Jane: “? -mark, [NNC]
i can’t see you on the radar” [CIS]
Jane: “!-oh ok, i see you now” [CIS]
Mark: “i’m back [name]. i had left.” [CIS+]
Jane [NNC]

Excerpt 71 taken from session 6, group A.
6.3.2.2 Discussion

The perceived usefulness of the radar display did not change as the course proceeded. Students rated its usefulness neutral. Information in the radar display, who is present, who is not, as well as how much they are contributing, provides information on the current session and depends on dynamics occurring in that session. Thus, students should find the display and information equally useful. This is supported by questionnaire responses.

6.3.3 Participation Chart

6.3.3.1 Findings

The participation chart displayed information regarding who edited which kinds of files, and how much a person contributed to the online environment. Participation chart usefulness can be viewed in detail, in Table 45. There is no rating for sessions 2 and 3, as the chart was introduced in session 4.

Students perceived the participation chart somewhat useful. This did not change as the course proceeded. Again, group A showed a slightly higher tendency to perceive the participation chart as useful (ranging from $M = 1.00$ to $M = 3.67$) compared to group B (ranging from $M = 1.0$ to $M = 2.33$).
Table 45: Mean and standard deviation (in brackets) of perceived usefulness of participation chart* in the mandatory sessions for group A and B (N = 7).

<table>
<thead>
<tr>
<th></th>
<th>Session 2</th>
<th>Session 3</th>
<th>Session 4</th>
<th>Session 6</th>
<th>Session 7</th>
<th>Session 9</th>
<th>Session 10</th>
<th>Session 12</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group A (SD)</td>
<td>-</td>
<td>-</td>
<td>1.50 (0.71)</td>
<td>2.00 (1.00)</td>
<td>1.67 (0.58)</td>
<td>3.67 (1.15)</td>
<td>2.00 (0.00)</td>
<td>1.00 (1.15)</td>
</tr>
<tr>
<td>Mean Group B (SD)</td>
<td>-</td>
<td>-</td>
<td>1.50 (0.71)</td>
<td>1.50 (2.12)</td>
<td>1.00 (1.00)</td>
<td>0.67 (1.15)</td>
<td>1.00 (1.00)</td>
<td>2.33 (2.08)</td>
</tr>
<tr>
<td>Overall mean (SD)</td>
<td>-</td>
<td>-</td>
<td>1.50 (0.58)</td>
<td>1.80 (1.30)</td>
<td>1.33 (0.82)</td>
<td>2.16 (1.94)</td>
<td>1.50 (0.84)</td>
<td>1.57 (1.61)</td>
</tr>
</tbody>
</table>

The scale ranged from not at all useful (0), somewhat useful (1), neutral (2), useful (3) to very useful (4)).

6.3.3.2 Discussion

Generally, students found the participation chart only somewhat useful with a tendency to not useful at all. This might be due to the fact that the participation chart was not integrated into their online communication tool. It was separately integrated into the workspace and students were not encouraged or obligated to use it as part of their daily activities.

The participation chart was not the only opportunity for students to get information on who was editing which documents. Students also knew each other face-to-face and they had the opportunity to use other means of communication to retrieve such information. Perceived usefulness might be rated differently in an entirely online course.
6.3.4 Static Visualisations

6.3.4.1 Findings

During the two asynchronous sessions 10 and 12, visualisations were provided illustrating group dynamics, i.e. wattle tree, radar graphs and social network graphs. They were all perceived neutral (Table 46). Group A had a tendency to rate visualisations as neutral during session 10, and not useful at all during session 12. This was reversed in group B.

Table 46: Mean and standard deviation (in brackets) of perceived usefulness* for different visualisations as introduced during session 10 and 12 for group A and B (N = 7).

<table>
<thead>
<tr>
<th></th>
<th>Session 10</th>
<th></th>
<th>Session 12</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wattle Tree</td>
<td>Radar</td>
<td>Social</td>
<td>Wattle Tree</td>
</tr>
<tr>
<td></td>
<td>Tree</td>
<td>Graph</td>
<td>Network</td>
<td>Tree</td>
</tr>
<tr>
<td>Mean Group A</td>
<td>2.00</td>
<td>2.00</td>
<td>-</td>
<td>0.75</td>
</tr>
<tr>
<td>(SD)</td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.75)</td>
<td>(0.96)</td>
</tr>
<tr>
<td>Mean Group B</td>
<td>1.33</td>
<td>1.33</td>
<td>-</td>
<td>2.00</td>
</tr>
<tr>
<td>(SD)</td>
<td>(1.53)</td>
<td>(1.15)</td>
<td>(1.00)</td>
<td>(1.00)</td>
</tr>
<tr>
<td>Overall mean</td>
<td>1.67</td>
<td>2.00</td>
<td>-</td>
<td>1.29</td>
</tr>
<tr>
<td>(SD)</td>
<td>(1.03)</td>
<td>(0.82)</td>
<td>(1.11)</td>
<td>(1.27)</td>
</tr>
</tbody>
</table>

*The scale ranged from not at all useful (0), somewhat useful (1), neutral (2), useful (3) to very useful (4)).

The following excerpts, Excerpt 73, Excerpt 74 and Excerpt 75, depict students’ comments and reflections on the three visualisation types.

Re: Visualisations (Posted by Mark)

interesting data analysis. I thought I had contributed more to the chat room, but I guess statistics don’t lie. [NNC]

LOL. [NNC]

16 Visualisations are described and portrayed in more detail in Chapter 4.5 Study Setting: A Blended Teacher Education Course.
Nevertheless, I do like the fact that we can see our participation of visual graphs. [NNC]

Excerpt 73 taken from discussion forum during session 10, group B (thread 4).
Re: Visualisations (Posted by Dave)
I’m always weary of statistics. They only show part of the story. The depth and insight of the participation is just as important as the amount of ‘hits’. [NNC]

Excerpt 74 taken from discussion forum during session 10, group B (thread 4).
Re: Visualisations (Posted by Eric)
Assessing participation rates is not an effective way to determine the contributions of all learners. The following issues would have affected participation rates. [NNC]
Participants who were sick could not participate. How is this accounted for? [NNC]
The Summary of Assignments page was not laid out clearly and not all participants would have known that our participation was being assessed. [NNC]
Chat was often used to support our use of the concept map, whiteboard, and wiki tools and to organise projects. Most of the contributions to these sessions were based around how to do something. Those familiar with the tools would not need to interact as often. [NNC]
Chat is an ineffective tool for discussion as it is fast-paced and does not allow for reflection. Meaningful dialogue is limited and does not encourage participation. [NNC]
The forums questions were not well designed and were not well moderated. Moderators were unable to keep the discussion on track, summarise posts or keep the discussion moving. The discussions were often based on personal impressions formed before the research papers were read and did not address important issues. Often the posts were repetitive and did not develop into meaningful discussion. The small size of each group meant
that if some individuals participate then the discussion was limited. Language barriers made posts hard to interpret and restricted discussion. [NNC]

On occasions email was used to arrange meetings and to determine the agenda. We also, had several face-to-face meetings and as this is done outside of LrnLab our participation could not be recorded. [NNC]

Excerpt 75 taken from discussion forum during session 12, group A (thread 2).

6.3.4.2 Discussion

Visualisations were perceived neutral with a tendency towards not useful. Clearly, students’ comments and reflections (Excerpt 73, Excerpt 74 and Excerpt 75) point to the fact students were frustrated, and feeling the visualisations did not portray all the exceptions and extraordinary situations they encountered, e.g. someone being sick or communication bypassing the learning platform, such as face-to-face meetings (Excerpt 75).

While some comments and reflections are valid, e.g. “quantitative measures cannot be the only way to evaluate participation”, others show a successful integration into course of actions has not taken place, e.g. “it was not clear that participation was being assessed”. Students’ comments and reflections on visualisations show it is not enough to introduce the visualisations to students and point out the kind of information they display. It might be beneficial to integrate such information into the course design. Discourse over the information portrayed is certainly necessary, as the information is potentially powerful and should not be used to single participants out, or foster a negative perception of one’s own performance. It should encourage group members to contribute in balanced terms.
6.3.5 Summary and Concluding Remarks

The usefulness of biography information posed one exception in the overall findings; students perceived biography information as useful, declining during the course. As expected, group members knew each other better, and they did not have to rely on biography information.

Awareness information, i.e. radar graph, social network graph and wattle tree graph, was perceived neutral with a negative tendency towards only “somewhat useful”. A possible explanation could be, students paid more attention to other screen features rather than awareness information, especially since using the information was optional.

There seemed to be some difference in perceived usefulness between the two groups. Generally, group A showed a slightly higher tendency to perceive awareness features useful. This relationship seemed to be reversed in session 12. Interestingly, group B contributed more during the asynchronous sessions than group A. This would suggest, the tendency to accept a communication medium and the amount to which a group feels comfortable with it, is possibly linked to how they accept other features of the learning environment, such as awareness information.

The neutral usefulness perception indicates a lack of attention and acceptance. Thus, it is beneficial for such environments to provide stronger integration into course design, beyond the mere offer of awareness information. It would be interesting to see how useful participants perceived such awareness information, if use was mandatory. Also, it is unclear, to what extent students used other means of communication. As the course was partially face-to-face and students saw each other on a more or less regular basis, they also met outside of class or spoken on the phone etc.
6.4 INTEGRATIVE SUMMARY AND CONCLUSIONS

The previous chapter investigated two elements influencing the experience of social presence in an online environment: mediating communication medium and individual members.

Students expressed higher levels of social presence indicators during synchronous communication compared to asynchronous communication. Asynchronous discussion allows for less immediacy behaviour compared to synchronous discussion and thus produces a smaller experience of social presence.

Overall, expression of social presence indicators increased as the semester proceeded, and as long as the students remained in the synchronous communication environment. The amount of social presence declined as the medium switched from synchronous to asynchronous. That decline was delayed, which is an example of a group’s resistance to altering the path on which they have set out and which has formed as part of group dynamics. Furthermore, the decline in social presence highlights, the medium’s impact on social presence expression is stronger than emerging longitudinal effects.

The social presence density measure revealed differences between the social presence experienced by students in this study, compared to reports from other studies, e.g. Rourke et al. (1999).

The expression of social presence varied intra- and interindividually; students expressed different levels of social presence indicators as well as different characteristic patterns. Generally, social presence fluctuated from session to session.
Furthermore, group members reacted differently to changes in communication media: the switch from synchronous to asynchronous communication media marked a clear incision for individuals in both groups. For most members, the switch triggered a trend towards less social presence.

The general decline in social presence, after switching from synchronous to asynchronous media, shows the medium’s influence is stronger than temporal effects. The medium is a strong enabler of quantity and quality of social presence in online communication. However, varying reactions from different members point to the fact, the experience depends heavily on the individual as well.

Medium and members both influence social presence in online learning environments. They are equally important when considering social presence’s enabling function as a context parameter.

Each of the awareness features was only perceived as partially useful. Information on who is present as well as information on members' biography was rated useful. It might be beneficial to integrate such information more tightly in course design, to support students' engagement with that type of information. Also, it might be less important in blended learning courses compared to online courses.

However, the awareness information influenced students. This becomes evident through the amount of feedback and comments given on visualisations during the asynchronous communication sessions.

Overall, findings in the field of social presence are particularly heterogenous. The presented study on the influence of media and members only illuminates selected aspects of social presence. Lately, researchers claimed that the direction of the relationship between social presence and related variables is unclear. Historically,
research considered social presence to be a characteristic of the medium and its impact can be manipulated through the use of different media. However, as research progressed, different definitions of social presence are identified and the concept becomes increasingly complex. It is not clear whether, for example, a higher motivation of a participant results in more involvement which in turn leads to the experience of increased social presence or if a participant is more motivated and involved because of the social presence experience. This limits the findings from the current study. Even though media and members influence the experience of social presence, it is not clear whether this relationship also works the other way round.

Concerning the impact of single members, this research as well as others point to the importance of understanding individuals’ perceptions in order to understand social presence (Hwang & Park, 2007). This study concluded with the exploration of differences in amount of social presence experienced, focusing on a longitudinal perspective. However, more in-depth research is needed to understand the nature and quality of social presence experienced by members.

