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Maarit Arvaja

Collaborative knowledge construction

IN AUTHENTIC SCHOOL CONTEXTS

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Collaborative knowledge construction in authentic school contexts

Maarit Arvaja

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Arvaja, M. 2005

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Abstract

This study explored collaboration and its prerequisites in three different learning projects conducted in authentic classroom settings. The aim was to study how collaboration is manifested in students' shared activities and especially what features in the learning context were enhancing or restricting successful collaboration. Furthermore, one general aim was to find methodological tools for studying the process of collaboration and its intertwined social, cognitive, and contextual aspects in students' ongoing activities.

All the studies concerned lower secondary education. In the first and second study the participants were one student group working on a science report writing assignment. In the third study the main focus was on studying interaction between the students of two schools participating in a history project on Imperialism through a role-play in a web-based environment. The fourth study dealt with a student pair's working on Cultural history project face-to-face at a computer and engaged in a web-based discussion.

The data were collected by various means. In all of the studies students' activity was videotaped, students' were interviewed and they filled out questionnaires. In addition, in two of the studies the material produced in the web-based environment was collect-

ed. The general approach of this study was a case study approach, each of the three projects representing an individual case on a same theme; how collaboration is manifested in students' activity. The main analysis method used in the studies can be called qualitative content analysis (Chi 1997). The interaction was systematically and extensively analysed according to categorisations that arose both from theoretical and empirical, data-based contents.

Results showed that collaboration where students were engaged in cognitively high-level construction of shared understanding was rare. Instead, the nature of interaction both in face-to-face and computer-mediated situations was mostly uncritical knowledge sharing, where the topic in question was not discussed very deeply. Even though the study was looking for cognitively productive interaction, it became clear in all of the studies that the context for productive interaction presupposed 'productivity' also at the social and emotional level. It presupposed mutual and equal (symmetrical) involvement and engagement to construct shared understanding. Collaboration also presupposed a positive atmosphere for enabling engagement and for creating a safe environment for 'productive' conflicts and disagreement.

All the studies demonstrated that shared knowledge construction typically occurred in situations where students had a clear task assignment and where the task itself triggered reasoning. In addition to task nature, the level of structuring students' activities seemed to have an effect on the quality of students' interaction. Students were able to better engage in working and constructing shared knowledge when the task was clear and well defined, whereas too general tasks made the engagement and orientation to the task difficult.

Another essential feature influencing the nature of interaction was students' interpersonal relations. Interaction between friends was more collaborative than between non-friends. It seemed that in the context of close relationship students were able to communicate more openly with each other. Another social issue studied was the symmetry of students' knowledge-based roles in the activity. Students' symmetrical relations changed depending on the other influential social and contextual factors in the situation.

In two of the projects, a technology-based environment was used as a part of the learning activities. In both of these projects technology was used mostly for interaction between participants. Partly because of lacking structuring or guidance by the teacher or by the technological application, students' web-based interaction remained superficial and aimless and was obviously motivated more by personal entertainment than by

the school task itself. The value of technology in these two projects seemed to be more in entertaining students than in supporting collaboration.

Altogether, the results of these studies suggest that there is not any single factor that could be pointed out as the reason for successful or unsuccessful collaboration in school contexts. Rather, it is a sum of many intertwined cognitive, social, emotional and contextual features involved in the specific situations. In the area of collaboration there is a need for more process-oriented research that reveals not only the core process of collaboration, as such, but also those features in the learning context that support or hinder it. Process-oriented research of collaboration is needed to capture the situational dynamics of learning together and thereby shed light on collaborative knowledge construction as a temporally evolving context-bound phenomenon.

Keywords: collaborative learning, knowledge construction, learning process, social interaction, computer-assisted instruction, computer-supported collaborative learning, learning context

Arvaja, M. 2005

Kollaboratiivinen tiedonrakentaminen kouluprojekteissa

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Tiivistelmä

Tämän tutkimuksen tarkoituksena oli selvittää kollaboraation eli yhteisen tiedonrakentamisen ilmenemistä ja sen edellytyksiä peruskoulun yläasteella kolmessa erilaisessa oppimisprojektissa. Tavoitteena oli tutkia yhtäältä kollaboraatiota oppilaiden yhteisessä toiminnassa ja toisaalta selvittää niitä tekijöitä, jotka estävät tai edistävät korkeatasoista yhteisen tiedon rakentamista. Tutkimuksella pyrittiin pureutumaan kollaboratiivisen oppimisen prosessiin ja erityisesti niihin sosiaalisiin ja kontekstuaalisiin tekijöihin, jotka ovat yhteydessä korkeatasoiseen tiedonrakentamiseen. Tutkimuksen tavoitteena oli lisäksi löytää metodologisia välineitä kollaboratiivisen oppimisprosessin ja siihen yhteydessä olevien kognitiivisten, sosiaalisten ja kontekstuaalisten tekijöiden tutkimiseen.

