Piia Näykki

AFFECTIVE AND EFFECTIVE COLLABORATIVE LEARNING

PROCESS-ORIENTED DESIGN STUDIES IN A TEACHER EDUCATION CONTEXT
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AFFECTIVE AND EFFECTIVE COLLABORATIVE LEARNING
Process-oriented design studies in a teacher education context

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Abstract

This study explores the socio-cognitive and socio-emotional activities of teacher education students in collaborative learning, how the students interpret their activities and how the activities influence collaborative learning.

The study consists of two empirical studies, which are reported in four articles. The first study focuses on knowledge co-construction in face-to-face interactions enhanced with cognitive tools and pictorial knowledge representations. The second study explores groups’ monitoring activities in collaborative interaction, along with challenges and socio-emotional conflicts in collaborative learning. The data collection methods include video observations, video-stimulated recall interviews and pre- and post-knowledge tests.

The results indicate that collaborative learning is a cognitively and emotionally challenging learning process. The way in which group members share and develop their ideas depends on how actively they monitor their own and each other’s evolving understanding. However, monitoring cognitive activities as a group is only one part of effective and enjoyable learning. Troubled interaction can create a socio-emotionally unbalanced group climate, and can endanger effective collaborative learning unless group members are capable of regulating their emotional experiences and expression of their emotions. Therefore, in addition to effective knowledge co-construction, effective collaborative learning requires that group members proactively monitor their own and each other’s shared learning activities at both cognitive and emotional levels.

The findings of this study contribute to the understanding of how individuals learn together as a group. Methodologically, this study provides several process-oriented analysis schemas for analysing socio-cognitive and socio-emotional activities within collaborative learning. Practically, this study offers teachers and educational professionals ideas for the design of collaborative learning environments.

Keywords: collaborative learning, emotions, knowledge construction, monitoring, socially shared regulation of learning
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Tiivistelmä
Väitöstutkimus tarkastelee opettajaksi opiskelevien yhteisöllistä oppimista sosiokognitiivisena ja sosioemotionaalisena vuorovaikutusprosessina. Tutkimuskohteina ovat yhteisöllinen tiedonrakentelu, yhteisöllisen oppimisen haasteet ja ryhmän toiminta sosioemotionaalisseen konfliktitalteeseen. Yhteenvedossa tarkastellaan sitä, mitä yhteisöllisen oppimisen aikana tapahtuu, miten opiskelijat tulkitsevat prosessinaikaisia toimintoja ja miten ne vaikuttavat oppimistilanteeseen.

Tutkimus koostuu kahdesta osatutkimuksesta, joiden tulokset on raportoitu neljässä artikkeissa. Väitöstyö on luonteeltaan design-tutkimus, jossa ilmiöitä tarkastellaan aidoissa, etukäteen pedagogisesti suunnitelluissa ja tieto- ja viestintäteknologiaa hyödyntävissä oppimistilanteissa. Tutkimusaineisto koostuu videoiduista ryhmätilanteista, opiskelijoiden haastatteluista sekä oppimistesteistä, joilla mitattiin opiskelijoiden sisällöllistä ymmärrystä. Lisäksi sosioemotionaalisen vuorovaikutuksen analyysia syvennettiin menetelmällä, jossa opiskelijoiden haastattelua stimuloitiin videon avulla.

Tutkimustulokset osoittavat, että tiedonrakentelun yhteen säätely edesauttaa yhteisöllistä oppimista. Tehokas ja mielekäs yhteisöllinen oppiminen edellyttää, että ryhmän jäsenet monitoroivat, kuinka ymmärrys tehtävää ja sisällöstä kehityy, kuinka mielenkiinto säilyy ja kuinka ryhmä etenee. Kognitiivisten prosessien ohella opiskelijoiden tulee tarkkailla oppimistaan sosioemotionaaliseen näkökulmasta. Ryhmien on tärkeä arvioida ja säädellä työskentelyään siten, että sosioemotionaalin ilmapiiri säilyy yhteisölliselle oppimiselle suotuisana.

Väitöstutkimuksen tulokset lisäävät teoreettista ymmärrystä yhteisöllisen oppimisen mahdollisuuksista ja haasteista. Tutkimus myös edistää prosessiorientoituneiden tutkimusmenetelmien kehittämistä. Lisäksi tulosten perusteella voidaan kehittää korkeakoululupetusta ja erityisesti opettajankoulutusta. Tutkimukseen suunnitellut oppimisympäristöt tarjoavat konkreettisia ideoita, joilla voidaan tukea yksilöllisiä ja sosiaalisesti jaettuja oppimisprosesseja.

Asiasanat: emootiot, monitoroiminen, oppimisen jaettu säätely, tiedonrakentelun, yhteisöllinen oppiminen
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Kempele, November 2014

Piia Näykki
List of original articles

This thesis is based on the following publications, which are referred to throughout the text by their Roman numerals:


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1 Introduction

Collaborative learning skills and an ability to take an active role in one’s own learning, the learning of others and learning together are highlighted as success factors in a modern society (Griffin et al. 2012). In general, individuals are expected to master the skills of communicating, collaborating, problem solving, and critical thinking in order to participate fully and effectively in society (Binkley et al. 2011, OECD 2013). To develop these skills, students need their own experience of inquiry- and collaborative-based instructional approaches to engage in solving authentic, ill-structured and complex problems (Hmelo-Silver 2004). Across all levels of schooling, an increasing amount of attention is being devoted to exploring how students can study and learn better in groups (Hmelo-Silver et al. 2013). Researchers from a variety of disciplines along with international organizations (OECD, EU and UNESCO) and educational organizations (ISTE and NAEP) have formulated frameworks describing the skills necessary in the 21st century (e.g. Ananiadou & Claro 2009). From this standpoint, one of the fundamental tasks of education is to enculturate youth into knowledge-creating civilization and to help them to find their own place in it (Goldman & Scardamalia 2013, Rotherham & Willingham 2009, Scardamalia & Bereiter 2006). In light of this task, traditional educational school practice – with its emphasis on teacher-directive knowledge transmission, where the instructor is assumed to be the distributor of knowledge and skills – appears to be limited in scope, if not entirely missing the point.

Collaborative learning as an instructional method is characterized as a method of supporting the development of important knowledge creation skills, and is increasingly being used at all levels of educational systems. In the public discourse, the term collaborative learning is often misleadingly used to refer to any learning activities that pairs or groups of people perform together. Within the learning sciences, collaborative learning is defined as a special form of learning and interaction, and the ideas of co-construction of knowledge and mutual engagement as well as coordination are highlighted (Baker 1999, Dillenbourg et al. 1996, Jeong & Chi 2007, Kirschner et al. 2008, Roschelle 1992). Rochelle and Teasley’s definition (1995: 70) is one of the most well-known and used: “collaboration is a coordinated, synchronous activity that is the result of a continued attempt to construct and maintain a shared conception of a problem”.

Working as a group is not self-evidently successful in terms of high-level individual learning outcomes or group-level accomplishments (Barron 2003).
Group activities can be challenging, and particularly problem-, project- and case-based learning scenarios as collaborative learning tasks are often complex by their nature (Kirschner et al. 2006, Savery 2006, Wilhelm et al. 2008). In short, productive collaboration in a group learning activity, although desired, cannot be presumed. Collaborative learning does not take place simply by putting people together; it requires systematic cognitive, motivational and emotional effort to be effective (Blumenfeld et al. 2006, Boekaerts & Minnaert 2006). Therefore the nature of collaboration itself requires high-level cognitive activities as well as emotional sensitivity to fulfil the requirements of effective collaborative learning (Barron 2003).

In general, socio-cognitive activities within collaborative learning are well defined, highlighting, for example, knowledge co-construction activities (Baker 1999, Chi 2009, Dillenburg 1999, Jeong & Chi 2007, Kirschner et al. 2008, Roschelle 1992). However, what is still missing is a more thorough elaboration of the emotional characteristics of collaborative learning (Linnenbrink-Garcia et al. 2011) and particularly a bridge between socio-cognitive and socio-emotional activities within collaborative learning interaction. Understanding the socio-emotional dimension in collaborative learning as situated in a social context (Baker et al. 2013) can particularly shed light on what characterizes effective collaborative interaction. Previous studies have acknowledged meta-level coordination activities as one of the necessities for collaborative learning (Barron 2003, Roschelle 1992), and a growing body of literature on student-led regulation in collaborative learning contexts has emerged in recent years (Hadwin et al. 2011, Rogat & Linnenbrink-Garcia 2011, Volet et al. 2009, Volet & Vauras 2013). For example, studies have started to elaborate (with empirical evidence) what kind of self-regulated, co-regulated and socially shared regulation activities are present in collaborative learning (Hadwin et al. 2011, Järvelä & Hadwin 2013). To date, however, little is known about the nature, function and implications of social regulatory processes in collaborative learning. For example, can groups’ differences in regulation during collaborative learning, explain differences in the groups’ learning process and outcomes.

This study characterizes successful learning in and through collaboration as the sum of multidimensional cognitive, social and emotional processes at both individual and group levels, which are effectively coordinated and regulated in interaction between the group members. Therefore, the general objective of this study is to combine the socio-cognitive (i.e. knowledge co-construction and monitoring evolving understanding) and socio-emotional (monitoring emotional
experiences and expression of emotions) dimensions to explore collaborative learning activities, students’ individual interpretations of their activities and the possible influence of these activities have on collaboration and learning. To enable this, two pedagogical interventions involving inquiry-based and technology-supported collaborative learning situations were designed in the authentic learning context of the educational sciences and teacher education studies.

This study highlights collaborative learning as a multifaceted and complex phenomenon, and thus uses multiple perspectives and methods to obtain an understanding of collaborative interactions. Throughout the dissertation, the main focus is on process-orientation and analysis of group- and individual-level activities (Arvaja et al. 2007, Järvelä et al. 2013, Turner 2006). In this view, the focus shifts from what the person (as a group member) is thinking to what the person (within a group) is doing. By looking at activity, one can analyze when, how and why student groups implement certain strategies (i.e. knowledge construction and regulation). In general, analysing the dynamic and multidimensional process of collaborative learning is challenging and has much in common with the Indian parable about the blind men and the elephant that describes how they observe the elephant, each from their own point of view (see also Hmelo-Silver 2003). That example shows how each of the men perceived only a part of the big animal and thus could only provide a narrow and misrepresentative description of it. This is much like in analysing collaborative learning – as with the elephant; one needs to simultaneously take account of several points of view and use multiple methods to understand the learning processes of a group. The original elephant example could even be broadened by including the elephant’s situation-specific behaviour, actions and activities (e.g. when attacking to rescue its offspring or escaping from a hunter). The central idea of the present work is that by combining several theoretical perspectives, research traditions, and methodologies, one can build a more comprehensive picture of teacher education students’ collaborative learning processes. Further, connecting the traditions may ultimately help one create innovative pedagogies and learning environments, which may promote active collaborative learning.

This dissertation consists of two parts: In the first part, the theoretical foundations and methodological orientations are discussed, and it concludes with a discussion of the main findings. The second part consists of four articles published in or submitted to international peer-reviewed journals. These articles report the body of the empirical results of this dissertation. These are the
cornerstones of this dissertation study in order to explore and understand socio-cognitive and socio-emotional activities, influences and interpretations in a collaborative learning context.
2 Theoretical and methodological framework

Learning in groups is viewed in this dissertation as a reciprocal and contextual activity where cognitive processes are distributed across the knower and the environment (Pea 1993, Resnick 1991, Salomon 1993). Cognition propagates from mind to mind, from mind to tools (i.e. technological and other artifacts) and from tools to mind in such a way that it extends the boundaries of the mind by creating understanding within and between the learners (Hutchins & Clausen 1998). The focus is on the processes that take place in an extended cognitive system, which provides a basis for the coordination of individual actions as well as for the future communication and activity of the group (Clark & Brennan 1991, Hutchins 1995). Knowledge is something that individuals can possess and distribute around a variety of artifacts, and other individuals and group processes are seen as a way to facilitate individual learning. However, extended cognitive systems, namely, those in which there are multiple people interacting with each other and a range of artifacts to perform an activity, have properties that differ from the individuals that participate in them (Hutchins 1995). For example, individuals working together on a collaborative task possess different kinds of knowledge and so will engage in interactions that will allow them to pool their various resources to create new knowledge and understanding while accomplishing their tasks.

This view of distributed cognitive processing is further extended within this study with the idea of proactive and self-regulated learners in a group context. The efficient extended cognitive system requires the negotiation and coordination of group members’ diverse views and understandings. Students’ adaptation to collaborative learning situations – sharing knowledge and maintaining coordinated activity (Roschelle & Teasley 1995) – requires strategies, self-regulation (Pintrich 2000, Zimmerman 2000), and socially shared regulation of learning (Hadwin et al. 2011, Järvelä & Hadwin 2013), which are different from, and often more challenging than the strategies required for individual learning (Barron 2003, Kirschner et al. 2006). Within this type of learning activities, students are viewed as proactive participants in educational processes, being responsible in their own learning and also the learning of others within their learning group/community. In other words, the framework of this dissertation is built on a vision of proactive and self-regulated learners within a group context (Hadwin et al. 2011, Järvelä & Hadwin 2013).
In addition to the cognitive processes, affective and socio-emotional processes are highlighted in this study. In other words, this dissertation advocates the view that a purely cognitive vision of isolated individuals, and also a socio-cognitive vision of social and situated individuals, needs to be broadened to a socio-emotional vision of feeling and acting individuals. Vygotsky emphasized that: “The separation of the intellectual aspect of our consciousness from its affective and volitional aspect is one of the major and fundamental shortcomings of all traditional psychology. Thinking is thereby inevitably transformed into an autonomous current of ideas that think themselves; it is cut off from all the fullness of real life, impulses, interests, and real tendencies of Man who thinks.” (Vygotsky 1997: 61). It is argued that collaboration can be beneficial for learning, but the conditions under which it is successful are elusive and positive outcomes are not guaranteed. Group members have a proactive role in regulating their own learning, the learning of others and learning together in order to be effective in cognitive proceedings, but also and in particular, in order to create socio-emotionally balanced and enjoyable learning environments for all the participants in the group (Barron 2003).

The theoretical framework of this dissertation introduces and builds on theoretical ideas of learning in social interaction, socio-cognitive and socio-emotional activities and interaction in collaborative learning situation.