A lack of research exists concerning participants’ individual perceptions and their experience within the field of computer-mediated communication.
7 TAKING A CLOSER LOOK ON SOCIAL PRESENCE: AN EXPERIMENTAL STUDY

The following section further investigates social presence by pursuing findings from earlier chapters in this thesis. The below presented experiment specifically considers findings from the qualitative study as described in this thesis. In doing so, it focuses on the concept of social presence, as findings were not as detailed and conclusive as with the concept of coordination in groups. However, the study not only picks up open questions from earlier research, but also broadens the concept of social presence and takes it one step further by investigating its potential as a causing factor.

7.1 OBJECTIVES

Researchers have pointed to the importance of understanding individuals’ perceptions in order to understand social presence (Hwang & Park, 2007). For example, the presence of a message sender influences the recipient’s understanding and in turn influences intersubjective interpretation. This study aims at the lack of research concerning participants’ individual differences in perception and their experience within the field of computer-mediated communication. In order to shed further light onto the reasons why individuals experience social presence differently, already introduced impacting factors will be illuminated from a
different angle: The task, the handling of the task and the medium, but also measures of the individual such as motivation and attitude will be targeted in this experiment.

While the qualitative study in this thesis did not reveal a significant effect of the task on the social presence experience, evidence can be found that a misfit between the medium and a task’s social need can disadvantageously influence the experience of social presence (Chou & Min, 2009) as well as communication performance (Mennecke, Valacich & Wheeler, 2000). For example, simple tasks with unambiguous answers benefit from media with low social presence and judgement tasks require media with high social presence.

In addition, a larger body of research suggests that social presence is related to increased satisfaction (Gunawardena & Zittle, 1997; Hostetter & Busch, 2006; Richardson & Swan, 2003). These findings hint to the connection between individual’s perception and social presence.

Lately, researchers have claimed that the direction of the relationship between social presence and related variables is not clear. In current research, social presence is often seen as either a cause or an influenced factor (Gunawardena, 1995; Wise, Chang, Duffy & del Valle, 2004). Due to research diversity and to different operationalisations of measuring social presence, it is not clear whether, for example, a higher motivation of a participant results in more involvement which in turn leads to the experience of increased social presence or if a participant is more motivated and involved because of the social presence experience.

This experimental study pursues a detailed investigation of the relationship of dependence. It expands the concept of social presence as introduced in the qualitative part of this thesis and illuminates social presence’s potential as a
causing factor. Indeed, former research shows that effects are not as straightforward and that reciprocal effects might be at work. So far, no research study has investigated the causal direction between social presence and related variables, such as media and members. The combination of both views on social presence will provide further guidance on the interpretation of today’s research diversity concerning the concept of social presence.

Furthermore, researchers claim that numerous individual differences and situational variables possibly mediate the impact of social presence (Wise et al., 2004). Such individual differences in relation to increased experience of social presence are, for example, students’ positive perceptions of their own computer expertise or a low level of privacy of the medium or a high level of trust among participants. Continuing from results of the qualitative study, one such aspect to consider is a learner’s preexisting experience with ICT and online media. So far, research has found some evidence for a positive impact of existing experience with online courses on the social presence experienced (Hostetter & Busch, 2006; Mykota & Duncan, 2007). The following study will investigate the nature of this experience in more detail.

The goal of this experimental study is to investigate both aspects further: The relation of social presence and the perception of task and medium, as well as the role of prior ICT and online media experience in online behaviour.

### 7.2. Hypotheses

The following derived hypotheses each address one of the three issues appearing in the research into social presence:
the above stated lack of research in the field of computer-mediated communication investigating individual’s perceptions in order to understand the concept of social presence further.

• unclear research findings into the causal relationship of social presence and related concepts.

• findings and open questions from the qualitative study in this thesis.

7.2.1 Task influence

Even though the task itself does not directly influence the level of social presence experience, this level might influence participants perception of the task. This hypothesis acts under the presumption of an optimal task–medium fit, based on research findings, e.g. by Chou and Min (2009). For example, an optimal task–medium fit is accomplished when a task’s social need is met by the medium’s potential to convey social presence: Simple tasks require media with low social presence conveyance and complex tasks require media with high social presence potential.

1. The more sociable an environment, the less strenuous and threatening will a task be perceived. Social presence leads to a positive attitude towards the task.

7.2.2 Influence on the Perception of the Medium

The qualitative study found that the level of immediacy, as experienced in different media, leads to increased social presence levels. Assuming that higher social presence levels lead to a less strenuous and threatening perception of the task, it
will also lead to increased satisfaction with the medium. High levels of social presence have been found to result in high levels of perceived learning satisfaction and perceived satisfaction with the instructor (Richardson & Swan, 2003).

2. The higher the level of social presence, the higher the level of satisfaction with the online environment.

7.2.3 Influence on the Perception of the Collaboration

The level of social presence influences the perception of collaboration within the team. Lower levels of social presence can diminish communication quality (Roberts, Lowry & Sweeney, 2006) and as a result influence the perception of the collaboration.

3. The higher the sociability of interaction, the more favourable collaboration is experienced.

7.2.4 Prior ICT and Online Media Experience

The effects that social presence has on the judgement of the task and the medium vary with the level of prior ICT and online media experience. For example, a higher level of preexisting computer-expertise is related to a higher level of social presence experienced (Hostetter & Busch, 2006; Mykota & Duncan, 2007).

4. The more candidates are experienced with ICT and online media, the less strenuous will they perceive a task.
5. The more candidates are experienced with ICT and online media, the more easily will they experience social presence and therefore perceive the online environment, i.e. the medium, more favourable.

7.3 VARIABLES

7.3.1 Independent Variables

The univariate-experimental design considers one independent variable besides socio-demographic variables of participants (age and gender):

The sociability of the task environment is divided into three conditions (sociability in increasing order): 1. task-oriented online puzzling, 2. socially-encouraged online puzzling, 3. face-to-face puzzling (control group).

7.3.2 Dependent Variables

The above described study suggests that the task as well as the medium both have an impact on the social presence experienced in online environments.

Dependent variables can be assigned to one of three different areas: task, task handling and puzzle environment. Items concerning the task mainly aim at the estimation of the amount of cognitive strain the task posed on participants. The second area, judgement of the puzzle environment, target perception of the medium. In opposition to previous chapters, the following chapter uses the term “medium”, in its singular form since this experiment is only concerned with one environment. It is interchangeable with the term “media”, as used in previous
chapters, where various online environments were investigated. The third dependent variable, **task handling**, captures the collaborative aspect in the team work. While task and puzzle environment judgement aim more at a participant's perception of their individual experience, the variable task handling aimed at the perception of the collaboration and their mutual interaction.

### 7.3.3 Covariates

As suggested by the qualitative study in this thesis, **ICT experience** and **online media experience** are captured. These two scales contain two aspects of preexisting experience: 1. The ICT experience scale focuses on the general ability to handle computers and 2. the online media experience scale aims at the experience with online communication.

### 7.4 Method

#### 7.4.1 Participants

The study was conducted at the Technical University of Darmstadt, Germany and the Paris Lodron University of Salzburg, Austria. Out of the 60 participants, 57 were students at one of the two Universities. The participants` age ranged between 20 and 43 years, with a mean of $M = 25.27$ ($SD = 5.68$). Five participants did not give their age. Out of the 60 participants, 49 were female (81.7%) and 11 were male (18.3%).
7.4.2 Treatment

Three conditions were examined in this study. Two conditions were conducted online and the third condition, the control group, was conducted in a face-to-face mode. The two online conditions differed in the amount of sociability: one condition was strictly task-oriented and the other had an additional social focus. The differing sociability was ensured through the instruction given at the beginning of the experiment; instructions can be viewed in Appendix B. As shown by Yang, Chung and Chien (2008) for asynchronous computer-mediated communication, providing an open communication environment can promote social presence. This concept was transferred to a synchronous communication environment and used to vary the amount of social presence experience within the online conditions. Further research argues that cues, such as sharing personal information, within computer-mediated communication manipulate the level of presence felt (Wise et al., 2004).

Twenty participants were randomly assigned to each of the three conditions, overall 60 participants took part. They were instructed and given a pretest. Instructions can be viewed in Appendix B and the pretest in Appendix C. The instructor also talked them through the functionality of the online environment. The puzzle exercise took 30 minutes. Participants were informed that the puzzle exercise was too complex to be solved within 30 minutes and their goal was to achieve a solution as best as possible. Afterwards, participants answered a posttest. The posttest can be viewed in Appendix D.

The task was to solve an online mouse puzzle in a dyad (see Figure 27). Each of the team members had 8 cards with mouse heads and tails. Team members had to align matching colored heads and tails of a mouse. The puzzle could only be solved by using all 16 cards at once.
Figure 27: Screenshot of a solution example to the mouse puzzle exercise.

The puzzle exercise was chosen as it provided a task with potential for mutual communication and negotiation. It was easy to comprehend and did not need a lot of explanation. The puzzle was implemented in a similar manner to studies conducted by Mühlenbrock (2004). The puzzle environment was adjusted and modified to this studies’ specifics by the Collide Research Group of the University Duisburg–Essen, Germany.

In the beginning, each of the team members received their 8 cards in a private space. In addition to that, they both had a common space where they could place the puzzle cards and use the chat. Participants in the face-to-face condition only used the online puzzle environment to solve the puzzle but did not use the chat to communicate. For the layout and the functionality of the puzzle environment, see Figure 28.
Once the cards were placed in the public space they could be moved and rotated by both team members, but could not be placed back to the private area anymore. In order to develop and negotiate a common strategy, the two online conditions had the possibility to use a chat, while participants in the control group were able to communicate face-to-face. The task-oriented online group was instructed to use the chat only for task-related topics while the socially-oriented online group was encouraged to use the chat freely.

7.4.3 Procedure

The experiments took place between December 2008 and March 2009. Participants were asked to sign up in dyads for a collaborative online experiment with a partner they preferably did not know. Even though the dyads were mostly recruited from within one University, a low level of knowledge about each other was supported through scheduled slots to be filled by students from different semesters.
7.4.4 Instruments

A number of different instruments were used to gather data in the pre- and posttests to the experiment. The pretest was composed of two scales: general task attitude and specific task attitude (see Table 12).

Table 47: Detailed description of the pretest scales General Task Attitude and Specific Task Attitude.

<table>
<thead>
<tr>
<th>Scale</th>
<th>Items*</th>
<th>Value Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Task Attitude</td>
<td>• “I like such tasks.”&lt;br&gt;• “I like the role as a scientist.”&lt;br&gt;• “I feel under pressure.”&lt;br&gt; • “The task seems interesting.”&lt;br&gt; • “Afraid to embarrass me.”&lt;br&gt; • “The task is fun.”&lt;br&gt; • “Embarassed to fail.”&lt;br&gt; • “Uneasy when thinking of the task.”&lt;br&gt; • “The requirements paralyze me.”</td>
<td>1 (not true at all) to 7 (entirely true)</td>
</tr>
<tr>
<td>(Final version: 9 items)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specific Task Attitude</td>
<td>• “Can handle the difficulty of the task.”&lt;br&gt; • “Will not master the task.”&lt;br&gt; • “Excited to see how well I will do.”&lt;br&gt; • “Will make an effort.”&lt;br&gt; • “Anyone can solve a task like this.”&lt;br&gt; • “I cannot do this.”&lt;br&gt; • “Will be proud to solve the task.”</td>
<td>1 (not true at all) to 7 (entirely true)</td>
</tr>
<tr>
<td>(Final version: 7 items)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Pharaphrased only, exact wording can be found in Appendix C.

Both scales from the pretest were derived, in a slightly changed format from the instrument FAM (Fragebogen zur Erfassung aktueller Motivation in Lern- und Leistungssituationen ["Instrument to determine motivation during learning and performance tasks"], (Rheinberg, Vollmeyer & Burns, 2001). The original instrument by Rheinberg et al. (2001) was composed of 18 items, measuring four different aspects of motivation during learning and motivation tasks. The four aspects are: failure orientation, success probability, engagement/interest and challenge. The scale determining the General Task Attitude was composed of most of the FAM’s items from the engagement and failure orientation scales. The Specific Task Attitude scale was composed of most items out of the success probability and
challenge scales from the FAM. The scales were relabeled with “task attitude” instead of “motivation” since this reflects the instruction more precisely.