Kaikissa kolmessa projektissa tutkimuksen kohteena olevien oppilaiden toimintaa videoitiin, oppilaita haastateltiin sekä kaikki oppimisprojektiin osallistuvat oppilaat täyttivät kyselylomakkeita. Tutkimuksen yleinen lähestymistapa oli tapaustutkimus. Tällöin kaikki kolme projektia edustivat yksittäistä tapausta samasta tutkimusaiheesta eli siitä, kuinka kollaboraatio ilmeni oppilaiden toiminnassa. Tutkimuksessa käytettyjä analyysimenetelmiä voitaisiin yhteisesti kutsua laadulliseksi sisällönanalyysiksi (Chi 1997). Vuorovaikutusta analysoitiin systemaattisesti erilaisten luokitusten avulla, jotka perustuivat sekä teoreettisiin oletuksiin että aineistolähtöisiin luokituksiin.

Tulokset osoittivat, että kollaboraatio, jossa oppilaat olivat sitoutuneita kognitiivisesti korkeatasoiseen yhteisen tiedon rakentamiseen, oli tutkituissa projekteissa harvinaista. Sen sijaan sekä kasvokkain tapahtuvassa keskustelussa että verkkokeskustelussa vuorovaikutus oli pääosin luonteeltaan epäkriittistä tiedonjakamista. Vaikka tässä tutkimuksessa etsittiin kognitiivisesti 'tuottavaa' vuorovaikutusta, kaikki tutkimukset osoittivat, että tuottava vuorovaikutus edellytti 'tuottavuutta' myös sosiaalisella ja emotionaalisella tasolla. Kollaboratiivinen vuorovaikutus edellytti molemminpuolista ja tasa-arvoista osallistumista sekä sitoutumista yhteisen ymmärryksen luomiseen. Näin ollen oppilaat neuvottelivat sekä kognitiivisella että sosiaalisella tasolla.

Kaikki tutkimukset osoittivat, että korkeatasoinen yhteinen tiedonrakentaminen tapahtui yleensä tilanteissa, joissa oppilailla oli selkeä oppimistehtävä tai he pystyivät asettamaan selkeän tavoitteen työskentelylleen ja joissa oppimistehtävä oli luonteeltaan pohtimista tukevaa. Tällaisissa tilanteissa oppilaat vastasivat esimerkiksi kysymyksiin, jotka peräsivät selityksiä ja johtivat erilaisten näkemysten pohtimiseen. Sen sijaan esimerkiksi faktatietoa peräävät kysymykset johtivat helposti epäkriittiseen tiedonjakamiseen. Tehtävän luonteen lisäksi kaikki tutkimukset osoittivat, että tiedonrakentamisen laatuun vaikuttivat oppilaiden väliset henkilökohtaiset suhteet. Ystävien välinen vuorovaikutus oli kollaboratiivisempaa kuin pelkästään luokkatoverien.

Tieto- ja viestintätekniikkaa käytettiin osana oppilaiden toimintaa kahdessa projektissa. Kuitenkin teknologian arvo yleisesti näissä projekteissa oli enemmänkin oppilaiden viihtymisessä kuin kollaboraation tukemisessa. Eräs tärkeä tekijä, joka vaikutti oppilaiden kollaboraatioon, oli sosio-kulttuurinen konteksti, joka ilmentyi oppilaiden toiminnan kautta. Kaikkien neljän tutkimuksen perusteella voidaan päätellä traditionaalisen koulukulttuurin olevan vahvana läsnä oppilaiden toiminnassa. Tämä näkyi fakta- ja asiantuntijatiedon arvostamisena ja omien ajatusten väheksymisenä sekä epäkriittisenä tiedon jakamisena. Voidaankin sanoa, että korkeatasoisen kollaboratiivisen toiminnan tukeminen edellyttää lähes koko koulukulttuurin muutosta.

Kaiken kaikkiaan tämä tutkimus osoitti, että ei ole olemassa yksittäistä tekijää, joka voitaisiin osoittaa kollaboraation onnistumisen tai epäonnistumisen syyksi autenttisissa luokkatilanteissa. Kollaboraation onnistumiseen tai epäonnistumiseen vaikuttavat monet yhtyeenkietoutuneet kognitiiviset, sosiaaliset, emotionaaliset ja kontekstuaaliset tekijät kussakin spesifisessä ympäristössä. Kuitenkin tämä tutkimus paljasti joitakin kollaboratiivisen oppimisen perusprosesseja ja sitä tukevia ja estäviä tekijöitä. Tämä olisi ollut mahdotonta, jos tutkimuksessa olisi keskitytty pelkästään kognitiivisiin tekijöihin, mikä kollaboratiivisen oppimisen tutkimuksessa on yhä hallitseva tapa.

Tämän tutkimuksen avulla ei voida tehdä laajoja päätelmiä kollaboraatiosta autenttisissa koulukonteksteissa tutkimusjoukon pienuuden takia. Kuitenkin jokaisesta tapauksesta saadut tulokset olivat samansuuntaisia. Näin ollen tämän tutkimuksen avulla saatiin viitteitä niistä kollaboraatiolle olennaisista tekijöistä, joita seuraavissa tutkimuksissa voidaan tutkia laajemmilla oppilasjoukoilla ja erilaisissa konteksteissa. Tutkimuksen toivotaan antavan myös opettajille apua ja välineitä kollaboratiivisten projektien suunnitteluun, toteuttamiseen ja arviointiin eli kollaboratiivisen koulukulttuurin luomiseen.