2.1 Learning in social interaction

More than thirty years of learning research has placed social interaction at the focus, arguing that knowledge is built together in a social context (Sawyer 2006). Social interaction with learning orientation has been explored, for example, in studies on cooperation (Johnson & Johnson 1986), peer and group learning (O’Donnell 2006), group cognition (Stahl 2006), and collaborative learning (Baker et al. 1999, Crook 2000, Dillenbourg 1999, Dillenbourg et al. 1996, Roschelle & Teasley 1995). The general consensus has been reached (e.g. Sawyer 2006) that interaction is the mediating mechanism whereby specific cognitive, motivational and emotional factors are activated that can contribute to individuals’ learning and collaboration within groups (Blumenfeld et al. 2006, Dai & Sternberg 2004).

Slavin (1997) presented four major theoretical perspectives as explanations for the achievement effects of cooperative learning: motivational, social cohesion, cognitive elaboration and developmental perspectives. Even though, cooperative
and collaborative learning have distinct characteristics (Dillenbourg 1999), the same perspectives can be used for justifying achievement effects of collaborative learning. Motivational and social cohesion perspectives are related to each other (Slavin 1997). However, whereas motivational viewpoint stresses intrinsic and extrinsic rewards of collaboration – students help their peers in group to learn because it is in their own interests to do so. Social cohesion theorists, in contrast, emphasise the idea that students help each others to learn because they care about the group. Both of these perspectives emphasises primarily motivational rather than cognitive explanations for the effectiveness of collaborative learning. The positive effects of social interaction on learning have also been explained by the notion that peer interaction particularly stimulates the elaboration of knowledge, and thus promotes individuals’ learning (van Boxtel et al. 2000). For example, Webb (1989) found that the students who gained the most from cooperative activities were those who provided elaborated explanations to others. Last theoretical explanation in the Slavin’s list (1997) is developmental viewpoint. Both major traditions of developmental psychology, the Vygotskyan and the Piagetian, have substantially contributed to the theory of collaborative learning and a brief review of their theoretical basis demonstrates some of the developmental factors that explain productive social interaction.

The historical roots of learning in social interaction are often traced to Vygotsky’s ideas of the ‘zone of proximal development’ (1978) and Piaget’s construct of ‘socio-cognitive conflict’ (1985). The former is the centre of a socio-cultural theoretical framework, where social interaction is characterized as fundamental for the development of individuals as more knowledgeable person scaffolds the other to learn. The latter is often used as a basis for socio-cognitive orientation, and social interaction is viewed as important for making the discrepancies in an individual’s understanding visible. Among Piaget’s key assumption was that a child is situated in an environment and strives to make sense of that environment. This means that learning occurs when individuals aim to hold a consistent conception of their world and accommodate cognitive structures to better represent the context. Piaget’s famous statement that, “one comes to know the world through knowing oneself” (cited in von Glasersfeld 1982: 613), emphasizes his view that while knowledge involves descriptions of an external world, it also invariably involves an interaction between the knower and the known. According to neo-Piagetians (Doise & Mugny 1984) the socio-cognitive conflict is one of the central mechanisms in learning interaction (Kruger 1993) and a core mechanism for the cognitive growth of individuals (Buchs et al.
2004, Doise & Mugny 1984). It includes both a cognitive component and a social component, and it is characterized as a productive process of negotiation that reaches out of the participants’ comfort zones and uncovers diversity in opinions and identity within social interaction.

More recently, Decuyper and colleagues (2010) approached effective social interaction from a team study perspective. In their meta-analysis, constructive conflict was advocated as a basis for effective learning. Socio-cognitive and socio-constructive conflict can both be defined as arising from similar branches, as both concepts are used to define cognitive conflict processes in effective group interaction. Substantial attention has been paid to understanding the impact of socio-cognitive and/or constructive conflict on the processes and outcomes of work teams (Jehn 1997, Jehn & Mannix 2001). Studies have shown that socio-cognitive/constructive conflicts can be positively related to team outcomes by encouraging confidence among the team due to a greater understanding of the issues (De Dreu & Weingart 2003). This can be comprehended so that greater understanding can be reached by group members’ arguing over different perspectives, understandings and ideas. Increased confidence can further enhance group cohesion and member commitment (Jehn & Mannix 2001). According to van den Bossche and colleagues (2006), it is not the occurrence of conflicts that facilitates learning and performance; rather, it is the effort expended on elaborating different viewpoints made visible through the conflict. That is also one of the main arguments of this thesis study. However, as group members are challenged out of their comfort zones, these socio-cognitive conflicts are likely to give rise also to socio-emotional conflicts or relational conflicts (Darnon et al. 2006, De Dreu & Weingart 2003, Sommet et al. 2012), which can be destructive for effective interaction and learning, as these conflicts can also create detrimental off-task disagreement within the group (Garcia-Prieto et al. 2003).

Socio-emotional conflict is characterized in this study as an interaction that involves frustration and personality clashes within the group and which is negatively related to group cohesion, commitment, satisfaction and performance (De Dreu & Weingart 2003, Jehn & Mannix 2001). A socio-emotional approach to collaborative interaction is one of the focal themes in this dissertation, and thus, it will be examined more thoroughly in sections 2.2.2 in activities point of view and 2.3.2. in regulation of activities viewpoint.
2.2 Collaborative learning

The study of group learning began long before studies of collaborative learning or computer-supported collaborative learning (CSCL). Research over small groups has a long history, for example within social psychology. To differentiate collaborative learning from its earlier investigations of group learning, it is useful to follow Dillenbourg’s (1999) distinction between cooperative and collaborative learning. The often cited difference between these concepts is in the division of labour, where the cooperative form of learning interaction is characterized as the division of sub-tasks and responsibilities, whereas collaborative learning entails shared learning activities (Roschelle & Teasley 1995).

Collaborative learning as a special form of learning and interaction has been theoretically operationalized, for example, using terms of knowledge acquisition versus participation (Sfard 1998), knowledge building (Scardamalia & Bereiter 2003), knowledge creation (Paavola et al. 2004) and as a process supported by technology (i.e. CSCL as discussed in Stahl 2006, Stahl et al. 2006). All these approaches and descriptive metaphors aim to target active and dynamic processes within the group – and the community (Crook 2000). Bereiter (2002) and Bereiter and Scardamalia (2006) differentiated knowledge-building discourse from other types of discourse by advocating three principles: a commitment to progress, a commitment to seek common understanding, and a commitment to expand the base of accepted facts. The emphasis is on individuals’ taking agency over their shared activities to generate questions and produce explanations to improve and advance their own knowledge and understanding, as well as the knowledge of others’ within a group/community. Even though this dissertation acknowledges the above described principles, the concept that is implemented in this study is knowledge co-construction instead of knowledge-building or knowledge creation, to emphasize the cognitive knowledge construction processes (Baker 1999, Chi 2009, Jeong & Chi 2007, Kirschner et al. 2008, O’Donnell & King 1999, Shirouzu et al. 2002, Webb et al. 1995) and to differentiate from socio-cultural orientation and theoretical discussions of knowledge-building communities and communities of practice (e.g. Lave & Wenger 1991).

Collaborative learning based upon the socio-cognitive paradigm advocates students’ involvement in a process of knowledge construction, which in its most successful forms will result in deep learning and understanding, and will enhance conceptual change of individuals (Bereiter 2002, Bruffee 1993, Crook 2000, Dochy et al. 2003). The power of collaborative learning is in bringing together
people with different experiences, values and knowledge to solve complex and undefined problems (Light et al. 1994, Van den Bossche et al. 2006). In effective collaboration, students engage in shared knowledge construction, coordinate different perspectives, commit to joint goals, and evaluate together their collective activities (Blumenfeld et al. 2006, Clark & Schaefer 1989, Roschelle & Teasley 1995). At its best, a collaborative group is able to create something that exceeds what any individual could achieve alone.

The effectiveness of collaborative learning is best evaluated by the participants of learning activity themselves. When the participants in the interaction are satisfied with the quality of the process and the outcomes of their collaboration, the collaborative learning can be seen as effective for them. However, some general assumptions can be offered about the group characteristics and processes likely to lead to effective (and ineffective) processes and products of collaborative learning. This dissertation highlights the contextual and situative process of collaboration as being more important than group members’ individual characteristics for effective collaborative learning (Crook 2000, Greeno 2006, Järvelä et al. 2013). However, following the socio-cognitive research tradition, personal knowledge, skills, interests and other characteristics individuals’ bring to the collective activity have a meaning for effective collaborative interaction. For example, groups in which members share the same intention of achieving deep learning and conceptual change are considered to be more effective than groups where the learning intention and goals vary greatly (Benware & Deci 1984, Blumenfeld et al. 2006, Darnon et al. 2006, Salomon & Globerson 1989).

The initial goal of collaborative learning research was to discover the circumstances in which collaborative learning was more effective than learning alone (Dillenbourg et al. 1996). For that reason, the researchers controlled for several independent variables, including the size and composition of the group, the nature of the task and the communication media used for learning and interaction. However, these variables interacted in ways that made it impossible to establish causal links between the conditions and the effects of collaboration. This preceded a shift from determining the individual characteristics and external conditions to determining the interpersonal interactions that occur, the conditions under which they occur and the effects of these interactions (i.e. from the condition paradigm to the interactions paradigm; see Dillenbourg et al. 1996).

Recent research has increasingly turned its focus on the processes that take place – in both individual learners and in the group – during collaborative
learning (Arrow et al. 2004, Arvaja et al. 2007, Barron 2003, Reimann 2009, Salomon & Perkins 1998, Strijbos & Fischer 2007, Weinberger et al. 2007). The group itself has become the unit of analysis and the focus has shifted to more emergent, socially constructed properties of the interaction (Greeno 2006). Specific interaction processes have been explored that can increase the effectiveness of groups, for example the monitoring of group interactions (Hare & O’Neill 2000, Janssen et al. 2012; Sangin et al. 2011), efficient decision-making strategies, and members showing commitment toward the task and group (Williams et al. 2006).

Successful collaboration does not happen as frequently as might be expected. It usually requires time and effort to accomplish a good collaborative group that can engage deeply in shared learning processes (Fransen et al. 2013). Empirical studies have shown that, while members of a group may cooperate, the group itself, as a collective entity, does not always follow the mutually shared cognitive and social processes of collaboration (Barron 2003, Järvelä & Häkkinen 2002). In the next sections, the interaction processes in successful and less-successful collaborative learning, with socio-cognitive and socio-emotional orientation, will be presented.

2.2.1 Socio-cognitive activities

Collaborative learning situations offer learners opportunities to knowledge co-construction as they call for sharing, questioning and justifying one’s own ideas and understanding, and those of others (Chi 2009, Dillenbourg 1999, Roschelle 1992). In general, interaction among learners is the key element in learning. The premise underlying this is that when learners externalize and articulate their unformed, still-developing understanding together, they learn more effectively (Baker 1999, Chi 2009, Shirouzu et al. 2002, Van der Linden et al. 2000).

The theoretical ideas of knowledge co-construction in this dissertation follow Roschelle’s (1992) notion of convergence; group members construct shared meanings by monitoring the degree to which they understand each other’s thinking, extend the ideas of others, acknowledge divergent interpretations, and resolve inconsistencies between ideas proposed (see also Fischer & Mandl 2005, Kirschner et al. 2008, Schirouzu et al. 2002, van Boxtel et al. 2000, Weinberger et al. 2007). Knowledge co-construction has been differentiated from information sharing processes. The former represents high-level interactive processes where understanding and ideas are emphasized, whereas the latter is about pooling
together different pieces of information. In other words, co-construction refers to processes where group members aim to extend each other’s understanding and to process their own as well as others’ ideas further (Baker 1995 and 1999, van Boxtel et al. 2000, Webb et al. 1995). Furthermore, individual’s participation to the collaborative learning activities, is theoretically explained in this dissertation with the term of spiral of causality – “a given level of individual development allows participation in certain social interactions which produce new individual states which, in turn, make possible more sophisticated social interaction” (Dillenbourg et al. 1996: 3, see also Cohen 1994, Dawes & Sams 2004, Littleton & Miell 2004, O’Donnel & O’Kelly 1994).

One way of describing socio-cognitive interactions in collaborative learning is to assess the degree of elaboration of information provided by one learner to another (i.e. the continuum from providing the correct answer to providing a detailed explanation). Prior research has, for example, introduced three potential elaboration mechanisms enhancing learning: self-directed explaining (Chi 2000, Chi et al. 1989), other-directed explaining (Ploetzner et al. 1999; Roscoe & Chi 2008), and co-elaboration or knowledge co-construction (Baker 2003, Damon 1984, Rafal 1996, Shirouzu et al. 2002). Self-directed explaining is a process where thinking and problem-solving are directed at individuals’ own understanding, not towards collaborating peers. Other-directed explaining means that one or more individuals take the lead in instructing others or explaining how to solve a learning task. Knowledge co-elaboration is defined as a process where learners attend to each other’s ideas and understanding and generate new knowledge and understanding through processing and extending the ideas presented in the interaction (Forman & Kraker 1985, Hatano & Inagaki 1998, Hogan et al. 1999, van Boxtel et al. 2000).

In general, this cognitive-elaboration perspective improves understanding of the specific socio-cognitive activities and strategies students engage in while collaborating in learning (Baker 2003, O’Donnell & King 1999, O’Donnell & O’Kelly 1994). Previous studies within this framework, have shown that high-order thinking processes (e.g. asking complex questions and elaborating answers) enhance learning outcomes (Howe et al. 2007, Veenman et al. 2005). Highlighting complex explanations as particularly beneficial for individuals’ learning; i.e. when further evidence is provided and multiple concepts are integrated into the explanation (Chinn et al. 2000, Roscoe & Chi 2008). Webb’s meta-analysis (1991) showed that it is actually the explainer who benefits more from this interaction than the person receiving the explanation. One possible
reason is that the explainer is more engaged in learning activities than the listener (Chi 2009, Linn 2006, Webb et al. 1995). When people explain and elaborate their own ideas to others, they are required to monitor their own thinking and to transform their own knowledge into a relevant, coherent and complete form so that others can understand it (Bargh & Schul 1980, Chi 2009). In order to be able to prepare the externalization of an idea, the following cognitive processes need to be activated: identifying the problem, prioritizing and reorganizing one’s own previous knowledge of the problem, building new connections with new pieces of information, and generating accurate ways of representing information (Bargh & Schul 1980), as well as taking other perspectives into account (Levine et al. 1993).

During this process, students may recognize incompleteness or misconceptions in their own understanding more easily than they would when learning individually (Buchs et al. 2004, Forman & Cazden 1985). Listening to others’ explanations allows students to monitor their own thinking and to recognize possible gaps in their understanding (Goos et al. 2002, Palincsar & Brown 1984). Furthermore, having one’s own ideas challenged and being asked for justification may encourage students to seek new information, develop new ideas and build new connections between pieces of information (Chi 2000, Wittrock 1990).