The participants’ judgement of the task, the task handling as well as the puzzle environment were questioned in the posttest. Furthermore, their experience with ICT and online media were also asked for in the posttest. The latter two served as covariates as suggested by the qualitative study. Experience with ICT was composed of items from the ICT literacy instrument by Markauskaite (2005). One variable, Judgement of Online Environment, was calculated in two versions as only one version allowed for a proper comparison with the control group. This variable was composed of many questions concerning the communication in the online environment. Since the control group communicated face-to-face, the items in question were deleted for comparability reasons. The slimmed-down comparable version is called Judgement of Collaboration. For a detailed overview, see Table 48.

Table 48: Posttest scales as well as Task Judgement, Task Handling Judgement and Judgement of online environment as well as Experience with Online Media and with ICT.

<table>
<thead>
<tr>
<th>Scale</th>
<th>Items*</th>
<th>Value Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task Judgement</td>
<td>• “I felt under stress during the task.”</td>
<td>1 (none) to 5 (a lot)</td>
</tr>
<tr>
<td>(3 items)</td>
<td>• “Level of mental activity drawn by the task.”</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• “I felt under time pressure during the task.”</td>
<td></td>
</tr>
<tr>
<td>Task Handling Judgement</td>
<td>• “We established a common ground.”</td>
<td>1 (do not agree at all) to 5 (agree entirely)</td>
</tr>
<tr>
<td>(4 items)</td>
<td>• “Our communication suffered misunderstandings.”</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• “I knew what my partner wanted.”</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• “I was able to clearly state my ideas.”</td>
<td></td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Scale</th>
<th>Items*</th>
<th>Value Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Judgement of Online Environment (10 items)</td>
<td>• &quot;Our collaboration was successful.&quot;</td>
<td>1 (do not agree at all) to 5 (agree entirely)</td>
</tr>
<tr>
<td></td>
<td>• &quot;I enjoyed the collaboration.&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• &quot;I felt like part of a group.&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• &quot;The environment provided the possibility for social exchange.&quot;</td>
<td></td>
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<tr>
<td></td>
<td>• &quot;The environment provided the possibility to express feelings.&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• &quot;The means of communication were sufficient.&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• &quot;An online environment is a reliable communication medium.&quot;</td>
<td></td>
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<td></td>
<td>• &quot;Task/online environment were threatening.&quot;</td>
<td></td>
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<tr>
<td></td>
<td>• &quot;We found an efficient way to work on the task.&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• &quot;We made extensive use of chat.&quot;</td>
<td></td>
</tr>
<tr>
<td>Judgement of Collaboration (5 items)</td>
<td>• &quot;Our collaboration was successful.&quot;</td>
<td>1 (do not agree at all) to 5 (agree entirely)</td>
</tr>
<tr>
<td></td>
<td>• &quot;I enjoyed the collaboration.&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• &quot;The means of communication were sufficient.&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• &quot;Task/online environment were threatening.&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• &quot;We found an efficient way to work on the task.&quot;</td>
<td></td>
</tr>
<tr>
<td>Experience with Online Media** (2 items)</td>
<td>• &quot;I have experience with e-mail.&quot;</td>
<td>1 (no experience) to 5 (very experienced)</td>
</tr>
<tr>
<td></td>
<td>• &quot;I have experience with chat.&quot;</td>
<td></td>
</tr>
<tr>
<td>Experience with ICT** (6 items)</td>
<td>• &quot;Ability to handle computer and software.&quot;</td>
<td>1 (do not have this ability) to 6 (I am completely confident)</td>
</tr>
<tr>
<td></td>
<td>• &quot;Ability to handle files and folders.&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• &quot;Ability to surf in the internet.&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• &quot;Ability to collect information on the internet.&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• &quot;Ability to judge relevanced and credibility of collected information from internet.&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• &quot;Ability to publish media information on the internet.&quot;</td>
<td></td>
</tr>
</tbody>
</table>

*Pharaphrased only, exact wording can be found in Appendix D.

**Served as covariates.

The operationalisation of all three variables to determine either the task, the medium or the interactive collaborative aspect was accomplished by drawing on research from earlier phases of this thesis. Items were derived from the pool of questions administered during the qualitative study. The questions were slimmed down, since the original set of questions was developed for a long term course, where students would naturally meet at least on a monthly basis. The experimental study considered only relevant questions for the actual experimental setting. For
example, “How would you rate the difficulty of the task you have been working on during the last week?” was amended to “How strenuous was the puzzle task on you?”

7.5 RESULTS AND DISCUSSION

The following sub-section presents the results and associated discussions for the experimental study. The first part investigates the quality of the instruments and implications for the variables. The second part presents and discusses the study’s findings concerning social presence and its potential as a causing factor. The third part of the section sheds further light onto the influence of experience with ICT and online media. Results for this study were calculated with SPSS 17.0 for Windows.

7.5.1 Instruments

Most variables achieved a satisfiable reliability measure with a Cronbach’s Alpha of $\alpha \geq .7$ (see Table 49). Three variables included items that needed to be deleted to achieve a more reliable scale: Specific Task Attitude, Task Judgment as well as Experience with Online Media.

Table 49: Statistics and reliability measures (Cronbach’s $\alpha$) of used scales ($N = 60$).

<table>
<thead>
<tr>
<th>Scale</th>
<th>N of items</th>
<th>N of cases</th>
<th>M of scale</th>
<th>SD of scale</th>
<th>Cronbach’s $\alpha$</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Task Attitude</td>
<td>9 items</td>
<td>60</td>
<td>32.43</td>
<td>7.55</td>
<td>.78</td>
</tr>
<tr>
<td>Specific Task Attitude</td>
<td>7 items</td>
<td>57</td>
<td>34.30</td>
<td>5.41</td>
<td>.62</td>
</tr>
<tr>
<td>Task Judgement</td>
<td>3 items</td>
<td>60</td>
<td>7.35</td>
<td>2.34</td>
<td>.70</td>
</tr>
<tr>
<td>Task Handling Judgement</td>
<td>4 items</td>
<td>60</td>
<td>15.50</td>
<td>3.41</td>
<td>.83</td>
</tr>
<tr>
<td>Judgement of Online Environment</td>
<td>10 items</td>
<td>40</td>
<td>34.28</td>
<td>6.76</td>
<td>.81</td>
</tr>
<tr>
<td>Judgement of Collaboration*</td>
<td>5 items</td>
<td>57</td>
<td>18.68</td>
<td>3.92</td>
<td>.79</td>
</tr>
<tr>
<td>Experience with Online Media**</td>
<td>2 items</td>
<td>60</td>
<td>8.28</td>
<td>1.62</td>
<td>.66</td>
</tr>
<tr>
<td>Experience with ICT**</td>
<td>6 items</td>
<td>60</td>
<td>23.58</td>
<td>4.86</td>
<td>.87</td>
</tr>
</tbody>
</table>

*Comparable Version of Judgement of Online Environment: items aiming at online communication were deleted. **Served as covariates.
7.5.2 Social Presence

7.5.2.1 Findings

In a first step, descriptives for the dependent variables are presented (compare Table 50). The attitude towards tasks in online environments [General Task Attitude] was most positive during the Social Presence F2F treatment ($M = 4.97$, $SD = 1.00$), followed by Social Presence Online ($M = 4.95$, $SD = 0.91$) and finally the Task Oriented Online treatment ($M = 4.36$, $SD = 0.98$). The attitude towards the specific puzzle task [Specific Task Attitude] was most positive during the Social Presence Online treatment ($M = 4.95$, $SD = 0.55$), followed by Social Presence F2F ($M = 4.94$, $SD = 0.92$) and finally the least positive during the Task Oriented Online treatment ($M = 4.82$, $SD = 0.78$).

With only slight differences, participants judged the task more strenuous during the Task Oriented Online treatment ($M = 2.80$, $SD = 0.54$), followed by Social Presence F2F ($M = 2.78$, $SD = 0.59$). The task was judged least strenuous during the Social Presence Online treatment ($M = 2.76$, $SD = 0.77$). Among the two online conditions, participants judged the online environment [Judgement of Online Environment] more positive during Task Oriented Online treatment ($M = 3.46$, $SD = 0.68$) compared to Social Presence Online ($M = 3.40$, $SD = 0.69$). The task handling [Task Handling Judgement] was judged most positively during the Social Presence F2F treatment ($M = 4.43$, $SD = 0.41$), followed by the Task Oriented Online treatment ($M = 3.85$, $SD = 0.92$) and the Social Presence Online treatment ($M = 3.76$, $SD = 0.86$).

Similarly, the collaboration [Judgement of Collaboration] was judged most positively during the Social Presence F2F treatment ($M = 4.25$, $SD = 0.49$), followed by the Task Oriented Online treatment ($M = 3.72$, $SD = 0.75$). The least positive did
Taking a Closer Look on Social Presence: An Experimental Study

Participants judge their collaboration during the Social Presence Online treatment ($M = 3.39, SD = 0.87$).

Table 50: Descriptives for dependent variables ($N = 60$).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Min</th>
<th>Max</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General Task Attitude</strong></td>
<td>Task Oriented Online</td>
<td>20</td>
<td>2.67</td>
<td>5.78</td>
<td>4.36</td>
</tr>
<tr>
<td></td>
<td>Social Presence Online</td>
<td>20</td>
<td>2.56</td>
<td>6.33</td>
<td>4.95</td>
</tr>
<tr>
<td></td>
<td>Social Presence F2F</td>
<td>20</td>
<td>3.00</td>
<td>6.89</td>
<td>4.97</td>
</tr>
<tr>
<td><strong>Specific Task Attitude</strong></td>
<td>Task Oriented Online</td>
<td>20</td>
<td>2.29</td>
<td>6.14</td>
<td>4.82</td>
</tr>
<tr>
<td></td>
<td>Social Presence Online</td>
<td>20</td>
<td>3.86</td>
<td>5.86</td>
<td>4.95</td>
</tr>
<tr>
<td></td>
<td>Social Presence F2F</td>
<td>20</td>
<td>2.71</td>
<td>6.57</td>
<td>4.94</td>
</tr>
<tr>
<td><strong>Task Judgement</strong></td>
<td>Task Oriented Online</td>
<td>20</td>
<td>2.00</td>
<td>3.75</td>
<td>2.80</td>
</tr>
<tr>
<td></td>
<td>Social Presence Online</td>
<td>20</td>
<td>1.25</td>
<td>4.25</td>
<td>2.76</td>
</tr>
<tr>
<td></td>
<td>Social Presence F2F</td>
<td>20</td>
<td>1.75</td>
<td>3.75</td>
<td>2.78</td>
</tr>
<tr>
<td><strong>Task Handling Judgement</strong></td>
<td>Task Oriented Online</td>
<td>20</td>
<td>1.60</td>
<td>5.00</td>
<td>3.85</td>
</tr>
<tr>
<td></td>
<td>Social Presence Online</td>
<td>20</td>
<td>1.80</td>
<td>5.00</td>
<td>3.76</td>
</tr>
<tr>
<td></td>
<td>Social Presence F2F</td>
<td>20</td>
<td>3.40</td>
<td>5.00</td>
<td>4.43</td>
</tr>
<tr>
<td><strong>Judgement of Online Environment</strong></td>
<td>Task Oriented Online</td>
<td>20</td>
<td>2.40</td>
<td>4.80</td>
<td>3.46</td>
</tr>
<tr>
<td></td>
<td>Social Presence Online</td>
<td>20</td>
<td>1.90</td>
<td>4.90</td>
<td>3.40</td>
</tr>
<tr>
<td><strong>Judgement of Collaboration</strong></td>
<td>Task Oriented Online</td>
<td>20</td>
<td>2.60</td>
<td>5.00</td>
<td>3.72</td>
</tr>
<tr>
<td></td>
<td>Social Presence Online</td>
<td>20</td>
<td>1.80</td>
<td>5.00</td>
<td>3.39</td>
</tr>
<tr>
<td></td>
<td>Social Presence F2F</td>
<td>20</td>
<td>3.20</td>
<td>5.00</td>
<td>4.25</td>
</tr>
<tr>
<td><strong>Success Regarding Task Solution</strong>*</td>
<td>Task Oriented Online</td>
<td>20</td>
<td>1.00</td>
<td>4.00</td>
<td>2.65</td>
</tr>
<tr>
<td></td>
<td>Social Presence Online</td>
<td>20</td>
<td>1.00</td>
<td>4.00</td>
<td>2.25</td>
</tr>
<tr>
<td></td>
<td>Social Presence F2F</td>
<td>20</td>
<td>2.00</td>
<td>4.00</td>
<td>3.00</td>
</tr>
<tr>
<td><strong>Was Able to Express my Ideas</strong>*</td>
<td>Task Oriented Online</td>
<td>20</td>
<td>1.00</td>
<td>5.00</td>
<td>3.45</td>
</tr>
<tr>
<td></td>
<td>Social Presence Online</td>
<td>20</td>
<td>2.00</td>
<td>5.00</td>
<td>3.45</td>
</tr>
<tr>
<td></td>
<td>Social Presence F2F</td>
<td>20</td>
<td>3.00</td>
<td>5.00</td>
<td>4.35</td>
</tr>
</tbody>
</table>

*Single items, carried over for relevance reasons.

Furthermore, Table 50 presents descriptives for two single items that are carried over for relevance reasons. Participants judged their task solution as more successful during the Social Presence F2F ($M = 3.00, SD = 0.80$), followed by the Task Oriented Online treatment ($M = 2.65, SD = 0.93$). The least successful was the task solution judged during the Social Presence Online treatment ($M = 3.00, SD = 0.91$). Furthermore, participants felt they could express their feelings the best during the Social Presence F2F treatment ($M = 4.35, SD = 0.81$); both online conditions did not differ and participants perceived them as being less able to
express their feelings Social Presence Online ($M = 3.45$, $SD = 1.15$) and Task Oriented Online ($M = 3.45$, $SD = 1.05$).

In order to test for significant differences between treatment groups, inferential statistics were applied. In a first step, all dependent variables were tested for normal distribution of values. Results of the "One-Sample Kolmogorov-Smirnov Test" showed that all but one variable did not differ statistically significant from a normal distribution. For these variables, the prerequisite for the application of parametrical test procedures was given. Only one variable, Judgement of Task Handling, was not distributed normally and non-parametrical test procedures were applied here. Another prerequisite for the application of parametrical tests is the homogeneity of variances. Only one variable revealed significantly different variances: Judgement of Collaboration (the shorter, comparable version of the participants' Judgement of Online Environment). To Judgement of Collaboration, non-parametric tests were applied as well.

The complete version of the scale Judgement of Online Environment was considered separately, since it was only answered by the two online groups. The ANOVA revealed no statistically significant differences between groups ($F(1, 38) = 0.09$, $p$ (one-tailed) $= .40$, $eta^2 = .00$). The ANOVA for the remaining three variables revealed only a significant influence for the General Task Attitude ($F(2, 57) = 2.50$, $p$ (one-tailed) $= .05$, $eta^2 = .08$). The other two variables showed no significant influence of the online environment's sociability on the attitude towards this specific puzzle task [Specific Task Attitude] ($F(2, 57) = .17$, $p$ (one-tailed) $= .42$, $eta^2 = .01$) or the Judgement of the Task ($F(2, 57) = .02$, $p$ (one-tailed) $= .49$, $eta^2 = .00$). This only partially supports hypothesis 3.

In further investigations, the ANOVA also considered two of the deleted items: the perception of the task solution (capturing the cognitive strain of the task) as well as
participant’s perception to express their ideas (capturing the collaborative aspect).

Both items revealed a statistically significant difference for the sociability of the environment (Success Regarding Task Solution: $F(2, 57) = 3.62, p = .03, \eta^2 = .11$; Was Able to Express my Ideas: $F(2, 57) = 5.27, p = .01, \eta^2 = .16$). For details, see also Table 51.

Table 51: Overview of parametric test results (ANOVA) for dependent variables.

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig. (one-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General Task Attitude</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>4.76</td>
<td>2</td>
<td>2.38</td>
<td>2.49</td>
<td>.09</td>
</tr>
<tr>
<td>Within Groups</td>
<td>54.51</td>
<td>57</td>
<td>0.96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>59.26</td>
<td>59</td>
<td></td>
<td>2.49</td>
<td>.05</td>
</tr>
<tr>
<td><strong>Specific Task Attitude</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>0.20</td>
<td>2</td>
<td>0.10</td>
<td>0.17</td>
<td>.84</td>
</tr>
<tr>
<td>Within Groups</td>
<td>33.26</td>
<td>57</td>
<td>0.58</td>
<td></td>
<td>.42</td>
</tr>
<tr>
<td>Total</td>
<td>33.47</td>
<td>59</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Task Judgement</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>0.02</td>
<td>2</td>
<td>0.01</td>
<td>0.02</td>
<td>.98</td>
</tr>
<tr>
<td>Within Groups</td>
<td>23.37</td>
<td>57</td>
<td>0.41</td>
<td></td>
<td>.49</td>
</tr>
<tr>
<td>Total</td>
<td>23.39</td>
<td>59</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Judgement of Online Environment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>0.04</td>
<td>1</td>
<td>0.04</td>
<td>0.09</td>
<td>.80</td>
</tr>
<tr>
<td>Within Groups</td>
<td>17.76</td>
<td>38</td>
<td>0.47</td>
<td></td>
<td>.40</td>
</tr>
<tr>
<td>Total</td>
<td>17.80</td>
<td>39</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Success Regarding Task Solution</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>5.63</td>
<td>2</td>
<td>2.82</td>
<td>3.62</td>
<td>.03</td>
</tr>
<tr>
<td>Within Groups</td>
<td>44.30</td>
<td>57</td>
<td>0.78</td>
<td></td>
<td>.11</td>
</tr>
<tr>
<td>Total</td>
<td>49.93</td>
<td>59</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Was Able to Express My Ideas</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>10.80</td>
<td>2</td>
<td>5.40</td>
<td>5.27</td>
<td>.01</td>
</tr>
<tr>
<td>Within Groups</td>
<td>58.45</td>
<td>57</td>
<td>1.03</td>
<td></td>
<td>.16</td>
</tr>
<tr>
<td>Total</td>
<td>69.25</td>
<td>59</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Two stages of independent variable only: Task oriented vs. Social Presence ($N = 40$).

**Single items, carried over for relevance reasons.

Scheffé post hoc tests for variables and items with statistically significant differences revealed the following measures: Regarding the item Successful Task Solution, post hoc tests revealed a difference between the social presence online
condition and the control group ($p = .03$). This only partially supports hypothesis 3. Furthermore, participants’ perception to express their ideas differed statistically significant ($p = .03$) in both online conditions compared to the control group while they did not differ amongst each other. For detailed overview compare Table 52.

The variable General Task Attitude is only significant at the one-tailed level ($p = .046$). Means for General Task Attitude in each of the conditions hint to the fact that both groups with the possibility for social exchange, online and face-to-face, differ from the task-oriented group. This again provides only partial support for hypothesis 3.

### Table 52: Overview of post hoc tests for statistically significant items.

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>(I) Condition</th>
<th>(J) Condition</th>
<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>Sig.</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Success Regarding Task Solution</td>
<td>Task Oriented Online</td>
<td>Social Presence Online</td>
<td>.40</td>
<td>.28</td>
<td>.36</td>
<td>-.30 1.10</td>
</tr>
<tr>
<td></td>
<td>Social Presence Online</td>
<td>Social Presence Online</td>
<td>-.35</td>
<td>.28</td>
<td>.46</td>
<td>-1.05 .35</td>
</tr>
<tr>
<td></td>
<td>Task Oriented Online</td>
<td>Social Presence F2F</td>
<td>-.40</td>
<td>.28</td>
<td>.36</td>
<td>-1.10 .30</td>
</tr>
<tr>
<td></td>
<td>Social Presence F2F</td>
<td>Social Presence F2F</td>
<td>-.75*</td>
<td>.28</td>
<td>.03</td>
<td>-1.45 -.05</td>
</tr>
<tr>
<td>Social Presence F2F</td>
<td>Task Oriented Online</td>
<td>Social Presence F2F</td>
<td>.35</td>
<td>.28</td>
<td>.46</td>
<td>-.35 1.05</td>
</tr>
<tr>
<td></td>
<td>Social Presence Online</td>
<td>Social Presence Online</td>
<td>.75*</td>
<td>.28</td>
<td>.03</td>
<td>.05 1.45</td>
</tr>
</tbody>
</table>

*Table continued on following page*
Non-parametric tests for both concerning variables, Task Handling Judgement ($X^2(2) = 8.51, p = .01$) and Judgement of Collaboration ($X^2(2) = 11.48, p = .00$), indicated a statistically highly significant difference among the three levels of social presence. The Kruskal–Wallis test indicated for both variables the lowest mean rank during the social presence online condition (Judgement of Collaboration: $M = 22.70$; Task Handling Judgement: $M = 24.70$). The social presence face-to-face condition (control group) received the highest rank (Judgement of Collaboration: $M = 40.83$; Task Handling Judgement: $M = 39.60$).
Table 53: Overview of non-parametric test results (Kruskal–Wallis test) for both not normally distributed variables Judgement of Collaboration and Task Handling Judgement.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Task Handling Judgement</th>
<th>N</th>
<th>Mean Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task Oriented Online</td>
<td>20</td>
<td>27.20</td>
<td></td>
</tr>
<tr>
<td>Social Presence Online</td>
<td>20</td>
<td>24.70</td>
<td></td>
</tr>
<tr>
<td>Social Presence (F2F)</td>
<td>20</td>
<td>39.60</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Condition</th>
<th>Judgement of Collaboration</th>
<th>N</th>
<th>Mean Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task Oriented Online</td>
<td>20</td>
<td>27.98</td>
<td></td>
</tr>
<tr>
<td>Social Presence Online</td>
<td>20</td>
<td>22.70</td>
<td></td>
</tr>
<tr>
<td>Social Presence (F2F)</td>
<td>20</td>
<td>40.83</td>
<td></td>
</tr>
</tbody>
</table>

Test Statistics\(^{a,b}\)

<table>
<thead>
<tr>
<th></th>
<th>Chi-Square</th>
<th>df</th>
<th>Asymp. Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task Handling Judgement</td>
<td>8.51</td>
<td>2</td>
<td>.01</td>
</tr>
<tr>
<td>Judgement of Collaboration</td>
<td>11.48</td>
<td>2</td>
<td>.00</td>
</tr>
</tbody>
</table>

a. Kruskal Wallis Test
b. Grouping Variable: Condition

Post-hoc tests for both variables confirmed hypotheses 4 and 5 only partially. Based on the Mann–Whitney U measure, both variables revealed significant differences between online conditions and the face-to-face condition. The social presence online condition and the social presence face-to-face condition differed significantly (Task Handling Judgement: \( U = 100.50, p = .01 \), Judgement of Online Environment: \( U = 83.00, p = .00 \)). Furthermore, both variables revealed a difference between the task oriented and the social presence face-to-face condition (Task Handling Judgement: \( U = 117.50, p = .02 \), Judgement of Online Environment: \( U = 110.50, p = .01 \)). Compare also Table 54 for detailed results.
Table 54: Overview of nonparametric post hoc tests for the two variables Judgement of Collaboration and Task Handling Judgement (N = 60).