### 2.2.2 Socio-emotional activities

Learners’ socio-cognitive processes during collaborative learning are well researched, but a smaller amount of research has focused on the socio-emotional processes that occur in collaborative learning; e.g., the creation and maintenance of socio-emotional balance and wellbeing through sensitive relationships and a sense of community (Kreijns et al. 2003). This dissertation argues that, during collaborative interaction, cognitive processes interact with emotional (and motivational) processes at both the individual and group levels (Blumenfeld et al. 2006, Crook 2000, Dai & Sternberg 2004, Thompson & Fine 1999). For example, antecedent processes such as beliefs, interests, values and attitudes between learning group participants are acknowledged as enhancing or inhibiting well-functioning interaction within a group (Boekaerts & Minnaert 2006, Harrington & Fine 2006). In general, learning involves cognitive operations, but also how learners feel in the situation; what kinds of negative or positive emotional reactions are aroused. Therefore, socio-cognitive activities as an explanation for
the effectiveness of collaborative learning offers only one side of the phenomenon, and the approach needs to be extended to include socio-emotional activities.

Emotions are intense reactions that are usually generated by a process of appraisal of the situation or dispositions that are transferred to the situation (Frijda 1986, Goetz et al. 2003, Lazarus 1991). The emotions that are traditionally listed as basic are: fear, joy, anger, sadness, disgust and surprise (Ekman et al. 1972). In a literature search on academic emotions, Pekrun and colleagues (2002) found that learning research most often targets anxiety (particularly test anxiety). Anxiety may increase task-irrelevant thinking, and thus reduce constructive cognitive processes. However, anxiety is certainly not the only emotion that can influence students’ cognitive (and motivational) processes and achievement, especially within a group context. Students can experience a variety of emotions in an academic setting: positive emotions such as enjoyment, hope, pride and relief, or negative emotions such as anger, shame, frustration and anxiety (Schutz & Pekrun 2007).

The social context, and particularly collaborative learning – which is built on the relationships of feeling human beings – is filled with different affective experiences and emotional reactions (Baker et al. 2013). Many of these emotional reactions relate to interpersonal interactions, and thus require one to consider social norms and other people in the interaction (Dowson & McInerney 2003, Goetz et al. 2003, Hareli & Weiner 2002, Järvenoja & Järvelä 2005). The literature on group emotions considers the notion of emotional climate in terms of shared convergent emotions within a group (Scherer & Tran 2001). The emotional climate is based on group members’ appraisal of the situation. For example, students in learning groups may consider the situational meaning as “having fun”, “wasting time”, “passing time” or “learning together”. The meanings they attribute to such a situation also influence their emotions, which when perceived by others will further influence the overall emotional climate or atmosphere of the group, as well as the group’s problem-solving activities; this in turn will transform appraisals and emotions. More specifically, both negative and positive affective states and emotions experienced within the group derive from multiple sources that encompass a variety of factors, from personality differences to the dynamics and processes created within the collaborative group (Järvenoja & Järvelä 2009, Van den Bossche et al. 2006, Volet & Mansfield 2006).

Previous studies have elaborated the notion of positive and negative emotional loops within learning interaction (Linnenbrink-Garcia et al. 2011). For
example, if students are positively attached to a group, they are more likely to do their best to succeed in the learning activity. This creates a positive emotional loop, where experience of success as a group can also increase (collective) efficacy; beliefs that the group can master the task, and enjoy working together (Gibson 1999). In contrast, a negative emotional loop can be created when group members are not positively connected as a strong and well-functioning group (Carless & De Paola 2000, Sargent & Sue-Chan 2001). If students do not, for example, get along well with their learning partners and display negative emotions towards them, they may decrease their engagement in the learning activity, and thus create an asymmetrical relationship (Salonen et al. 2005) and negative emotional loop (Linnenbrink-Garcia et al. 2011). The group members’ emotional reactions to the challenges will further influence and shape the group’s emotional climate. When challenges emerge, the collaborative group encounters them with the means they possess in that specific context and at that time. The result can be positive, and thus lead to increased engagement and efforts in group activities; alternatively, it can be negative and lead to disengagement and withdrawal from group and its activities (Linnenbrink-Garcia et al. 2011).

2.3 Self-regulated learning and socially shared regulation of learning

Decades of educational research has proven that to learn effectively, learners need to take responsibility for their own learning and recognize their strengths and weaknesses in various learning situations (Pintrich & de Groot 1990, Zimmerman 2002). This study is grounded on the theoretical assumption that the students in collaborative learning situations similarly play an active, or even proactive, role in their own learning. Furthermore, it is argued that as collaborative learning is challenging student-led activity (Kirschner et al. 2006), effective collaborative learning requires that students regulate their own learning, that of others, and learning together (Volet & Vauras 2013). Within this line of reasoning, Hadwin and Järvelä with their colleagues (Hadwin et al. 2011, Järvelä & Hadwin 2013) have built a theoretical basis for socially shared regulation of learning (SSRL). Their approach is grounded on and extends models’ of self-regulated learning (SRL) (Pintrich 2000, Winne & Hadwin 1998, Zimmerman 1989), which broadly refers to the processes through which learners control their own thoughts, feelings and actions towards learning.
Traditionally, SRL has been conceptualized as an individual, cognitive-constructive activity (e.g., Winne 1997, Winne & Hadwin 1998) where the social context is viewed as one component of self-regulation (Bandura 1986, Schunk & Zimmerman 2008, Zimmerman 2000). Self-regulated learners are characterized as self-directed, reflective and well-organized, having the cognitive and metacognitive skills, as well as the motivational beliefs and attitudes, needed to understand, monitor and direct their own learning (Schunk & Zimmerman 2008, Zimmerman 2002). Despite its focus on individual learners, SRL is also often characterized as fundamentally social; individuals’ acquisition and use of learning strategies are greatly influenced by modelling the learning activities of their peers (Bandura 1986). Recently, it has been recognized that contextual features and situational interpretations affect the strategies learners apply in their learning (Järvelä et al. 2013, Järvelä & Niemivirta 2001, Zimmerman 2008). The recent theoretical addition by Järvelä and Hadwin (2013) therefore aims to make social elements of SSRL even more accurate and transparent. The ultimate goal of SSRL is to explore how group members jointly co-construct and synthesize strategies, monitoring, evaluation, goal setting, planning and beliefs toward shared outcomes (Hadwin et al. 2011, Winne et al. 2013).

In this dissertation study these coordination and structuring activities are defined as regulation of collaborative learning, which refers broadly to individuals’ abilities to monitor, understand and control their own as well as shared learning processes. These regulation activities are explored in this study within socio-cognitive and socio-emotional dimensions, focusing particularly on monitoring activities. In the next sections, monitoring activities are introduced in more detail within a group context and with a cognitive and emotional orientation. These processes are highlighted as important factors for monitoring the thinking and emotions within group context in order to communicate and collaborate effectively (Jost et al. 1998; Nelson et al. 1998).

### 2.3.1 Monitoring and regulating socio-cognitive activities in interaction

Several self-regulated learning models have introduced phases of SRL activities, such as forethought phase, performance phase and self-reflection phase (Pintrich 2000, Zimmerman 1989, Winne & Hadwin 1998). All of the models created for describing self-regulated learning presents cyclical regulation processes through which learners proactively orient themselves for learning, monitor their own
progress, and evaluate how they accomplish their self-stated goals (Pintrich 2000, Zimmerman 1989, Winne & Hadwin 1998). Monitoring as a regulation activity is, thus, recognized as a fundamental part of SRL (e.g. Pintrich 2000) and SSRL (Hadwin et al. 2011). In general, monitoring refers to individuals’ efforts to observe themselves as they evaluate information about specific personal processes or actions that affect their learning (Pintrich 2002). Monitoring informs students about their own progress or lack of progress, and it aims to differentiate effective and ineffective performance (Thoresen & Mahoney 1974, Winne 2011). Monitoring fosters also reflective thinking (Bandura 1986) leading to a better organisation of one’s knowledge, more accurate self-judgements and more effective planning and goal setting for learning (Pintrich 2002).

How monitoring processes are enacted in group-level interactions is one of the fundamental interests of this dissertation study. This question can be theoretically operationalised by following and combining previous studies in SRL/SSRL and collaborative learning research. Collaborative learning research has approached monitoring processes through concepts such as: shared mental models (Van den Bossche et al. 2006, Van den Bossche et al. 2011), common ground (Baker et al. 1999; Beers et al. 2006, Clark & Brennan 1991, Mäkitalo et al. 2002), or successful coordination of group working strategies (Barron 2003). These theoretical constructs highlight the importance of monitoring activities for effective collaboration; monitoring is emphasised as important for building and maintaining shared mental models and common ground in interaction and can actually be gathered under the umbrella term: awareness in collaborative learning (Fransen et al. 2011, Kirschner et al. 2014, Leinonen et al. 2005, Schraw 1998).

In other words, monitoring is termed as an active process that aims to increase different types of awareness in group interaction. To this end, a distinction can be made (again following the collaborative learning research branch) between group-, task- and content-related monitoring (Janssen et al. 2012, Saab 2012). In group-related monitoring, the focus is on the awareness of group functioning and on the expected behaviours of both the group as a whole and the group members individually and in relation to each other (Engelmann et al. 2009). Task-related monitoring focuses on awareness regarding the materials and strategies needed to successfully carry out the task. Furthermore, content-related monitoring (monitoring of understanding and monitoring for understanding) is defined here as a specific monitoring process intended to increase the individual’s own, other group members’ and shared understanding of the content and topic on which they are currently working. Roscoe and Chi
(2008), for example, evaluated events where explaining own understanding by using statements such as “I didn’t understand that before” were useful for making new connections and building understanding at group level. Also, Janssen and colleagues (2012) indicate that monitoring has positive effects on groups’ performance. Group-, task- and content related monitoring all facilitate task execution by creating a framework that promotes common understanding within a group (e.g. Janssen et al. 2012, Saab et al. 2013).

Despite a growing agreement that effective collaborative learning requires monitoring activities, at both individual and group levels (Hadwin et al. 2011), empirical evidence with this topic in the SSRL field is scarce, but growing. One of the earliest work in the field, Iiskala with colleagues (2004) and Vauras with colleagues (2003) illustrated that the dyads can monitor and regulate their performance jointly. In a similar approach, Hurme and colleagues (2006) showed different regulatory strategies and concluded that socially shared metacognition was a differentiator that made a problem solving successful in groups. In general, prior studies have shown that in collaborative problem-solving, groups in which participants monitor their own and their peers’ learning and thinking processes seem to have an advantage over groups who do not (Goos et al. 2002, DiDonato 2013, Hurme et al. 2006, Khosa & Volet 2013).

This dissertation study highlights the specific monitoring activities that are enacted within collaboration process (particularly in Articles II-III), differences between the number of monitoring activities and temporal variation in differently performing groups (i.e. high- and low performing groups).

### 2.3.2 Monitoring and regulating socio-emotional activities in interaction

This dissertation extends the theoretical ideas of regulation of socio-cognitive activities by acknowledging the need to regulate emotional experiences and emotional expressions as a shared activity as well (Baker et al. 2013, Järvenoja et al. 2012). Social interaction and collaborative learning in particular, can be filled with emotional variables. Groups are often ad-hoc compositions tackling with challenging, open-ended tasks with limited time to be used – emotional challenges are therefore easily arised. For example, differing viewpoints and interpretations of situational demands and task requirements can lead to negative emotional arousal within a group. To overcome these challenges, group members
Elaboration of raw text:

are required to exercise control over their emotions to be effective at learning and interaction (Wolters 2003).

Emotion regulation refers to the process involved in becoming aware of one’s affective reactions and having an ability to monitor and control one’s emotional experiences (Schutz & Davis 2000, Thompson et al. 2003). Boekaerts (2011) defines emotion regulation as the capacity to understand one’s own emotions and their expression and those of others, as well as the ability to modify or temper aspects of the emotional experience (e.g. when it interferes with the group’s goals and with social interaction). Wolters (2003) defines emotion regulation as learners’ ability to monitor, evaluate and change the occurrence, intensity or duration of a particular emotional experience so that productive engagement can be maintained. An inability to increase or decrease the intensity and duration of emotional arousal hinders performance and interpersonal relationships, whereas the capacity to temper emotions facilitates functioning in social and academic contexts (Boekaerts 2011). In fact, emotion regulation can be seen as a diverse set of control processes manipulating which emotions are experienced, when and how they are experienced, and how they are communicated.

While empirical studies of emotion regulation within the individual learning context are well documented (e.g. Gross & Thompson 2007, Linnenbrink-Garcia & Pekrun 2011), researchers have only recently begun to show interest in studying emotional experiences, expression and regulation within collaborative learning situations (Baker et al. 2013, Järvenoja & Järvelä 2009, Linnenbrink-Garcia et al. 2011). Järvenoja and Järvelä (2009) studied emotion and motivation regulation within group contexts and found that students used social reinforcement (e.g. positively supporting each other’s suggestions) and task structuring (e.g. reducing off-task behaviour) to maintain collaborative group work. Andriessen with colleagues (2013) studied variation of emotion regulation through the roles of tension and relaxation in task progress during collaborative learning. Linnenbrink-Garcia and colleagues (2011) also focused on exploring the dynamic role of emotions in collaborative learning. They highlighted the fact that the quality of group interactions initiated affect and that the relationship between the quality of group interactions and affect is cyclical. For example, disrespectful interaction was followed by sustained negative affect, creating a negative interaction loop.

One challenge to studying emotional regulation in collaborative learning is that, while there are classification systems for individual emotion regulation strategies, there is no generally accepted system specifically for collaborative
learning. To this end, Boekaerts (2007), Op’t Eynde with colleagues (2007), and Gross and Thompson (2007) have all produced classifications that can be adapted to the collaborative learning context. Regulating emotions and maintaining focus in the face of obstacles plays a central role in Boekaerts’ dual-processing self-regulation model (2007). Learners who feel unable to control emotionally challenging learning situations will focus on coping with their emotions rather than on participating in problem-solving. Op’t Eynde with colleagues (2007) studied coping strategies that students use to regulate their emotions in a mathematics classroom and defined problem-, task- and avoidance-focused strategies. When confronted with a learning challenge, an avoidance-focused strategy is used to escape from emotionally unpleasant situations at the expense of learning and performance. A task-focused strategy is used to continue focusing on task progression, while a problem-focused strategy targets the problems experienced behind the emotional arousal (Boekaerts 2007, Op’t Eynde et al. 2007).