<table>
<thead>
<tr>
<th>Scale</th>
<th>Comparison of Conditions</th>
<th>Test statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>U</td>
</tr>
<tr>
<td>Task Handling Judgement</td>
<td>Task Oriented Online</td>
<td>Social Presence Online</td>
</tr>
<tr>
<td></td>
<td>Social Presence Online</td>
<td>Social Presence (F2F)</td>
</tr>
<tr>
<td></td>
<td>Task Oriented Online</td>
<td>Social Presence (F2F)</td>
</tr>
<tr>
<td>Judgement of Collaboration</td>
<td>Task Oriented Online</td>
<td>Social Presence Online</td>
</tr>
<tr>
<td></td>
<td>Social Presence Online</td>
<td>Social Presence (F2F)</td>
</tr>
<tr>
<td></td>
<td>Task Oriented Online</td>
<td>Social Presence (F2F)</td>
</tr>
</tbody>
</table>

*two-tailed

7.5.2.2 Discussion

Results further completed findings on the relationship between task and social presence. While the qualitative study did not find a causal connection between the task and social presence, the quantitative study revealed findings that social presence influences the attitude towards the task. Interestingly, when asked directly after the instruction about their general task attitude, participants in the two social conditions experienced less pressure and less unease than participants in the task-oriented condition. The initial lower levels of stress for social conditions may be explained by the fact that participants expected to freely converse with their peers and, thus, could address their worries as well. However, after task completion this difference disappeared and all three conditions reported equal levels of cognitive strain caused by the task. This finding illuminates the complex role of social exchange in communication: Expectations towards social exchange are mostly based on the experience with face-to-face communication. However, online communication differs from this form of communication in various ways. The study pointed to this gap between expectations and online experience. This confirms
conclusions from the qualitative study, ambiguity and uncertainty in online communication can be minimised through the use of chat protocols and norms. More research is needed to determine if such rules can influence the perceived quality of the communication or if social presence indeed does not impact the attitude towards tasks.

These findings can be explained by considerations from Wise et al. (2004): Social presence is a variable with some kind of threshold and it is important to exceed a critical level. In order for it to alter participants’ perceptions or interactions, participants need to feel a certain level of someone else’s involvement. Participants of both conditions encountered a level of involvement from their counterpart. This did not necessarily happen through the communication in the chat, but could also have been caused by the movement of puzzle pieces. Furthermore, these findings support and extend research (e.g. Rourke et al., 1999; Swan, 2003) contradicting the notion of social presence as a capability of the medium itself, as introduced initially by Short et al. (1976). Participants found other ways to convey social presence than the medium’s abilities and judged the involvement of their team member, e.g. by movement of puzzle pieces. Interactive responses are one way to convey social presence (Rourke et al., 1999). Another way is the use of emoticons or verbal expressions to introduce intimacy into text-based communication.

Furthermore, the medium as well as the collaborative aspect were effected most distinctly by the amount of social presence experienced. Participants favoured communication in a face-to-face setting over the communication in the online environment. They judged the communication as more successful, enjoyed the collaboration more and were of the opinion that they found an efficient way to solve the task. This can partially be explained by the fact that face-to-face communication is less time-consuming and less strenuous than text-based communication.
There was a trend within the two online conditions for the task-oriented condition to have a more positive effect on the judgement of the medium. However, this trend was not statistically significant. Again, this supports threshold considerations by Wise et al. (2004). They reported that even though both groups experienced different levels of social presence, they still perceived the messages as friendly and positive.

The above stated arguments receive further support through the finding that participants in both online conditions felt they could express their feelings equally well. The study showed no difference between online conditions, but revealed differences between the online conditions and the face-to-face condition. Participants in the control group felt they could express their ideas more clearly.

The above stated arguments continue findings from the qualitative study. The qualitative study found that higher levels of social presence were experienced in synchronous communication tools compared to asynchronous tools. However, the level of social presence experienced within a medium in the experimental study did not lead to differences in the perception of the medium itself. While the difference in social presence (face-to-face vs. online) across media led to different perceptions of a medium, the variations within one particular medium were not strong enough to alter the perception. This leads to the assumption that the concept of social presence is a stronger predictor of behaviour when looking at differences across media, as opposed to variations within one medium.

Furthermore, the interaction among individuals was also perceived differently among the groups. Participants judged the handling of the task more favourable during the face-to-face condition, compared to the online conditions. A trend among the online conditions crystalized, pointing to the lesser of the two social presence conditions being favoured. However, this trend did not show as
statistically significant. Such a trend could possibly be explained by findings concerning the proper task–media fit (Chou & Min, 2009; Mennecke et al., 2000). Possibly, the task did not inherit the amount of social interaction that was intended by the author. As already stated above, it might have been sufficient for participants to follow the movements of the puzzle pieces to gain a feeling of social presence through this measure of involvement. This would lead to the conclusion that the optimal task–medium fit would be found when only discussing the task and not considering personal information.

Finally, combining findings from both studies in this thesis, the causal relationships indeed seem to be of a reciprocal nature. While the qualitative study found that different media convey different levels of social presence, the quantitative study revealed that increased levels of social presence also influence the perception of the medium. Furthermore, the qualitative study did not reveal an influence of the task on social presence. However, as shown in the experimental study, different levels of social presence alter the perception of the task. Furthermore, social presence influences the perception of group interactions, which in turn have been found to influence the social presence experienced. That is, the more social interaction takes place, the more social presence is experienced (e.g. Wise et al., 2004). Such findings underline the complex nature of social presence. In order to understand the concept and its impact as well as the influence it is prone to, a variety of considerations are of importance.

The experimental study is a good example to show that seemingly contradictory views of social presence can provide explanations to the concept at different levels. For one, Short et al.'s (1976) view on social presence as a medium's ability can provide insight into the optimal fit of task and medium. Secondly, the social perspective on social presence as a participant's potential delivers insights into the
complex causal relationships of the concept and explains participant's potential to adapt to certain media.

7.5.3 The covariates: ICT and Online Media Experience

7.5.3.1 Findings

The correlational analysis for ICT and Online Media Experience and the dependent variables revealed a relationship between them (compare Table 55). Experience with ICT correlated positively with the perception of task aspects. The more experienced someone was with ICT, the less they felt under pressure to perform well [General Task Attitude] \((r = .33, p = .01)\). After task completion, they were also the ones to judge the task as less strenuous [Task Judgement] \((r = -.24, p = .03)\).

The experience with online media revealed a slightly different connection to the dependent variables (compare Table 55). It was connected to all three types of dependent variables: task, media and collaboration. The more participants were experienced with online media, the less they felt under pressure to perform well [General Task Attitude] \((r = .32, p = .01)\), the more favourable they judged the online environment [Judgement of Online Environment] \((r = .25, p = .03)\) and the more positively they perceived their collaboration [Task Handling Judgement] \((r = .28, p = .02)\). The prior experience with ICT or Online Media was not connected at all to the specific task judgement, which captured the attitude towards the puzzle task.

A subsequent covariance analysis with prior ICT experience or online media experience in dependence with varying social presence revealed no significant
influence on any of the four dependent variables. This disproves hypotheses 1 and 2.

Table 55: Correlations between ICT and Online Media experience with dependent variables (N = 60).

<table>
<thead>
<tr>
<th></th>
<th>General Task Attitude</th>
<th>Specific Task Attitude</th>
<th>Task Judgement</th>
<th>Task Handling Judgement</th>
<th>Judgement of Collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experience with Online Media Pearson Correlation</td>
<td>.32</td>
<td>.08</td>
<td>-.16</td>
<td>.28</td>
<td>.25</td>
</tr>
<tr>
<td>Sig. (1-tailed)</td>
<td>.01</td>
<td>.27</td>
<td>.12</td>
<td>.02</td>
<td>.03</td>
</tr>
<tr>
<td>Experience with ICT Pearson Correlation</td>
<td>.33</td>
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<td>-.24</td>
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<td>.11</td>
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<tr>
<td>Sig. (1-tailed)</td>
<td>.01</td>
<td>.31</td>
<td>.03</td>
<td>.20</td>
<td>.21</td>
</tr>
</tbody>
</table>

7.5.3.2 Discussion

Results revealed no statistically significant connection between prior experience of ICT and Online Media as a covariate to social presence affecting the task, medium or collaboration aspect.

However, correlations revealed a connection between prior experience and the three aspects of task, media and collaboration. While ICT experience was linked more closely to task aspects, the experience with online media was linked to all three aspects. The more experienced participants were with ICT and online media, the more they had a positive general attitude towards working in an online environment. Furthermore, the more experience, the more favourable they judged the medium as well as the collaboration.

Concluding from these findings, the effects on social presence that have been found in former research (Hostetter & Busch, 2006; Mykota & Duncan, 2007; Wise et al., 2004) were more closely related to the experience with online media than the
experience with ICT in general. Most of the research reported findings concerning former online course participation. This leaves to conclude that the more often a participant experiences the same exact situation, the more they experience social presence. This conclusion is also supported by research into social presence time patterns. The qualitative study in this thesis as well as further research found that social presence in a group increases over time (e.g. Picciano, 2002).

Considering the definition of social presence as a participant’s potential, this would mean that such a potential is not a fixed ability but can be trained over time. This is an important finding for understanding social presence. Some research already points to the fact that introducing participants to the concept of social presence alters their experience in a positive way. The above stated findings support and expand current research findings and hint to the fact that the training of social presence can be beneficial to its experience in online settings.

Despite the fact that the findings disproved the first two hypotheses and prior experience might be independent of the experience of social presence, it still seems to play an important role in the experience of online communication. Further research needs to be conducted to better understand the connection between prior experience and the perception of interaction in an online setting.

### 7.6 SUMMARY AND CONCLUDING REMARKS

The experimental study revealed the influence of social presence on participants’ perception of the medium and the interaction. It also supported research considerations into the optimal fit of task and medium. In addition, findings
illustrate a different perspective of social presence: the idea of a threshold (Wise et al., 2004).

Findings also revealed that prior experience with online media is more closely linked to the concept of social presence than ICT experience in general. Presuming the definition of social presence as a participant’s potential, this leads to the conclusion that social presence can be trained and in such a way that teachers can positively influence participant’s experience in an online setting.

Most importantly, the integration of findings from both studies deliver new insights into the reciprocal nature of social presence and associated concepts. Most of the investigated variables, e.g. the medium, are often influenced by the experience of social presence and this in turn influences participants perception of that same exact variable. These findings address a research lack into the causal nature of social presence.

Overall, this highlights the concept’s complex nature and stresses the importance to not only consider it as a cause but also as an influenced variable in online settings. The concept of social presence is interwoven with a variety of variables, important to be considered in online settings. It plays an integral part in understanding dynamics in such an environment. However, its complexity is not fully understood at this point in research.
Each of the concepts, coordination and social presence, contributes to students’ online learning experience: The analysis of coordination illuminates emerging dynamics shaping learning. The analysis of social presence provides insight into powerful enabling factors for effects shaping coordination dynamics.

Increasing social presence provides a greater opportunity for establishing common ground, which in turn creates a supportive environment for coordination. Thus, an increase in social presence should be accompanied by a greater opportunity for group coordination. This is supported by the findings in this study. Synchronous environments enable a stronger sense of social presence; they also provide a rich opportunity for coordination. The more students are aware of each other, the bigger the opportunity to create a positive group culture and engage in common grounding. Naturally, one would be more committed to group activities in a group that one feels part of as opposed to a group that does not engage at all. This in turn provides a sound basis for coordination patterns. It does not guarantee that such patterns develop in a positive direction, as a wealth of other factors, as described in this thesis, contribute to the forming of coordination patterns, particularly during the early stages of a group’s life. However, social presence experience can offer a rich and enabling environment for coordination processes to occur.
Even though the current studies do not provide distinct insight into the causal direction of the relationship between coordination and social presence, findings give way to formulating assumptions about the relationship. Theoretical considerations emerging out of the analytical framework suggest social presence as an enabling context factor, providing the basis for further group processes. Group processes, such as establishing common ground, provide a rich basis for coordination.

Such considerations are further supported by findings from this study. Students experienced a higher amount of social presence during synchronous communication, providing a larger opportunity for common grounding and coordination. Consequently, students revealed a larger coordination variety and amount during synchronous communication. The reverse relationship is true as well, students showed a smaller amount of social presence and coordination in asynchronous discussion forums.

Furthermore, not considering coordination and social presence simultaneously might come at a cost to the group. Results show, activities with fewer interdependencies, such as discussions, require less coordination than activities with more interdependencies, such as the joint construction of a concept map. Thus, the natural medium of choice for discussions would be a tool triggering little coordination, such as asynchronous discussion forums. However, implementing asynchronous communication media comes with its own set of advantages and disadvantages, such as reduced social presence experience. Neglecting social processes in online groups can adversely affect the learning process. To put emphasis on the social dimension, the lecturer should encourage exchange about social topics in other discussion forums. This in turn accumulates additional costs in terms of coordination and time that are not accounted for in the direct comparison between synchronous and asynchronous tools. The introduction of
rules and roles to online communication in groups is one measure to meet such costs.

The present study investigates social presence only with respect to its importance for coordination. Clearly, social presence impacts beneficially on other group processes, such as a sense of accountability. However, such an investigation is beyond the scope of this thesis, but poses an interesting direction for future research.

The relationship between social presence and coordination is complex. In order to interpret this relationship, one must consider task, tool and member characteristics respectively at all times. The simultaneous consideration of coordination costs and the social dimension contributes beneficially to exploring students' online learning experience. However, the subtleties of this relationship have to be determined in future research.
9 CONCLUSIONS

This work illuminates students' interaction and learning experience in loosely structured constructivist learning environments in a higher education setting. Two concepts, coordination behaviour and social presence experience, examine important aspects of students' learning processes. Different levels of analysis provide insight into the learning process, delivering the basis for recommending sustainable improvements in such settings.

One of the main strengths of this work is its layered analytical approach. The complexity of learning experiences and processes are analysed from different perspectives, on different levels of abstraction, from the perspective of coordination behaviour and social presence experience. The combined analysis provides an integrative view of group dynamics in computer-supported collaborative learning environments, alluding to the complexity of learning experiences and processes as well as providing suggestions for more efficient facilitation of teaching and learning processes.

9.1 COORDINATION CONCLUSIONS

9.1.1 Single Layer Perspective

9.1.1.1 Complexity of Learning Experiences and Processes

A key strength of this research is the discrete analysis on a single layer perspective. Arrow et al. (2000) propose in their groups as complex systems theory, groups
establish patterns of behaviour on a local level. These patterns are not predictable. The detailed analysis in this thesis exposed numerous micro-processes regarding groups' dynamics. Within groups' micro-processes, stable patterns are found on a single perspective level. These results confirm considerations regarding coordination and local patterns as put forward by Arrow et al. (2000).

The analysis of coordination revealed characteristic patterns for each of the influencing factors. Complex coordination patterns are detected across tools, tasks and members.

**Tools**
Results show clearly, asynchronous tools require less coordination behaviour and fewer variety than synchronous. In synchronous communication, the immediacy of contact and the change in communication structure, due to different media characteristics, result in more coordination. Results show, media type influences nature and amount of coordination occurring in groups. This is an important finding for CSCL research, as coordination shapes learning processes and is linked to group performance.

Differences in groups' local dynamics support the theory of groups as complex systems. Even though both groups seem to have equal conditions and work in the same environment, they develop different dynamics specific to that group regarding initiation-closure behaviour and the overall amount of coordination.

**Tasks**
Each task revealed its own coordination pattern. Some tasks are characterised by extensive use of a small variety of coordination actions, such as discussion activities. Other tasks use the full range, but show differences in the frequency of single coordination tasks, i.e. concept mapping tasks.
As tools demand different coordination behaviour, different tasks also rely on a specific mix of coordination behaviour, such as discussion tasks showed minimal coordination regarding quantity and quality, compared to concept mapping tasks. This reveals, task complexity and increased interdependency results in increased coordination requirements.

These coordination behaviours are further influenced by group members.

Members
Findings showed that assigned member roles had an impact on coordination patterns. The introduction of roles and rules both decreased coordination costs. Thus, introducing structuring elements has a positive impact on coordination.

9.1.1.2 Facilitation to more Efficient Teaching and Learning Process
An educational designer’s choice to implement a particular tool, such as a synchronous chat tool, has implications for learning processes. Based on the findings from this thesis, considerations regarding task and members must be identified in addition to the tools characteristics.

The following recommendations for educators can be put forward:

- Providing the group with a structure that they may follow, but also allowing them freedom to choose other paths, is one way to minimise coordination costs.
- Students showing coordination behaviour not required for a particular task increases coordination costs. The tutor may point this out to minimise unnecessary task–related coordination.
- Support for members includes the establishment of roles and rules to facilitate efficient coordination and minimise coordination costs.
To judge coordination patterns, it is important to look at the quality and quantity of coordination behaviour shown. Support regarding tools and tasks is of similar nature, while member support is much more intricate.

Furthermore, if a teacher becomes aware of adverse coordination behaviour, such as continuous reiteration, he or she should point this out to the group. If such an intervention takes place in the vulnerable early stages of a group, this could sustainable prevent disadvantageous group dynamics. If not managed, the group may permanently take up this behaviour, and become frustrated when the medium takes too much time away from content or task completion. Students need to be helped to form positive online coordination habits, especially when having no prior experience.

9.1.2 Concept Perspective

9.1.2.1 Complexity of Learning Experiences and Processes

Coordination analysis on a concept level provides insight into the complexity of learning processes. While the single layer perspective provides a local level behavioural view, the concept layer delivers an abstract view on coordination dynamics in groups.

A main strength of this research is its emphasis on the dual nature of coordination: describing coordination in terms of cost and gain. Improved support for CSCL type environments optimises the balance between the two.

The complexity of learning experiences becomes evident, when considering findings from all three factors simultaneously. Synchronous tools trigger more coordination behaviour, compared to asynchronous tools. Complex tasks need an
appropriate platform to develop coordination behaviour. This implies the right mix between task and tool, between interdependencies and triggering mediating environment, aligning on broader terms with findings and conclusions from Veerman et al. (1999). Considering only one factor can come at a cost to coordination dynamics in the other.

However, the right match of tool and task illustrates only one aspect in trying to improve coordination dynamics. For example, illuminating the relation between tools and members, single members with preconceptions of media will use them differently. Thus, the tool can offer an affordance, while utilisation depends on the individual.

Overall, the consideration of tools, tasks and members for coordination processes provides a rich and sound basis for exploring the complexity of learning experiences and processes.

9.1.2.2 Facilitation to more Efficient Teaching and Learning Process

Minimising costs supports learning processes and contributes to group performance. Coordination costs provide a powerful measure for online group dynamics. In order to solve a problem it has to be identified. However, coordination mechanisms are often subtle and coordination problems are difficult to pinpoint during the collaboration process. Distinguishing between micro-level behaviour and malfunctional coordination patterns poses a challenge to teacher and students. Such problems are partially met by technology itself, for example through awareness visualisations. However, such visualisations can only portray quantitative issues and generally do not display quality of contributions. These are left to human judgement.
The right match between media characteristics and student behaviour can prevent coordination costs. Incongruence between these two factors results in additional coordination overhead, and group members become frustrated. A “behaviour x media characteristics”-matrix can support teacher and students in aligning individual actions with tool characteristics and consequently reducing coordination costs.

Overall, the educational designer needs to match the pedagogical aim with the choice of tool (e.g. synchronous or asynchronous), particularities of the task (e.g. interdependencies) and members’ needs and characteristics (e.g. media experience and preoccupations).

9.2 Social Presence Conclusions

9.2.1 Single Layer Perspective

9.2.1.1 Complexity of Learning Experiences and Processes

Synchronous media considerably convey a stronger sense of presence, compared to asynchronous media. The level of expressed social presence in synchronous media clearly increases as the course proceeds. Thus, the mediums’ ability to convey social presence plays an integral part in the learning experience.

The two media trigger different levels of social presence, supporting considerations that not only the affective channel but also further factors might play a role in the medium’s ability to convey social presence, such as interactive responses. However, in order to impact collaboration dynamics, the experience of social presence needs
to exceed a certain threshold, highlighting the subtlety and complexity of the concept.

Not all members in the current qualitative study experienced the same level of social presence at all times, indicating the individual’s perception plays an important role (Weinel & Hu, 2007). In addition, the expressed variety and quality of social presence indicators varied among members. Furthermore, they reacted differently to the change in communication media.

The reasons behind intra- and interindividual fluctuations in members’ perceptions require further research. While some fluctuations might be due to expected behavioural variation at a micro-level, some of it could be due to belief systems, preoccupations towards a medium, or personality traits. Prior experience with online media is linked to the attitude towards online collaboration and thus, indirectly to social presence as well. Examining such trends can be valuable for theoretical considerations related to pedagogical decisions, and practical considerations in the classroom.

Students revealed longitudinal effects in experiencing social presence, providing they remained in the synchronous medium. Such effects can be attributed to emerging group dynamics, since the medium’s characteristics remained the same. For future research, it would be interesting to see if longitudinal effects emerge in other media with smaller abilities to convey a sense of presence, like discussion forums.

When the medium changed from synchronous to asynchronous, social presence experience underwent a strong decline. This implies, the medium’s influence is stronger than longitudinal effects emerging from group dynamics. But individual
analysis showed, the point of change between media was not perceived equally for all members. A few students revealed increased social presence instead of a decline.

Such findings clearly indicate the medium’s limitations to determining social presence. The medium provides the scope for action and it is left to the individual to take this up.

9.2.1.2 Facilitation to more Efficient Teaching and Learning Process

Social presence findings outline the limits for pedagogical intervention in online groups, as final use of media affordances depends on the individual. Longitudinal effects, such as increase of social presence in synchronous communication over time, support the teacher in his or her mission to support social presence. However, the teacher can only strive to facilitate the experience within certain boundaries during the learning process.

A rich and enabling environment for students, moderator support and promoting immediacy behaviours can improve the experience of social presence. For example, the introduction of rules and roles can minimise ambiguity in online communication, especially for inexperienced users. Managing underlying and developing group dynamics can also be achieved, but the individual's perception is much more difficult to anticipate.

9.2.2 Concept Perspective

9.2.2.1 Complexity of Learning Experiences and Processes

Contextual parameters constitute an important influence in computer–based collaborative learning settings. Social presence is portrayed as the main enabling
factor in such environments. It forms the basis for other effects that are crucial for successful learning, such as the establishment of common ground (Clark & Brennan, 1991) or satisfaction (Gunawardena & Zittle, 1997; Richardson & Swan, 2003).

While some findings separately point to the impact of the medium and individual for social presence, the current study pulls these two factors together and explores the combined influence and their interrelationships.

The analysis of chat logs from a media perspective clearly indicates different communication media exhibit different abilities to convey social presence. The findings draw attention to the importance of factors beyond the ability to convey affective information.

A medium’s ability to convey a sense of presence does not shape the social presence experience by itself, and consequently the learning experience. An individual member’s characteristic way to adopt a particular medium determines their actual social presence experience. Strong intra- and interindividual differences in the expression of social presence confirm such conclusions. The findings clearly indicate the importance of the individual, as well as the medium for experiencing social presence.

Finally, the causal relationships of social presence and associated factors are of a reciprocal nature. While different media convey different levels of social presence, increased levels of social presence also influence the perception of the medium. Furthermore, the qualitative study did not reveal an influence of the task on social presence. However, the experimental study showed that different levels of social presence alter the perception of the task. Social presence influences the perception of group interactions, which in turn have been found to influence the social
presence experienced. The complex nature of social presence is underlined by the reciprocal nature of the causal relationships.

### 9.2.2.2 Facilitation to more Efficient Teaching and Learning Process

Social presence adds a complex, but crucial, layer to the learning experience. It mediates important processes, such as common grounding or positive group culture. Additionally, the experience depends on the individual’s utilisation of the medium’s potential. It is quite difficult to predict a learning path for an online group. For example, some students’ showed a higher medium acceptance rate, resulting in more online sessions for that group.

Inferring from the social presence findings, the experience of social presence is complex in its origination and formation. Promoting the experience of social presence can take up one of various forms:

- Choosing a medium possessing a greater ability to convey social presence.
- Encourage social exchange during early stages of the group development.
- Promoting students’ awareness of others’ presence, such as through awareness devices like wattle tree or social network visualisations or even biography information.
- Moderator efforts to achieve a balance between social and on-topic actions, for example asking students to post social contributions in another forum during topic discussion.
- Evaluate students’ prior ICT and CSCL experience to form a balanced group. For example, most group members showing higher medium acceptance, might result in more online meetings and more engagement with the medium.
- To introduce rules and roles to online communication.
9.3 INTEGRATIVE PERSPECTIVE CONCLUSIONS

9.3.1 Complexity of Learning Experiences and Processes

Coordination and social presence shape learning experiences and processes in a complex way. Coordination analysis sheds light on emerging dynamics which shape learning, and social presence analysis provides insight into a powerful enabling factor effecting the shape of coordination dynamics.