In addition to defining general emotion regulation strategies, more specific emotion regulation strategies have been defined (Gross & Thompson 2007), namely situation selection, situation modification, attentional deployment, re-appraising the situation and response modulation. Situation selection may offer short-term relief from experienced negative emotions, but it may not always be possible within collaborative learning situations. Situation modification is considered a strategy to change the nature of the situation. For example, the expression of emotions within collaborative learning may change the type of ongoing group interaction (Rimé 2007). Attentional deployment (or attentional shift) refers to strategically choosing the direction of attention, either to focus attention away from the situation (distraction) or to draw attention to the emotional features of the situation (concentration). Re-appraising the situation means reassessing the situation, for example with respect to how one thinks about one’s own capacity to manage the emotions the situation induces. Finally, response modulation is the most direct type of emotion regulation, aiming to influence physiological, experiential or behavioural responses, for example by acquiring and providing social support. Through emotion regulation, it is possible to control the emotional experience and expression of emotions and to enhance individuals’ capacity to understand and modify their own and others’ emotions within collaborative learning situations (Andriessen et al. 2013).

This study argues that a socio-emotionally well-functioning group is open in the sense that it makes socio-emotional expression possible (Kreijns & Kirschner 2004).
An open and secure atmosphere also makes it possible to express contradictory ideas and points of view, increasing the possibility of socio-cognitive conflicts (Buchs et al. 2004, Doise & Mugny 1984). However, a well-functioning group also recognizes when challenges are present, and particularly what types of challenge the group is facing (i.e. cognitive, motivational and/or socio-emotional) (Järvenoja & Järvelä 2009). Most importantly, a well-functioning group recognizes when there is a need for emotion regulation in order to avoid challenges becoming detrimental conflicts (Daron et al. 2006, De Dreu & Weingart 2003, Sommet et al. 2012). To conclude, negative emotions experienced within collaborative learning invite productive reactions and successful emotion regulation from individuals as well as from the group as a whole.

2.4 Situative and temporal perspective to collaborative learning

Interest in collaborative learning interaction entails a temporal, process-oriented approach (Arrow et al. 2004, Bakeman & Gottman 1997, Reimann 2009). This dissertation characterizes a group as a learning context that is a complex social system, dynamic and constantly evolving; every new contribution is the result of a previous discussion or decision which affords the group members new possibilities to become involved, remain involved or withdraw from the group and its activities (Mercer 2008). Sawyer’s (2003) notion of collaborative emergence and Greeno’s (2006) situative approach of learning in activity are both useful in guiding this dissertation’s theoretical grounding in a process-oriented view of collaborative interactions.

Greeno (2006) introduces a programme of research that he refers to as situative. The defining characteristics of a situative approach are that, instead of focusing on individual learners, the main focus of analysis is on activity systems: complex social organizations including learners, teachers, curriculum material, software tools and the physical environment. Learning can thus be understood as improved participation in interactive systems, in which the participation is related to the other subjects and the material and representational systems within the activity (Arvaja 2012, Greeno 1997). Individuals and the learning environment are thus treated as inseparable (Brown et al. 1989). In other words, individuals are not separate parts of their learning context; their participation to in knowledge co-construction activities is viewed as a reciprocal activity between interacting minds.

The situative perspective builds on and synthesizes two large research programs: cognitive science and interactional studies (Greeno 2006). These two lines of research have been, until very recently, developed mainly in isolation from one another. Research into the individual cognitive perspective has analysed information structures but has had little to say about the interactions that people have with each other and with technological resources. Research into the interactional approach has analysed patterns of coordination of activity but has had little to say about the information structures that are involved in the context of joint activity. Following Greeno’s (2006) arguments, it is valuable to develop mechanisms for bringing concepts and methods from the two programmes together.

The sequential characteristics of collaborative learning consider which actions typically follow each other and the temporal perspective illustrates differences in different points in time in group interaction (Reimann 2009). This dissertation highlights the fact that learning unfolds over time and that there are temporal differences within group activities (Kapur 2011, Mercer 2008, Reimann 2009). In practice, the temporal perspective implies two points of view. First, some activities are needed and used more often at certain points in a group’s learning process (e.g. some activities are precursors of others, while some activities follow naturally from others). Second, when learning proceeds, groups become more capable of using some activities more often (e.g. as the group learns certain processes that were impossible earlier, these processes become possible and/or even necessary) (Arrow et al. 2004).

Previous studies have stated that group learning unfolds over time; is dependent on the groups’ previous actions; is cumulative in that current knowledge influences future knowledge; and has an anticipated future based on the interpretation of past experiences (Hillyard et al. 2010, Reimann et al. 2011). Fransen with colleagues (2013) suggested that it takes time before the group members can function as an effective group. One of the most well-known developmental models is Tuckman’s (1965) stages of group development – forming, storming, norming, and performing – where the group goes through different stages before achieving its best functionalities. Furthermore, the importance of the early stages of group activities have been emphasized (e.g. Kapur et al. 2008); they observed that group performance could be predicted based on earlier phases of group discussion. Also, Fransen with colleagues (2011)
found that group effectiveness was conditional on building a shared understanding of task characteristics and the group’s abilities in the early stages of the group work.

Thus, tracking the temporal nature of socio-cognitive and socio-emotional interaction as part of group development processes is essential for understanding what emerges in a group, as well as possible reasons for why such things emerge (Greeno 2006, Järvelä et al. 2013).
3 Aims of the study

The general objective of this study is to investigate collaborative learning by combining socio-cognitive and socio-emotional dimensions. The aim is to study knowledge co-construction processes and monitoring activities, as well as emotional experiences and emotion regulation within the group. To enable this, two pedagogical interventions were designed, involving inquiry-based and technology-enhanced collaborative learning situations. The study was based on a collaborative learning approach, which guided the setting of research questions and the analysis of the data. Furthermore, one general aim was to find methodological tools for exploring the process of collaboration and its intertwined socio-cognitive and socio-emotional activities: the influences of activities and students’ own interpretation of the activities.

Within this general framework, there were specific aims and research questions in each individual study/article, which are reported in the original articles. The general aims of this dissertation can be divided into two, where the first set of aims focus on the empirical questions, and the second considers a methodological question.

The empirical aims are as follows:

1. To explore teacher education students’ socio-cognitive (Articles I and II) and socio-emotional (Article III) activities in collaborative learning interaction.
2. To explore teacher education students’ individual interpretations of socio-cognitive (Article I) and socio-emotional (Article III) activities.
3. To explore the influence of socio-cognitive (Article II) and socio-emotional activities (Article III) on collaborative learning.

The methodological aim is as follows:

1. To combine data from different sources in order to understand group activities, individual interpretations and influences (Articles I–IV).
4 Methods of the study

The research approach of this dissertations study combines characteristics of design-based research (Barab 2006, Brown 1992), case studies (Yin 2009) and the mixed methods approach (Cresswell 2003). In this study, instructional design is developed in iterative cycles, where the first study is used in grounding the second study. Furthermore, two empirical studies represent a case study approach, defined as an empirical study that investigates collaborative learning within a real-life, yet designed context.

4.1 Design- and case-based research

This dissertation study follows a design- and case-based research approach to blending empirical educational research with a theory-driven design of learning environments (Barab & Squire 2004, Confrey 2006, Design-Based Research Collective 2003). The general goal of design-based research (DBR) in collaborative learning research is to create learning activities, artifacts and learning environments that enhance the practices of collaborative learning (Confrey 2006). DBR is a form of interventionist research that creates and evaluates novel conditions of learning (Schwartz et al. 2008) and introduces new topics, new technologies and/or novel forms of interaction (Confrey 2006) in order to understand how, when and why a pedagogical and/or technological innovation works in a learning context over time and across contexts (Brown & Campione 1996). The desired outcomes of DBR include a deeper theoretical understanding of learning, but also, developed learning practices (Brown 1992, Collins 1992, Schwartz et al. 2008). Reflection between learning theories and findings gathered from DBR interventions can, for example, provide a lens for understanding how theoretical claims about learning can be transformed into effective teaching and studying practices (Design-Based Research Collective 2003). Furthermore, Cobb with colleagues (2003) highlight the complexity of educational systems; a learning ecology involves multiple elements, such as learning tasks or problems, the tools and materials, the norms of discourse and participation, and the practical means by which teachers can orchestrate relations between these elements. Therefore, at a general level, the designed context can be conceptualized as interacting systems rather than separate activities (Cobb et al. 2003).
This class of research methods is also referred to as design research, design experiment, or design-based research methods. Allan Collins (1992) originally used the term design experiments to differentiate between natural science and design science. Collins (1992: 16) wrote, “a design science education must determine how different designs of learning environments contribute to learning, cooperation, motivation, etc.” Ann Brown’s article (also from 1992) has been influential on the development of the design-based research approach. Brown (1992) specified, for example, that there is a need for rich data sources and mixed methods in design experiments. Since the 1990s, many respected educational researchers have promoted a design methodology for educational research that addresses complex problems (Anderson & Shattuck 2012).

Overall, this kind of research work rejects the view that research is conducted in laboratory or experimental settings and only later exported to classrooms. Instead, the intention is to capture the complexity of the authentic learning situation (Brown 1992, Greeno 2006). One fundamental characteristic of the design process, as defined by Barab and Squire (2004), states that the design process allows the researcher to move beyond simply understanding the world as it is, and involves working to change it in useful ways with the broader goal of examining how changes influence learning and practice. Collins with colleagues (2004) posited major differences between traditional psychological methods and the design-experiment methodology in terms of location of the research, complexity of variables, unfolding of procedures, reporting of findings and role of participants (see Table 1, modified from Barab 2006: 157), and these have also guided the design approach developed within this study. Whereas, psychology experiments are often conducted within laboratory context with a few dependent variables, aims the DBR approach to study the phenomenon in real-world learning environments with multiple types of dependent variables (Collins et al. 2004). The other difference that can be mentioned is that within the DBR setting not all the variables of interest are known in advance, in contrary the interests may change or transform during the research. Therefore, also research procedure is flexible and evolving.
Table 1. Differences between design-based research and psychology experiments.

<table>
<thead>
<tr>
<th></th>
<th>DBR</th>
<th>Psychology experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Authentic learning environments</td>
<td>Laboratory</td>
</tr>
<tr>
<td>Complexity</td>
<td>Multiple types of dependent variables</td>
<td>A few dependent variables</td>
</tr>
<tr>
<td>Treatment</td>
<td>Not all variables of interest are known in advance; emergent interests</td>
<td>A few variables that are selected in advance</td>
</tr>
<tr>
<td>Procedure</td>
<td>Flexible and evolving procedures</td>
<td>Fixed procedures</td>
</tr>
<tr>
<td>Reporting</td>
<td>Describing design in practice</td>
<td>Testing of hypotheses</td>
</tr>
<tr>
<td>Participants</td>
<td>Experimenter and participants are active and influence the design of the research</td>
<td>Experimenter should not influence the subject; and subjects do not influence the design</td>
</tr>
</tbody>
</table>

This dissertation study follows the main ideas of DBR research in the sense that, in the two empirical research interventions, the context under study, including the pedagogical and socio-technical learning environment, were designed with multidisciplinary collaboration. In the experimental design, appropriate tools, instructional design and practical arrangements for learning setting were carefully designed. Furthermore, the iteration characteristics of DBR were fulfilled by taking the previous intervention into consideration when designing the following study.

4.2 Mixed methods orientation

The mixed methods approach has emerged as a ‘third methodological paradigm and in general it can be regarded as a methodological orientation that combines quantitative and qualitative methods (Creswell 2009, Johnson & Onwuegbuzie 2004). Mixed methods research has been emerging since the 1990s, establishing itself alongside previous paradigms so that currently all three research paradigms coexist: quantitative, qualitative, and mixed methods research (Johnson & Onwuegbuzie 2004). The roots of mixed methods research are generally traced to the early work of Campbell and Fiske (1959) on mixing methods (see also Creswell 2009, Creswell & Plano Clark 2007).

The notion of triangulation is regarded as one of the most important in the development of the mixed methods approach (Denzin 1970, Jick 1979). Denzin (1970) introduced different types of triangulation: 1. Methodological triangulation (the use of more than one method for gathering data); 2. Data triangulation
3. Theoretical triangulation (the use of more than one theoretical position in interpreting the data). The defining characteristics of the mixed methods approach involves its use of quantitative and qualitative methods within the same research project and a research design that clearly specifies the sequencing and priority that is given to the quantitative and qualitative elements of data collection and analysis (Creswell 2009, Creswell & Plano Clark 2007). Different combinations of methods allow rich and comprehensive views to be constructed of the phenomena under investigation (Puntambekar 2013).

This study implements a mixed methods approach, and thus, acknowledges both positivist as well as constructivist research paradigms. The mixed methods approach is used for exploring both the number as well as the specific characteristics of the phenomenon under investigation. However, the emphasis in this study is on a qualitative approach to understanding and uncovering specific kinds of interactions and a method of quantifying is used for the purpose of exploring the numeric differences between groups (Chi 1997, De Wever et al. 2006, Jeong 2013, Strijbos et al. 2006). Qualitative orientation is viewed as particularly valuable for characterizing the complex nature of collaborative emergence, and was used to create rich descriptions of the interactions, and to analyse selected aspects relating to specific cases (Sawyer 2013). More detailed elaboration of the implemented data analysis methods is in the chapter 4.5.

4.3 Participants and instructional settings

Both of the empirical studies (study I and II) were implemented in a higher education context within the Department of Educational Sciences and Teacher Education of the University of Oulu. The specific pedagogical and technological learning environments were designed in multidisciplinary collaboration.

The assignment which were developed for these studies required students not only to learn and apply content knowledge, but also to generate their own learning objectives, goals and standards of working as a group. In other words, the designs included a macro-level scripting approach (Kobbe et al. 2007, Häkkinen et al. 2010) and open-ended problems. In general, macro scripts were used as an activity models which aimed to structure and support collaborative learning among students whose action or interaction was (at least partially) mediated by technology (King 2007, Kollar et al. 2006, Weinberger et al. 2005). As defined in Kobbe and colleagues (2007) and Dillenbourg and Jermann (2007), CSCL macro-
scripts are coarse-grained scripts that follow a pedagogy-oriented approach and emphasize the orchestration of activities. They differ from micro-scripts, which are finer-grained scripts following a more psychological and bottom-up approach (Kobbe et al. 2007). The groups’ working phases were designed, but how the groups were to work together was not specified. Thus, the students needed to make choices, plan and together regulate their own work.

The basic idea behind the socio-technical infrastructures of these two studies was to use available tools and services. The decision was made to use the tools, which were easily available at the time these empirical experiment were conducted, so that the participants (as current and future teachers) could get better ideas about how to implement available technologies (i.e. mobile phones, blogs and wikis) to develop the learning environment for their own teaching purposes as well.