Social presence, as a contextual parameter, forms the basic experience for other effects relevant for online collaboration success, e.g. ‘common ground’, and for further groups dynamics. Its complexity is highlighted by its reciprocal causal nature.

Furthermore, the current studies do not provide insight into the causal direction of the relationship between coordination and social presence. Theoretical considerations emerging out of the analytical framework offer an explanation for social presence as a context factor. The interplay between the concepts on an integrative level and their causal relationship provides ground for future research.

9.3.2 Facilitation to more Efficient Teaching and Learning Process

The simultaneous consideration of coordination and social presence has practical implications as well. Results show certain activities, e.g. discussing a topic, require little coordination compared to other activities, e.g. the joint construction of a concept map. Thus, the natural medium of choice for discussion would be an asynchronous discussion forum, as it triggers little coordination. However, implementing asynchronous communication media comes with its own set of
advantages and disadvantages, e.g. reduced social presence experience. If the lecturer wants to put emphasis on the social dimension, they should encourage exchange about social topics in other discussion forums. This in turn accumulates additional costs in terms of coordination and time that are not accounted for in the direct comparison between synchronous and asynchronous tools.

The simultaneous consideration of coordination costs and the social dimension contributes beneficially to students' online learning experience. However, the subtleties of this relationship have to be determined in future research.

### 9.4 Key Contributions to Research

One main strength of this research is the layered analytical approach. The discrete analysis with three different levels of abstraction, i.e. single perspective, concept level and integrative level, provides a powerful view on interaction dynamics in computer-based collaborative learning environments that has not been described so far.

- The single perspective level allows for recommendations on a tangible behavioural level.
- The concept level contributes to existing theories on coordination and social presence.
- The integrative approach provides a wider perspective, allowing generic application and transfer to learning settings.

A second main strength is the depth and detail of the analysis. So far, research has not targeted coordination as well as social presence with such detail longitudinally.
The development of both processes over the course of a semester illuminates the complexity of learning experiences and processes.

A third main strength is the level of breadth exploring social presence. So far, the reciprocal causal nature of the concept has so far not been explored in one piece of work. The findings indicate the complex and subtle nature of social presence. Its impact is not straightforward, as many factors contribute to it and its experience is hard to predict. This might be one reason for a research decline during the last year.

9.5 Key Contributions to Practice

This thesis provides educators with suggestions regarding how to adjust characteristics inherent in computer-mediated learning and to facilitate more efficient teaching and learning processes.

One main contribution to practice is the introduction and elaboration of coordination costs. Costs are introduced as a powerful concept, relative to evaluating group coordination processes. A list of suggestions is based on coordination costs, providing structure in unstructured tool environments, as well as behavioural matrix depending on media characteristics.

The second main contribution is further pointing educators’ attention to contextual parameters, such as social presence. While the educational designer has only limited influence on the utilisation of social presence in an online environment, it is of particular importance to promote the social presence experience where possible. This can take the form of choosing a medium with a higher ability, promoting
students’ awareness of the presence of others, or balancing between social and on-topic actions. The online teacher can promote the online experiencing by balancing social and on-topic discussions as well as regarding prior ICT acceptance.

9.6 **Summary**

Coordination in CSCL groups has not been investigated from a complex systems view. A research gap existed concerning the nature of coordination across the three factors involved: tools, tasks and members. Up until this point, research has investigated coordination separately in relation to only some of the three factors, e.g. tools and to some extent tasks.

This research study points to the importance of the right match of tools, tasks and member needs. It emphasises the strength of the tool-task relationship. While tools and tasks evoke similar recommendations for practice, e.g. correct medium choice, member suggestions include the raised awareness and introduction of assigned roles and their impact on group coordination.

Different communication media, with comparable abilities to convey affective information, in fact convey different levels of social presence. This impacts existing theory, as it partially undermines the current understanding of social presence. This has lead to a refined description of the concept. Another research lack is the time dimension. The analysis investigates the increase of social presence over time. Intra- and interindividual differences, as well as underlying group dynamics, further influence the experience of social presence. Findings point to the reciprocal causal nature of the concept and portray its complexity.
The interrelationship between the influencing factors coordination and social presence is complex. Pedagogical strategy can only anticipate developments within learning and teaching environments to a certain point, but it can begin to facilitate and manage student interactions whenever possible.
REFERENCES


References


presented at the 8th International Conference on Advanced Computer Systems, Szcecin, Poland.


References


References


APPENDIX A: WEEKLY INSTRUMENT

A. Information on your background
This section asks you information on your background. Please fill in the blank or tick the appropriate box.

Age

<table>
<thead>
<tr>
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Gender

Please indicate your level of experience in the following areas.

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<th>Not very experienced</th>
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<td>3. Shared whiteboard</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Webcam</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Computer based learning individually / by yourself</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Computer based learning in a group</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Totally disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Totally agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. I feel comfortable when working with a computer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Not at all</th>
<th>Somewhat</th>
<th>Well</th>
<th>Very well</th>
</tr>
</thead>
<tbody>
<tr>
<td>8. I knew my group members before the class started</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

17 Administered during qualitative study.
B. What do you think about the course?

Please answer the following questions and statements according to the feelings and impressions you had doing the coursework during the last week. Please indicate your (level of) agreement or disagreement by ticking the appropriate box.

<table>
<thead>
<tr>
<th></th>
<th>No</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Do you feel, certain things were too complicated?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If yes, then please specify by responding to the statements below.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Totally disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Totally agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical applications are too complicated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tasks/assignments are too complicated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group work activities are too complicated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Very difficult</th>
<th>Difficult</th>
<th>Not difficult</th>
<th>Easy</th>
<th>Very easy</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. How difficult do you find the task you are currently working on?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Please, rate the efficiency of the tools provided...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Not at all efficient</th>
<th>Somewhat efficient</th>
<th>Neutral</th>
<th>Efficient</th>
<th>Very efficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task management tool (dotProject)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chatrooms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whiteboard</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>No</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Besides the communication tools offered through the course website, did you use any other means of communication with your group (e.g. mobile phones, other chat tools)?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>If yes, which ones? Was there a reason for using another medium?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix A: Weekly Instrument

5. Please rate the efficiency of the information provided:

<table>
<thead>
<tr>
<th>Information on…</th>
<th>Not at all efficient</th>
<th>Somewhat efficient</th>
<th>Neutral</th>
<th>Efficient</th>
<th>Very efficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>…who is present in the chat</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>… who did what work/task</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>… did their work when</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>…the background of your group members</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

C. What do you think about the course work?

Please answer the following questions and statements according to the feelings and impressions you had doing the coursework during the last week. Please indicate your (level of) agreement or disagreement by ticking the appropriate box.

<table>
<thead>
<tr>
<th></th>
<th>Totally disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Totally agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The teamwork was satisfying.</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>2. I worked with the team with great pleasure</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>No</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Did you meet with your group members face-to-face?</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

If yes, how many times did you meet face-to-face?

[Blank]

If yes, what was the purpose of these meetings?

[Blank]

Thank you!
APPENDIX B: INSTRUCTIONS

B.1 Instructions for Task-oriented Online-Puzzling

Liebe Teilnehmerin, lieber Teilnehmer,


Sie werden in einer Zweiergruppe ein Puzzle bearbeiten. Dazu wird Ihnen zusätzlich zur Puzzleoberfläche eine Möglichkeit zur Abstimmung in einem Chat-Raum gegeben. Konzentrieren Sie sich bitte in Ihrer Gruppe ausschließlich auf die Aufgabe. Falls Sie den Chat nutzen, besprechen Sie bitte nur aufgabenrelevante Themen. Ihnen stehen 30 min zur Verfügung, um das Puzzle zu vervollständigen.

Im Anschluss daran bitten wir Sie, einen Fragebogen auszufüllen, um Ihre Bewertung der Lernumgebung zu erfassen. Bitte beantworten Sie alle Fragen zügig und spontan, ohne lange über die Antwort nachzudenken.

---

18 Instructions for the variation of the sociability of the environment during the experimental study.
Puzzleeinführung


Im rechten Teil des Fensters sehen Sie jeweils Ihre persönliche Kärtchenpalette. Wenn Sie ein Kärtchen mit Hilfe der Maus in das linke Aktionsfeld ziehen, wird es für Ihren Puzzelpartner ebenfalls sichtbar. Jedes Kärtchen kann nur einmal gezogen werden. Sobald die Kärtchen im Aktionsfenster liegen, können sie durch drücken der rechten Maustaste bearbeitet werden, um sie etwa zu drehen (vergleiche auch die folgende Abbildung der Lernumgebung).

Puzzleumgebung mit Chat und Aktionsbereich links sowie individuelle Puzzlekarten rechts.
Falls Sie den Chat nutzen, beschränken Sie sich bitte ausschließlich auf aufgabenrelevante Mitteilungen.


Mauspuzzle mit Beispiellösung

Beantworten Sie bitte nun zunächst den folgenden Teil des Fragebogens.
B.2 Instructions for Socially Encouraged Online-Puzzling

Liebe Teilnehmerin, lieber Teilnehmer,


Im Anschluss daran bitten wir Sie, einen Fragebogen auszufüllen, um Ihre Bewertung der Lernumgebung zu erfassen. Bitte beantworten Sie alle Fragen zügig und spontan, ohne lange über die Antwort nachzudenken.
**Puzzleeinführung**


Im rechten Teil des Fensters sehen Sie jeweils Ihre persönliche Kärtchenpalette. Wenn Sie ein Kärtchen mit Hilfe der Maus in das linke Aktionsfeld ziehen, wird es für Ihren Puzzelpartner ebenfalls sichtbar. Jedes Kärtchen kann nur einmal gezogen werden. Sobald die Kärtchen im Aktionsfenster liegen, können sie durch drücken der rechten Maustaste bearbeitet werden, um sie etwa zu drehen (vergleiche auch die folgende Abbildung der Lernumgebung).

Puzzleumgebung mit Chat und Aktionsbereich links sowie individuelle Puzzlekarten rechts.
Nutzen Sie den Chat frei um mit Ihrem/r Partner/in zu kommunizieren und sich näher kennen zu lernen. Beschränken Sie die Kommunikation nicht nur auf die Aufgabe selbst.


Beantworten Sie bitte nun zunächst den folgenden Teil des Fragebogens.
Appendix B: Instructions

B.3 Instructions for Face-to-Face Puzzling (control group)

Liebe Teilnehmerin, lieber Teilnehmer,


Sie werden in einer zweier Gruppe ein Puzzle bearbeiten. Ihnen stehen 30 min zur Verfügung, um das Puzzle zu vervollständigen.

Im Anschluss daran bitten wir Sie, einen Fragebogen auszufüllen, um Ihre Bewertung der Lernumgebung zu erfassen. Bitte beantworten Sie alle Fragen zügig und spontan, ohne lange über die Antwort nachzudenken.
Puzzleeinführung


Mauspuzzle mit Beispiellösung

Beantworten Sie bitte nun zunächst den folgenden Teil des Fragebogens.
**APPENDIX C: PRETEST INSTRUMENT**

*Nun wollen wir wissen, wie Ihre *momentane Einstellung allgemein* zu Ihrer Aufgabe in der *computerbasierten Lernumgebung* ist. Dazu finden Sie auf dieser Seite Aussagen. Kreuzen Sie bitte jene Zahl an, die auf Sie am Besten passt.*

*General Task Attitude*

<table>
<thead>
<tr>
<th></th>
<th>trifft nicht zu</th>
<th>trifft zu</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Ich mag solche Aufgaben.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>2. Bei der Aufgabe mag ich die Rolle des Wissenschaftlers, Problemlösestrategien zu entwickeln.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>3. Ich fühle mich unter Druck, bei der Aufgabe gut abschneiden zu müssen.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>4. Nach dem Lesen der Instruktion erscheint mir die Aufgabe sehr interessant.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>5. Ich fürchte mich ein wenig davor, dass ich mich hier blamieren könnte.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>* 6. Bei Aufgaben wie dieser brauche ich keine Belohnung, sie machen mir auch so viel Spaß.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>7. Es ist mir etwas peinlich, hier zu versagen.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>8. Wenn ich an die Aufgabe denke, bin ich etwas beunruhigt.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>* 9. Die konkreten Leistungsanforderungen hier lähmen mich.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
</tbody>
</table>

---

19 Administered during quantitative study; asterisks (*) indicate item deletion for reliability reasons.
Bitte schätzen Sie nun ihre **momentane Einstellung zu der Puzzleaufgabe** ein:

*[Specific Task Attitude]*

<table>
<thead>
<tr>
<th></th>
<th>trifft nicht zu</th>
<th>trifft zu</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Ich glaube, der Schwierigkeit dieser Aufgabe gewachsen zu sein.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>2. Wahrscheinlich werde ich die Aufgabe nicht schaffen.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>* 3. Die Aufgabe ist eine richtige Herausforderung für mich.*</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>4. Ich bin sehr gespannt darauf, wie gut ich hier abschneiden werde.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>5. Ich bin fest entschlossen, mich bei dieser Aufgabe voll anzustrengen.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>6. Ich glaube, dass kann jeder schaffen.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>7. Ich glaube, ich schaffe diese Aufgabe nicht.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>8. Wenn ich die Aufgabe schaffe, werde ich schon ein wenig stolz auf meine Tüchtigkeit sein.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
</tbody>
</table>

Wenn Sie alle Aussagen beantwortet haben, können Sie jetzt mit der Aufgabe beginnen. Nutzen Sie den Chat, um Ihre/n Partner/in näher kennen zu lernen und beschränken Sie die Kommunikation nicht nur auf die Aufgabe selbst.
**APPENDIX D: POSTTEST**

**INSTRUMENT**

Abschließend möchten wir Sie bitten die Lernumgebung zu bewerten. Bitte beantworten Sie alle Fragen zügig und spontan, ohne lange über die Antwort nachzudenken.

**A. Dieser Teil fragt nach Hintergrundinformationen. Füllen Sie bitte die entsprechenden Informationen ein oder ticken Sie die Box.**

<table>
<thead>
<tr>
<th>Alter</th>
<th>weiblich</th>
<th>männlich</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geschlecht</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stimme überhaupt nicht zu</th>
<th>Stimme eher nicht zu</th>
<th>Neutral</th>
<th>Stimme eher zu</th>
<th>Stimme voll zu</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1. Ich arbeite gerne mit Computern.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>A2. Ich arbeite gerne in Gruppen.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gar nicht</th>
<th>Ein wenig</th>
<th>Einigermaßen</th>
<th>Gut</th>
<th>Sehr gut</th>
</tr>
</thead>
<tbody>
<tr>
<td>A3. Wie gut haben Sie Ihre/n Puzzlepartner/in vorher gekannt?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>A4. Wie gut kennen Sie Ihre/n Puzzlepartner/in jetzt?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

---

20 Administered during quantitative study; asterisks (*) indicate item deletion for reliability reasons.
Appendix D: Posttest Instrument

B. Der folgende Abschnitt fragt nach Ihren Fähigkeiten, verschiedene Aufgaben im Bereich Informations- und Kommunikationstechnologie (IuK) auszuführen.

Geben Sie bitte den Grad der Erfahrung mit folgenden Medien an.

[Experience with Online Media]

<table>
<thead>
<tr>
<th></th>
<th>Keine Erfahrung</th>
<th>Wenig Erfahrung</th>
<th>Neutral</th>
<th>Erfahrung</th>
<th>Viel Erfahrung</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1. Email</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>B2. Chat</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>* B3. Computer basiertes Lernen in Gruppen</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Bitte lesen Sie jede Frage sorgfältig und geben Sie an, wie sicher Sie sich Ihrer Fähigkeit sind, eine bestimmte Aufgabe mit den spezifischen IuK-Werkzeugen auszuführen.

[Experience with ICT]

<table>
<thead>
<tr>
<th>Ich glaube,.....</th>
<th>Habe diese Fähigkeit nicht</th>
<th>Überhaupt nicht sicher</th>
<th>Nicht sehr sicher</th>
<th>Einigermaßen sicher</th>
<th>Ziemlich sicher</th>
<th>Völlig sicher</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>B4. Ich besitze die Fähigkeit, einen Computer und Software zu bedienen (z.B. einen Computer einschalten, Menüs, Werkzeugleisten, Scroll-Leisten und Buttons nutzen, Fenster bewegen und in ihrer Größe anpassen, Anwendungen öffnen und schließen)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>B5. Ich besitze die Fähigkeit, mit Dateien, und Ordnern umzugehen und andere Speichervorgänge zu handhaben (z.B. Dateien kopieren, löschen und in Ordnern organisieren, Dateien finden, Zip-Dateien entpacken)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>B6. Ich besitze die Fähigkeit, im Internet zu surfen und andere digitale Ressourcen abzurufen (z.B. Browser, Webadressen und Hyperlinks nutzen, Datenbanken in privaten Netzwerken, im Internet und auf CD-ROMs abrufen)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>B7. Ich besitze die Fähigkeit, Informationen aus dem Internet und von anderen digitalen Ressourcen zu suchen und zu sammeln (z.B. Informationen in Online-Datenbanken finden und sammeln, geeignete Suchmaschinen auswählen und verwenden, Stichworte verwenden, komplexe Anfragen stellen, erweiterte Suchfunktionen verwenden, Bookmarks verwenden, Informationen herunterladen und speichern)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
**Appendix D: Posttest Instrument**

<table>
<thead>
<tr>
<th>Ich glaube,.....</th>
<th>Habe diese Fähigkeit nicht</th>
<th>Überhaupt nicht sicher</th>
<th>Nicht sehr sicher</th>
<th>Einigermaßen sicher</th>
<th>Ziemlich sicher</th>
<th>Völlig sicher</th>
</tr>
</thead>
<tbody>
<tr>
<td>B8. Ich besitze die Fähigkeit, Relevanz und Qualität digitaler Ressourcen und Informationen einzuschätzen (z.B. Informationen von Websites interpretieren, entscheiden ob Informationen aktuell, korrekt und verlässlich sind)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>B9. Ich besitze die Fähigkeit, verschiedene Medieninhalte auf entsprechenden Webseiten zu veröffentlichen, bereitzustellen und mit anderen zu teilen (z.B. Texte, Bilder, Video per E-Mail, ftp und Webseiten (flickr oder youtube) verbreiten, elektronische Quellen korrekt zitieren)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

**C. Bewertung der Puzzleumgebung**

*Judgement of Online Environment*: all items

*Judgement of Collaboration*: items C1, C2, C6, C8, C9

<table>
<thead>
<tr>
<th></th>
<th>Stimme überhaupt nicht zu</th>
<th>Stimme eher nicht zu</th>
<th>Neutral</th>
<th>Stimme eher zu</th>
<th>Stimme voll zu</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1. Die Zusammenarbeit während des Puzzelns war erfolgreich.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>C2. Ich habe die Zusammenarbeit beim Puzzeln genossen.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>C4. Die online Umgebung hat die Gelegenheit zum sozialen Austausch geboten.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>C5. Die online Umgebung hat mir die Möglichkeit geboten meine Gefühle auszudrücken und ebenfalls die Gefühle von anderen kennen zu lernen.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>C6. Die Kommunikationsmöglichkeiten waren ausreichend zum Bearbeiten der Aufgabe.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>C7. Eine online Umgebung ist generell ein verlässliches Kommunikationsmittel.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>C8. Ich habe das Bearbeiten der Aufgabe in einer online Umgebung als bedrohlich empfunden.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>C9. Wir haben einen effizienten Weg gefunden die Aufgabe zu bearbeiten.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>C10. Wir haben den Chat ausführlich genutzt.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
Auf einer Schulnotenskala von 1 bis 6, wie bewerten Sie die Lernumgebung insgesamt?

<table>
<thead>
<tr>
<th>Sehr gut (1)</th>
<th>Gut (2)</th>
<th>Befriedigend (3)</th>
<th>Ausreichend (4)</th>
<th>Mangelhaft (5)</th>
<th>Ungenügend (6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

C11.

**D. Bewertung der Aufgabe**

Bitte geben Sie an, wie anspruchsvoll Sie die soeben durchgeführte Aufgabe im Sinne der unten aufgeführten fünf Dimensionen fanden. Hierzu kreuzen Sie bitte das für Sie zutreffende Viereck der Skala an.

<table>
<thead>
<tr>
<th>Task Judgement</th>
<th>Gar keine</th>
<th>Wenig</th>
<th>Neutral</th>
<th>Viel</th>
<th>Sehr viel</th>
</tr>
</thead>
<tbody>
<tr>
<td>*D1.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wie viel geistige Aktivität wurde gefordert (z.B. denken, entscheiden, rechnen, erinnern, anschauen)? Das heißt, war die Aufgabe leicht, bzw. einfach oder anspruchsvoll, bzw. fordernd?</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Task Judgement</th>
<th>Gar nicht</th>
<th>Wenig</th>
<th>Neutral</th>
<th>Stress</th>
<th>Sehr stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>D2.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wie gestresst fühlten Sie sich während der Aufgabe? (unsicher, entmutigt, verwirrt, verärgert etc.)</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Task Judgement</th>
<th>Gar nicht</th>
<th>Wenig</th>
<th>Neutral</th>
<th>Anstrengend</th>
<th>Sehr anstrengend</th>
</tr>
</thead>
<tbody>
<tr>
<td>D3.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wie anstrengend empfanden Sie diese Aufgabe?</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Task Judgement</th>
<th>Gar nicht</th>
<th>Wenig</th>
<th>Neutral</th>
<th>Erfolgreich</th>
<th>Sehr erfolgreich</th>
</tr>
</thead>
<tbody>
<tr>
<td>*D4.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wie erfolgreich schätzen Sie sich bei der Zielerreichung der Aufgabe ein?</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Task Judgement</th>
<th>Gar nicht</th>
<th>Wenig</th>
<th>Neutral</th>
<th>Viel</th>
<th>Sehr viel</th>
</tr>
</thead>
<tbody>
<tr>
<td>D5.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wie sehr fühlten Sie sich während der Aufgabe unter Zeitdruck?</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>
### E. Bewertung der Aufgabenbearbeitung

<table>
<thead>
<tr>
<th>Statement</th>
<th>Stimme überhaupt nicht zu</th>
<th>Stimme eher nicht zu</th>
<th>Neutral</th>
<th>Stimme eher zu</th>
<th>Stimme voll zu</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1. Mein/e Puzzlepartner/in und ich haben eine gemeinsame Ebene gefunden.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>E3. Wir hatten Missverständnisse bei der Kommunikation.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>E4. Wenn mein/e Puzzlepartner/in etwas vorgeschlagen hat, wusste ich sofort, worauf er/sie hinaus wollte.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>E5. Ich konnte meine Ideen immer klar darlegen.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Vielen Dank für Ihre Teilnahme!
APPENDIX E:

AUTHOR’S DECLARATION

This is to certify that:

I. this thesis comprises only my original work towards the Degree Doctor of Philosophy

II. due acknowledgement has been made in the text to all other material used.

III. no part of this work has been used for the award of another degree.

Signature: 

Name: 

Date: 

# APPENDIX F: CURRICULUM VITAE

## EDUCATION

<table>
<thead>
<tr>
<th>Year</th>
<th>Institution</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008 – 2009</td>
<td>Technical University Chemnitz</td>
<td>Chemnitz, Germany</td>
</tr>
<tr>
<td>2004 – 2007</td>
<td>University of Sydney</td>
<td>Sydney (NSW), Australien</td>
</tr>
<tr>
<td>1998 – 2003</td>
<td>Ruprecht–Karls–University</td>
<td>Heidelberg, Germany</td>
</tr>
<tr>
<td>1996 – 1998</td>
<td>Johannes Gutenberg–University</td>
<td>Mainz, Germany</td>
</tr>
</tbody>
</table>