4.3.1 Study I

The participants in the first study (Article I) were teacher education students doing introductory studies in educational technology (N = 13). The participants were randomly assigned to work in four groups. The students worked with a collaborative learning task facilitated with the mobile mind map tool and a problem-oriented pedagogical structure (Figure 1). The mobile mind map tool is a prototype learning tool designed by media artist Dr. Jürgen Scheible.

Student activities were structured around different phases in which they brainstormed, explored real-life examples to visualize their thinking and used pictures as knowledge representations to construct a group’s shared understanding. The idea was to use pictures as knowledge representations and an environment as a reference point for students to visualize their individual and shared thinking processes. The task required students to think and discuss the following topic: What kind of qualifications do studies of educational technology give for their future working life as a teacher and/or other educational expert?

In practice, the task began with the groups constructing mind maps with paper and pen of the described topic. The pedagogical aim of this phase was to support grounding; the students introduced their ideas to each other and negotiated about different ideas. In the second phase of the task, the groups were given mobile phones and asked to do a campus area exploration to visualize their thinking about the task with pictures. The abstract ideas were revised into more authentic form by asking participants to go around the campus and find real life
examples to support their previous discussion and then further construct new ideas. They were asked to document their findings by taking concrete, symbolic or framed pictures with mobile phones and by adding text annotations to the pictures. The annotated pictures were sent to a server. The aim of this phase was to develop and transform abstract ideas to concrete form, and thus engage students in a problem-based inquiry process (Hakkarainen 2003, Hmelo-Silver 2004). In the third phase ideas were developed further in a face-to-face group session by constructing a mind map of the self-generated pictorial knowledge representations and the text annotations with the Mobile mind map tool by the computer. The tool allowed the participants to move the pictures in a computer screen, change the size of the pictures and also connect the pictures with a line. The final phase included reflecting on the experience with a researcher. Each phase lasted from half an hour to one hour. The time schedule was flexible and groups were given as much time as they needed to finish their tasks.

![Fig. 1. The design of the first case study.](image)

### 4.3.2 Study II

The participants in the second empirical study were adult students (N = 22) attending a master’s programme in education at Department of Educational Sciences and Teacher Education. All participating students had previously obtained a bachelor’s or master’s degree in education and had teaching and/or administrative work experience (e.g. kindergarten teacher, kindergarten principal,
primary school teacher, adult educator). The students participated in a compulsory 12-week course entitled “Future Scenarios and Technologies in Learning”.

The design of the second case study (Articles II and III) consisted of lectures, collaborative face-to-face meetings, individual blog work and collaborative group work on a wiki (Figure 2). The overall course aim was to engage students in learning activities that would inspire them to implement new teaching practices in their teaching work. The content of the course included major theories and methods of technology-enhanced learning. Following the approach of progressive inquiry (Hakkarainen 2003) and problem-based learning (Hmelo-Silver 2004), the learning activities in the course were organized as a cyclical model that emphasized shared expertise and collaborative work for knowledge construction and inquiry. This was done by setting up the context and using questions, explanations, theories and scientific information in the cycle of deepening inquiry. In practice, the course structure included recurrent classroom, solo and collaborative phases mediated by the use of social software tools.

**Fig. 2. The design of the second case study.**

The different phases of the pedagogical design are listed and explained below (see also Figure 2).

1. **Lecture.** In the first phase of the course design, the students attended to an introductory lecture on the specific topic. The aim of the lectures was to introduce different course topics (six themes) to the students and to support their conceptual grounding and theoretical understanding. The themes were, in this order: learning infrastructures, learning communities, metacognition, self-regulated learning, learning design and social web as a learning environment.

2. **Face-to-face group work.** After the each introductory lecture, the students worked in face-to-face groups (six meetings). The aim was to negotiate the main approaches of the lecture and to formulate a working problem for the group, to be continued in subsequent phases. The groups were
advised to set their own learning objectives and to undertake an experiment with pictorial knowledge representations using smartphones, blogs and wikis.

3. Individual blog work (after every face-to-face session, with six topics). Students were asked to evaluate their everyday environment to find real-life examples and case scenarios to illustrate their ideas related to their group’s problem. Within this phase, the idea of pictorial knowledge representation was implemented; the students used their individual blog learning environment to share their pictorial knowledge representations and theoretical ideas of the topic.

4. Face-to-face group work (two meetings). The aim of the group work (in the middle of the course and at the end of the course) was to evaluate the previous work phases (three topics at the time) and to share ideas from their individual blog work. Students were asked to negotiate and choose the best examples from pictorial knowledge representations to illustrate their group’s shared ideas, which were then used as the basis for their shared wiki work in the next phase.

5. Group wiki work (after the first blog work). The aim of this last phase of the design was to co-construct a group’s shared wiki. In this phase, the students were asked to use their material (ideas and pictorial knowledge representations) from the previous phases as well as to generate new ideas and understanding when creating the wiki. The group wikis functioned as shared group products, which were presented to the whole class at the end of the course.

The socio-technological design consisted of recurrent individual, group and collective phases where students used multiple social media tools and mobile phones to perform designed tasks (see also Laru 2012, Laru et al. 2011, Laru et al. 2014). The mobile device was an important tool in the designed learning environment, as the students were required to identify, or create and capture, situated pictorial representations with mobile phones to describe their group’s understanding and interests. The device was equipped with the ShoZu cloud-based file-sharing tool that connected the mobile phones to the Flickr image hosting website. ShoZu offered functions to add tags, titles and descriptions before adding photos to the Flickr photostream. Second, an individual WordPress blog was used as a personal learning environment, where students individually reflected further on their ideas by writing journal entries regarding the respective pictures/videos. The Wikispaces was used as a collaboration tool and for
distributing resources (\textit{i.e.} course curricula, lecture slides and other information) and displaying content from Flickr (student accounts) and WordPress (the course blog and student blogs). These above described learning tools enabled the connections between different task phases, the students, and the content they produced.

The author of this dissertation participated in the design of the socio-technical infrastructure from a pedagogical perspective, but since the main responsibility for the technical infrastructure was taken by another researcher, the data from virtual learning situations have been reported in studies by Laru (2012) and Laru with colleagues (2011 and 2014), and thus, have been omitted from this dissertation.

4.4 Data collection

This dissertation study implemented multiple data sources; including video-observation, video-stimulated recall interviews and pre- and post-knowledge test. Overall, video data and observational methods were regarded as the most important for the conducted studies. Observational methods were considered as valuable as they make possible to record what students actually do, rather than what they recall or believe they do (Bakeman & Gottman 1997, Barron \textit{et al.} 2013, Jeong 2013, Jordan & Henderson 1995). Furthermore, video-recording afforded the opportunity to combining verbal and non-verbal behaviour of students (Whitebread \textit{et al.} 2009), which was highly valuable particularly within socio-emotional analysis of group interaction.

The data collection in case study I (Article I) included a video observation and interviews. Altogether six hours of video data were collected (about 90 minutes per group). During the session where the mind map tool and pictures were used, two video cameras were used to capture the students’ facial expressions and the activity on a computer screen. The interviews were conducted right after the given task was completed in order for the students to reflect on their learning experience, including how they viewed the group work, the design of the learning experiment, and the use of cognitive tools. Furthermore, the students’ mind maps were used to illustrate the outcome of their collaborative learning and to stimulate the recall of their learning process during the interview.

The data collection in case study II (Articles II and III) is composed of video recordings of the groups’ face-to-face collaborative sessions (33 h of video data), pre- and post-tests of student knowledge, and video-stimulated recall interviews
(Ericsson & Simon 1980, van Gog et al. 2005). The pre- and post-knowledge test consisted of six constructed-response questions based on the key concepts of the course. Students were asked to write a definition of the themes of the lectures. This meant that each theme was also connected to the specific lectures and its associated collaborative task, and thus it was used to measure the students’ learning outcomes in a particular task. The pre-tests were also used as a method to group students such that the level of prior knowledge was equally distributed between the groups. Furthermore, gain scores between the two tests were used to characterize the groups’ performances, differentiating between well- and weak-performing (Article II).

Video clips were used as stimuli in the interviews. During the individual interviews, students were first asked to describe how their group worked together, the challenges within their group and how they dealt with those challenges, resolved possible conflicts and regulated their group learning. Second, the participants were shown three video clips (2–3 minutes in length) chosen by the researcher with a research assistant. The clips portrayed what occurred just prior to, during and just after the emergence of challenges within the group (Article III). The participants were instructed to report retrospectively what had happened in the group, what they had done, how they had felt during the challenge, how they had tried to solve the challenge, and what name they would give to the situation in the video. The data collection overview of this dissertation study is presented in Figure 3.

![Fig. 3. Overview of the data collection.](image)

### 4.5 Data analysis

Throughout this study, the main focus is on analysing and understanding the interaction processes employed within collaborative groups (Greeno 2006). Content analysis is adapted in this study as “a research technique for making
replicable and valid inferences from data to their context” (Krippendorff 2004: 21, also Chi 1997 and Strijbos et al. 2006). The central idea in content analysis is to classify interaction into descriptive content categories. Words, phrases or larger episodes which are recognized to have similar meanings are classified into the same category, and the occurrences in each category are counted and their meanings are interpreted (Weber 1990, Tesch 1990).

The analysis in the empirical studies combined theory- and data-driven coding orientation, meaning that the content of the data was analysed according to categorizations that arose both from theoretical and empirical content (Mayring 2000). The categories will be explained in more details in sections 4.5.1, 4.5.2 and 4.5.3. The units of analysis were chosen based on the type of data and specific research questions in each empirical study. Defining the boundaries based on the semantic features of small group discussions was clearly challenging and time-consuming, adding significantly to the analytical work (Strijbos et al. 2006). For example, in Articles I–II, the unit of analysis is turns taken in speech, whereas in Article III the episode is used as the unit of analysis. Furthermore, attempts were made to recognize individual and group levels within the analysis (particularly in Article II).

A summary of the methods and data analyses in this dissertation is presented in Table 2 and explained in the next section. However, more detailed descriptions are provided in the original articles.

**Table 2. A summary of the data analysis.**

<table>
<thead>
<tr>
<th>Study</th>
<th>Participants</th>
<th>Focus</th>
<th>Data</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study I/ Article I</td>
<td>Teacher education</td>
<td>Knowledge co-</td>
<td>Video data, interviews</td>
<td>Qualitative content analysis, case description</td>
</tr>
<tr>
<td></td>
<td></td>
<td>construction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study II/ Article II</td>
<td>Teacher education</td>
<td>Knowledge co-</td>
<td>Video data, pre-</td>
<td>Qualitative content analysis, descriptive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>construction and</td>
<td>and post-knowledge test</td>
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<td></td>
<td></td>
<td>monitoring activities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study II/ Article III</td>
<td>Teacher education</td>
<td>Challenges,</td>
<td>Video data, video-stimulated</td>
<td>Qualitative content analysis, interaction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>emotional experiences and</td>
<td>recall interview</td>
<td>analysis, case description</td>
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<td>conflict</td>
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<tr>
<td>Study II/ Article IV</td>
<td>Teacher education</td>
<td>Methodological development</td>
<td>Video data</td>
<td>Case description</td>
</tr>
<tr>
<td></td>
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<td>of process-oriented SRL/SSRL</td>
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4.5.1 Video analysis

Video analysis is regarded as the most important part of this dissertation study (Barron et al. 2013, Derry et al. 2010, Goldman et al. 2007). The analysis of interaction focused on knowledge co-construction (Articles I–II), monitoring processes as a regulation activity (Article II) and socio-emotional challenges and emotion regulation (Article III). Figure 4 displays an overview of the video data analysis. In the next section, the analysis schemas are introduced in detail.

Phase I – Knowledge co-construction in interaction

The first analysis phase was based on identifying the level of knowledge co-construction within each group (Article I), i.e. analysing the groups’ knowledge level (Cannon-Bowers & Salas 2001) and transactive level activities (Teasley 1997, Weinberger & Fischer 2006) to identify how the students used each other
and tools as contextual resources for building on each other’s ideas (Chi 2009, Ploetzner et al. 1999, Roscoe & Chi 2008, Shirouzu et al. 2002). The main aim of this kind of analysis was to detect idea chains and also to explore how these ideas were developing within the group’s interaction. Furthermore, as pictorial knowledge representations were used to support interaction, analysis also evaluated what kind of interaction was stimulated with pictures.

The analysis of knowledge co-construction continued in Article II, but the focus of the analysis shifted to the more specific analysis of the levels of questions and answers (differentiating high, average and low level). The main idea behind this analysis was that the level of questions and answers would describe is group performing within high- or low-level knowledge construction (Hmelo-Silver 2003, King 1999, Webb et al. 1995). First, all of the content-related questions and answers were detected. These included only the interactions in which the group members were sharing or questioning content information. In practice, all of the speech turns where group members were asking questions or providing answers related to the task progress or off-task activities were excluded from the analysis. Second, the levels of questions and answers were evaluated and speech turns were divided either into the high-level, average-level or low-level categories. High-level question, for example, was a broad and the answer to the question required elaboration and high-level understanding. Whereas, low-level question did not require elaboration, merely recalling of facts and information. Average-level question was a middle type between above described; it was not a broad question, but required some elaboration (see further details from Article II).

Phase II – Monitoring activities

The second phase in the video data analysis focused on what kind of monitoring activities different groups used (Article II). The coding categories and overall coding protocol were developed in three phases. First, prior to viewing the videos, a list of preliminary areas of interest was developed according to the stated research questions and the developed theoretical framework. Second, the coding protocol was developed and elaborated further after viewing the videos and reading the transcribed group discussions. Third, the final coding categories were formulated and tested several times. This involved reorganization and renaming of categories, as well as specifying sub-codes and providing examples of the specified categories. The final version of the coding protocol included four categories: monitoring task understanding, monitoring task progress, monitoring
content understanding, and monitoring interests. The idea was based on the assumption that these types of activities would describe the groups’ meta-level functioning and cognitive regulation processes (Pintrich et al. 2000) i.e. the cognitive processes of planning, monitoring, controlling and evaluating during ongoing group activities (Brown 1987, Goos et al. 2002, Son & Schwartz 2002).

In terms of monitoring content understanding and monitoring interests, the analysis was also extended to cover the specific focus of the activity, i.e. whether the group members’ monitored their own or another group member’s evolving content understanding. Similarly, the interest monitoring was evaluated: were the group members monitoring their own, others’ or their shared interests? Within, this analysis phase, the qualitatively analysed interaction data was quantified to detect differences between well- and weak-performing groups’ number of monitoring activities (Chi 1997, Strijbos et al. 2006) as well as temporal variation in monitoring activities (Reimann 2009). Qualitative case examples were also explicated to illustrate and broaden the perspective of quantified analysis.

Phase III – Socio-emotional challenges and emotion regulation

The third analysis phase explored socio-emotional challenges and emotion regulation (Article III). During the previous analyses (for Article II; knowledge co-construction and monitoring activities) it became obvious that groups experienced challenges in their collaborative learning. Thus, the focus of the dissertation was extended to cover the variety of challenges experienced as well as the socio-emotional processes involved in group learning. In connection with the stimulated recall interviews, one case group was chosen for in-depth interaction analysis, as it faced more and different types of challenges in its collaborative learning than did the other groups (Article III, see also 4.5.2 more details of the interview analysis). Before the analysis, the granularity of the analysis unit was determined, and the analysis approach was refined by reviewing the video recordings and transcripts several times. A preliminary analysis indicated that the case group experienced a severe conflict in their first face-to-face task and that the phenomena investigated could best be described through challenging interaction episodes. Thus, the analysis was conducted within longer sequences of interaction instead of data at the speech turn level (Bakeman & Gottman 1997).

In practice, the transcribed video data was analysed in two phases. In the first phase, the case group’s first face-to-face task (62 min of video observation) was
analysed to capture socio-emotional challenges in interaction (Barron 2003, Chiu & Khoo 2003, Salomon & Globerson 1989). Challenges were recognized based on visible signs of arousal, tension or frustration, or on clear problems in fluent group work. During the analysis, four challenging interaction categories were developed: overruling interaction, undermining interaction, status-centric interaction and normative interaction. These interaction types created tension and a challenging atmosphere within the group, which could be observed in the video data, and the students also reported this atmosphere and interaction problems during the interviews.

In the second phase, the case group’s interaction was explored in detail to detect emotion regulation strategies. Previous studies of emotion regulation were used to develop the coding for group-level analysis. The aim was to detect the focus of their emotion regulation: an avoidance-, task- or problem-focused strategy (Op’t Eynde et al. 2007) and, more specifically, situation selection, situation modification, attentional deployment, situation re-appraisal or response modulation (Gross & Thompson 2007). The emotion regulation interaction was also explored by combining the stimulated recall interviews. In other words, the video data and the students’ own interpretations of group interaction offered a broader and more thorough picture of what was going on in the group that had experienced socio-emotional conflict.

**4.5.2 Interview analysis**

In both case studies, the content of the interviews was analysed (Articles I and III). In the first study, the analysis focused on the students’ interpretations of the collaborative activity. The focus of the analysis was to uncover meaningful statements regarding the students’ reflections of their learning experience, including how they viewed their group work and the cognitive tools they had been using. Particular attention was paid to the students’ evaluations of the use of pictures as knowledge representations.

In the second study (Article III), the students’ individual interviews were content-analysed to determine what kinds of challenges they had experienced in their group work. In practice, four main categories were created: cognitive, motivational, socio-emotional and other challenges. The cognitive challenges category included four sub-categories: different use of terminology, different task understandings, shallow knowledge construction and lack of self-evaluation. The motivational challenges included three sub-categories: different interests within
the task, different goals for the group work, and group members not being fully committed to the group work. The socio-emotional challenges included seven sub-categories: too-dissimilar backgrounds, overruling others’ ideas, envy of someone’s expertise, a pronounced need to please someone, incompatible working styles, different styles of interaction and a lack of team cohesion. Other challenges were personal reasons (e.g. other responsibilities in life). Next, all the interviews were coded into categories and the data was quantified to see the possible differences among groups.

In the second study (Article III), the data from video-stimulated recall interviews were also analysed. The aim was to place participants back in the group situation by using videos of their previous interactions and by posing questions related to that experience. This type of method, which takes care to help participants to reach a state of evocation of specific situations, seems appropriate for understanding how emotions emerge during collaborative learning (Cahour 2013). As explained above, the stimulated recall data was explored in connection with interaction data analysis, the students’ own recall and interpretation of their emotional experiences and emotion regulation was coded into avoidance-, task- or problem-focused strategies (Op’t Eynde et al. 2007) and, more specifically, situation selection, situation modification, attentional deployment, situation re-appraisal or response modulation (Gross & Thompson 2007).

4.5.3 Knowledge test analysis

Knowledge pre- and post-tests were used in Article II to characterize the students’ learning gain and to identify the students’ performances based on their individual test results in order to compare their learning results to their group activities. Firstly, the pre-knowledge test results were used to create groups in which the level of knowledge was equally distributed between the participants. The gain score of pre- and post-test was used to recognize high- and low-performing students (in terms of this specific task). Through the knowledge test, the best performers were localized from the different groups, allowing the well- and weak-performing groups in terms of the learning test results to be identified. The well-performing group was recognized as the group that had the highest number of well-performing students within it. In a similar manner, the weakest group was recognized as the group that had the least number of good performers within the group. The groups were, thus, divided into three categories – well-, average- and
weak-performing groups – based on their learning gain. This categorization was used as the basis for further interaction analysis.

In practice, three independent researchers (including the author) developed a criterion and marked the knowledge tests (min = 0, max = 3). The tests were analysed by marking points for individual answers. The researchers first negotiated the coding rules, then independently marked all the tests, and compared the results by calculating proportion agreement (%) as reliability indices. The pre-test coding agreement between the all three coders was 73.5%, and the post-test agreement was 65.9%. Any differences were negotiated until consensus was reached.

4.6 Evaluation of the research

The three articles (Articles I–III) and a methodological book chapter (Article IV) demonstrate a wide diversity of research topics, ranging from knowledge co-construction to monitoring activities and socio-emotional perspectives in collaborative learning. These required independent methodological designs. The analysis methods implemented varied, but shared a common orientation to the collaborative learning process and focused on the interaction.

The evaluation of reliability and validity are essential criteria in research. Patton (2002) states that validity and reliability are two factors which should be taken into account when designing a study, analysing the results and judging the quality of the study. In the mixed methods and qualitative research paradigms, terms such as credibility, neutrality, consistency and applicability are useful constructs for evaluating study’s quality (Creswell 1998, Lincoln & Guba 1985). When quantitative and qualitative approaches are compared, it becomes obvious that when quantitative studies aim to explain and generalize the explanations, qualitative and mixed methods studies aim to understand and find different possible reasons (Stenbacka 2001). This means that design studies are, in general, intended to create novel practices, not for efficient testing and descriptions of a causal hypothesis about learning. Design studies are more akin to case studies and ethnographies, in that they seek to provide levels of detail and specificity about complex interactions over extended periods of time, rather than establishing broad and representative patterns (Confrey 2006). In the complex group settings, understanding, explaining and gaining predictability are not about finding universal, immutable laws, but rather about creating models of likely frameworks that lead to successful learning outcomes, by means of theories, materials and
instructional approaches. In practice, a well-conducted and consistently reported qualitative study can help to “understand a situation that would otherwise be enigmatic or confusing” (Eisner 1991: 58).

Therefore, as Healy and Perry (2000) emphasize, the quality of a study in each paradigm should be judged by its own paradigm stems. Reliability in qualitatively oriented mixed methods research will be attained when the different phases of the research are made visible and transparent (Creswell 1998). Confrey (2006) argued over design studies methodological rigor, by advocating three forms of warranting evidence: 1. The investigation has been adequately conducted and analysed. 2. The claims are justified and are subjected to alternative interpretations. 3. The relevance of the claims to the practices of education is explicit and feasible.

This study’s methodological orientation followed a mixed methods approach, and thus aims to implement reliability and validity criteria based on both the quantitative paradigm and a qualitative paradigm. The documentation was prepared within the framework of each empirical study with the purpose of creating a careful description of the setting, data and data analysis process. In order to ensure the validity and reliability of the study, triangulation (Stake 2003) was used by having multiple data sources to analysing and confirming the findings. The triangulation in this study was performed by using several types of data, including video observations, stimulated recall interviews and knowledge tests, to examine the phenomena (Articles I–III). Reliability was also assured by acknowledging the participants’ points of view; using their interpretation of the video examples to confirm the findings of the interaction analysis (Article III) (Gijbels et al. 2006). In the analysis phase, the reliability of the coding, or “the degree of consistency with which instances are assigned to the same category by different observers or by the same observer on different occasions” (Hammersley 1992: 67) was checked by an independent coder (Neuendorf 2002, Silverman 2001). Reliability was also increased by offering several data examples throughout the different studies and by using intercoder agreement (Cohen’s kappa) as reliability assurance for the content analyses. To conclude, in each study, multiple sources of data and analytical methods were applied to increase the validity of the research (Puntambekar 2013).
4.7 Evaluation of ethical issues

The guidelines of the National Advisory Board on Research Ethics (2012) were followed when this dissertation study was conducted; data collection, analysis and reporting of the results have been carried out according to these ethical standards. All of the participants in two empirical studies were volunteers, and prior to the experiments they were informed about the experiments and data collection. All participants were asked to give written consent to their participation, and they had the opportunity to refuse to participate at any time during the data collection (e.g. one of the students declined to be interviewed). None of the participants were given extra credit or paid money for their participation. The data collection was implemented as part of their normal curricular studies. Privacy issues were carefully considered, and it is not possible to identify the participants in the research articles, as pseudonyms were used. The sources of financing were reported in articles and in the acknowledgements section of this dissertation.
5 An overview of the articles

This dissertation constitutes four articles. Table 3 summarizes the aims of each article, along with the main responsibility of this author in each article. Articles I–III are empirical studies, and Article IV considers methodological approaches to studying regulated learning in a collaborative learning context. In the following overview, the two empirical studies reported in the four articles are briefly described.

Table 3. Focus of the articles and responsibility of the author.

<table>
<thead>
<tr>
<th>Article</th>
<th>Aim</th>
<th>Author’s responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Characteristics of knowledge co-construction</td>
<td>1st author, responsible for empirical data collection, data analysis and theoretical grounding.</td>
</tr>
<tr>
<td>II</td>
<td>Characteristics of knowledge co-construction and monitoring activities</td>
<td>1st author, responsible for empirical data collection, data analysis and theoretical grounding.</td>
</tr>
<tr>
<td>III</td>
<td>Characteristics of challenges and conflicts</td>
<td>1st author, responsible for empirical data collection, data analysis and theoretical grounding.</td>
</tr>
<tr>
<td>IV</td>
<td>Methodological approach to analysing self- and socially shared regulation of learning</td>
<td>3rd author, responsible for video data analysis and case example, contributing to the theoretical grounding.</td>
</tr>
</tbody>
</table>


The aim of the first empirical study (Article I) was to explore knowledge co-construction processes when cognitive tools and self-created pictorial knowledge representations were implemented to visualize one’s own, others’ and shared ideas and understanding. The particular focus was on how students contribute to knowledge co-construction and use each other’s ideas and tools as contextual affordances for their learning.

The context of the study was an educational technology course for teacher education students’ (N = 13). The data collected for this study included transcripts of the face-to-face group activities which were video-recorded (mind maps using paper and pen, mind maps using the Mobile Mind Map Tool, and pictorial knowledge representations) as well as stimulated recall interviews. This analysis
used qualitative content analysis and revealed knowledge- and transactive-level activities, \textit{i.e.} processing one’s own and others’ ideas and understanding further.

The results show that students were more active in processing ideas further when pictorial knowledge representations were used. Furthermore, the results show that with pictorial representations, students started to use different metaphors and more vivid expressions in their interaction. The use of metaphors was interpreted as an indicator of deeper cognitive understanding, and shared metaphors as an indicator of deeper shared understanding. However, students also felt that reaching shared understanding was challenging, and that the use of pictures as knowledge representations required thorough negotiation and explanation in order to understand each other’s thinking and ideas. The experiment was short and it was decided to continue with the same kind of approach, but to design a longer-term experiment and theoretically build on ideas of socially shared regulation of learning, and to empirically explore monitoring activities within the collaborative groups.

\textbf{5.2 Article II. Näykki P, Järvenoja H, Järvelä S & Kirschner P (2014)}

\textit{Monitoring as regulation activity in higher education students’ collaborative learning – Quality and temporal variation.}

\textit{Manuscript submitted for publication.}

This study implemented a process-oriented approach to exploring what kinds of monitoring activities groups use, along with whether and how differently performing groups differ in terms of the amount, quality and temporal variation of their knowledge co-construction and monitoring activities.

Five groups of teacher education students (\(N = 22\)) were observed over a three-month course. Video recordings (33 hours) of face-to-face group interaction (\(N = 12,931\) speech turns) and pre- and post-tests of students’ knowledge were collected. The video data analysis targeted knowledge co-construction (\textit{i.e.} questions and answers) and monitoring activities (\textit{i.e.} monitoring task understanding, monitoring task interests, monitoring task progress and monitoring content understanding).

The results show that the well-performing group monitored content understanding significantly more often and from the very beginning of the group work, while their weak-performing counterparts focused on monitoring task-level activities. Furthermore, the well-performing group was active at individual as well as group levels by monitoring their own and each other’s understanding.
However, it became obvious during this study that it is necessary to extend the analysis to socio-emotional processes in collaborative learning. Monitoring cognitive activities as a group is only one part of effective and enjoyable (collaborative) learning, and thus the next study explored challenges and emerging socio-emotional conflict in more details.


This study explored what kinds of cognitive, motivational and socio-emotional challenges students experienced in their collaborative learning tasks, how those challenges turned into socio-emotional conflict within the group, and how the students reacted to and interpreted the conflict situation.

Face-to-face collaborative learning situations involving teacher education students (N = 22) were video-recorded (33 hours in all) during a three-month educational science course. Cued retrospective recall interviews (with video stimulus) were also conducted.

The results indicate that the groups faced several challenges in their collaborative learning and there were differences between the groups in the amount and type of challenges. One case group was chosen for in-depth analysis as it faced more challenges, and particularly socio-emotional ones, than the other groups. Interaction analysis indicated overruling, status-centric, undermining and normative interaction and that the case group failed in emotion regulation activities, which led to serious conflict and meant that group members drifted to avoidance-focused emotion regulation behaviour.

5.4 **Article IV Järvelä S, Järvenoja H & Näykki P (2013)**


The aim of this study was to explain the roles of social and contextual influences on all phases of self-regulated learning, as well as the distinctions between self- and socially shared regulation. These aims have presumed methodological efforts,
since many earlier methods have concentrated on the individual perspective in regulatory activity. This book chapter discusses how different types of data and methods of analysis make possible situated analysis of self-regulation strategies in groups. First, the key issues in the theoretical and conceptual grounding are explained, followed by methodological development and review of previous studies. Then, contextual and task-specific data collection methods are introduced and approaches to analysing regulation “in action” by combining individual- and group-level data are explained.
6 Main findings

The general objective of this dissertation was to combine socio-cognitive and socio-emotional dimensions to explore collaborative learning activities and individual interpretations of the activities, as well as the influences of the activities in the context of teacher education students’ collaborative learning. Another aim was to combine data from different sources and to exploit a process-oriented approach.

The study served to expand the current literature on collaborative and socially shared regulation of learning by combining socio-cognitive and socio-emotional dimensions to seek effective and enjoyable collaborative learning environments. Table 4 summarizes the main dimensions of the study. The socio-cognitive view in this study offered a point of view of actual knowledge co-construction processes (Articles I–II) and monitoring activities in collaborative learning (Articles II–III). The socio-emotional dimension was viewed through the interactional challenges experienced as well as emotional responses to emerging conflict within interaction (Article III). Figure 5 summarizes the main lines of this study, which are explained in the following sections. The original articles present more specific results of the empirical questions, and next the main findings are discussed more generally based on the stated research questions of this dissertation study.

Table 4. The main dimensions of the study.

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Activities</th>
<th>Influences</th>
<th>Interpretations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Socio-cognitive</td>
<td>Knowledge- and transactive-level (Articles I-II); Monitoring (Article II)</td>
<td>Learning outcomes, group practices (Article II)</td>
<td>Learning performance (Article I)</td>
</tr>
<tr>
<td>Socio-emotional</td>
<td>Challenging interaction (Article III); Monitoring (Article III)</td>
<td>Socio-emotional conflict (Article III)</td>
<td>Challenges, conflict, emotional experience (Article III)</td>
</tr>
</tbody>
</table>
6.1 Socio-cognitive and socio-emotional activities in collaborative learning

Many studies define collaborative learning at a rather general level as mutual engagement or a coordinated effort to solve the problem together (e.g. Roschelle & Teasley 1995). However, this study aimed to target more specific activities. The findings of this study indicate three levels of socio-cognitive activities: knowledge-, transactive- and monitoring-level activities. Knowledge-level activities demonstrate how students contribute to collaborative learning in terms of knowledge co-construction (Articles I and II). Transactive-level (Article I) activities explains how students use each other’s contributions and technological tools as a contextual affordance to construct shared understanding. Monitoring-level (Articles II and III) indicate activities which are used to monitor and regulate group interaction. Even though these three different types of socio-cognitive activities were not explored simultaneously, one of the main argument is that collaborative learning situations require all these levels to occur in parallel and reciprocally.
This dissertation’s findings highlight monitoring activities as being particularly essential for effective collaborative learning (Goos et al. 2002, Jost et al. 1998, Khosa & Volet 2013). Furthermore, the results indicate a distinction between group-, task- and content-related monitoring activities (Janssen et al. 2012, Saab 2012) and define different types and focal areas of monitoring within group interaction: monitoring content understanding, monitoring task understanding, monitoring interests and monitoring group’s progress (Article II), as well as monitoring emotional experiences and emotion expression in a group context (Article III). Prior studies have shown that monitoring is an essential component of successful self-regulated learning (Pintrich & de Groot 1990, Schraw 1998) as well as socially shared regulation of learning (Hadwin et al. 2011, Rogat & Linnenbrink-Garcia 2011). In general, being explicit about one’s own understanding as well as monitoring others’ understanding makes collaborative learning more effective and fundamentally possible (Goos et al. 2002). The findings of this study complement earlier findings by highlighting the specific monitoring sub-processes in group interaction.

Collaborative learning situations are built based on interaction between participants’ understandings, reflected through their previous experiences, interests and commitment towards the task and the group. This dynamic learning process places monitoring activities in an essential role. In order to effectively co-construct knowledge, learners need to make their thinking visible (Collins et al. 1991), to be aware of their own understanding as well as their peers’ understanding (Nelson et al. 1998, Jost et al. 1998). In addition to socio-cognitive activities, students need to be aware of other group members’ emotional experiences and also to monitor and regulate their emotional expression.

The third study (Article III) extended the focus from socio-cognitive activities to also include socio-emotional dimension of collaborative learning (Ayoko et al. 2008). The results highlight what kinds of activities/interaction created tension and challenges for interaction in the case group (Andriessen et al. 2013), and describe troubled interpersonal dynamics, lack of communication and dysfunctional communication (Barron 2003). Troubled dynamics and dysfunctional interactions were reflected in various interaction behaviours, by overruling and undermining others’ opinions and expertise and through status-centric and normative interaction when some group members’ expertise was emphasized at the expense of the others (Chiu & Khoo 2003, Salomon & Globerson 1989). Barron’s studies (2000 and 2003) show similar examples of less successful collaborative interaction, where a group was characterized as having
challenges in relational space, e.g. violations of turn-taking norms, competing claims of competence, and difficulties in gaining the floor. The main contribution of this study is, therefore, in explaining what kinds of activities lead to socio-emotional conflict, as well as how students react and try to solve the conflict (Carcia-Prieto et al. 2003, Goetz et al. 2003). In general, this study was based on the assumption that effective collaborative learning requires students to recognize their learning challenges and be able to respond to challenges successfully (Gross & John 2002, Gross & Thompson 2007, Linnenbrink-Garcia et al. 2011).

Cognitive/socio-cognitive activities within collaborative learning are well covered and defined, but there is a lack of research showing how socio-cognitive and socio-emotional activities are intertwined in collaborative learning interaction. The general contribution of this study is in combining different dimensions of collaborative learning in order to understand effective collaborative learning interaction. The emotional reactions that are awakened in learning situations, such as the emotional atmosphere within the learning context as well as the interaction between learners, all contribute to the learning process (Meyer & Turner 2006). Overall, when aiming for successful collaboration with shared understanding, it is likely that conflicting views will emerge and put cognitive as well as emotional pressure on individuals in a group to balance the emotional climate to be productive in knowledge co-construction (Boekaerts & Corno 2005, Järvenoja & Järvelä 2009). These challenges highlight the importance of understanding how collaborative groups jointly coordinate their interactions in ways that are productive (Summers & Volet 2010, Volet et al. 2009). When some members of the group, for example, are left out or withdraw from the group and its activities, they have less opportunity to engage in knowledge construction and make task contributions, with consequences for their individual learning but also for the group’s shared outcomes. This dissertation is built on the idea that in collaborative learning situations, the key to effective learning is a balance between socio-cognitive and socio-emotional activities. Within the socio-emotional dimension, monitoring of the socio-emotional climate, emotional experiences and emotional expression is needed (Baker et al. 2013, Järvelä et al. 2010). The study concludes that in order to understand what makes collaborative learning either successful or unsuccessful, the research needs to target both socio-cognitive and socio-emotional activities.
6.2 Individual interpretations of socio-cognitive and socio-emotional activities in collaborative learning

How students interpret the learning situation and the group activities they are engaged in can have a great influence on their current functioning as a group within the situation, but also on their future individual interest in and approach to collaborative learning tasks. This study revealed the students’ interpretations in terms of the collaborative learning challenges they reported experiencing, but also, and most importantly, how they experienced socio-emotional conflict situations.

The results show what kind of cognitive, motivational and socio-emotional challenges students in collaborative learning groups were experiencing (Article III). In this study, the most significant challenge type was socio-emotional challenges. Students described their groups’ challenges, including: a lack of connection within the group, overruling interactions, jealousy, the need to please someone, incompatible styles of interaction and, overall, a lack of team cohesion (Barron 2003, Chiu & Khoo 2003, Salomon & Globerson 1989). The motivational challenges the students experienced were: different goals and interests for the task, and commitment problems, as not all the group members were fully devoted to the group work (e.g. Blumenfeld et al. 1996, Järvelä et al. 2008). The least-reported issue was cognitive challenges (e.g. Kirschner et al. 2008): different uses of terminology and different task understandings, as well as superficial conversation, were experienced as group challenge. Challenges are a natural part of group functioning, but how the challenges are interpreted and treated is critical for the groups’ success (Van den Bossche et al. 2006). It can be argued that if group members are positively attached to a group, they are more likely to overcome the challenges productively (Linnenbrink-Garcia et al. 2011). In contrast, more negative outcomes of challenges are possible when students are not positively connected as a strong and well-functioning group (Carless & De Paola 2000, Sargent & Sue-Chan 2001) or when there is an apparent asymmetrical relationship between the group members (Salonen et al. 2005).

In this study, the results indicate that the socio-emotional conflict that the case group experienced had a great influence on the students’ learning experience; due to the conflict they were unable to feel success as a group (Article III). For some of the students, the pressure of the conflict created a mismatch with their learning intentions that also lowered their on-task engagement. Furthermore, some of the students described their emotional arousal increasing in the situation
and thus not being able to participate fully in the group activities. The group members explain that they escaped the unpleasant situation and regulated their own negative emotions by withdrawing from the group activities or by concentrating on the secondary issues (Boekaerts 2007, Op’t Eynde et al. 2007). Above described illustrations are examples of situational interpretations that are related to judgments, such as whether the learning situation is threatening to individual wellbeing, as well as what is required from the individual to handle the situation (Boekaerts & Niemivirta 2000). Regulating emotions and maintaining focus in the face of obstacles plays a central role in Boekaerts’ dual processing self-regulation model (2007). Learners who feel unable to control emotionally challenging learning situations will focus on coping with their emotions rather than on participating in problem-solving.

Overall, this study adds empirical example to the research evidence, that success as a group is not self-evident and the students can experience several types of challenges during their learning in interaction. It concludes that, within collaborative learning, situations are built based on interaction between participants’ understandings, interpreted through their previous experiences, interests and commitment towards the task and the group (Boekaerts & Minnaert 2006, Cahour 2013, Linnenbrink-Garcia et al. 2011). Within this dynamic learning process, how students interpret the situation and the interaction with others becomes essential.

### 6.3 Influences of socio-cognitive and socio-emotional activities on collaborative learning

In general, this study indicates what kinds of socio-cognitive and socio-emotional activities emerged in collaborative interaction and how the students themselves interpreted these activities. It also discusses the influences of the activities on student groups’ collaboration and learning. This study highlights that the occurrence and quality of these socio-cognitive and socio-emotional activities can be used to explain why some of the groups were successful and some were less successful in their collaborative learning; why higher or lower learning gains were achieved and good or weak collaborative learning practices were developed.

In the first empirical study (Article I) the activities used for processing one’s own, others’ and shared ideas further were advocated as an indication of successful collaboration. In other words, the results show the difference of merely adding information to the discussion and elaborating it further (Baker 1995 and
This study also highlighted that pictorial knowledge representations functioned as an affordance for a shared reference point in group members’ knowledge co-construction. Furthermore, pictorial knowledge representations also encouraged the use of metaphors in interaction, and this was regarded as an indicator of deeper cognitive understanding. Shared metaphors in particular were interpreted as an indicator of deeper shared understanding. To conclude, the student group as well as the cognitive tools they used for their interaction created contextual affordances for collaborative learning.

The influence of socio-cognitive activities were also approached in the second study (Article II), where the results identified the quality or level of questions and answers (high, average and low) that students contributed to the group discussion. The main findings of the study show that the well-performing group was the most active at the knowledge level (high-level questions and high-level answers) and also gained the best results in their knowledge test. This result indicates that knowledge-level activities and learning performance were intertwined. The results of the study also show the temporal variation in knowledge co-construction and monitoring activities in differently performing groups. Temporal analysis was implemented in order to evaluate whether groups differed in how they collaborated at the beginning and during their tasks (Article II). The results indicated that the well-performing group was active in high-level cognitive activities and monitoring activities; i.e. more actively monitoring content understanding from the beginning and throughout their group activities, whereas their weak-performing counterparts focused on monitoring task-level activities.

This dissertation shows that emotional balance and good group functioning is not self-evident. Many challenges can emerge during collaborative learning even when group members engage actively in knowledge co-construction activities (as described in section 6.2). In the previous section, the students’ interpretation of the challenges they experienced was explained. Here, the results of what kind of interaction created challenges are presented, as well as the influence on group functioning in terms of expression of emotions and regulation of emotions (Article III). For this purpose, previous studies of individuals’ emotion regulation (e.g. Boekaerts 2007, Op’t Eynde et al. 2007) were adapted to the group level. Based on the interaction analysis, including verbal and non-verbal interaction, an avoidance-, task- and problem-focused emotion regulation strategy was recognized (Op’t Eynde et al. 2007) and, more specifically, situation selection, situation modification, attentional deployment, situation re-appraisal and response
modulation (Gross & Thompson 2007). The results show how the case group’s collaborative learning was threatened as they employed avoidance-focused emotion regulation strategies to regulate socio-emotional challenges and restore emotional balance within the group (Boekaerts 2007, Op’t Eynde et al. 2007). In other words, students were unable to react successfully to the emotional arousal and frustration; thus, a conflict situation was created.

This study contributes process-oriented research evidence of what can happen when group members fail to satisfactorily regulate their emotional experiences and expression of emotions, resulting in the group becoming embroiled in a conflict situation. To conclude, this study indicates that unsolved challenges can be detrimental to effective collaborative learning as they arouse negative emotions, such as frustration, and move the focus away from on-task working (Ayoko et al. 2008). The study concludes that emotion regulation is important for creating an encouraging atmosphere and for balancing the group working environment. Finding a balance in the expression of emotions is required to sustain engagement in collaborative learning. In order to continue effective task-oriented collaborative learning and to avoid negative experiences, members of a group should direct their attention to solving the challenges and conflicts as well as reducing and regulating negative emotions (Järvenoja & Järvelä 2009, Järvenoja et al. 2012).

This study, however, does not advocate that emotions need to be put aside in group learning; rather, it implies that the occurrence and intensity of the emotional reaction should be controlled (Gross & Thompson 2007). Emotional expression can even be beneficial for learning and interaction since it enables people to take into account others’ feelings and to modify the group’s interaction accordingly (Boekaerts 2011, Rimé 2007). This is particularly central in collaborative learning, where the socio-emotional atmosphere is strongly present (Linnenbrink-Garcia & Pekrun 2011). The process of monitoring emotional experience and balancing the group’s socio-emotional atmosphere are thus emphasized as essential feature of a well-working group. To conclude, effective and enjoyable collaborative learning is not about outperforming others; it is about monitoring and directing one’s own and one’s learning partners’ understanding, interests and feelings towards the group, task and content that makes collaborative learning either successful or unsuccessful.
6.4 Exploiting process-oriented data for understanding group activities, influences and interpretations

Methodological choices in this dissertation study have been guided by the idea of focusing on the actual learning interaction and using a process-orientated approach (Articles I–IV). Furthermore, design-based and case study approaches were implemented, and thus, in addition to the empirical results of the dissertation, the pedagogical design, including ideas of implementing pictorial knowledge representations as contextual affordances for individuals’ learning, and also to support group members’ shared learning processes, can be treated as an important result of the study. The analysis schemas developed in the study (for analysis of knowledge co-construction, monitoring activities and socio-emotionally challenging interaction and emotion regulation) in Articles I–III also have methodological implications and are treated as methodological results of this dissertation.

Collaborative learning research has, to a large extent, concentrated on studying learning in well-arranged problem-solving tasks. However, the problem with this kind of approach is that it simplifies the multidimensional process of collaborative learning. This dissertation study explored collaborative learning during two authentic courses in a teacher education context as a multifaceted phenomenon, and thus used multiple perspectives and methods to obtain an understanding of collaborative interactions. The study was built on the idea that, in order to develop and design practices to support collaborative learning, research needs to target the real interactions and learning activities students engage in when collaborating to learn.

The methods for collecting and analysing data from authentic but designed collaborative learning situations were developed and employed in this study. The pedagogical and socio-technical design was developed in order to evaluate social interaction in small-group settings in two different data collection contexts and in four different analytical approaches. Methodologically, this dissertation followed a mixed-methods approach, and thus all the studies (Articles I–IV) used several types of data in the analysis, combining qualitative orientation with quantifying the interaction processes and learning gain of the students. Video-recorded interaction data was the most important type of data for this study, but it was also complemented with pre- and post- knowledge tests and stimulated recall interviews (video clips and pictorial knowledge representations as a stimulus). The interviews and knowledge tests complemented the process data with group
members’ individual interpretations and learning gain results. Interview data was particularly important in Article III, where students’ own interpretations of their group’s challenges and their emotion regulation in a socio-emotionally challenging situation were evaluated. In other words, the study combined interaction analysis and interview analysis to gain a more comprehensive view of what students in groups do and what they say they do (Gijbels et al. 2006). Particularly within the topic of socio-emotional challenges and emotion regulation, this approach was regarded as highly useful. Therefore, in addition to explicating what happens in group interaction, this study offers students’ own points of view and interpretations of their activities and also, what the learning results of their activities are.

The type of case study approach implemented in this dissertation study can fill a gap in the research on socio-cognitive and socio-emotional processes in collaborative learning and provide an explanation of how situations develop in interactions between group members (Greeno 2006). Several analyses of the video recordings enriched the understanding of group interaction as a moment-by-moment process (Barron et al. 2013). The advantages of in-depth interaction analysis were found particularly in evaluating how interaction emerges and how group members’ contributions were contingent on others. The process-oriented approach in this dissertation argues over three assumptions: 1. Students’ learning processes within a group vary across time and settings, and thus, generalization is not reliable or sought. 2. The features of the context are unstable and have different influences on participants in the context. 3. The direction of influence between learners and context is multidirectional. Thus, the conclusion within this study is to treat individuals and contexts in conjunction (Greeno 1998, Harrington & Fine 2006, Järvelä et al. 2013).

The methodological contribution of this study is related to process-oriented, contextual and temporal approaches to collaborative learning. The actual collaborative interaction was targeted in all of the empirical studies (Articles I–III). The process-oriented view captured effective knowledge co-construction activities but also dysfunctional interaction. To date, collaborative learning research has been criticized for its “coding and counting approach” (e.g. Arvaja 2012, Hmelo-Silver & Bromme 2007). Counting the number of turns that students take in a discussion and whether students’ participation is on-task or off-task has been regarded as an too narrow approach to provide an understanding of the process of collaboration. The aggregation of data – grouping utterances by types or codes rather than approaching them sequentially – ignores the complexity of
the relationships between the utterances and actions. The operationalization and quantifying interactional phenomena risks reducing rich relationships into categories that fail to capture the group processes and practices (Stahl 2006). The analysis schemas of this dissertation offer ideas of how to move on from a coding and counting approach to target the process of continuing each other’s ideas rather than purely concentrating on the single ideas contributed to the group discussion. The results of this dissertation study showed, for example, the transactive level of knowledge co-construction (Article I; Teasley 1997, Weinberger & Fischer 2006) and interactional challenges (Article III).

Today, the discussion has moved from process-oriented methods to considering how temporal and sequential data can inform the collaborative learning process (Molenaar & Järvelä 2014, Puntambekar 2013). In the study, the temporal aspect was evaluated by comparing temporal processes of well- and weak-performing groups’ monitoring activities (Article II). Within collaborative learning, a temporal approach can be particularly valuable as it explains the time and order of specific learning activities (e.g. Reimann 2009). Reimann with colleagues (2011) state that group learning is dependent on the groups’ previous actions; it is cumulative in that current knowledge influences future knowledge and has an anticipated future based on the interpretation of past experiences. Thus, following the development of a group’s interaction processes can also inform the stage of the group’s functioning.
7 Discussion

The group as a learning context is dynamic and constantly evolving; every new contribution is a new potential opportunity for group members to get involved in or withdraw from the group and its activities. Furthermore, all group situations are different as group members bring their prior knowledge, values and beliefs with them to their participation and the group develops along its working. This kind of multiple and dynamic system is a challenging target for research.

This study continues the research that highlights elaborating one’s own thinking and engaging with each other’s thinking as the main characteristics of productive small group interaction (Baker 1999, Barron 2003, Chi 2009, Webb et al. 1995). However, it also indicates that opportunities to benefit from knowledge co-construction may be lost if group members do not coordinate and regulate their learning and interaction; if they do not engage in active monitoring processes (Goos et al. 2002, Grau & Whitebread 2012, Pintrich et al. 2000). Uncoordinated conversations are characterized as students repeating their own ideas and positions, ignoring and rejecting others’ suggestions without elaboration, and interrupting and talking over others (Barron 2000). Thus, it can be concluded that successful collaborative learning requires proactive regulation from the group members; knowledge co-construction processes need to be activated, monitored, evaluated and sustained proactively (Volet et al. 2009).

Previous studies have indicated that student-led and inquiry-based activities are often very challenging (e.g. Kirschner et al. 2006) and effective collaboration skills are not self-evident (Dawes & Sams 2004, Littleton & Häkkinen 1999, Littleton & Miell 2004). In general, learning something new as a group requires challenging oneself, which also increases the possibility of cognitive and socio-emotional conflicts (Ayoko et al. 2008, Buchs et al. 2004, De Dreu & Weingart 2003, Garcia-Prieto et al. 2003). Within collaborative learning, and particularly with problem-oriented tasks, students may not even have a clear vision of what they are expected to accomplish individually and as a group. They are thus faced with a complex system of multidirectional influences between contextual meaning, emotions, collaboration and learning. It is quite clear that every learning situation is challenging, but particularly group contexts orient affective states that affect what kinds of actions students take and the relationships they together create. The mark of successful collaborative learning in this study is activities that are intended to coordinate and balance both socio-cognitive and socio-emotional processes; emotional experiences as well as expression of emotions.
In practical terms, the results of this study can be used to assist in designing instructional practices for collaborative learning. This dissertation study introduced an unbalanced and poorly functioning group. The results of their failures in collaboration and troubled interaction can be transformed into designing and implementing instructional support to overcome challenges within collaborative learning. For example, monitoring practices in general, related to content and task understanding as well as evaluating interests and group progress, could be highlighted in instructing and supporting effective collaborative learning. Furthermore, the instructional approach can be extended from cognitive orientation to acknowledging the importance of emotional monitoring and regulation of emotional expression during collaborative interaction.

One of the practical ideas behind this study has been the effort to design a learning environment that affords pre-service teachers new kinds of learning and interaction possibilities. The fundamental thinking behind this approach is that, in order to be able to transform schools to better correspond the requirements of the 21st century, future teachers need a modern pedagogical understanding and methods, based on their own experiences (Binkley et al. 2011, Griffin et al. 2012). Within the case studies in this dissertation, the participants were offered an experience of technology-enhanced collaborative learning activities that may stimulate participants’ future (or current) working life. In other words, this study’s practical implications are new ideas and understanding for the teachers and other educational professionals of the skills needed in 21st-century learning (i.e. collaboration and regulation skills) and how to support those skills in teaching.

It is especially critical to apply collaborative learning, as well as self- and socially shared regulation of learning, in teacher education. To succeed in the knowledge society, learners and knowledge workers need to – more often and more effectively – combine their expertise and ideas in various collaborative situations, to solve problems and to create new information and knowledge. Both formal training settings and everyday learning environments require the use of social skills and the ability to commit to coordinated work with co-learners or colleagues. The other practical implication of the study is related to the design of learning environments. This study followed a design-based research orientation and, in addition to exploring group’s learning, the overall learning environment was designed in multidisciplinary collaboration. From a practical perspective, this study highlights how recurrent individual, group and collective phases where students used multiple social media tools and mobile phones can be used to support collaborative learning. However, the detailed analysis, results and
discussion of technology-enhanced learning were excluded from the study, since these are reported elsewhere (Laru 2012, Laru et al. 2011, Laru et al. 2014).

The limitations of the research conducted need to be acknowledged. Foremost, the relatively small number of subjects in the research did not provide generalized information of collaborative interaction. However, the advantage of this study was that it was conducted in an authentic learning context and offered an in-depth view of group interactions. The second limitation of the study is related to the studying of socio-emotional activities in collaborative interaction; experienced affective movements may be masked and are not necessarily socially expressed. More specifically, the limitation of this study is that real access to the socio-emotionally experiences was dependent on the students’ willingness to engage in disclosure of their experienced emotions. Indicators of challenges and emotional experiences were detected based on the group’s interaction and the group members’ interpretation of the video stimulus. Thus, with this multiple approach the aim was to increase the reliability of the analysis related to emotional processes. The written report, in the form of research articles and thesis, is not sufficient to describe the participants’ emotional experiences and expression of emotions. They lack the non-verbal expression that is observed on a video recording of the interaction, such as gestures, posture and movements. It is obvious that when I, as a researcher, look at transcripts of these interactions, I can hear the voices, the enthusiasms about a great new idea or the frustration of not understanding the task, the anger in the voice of an offended participant, and the general engagement and disengagement of the students. But a reader without access to the video cannot. An attempt was made to overcome this limitation by offering several data examples, particularly in Article III. The broad perspective of this dissertation study can also set limitations; when several dimensions are approached simultaneously, the clarity of the study may suffer. However, the broad approach was chosen with the intention of offering a more illustrative view of collaborative learning.
8 Conclusions and future research

This study’s approach to collaborative learning is broad; it covers socio-cognitive and socio-emotional dimensions in knowledge co-construction and regulation within collaborative learning. Furthermore, three perspectives are implemented: activities, interpretations and influences. On one hand, the study explores what makes a collaborative group successful; however, in the last study this approach was reversed by pointing out factors that created socio-emotional conflict within the group and endangered successful collaborative learning. Overall, it is concluded that, as collaborative learning is wide-ranging, a broad focus is needed to explore cognitive as well as emotional perspectives to contribute to a discussion of what makes collaborative learning successful or unsuccessful. Each of these perspectives also offers ideas for future research.

Most modern authors agree that there has been a bias towards cognitive approaches in learning research, at the expense of socio-emotional or affective activities (e.g. Jones & Issroff 2005). Within collaborative learning research, previous studies have explored social and relational processes to some extent (e.g. Barron 2003, Kreijns et al. 2003). However, only recently has collaborative learning research started to acknowledge socio-emotional processes, emotional experiences and expression and regulation of emotions as an important explanation for effective collaborative learning (Baker et al. 2013). Further research is, however, needed to explore the socio-emotional characteristics of well- and poorly functioning groups.

The study shows how concepts which were initially developed for individual learning settings can also help to develop a socio-emotional perspective in collaborative learning research. In general, the impact of socio-emotional dispositions on thought processes is well established, but mostly in individual experimental settings (Linnenbrink-Garcia & Pekrun 2011, Schutz & Pekrun 2007). The psychological literature on emotions is often subject-centred and not group-oriented, concentrating mostly on individuals’ methods of appraising and coping in the critical situation for their own sake (Lazarus 1991). More work needs to be done on complex learning situations and ecologically valid contexts in order to gain a deeper understanding of these interactions between socio-emotional processes and complex cognitive activities in collaborative learning situations.

This study acknowledges that the emergence of an emotion is a subjective phenomenon which depends on individual characteristics, but also about
interaction with the specific situation and the meaning that the situation has for a person (Boekaerts & Minnaert 2006, Scherer & Tran 2001). Therefore, future research should aim to target both aspects: individual characteristics as well as contextual influence on experiencing strong emotions in collaborative learning situations. For example, knowing something about the actual challenges and emotional experiences learners confront (individually or collectively) in collaborative arrangements can provide information about what they are trying to accomplish as they experiment with or negotiate task understanding, shared goals, and cognitive or motivational strategies (Hadwin et al. 2011, Järvelä et al. 2014).

In the future, emotional experiences and expression should also be analysed in terms of different dimensions: for example, valency (positive and negative tonality), degree of arousal (level of intensity), triggering event, level of bodily reaction, degree of control, consciousness, and duration (Cahour 2013). These processes, based on the students’ interaction but also in connection to their physical reactions, could signal how the dynamics of collaborative learning are managed and why collaborative learning sometimes leads to undesirable outcomes (Barron 2003).

To conclude, the need for an emotional balance within group is clear when one considers the cognitive, motivational and emotional challenges of collaborative learning (Järvenoja & Järvelä 2009, Kirschner et al. 2006). However, more research needs to be carried out in order to understand how emotions circulate and interact with knowledge elaboration in natural settings. In the future, more specific theoretical models are needed that explicitly address the interplay between individual cognition, emotion and motivation with interpersonal communication and regulation, in the context of a collaborative learning environment.

The search for socio-cognitive and socio-emotional balance, not only for oneself but also for the persons with whom one interacts, or for the group itself, seems to be an essential process that should be a target for collaborative learning research. This ability to be in contact with others’ cognition and emotions is a primary source of intersubjectivity. How individuals as a group learn together; share and develop their ideas, and especially how they monitor their evolving understanding and emotional reactions, were the cornerstones of this study. Personally, participation in the improvisation theatre exercise was an eye-opener. In that world, it is not about how well one can act in front of the audience; it is about how to make one’s acting partner(s) shine! This example transfers well to collaborative learning – collaborative learning is not about outperforming others,
it is about monitoring and directing one’s own and one’s learning partners’ understanding, interests and feelings towards the group, task and content that makes collaborative learning either successful or unsuccessful. This study is an example that a group is more than the sum of its parts; something unique and often unpredictable is created between and within interacting minds.
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