Asiasanat: kollaboratiivinen oppiminen, yhteisöllinen oppiminen, tiedon rakentaminen, oppimisprosessi, sosiaalinen vuorovaikutus, verkko-opetus, oppimisympäristö

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My work at the Institute for Educational Research (IER) started in 1997 when I was hired for a research project called CATO (Collaboration and Authenticity in Open Technologically Enriched Learning Contexts). The CATO project was part of the Information Research Programme of the Academy of Finland. This thesis has strong roots in the CATO project and its main ideas. However, the ideas and thoughts presented in this thesis have also evolved and been further refined since that project as I have had the opportunity to participate in research activities more broadly as a member of the Research Team on 'ICT in Learning and Working Environments' lead by Professor Päivi Häkkinen. In fact, looking back I now realise that this thesis is a result of a wide range of collaborative moments with many different people in various contexts.

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Jyväskylä, February 2005 Maarit Arvaja

LIST OF PUBLICATIONS

I Arvaja, M., Häkkinen, P., Eteläpelto, A. & Rasku-Puttonen, H. 2000. Collaborative processes during report writing of a science learning project: The nature of discourse as a function of task requirements. European Journal of Psychology of Education 15(4), 455–466.

II Arvaja, M., Häkkinen, P., Rasku-Puttonen, H. & Eteläpelto, A. 2002. Social processes and knowledge building during small group interaction in a school science project. Scandinavian Journal of Educational Research 46(2), 161–179.

III Arvaja, M., Rasku-Puttonen, H., Häkkinen, P. & Eteläpelto, A. 2003. Constructing knowledge through a role-play in a web-based learning environment. Journal of Educational Computing Research 28(4), 319–341.

IV Arvaja, M. Contextual resources in the process of negotiating meanings in a web-based history project. Submitted for publication.

In the text, the original publications are referred to as 'articles' with Roman numerals I–IV.

The work reported in the three jointly authored articles (Articles I–III) was done to a great extent by the first author. The first author collected and analysed the data and reported the findings in all of the three studies. In Article I the theoretical background was written jointly with the second author. In Articles II and III the role of the three other authors concentrated on commenting the work of the first author and offering suggestions throughout the research and writing process.

1
Introduction

Collaboration and collaborative learning have become common terms occurring frequently in discussion among teachers, researchers, and politicians. In school curricula collaboration and collaborative learning are mentioned as an important means for developing learning and instruction in schools. This has been an answer to the requirements that information society sets for its citizens. Contemporary work requires ability to work productively with others, since a lot of work today is done in groups, teams and larger networks. Furthermore, it has been suggested that modern work requires the ability to communicate, negotiate and anticipate what is to be done in practice rather than just doing the job as such (Iedema & Scheeres 2003). However, from the teachers' perspective there are also other current values in support of collaboration and collaborative learning than just the mission to prepare future workers. Many studies have demonstrated that students do learn better in groups than individually. In addition, the teachers have acknowledged the motivating value of doing things together. Furthermore, collaboration is seen as one way to support students' own active knowledge construction – which is the cornerstone of the constructivist learning approach – instead of knowledge transferred from teachers to students.

What is collaboration and collaborative learning, after all? Both in everyday discussions among practitioners in the schools and among researchers in the field of learning and instruction, the term collaboration is sometimes used very loosely and the definition of collaboration is blurred. In many notions it has been regarded similar to cooperation, which is typical activity in school projects, where the students work towards a shared goal, usually a shared product, but the actual work is divided. In addition, it is

sometimes referred to very generally as a shared activity of the students, interaction between students or participating in learning communities. However, in those notions the nature of activity, interaction or participation is not specified. Here collaboration refers to a specific type of activity, where the students are together engaged in cognitively high-level construction of shared knowledge or understanding about the issues addressed. The purpose of this study is to explore how collaboration is manifested in students' activity in different classroom learning projects and what features in the learning contexts support or hinder it.

Recently, research interests have increasingly shifted from the outcomes and products of collaborative work towards analysing the processes of collaboration. This shift shows as attempts to gain understanding about the nature of productive joint activity and to identify interactional features that are important for collaborative learning. (Littleton, Faulkner, Miell, Joiner, & Häkkinen 2000.) However, we still lack studies where the nature of collaboration is considered in the larger framework of students' activity. Whereas the previous studies, to a large extent, have focused on the processes of collaboration mostly from a cognitive perspective, this study extends the perspective also to the social and contextual aspects of collaborative activity and to the classroom communities in which collaboration is embedded. Altogether, this research is hoped to contribute to the theoretical and pedagogical understanding of collaboration and collaborative learning.

2
Theoretical background of the study

2.1 Collaboration as a type of interaction

The most widely used definition of collaboration describes it as a construction of shared understanding through interaction with others, where the participants are committed to or engaged on shared goals and problem solving (Dillenbourg 1999; Littleton & Häkkinen 1999; Roschelle & Teasley 1995). In addition to the construction of shared understanding, collaboration is commonly referred to as co-construction of knowledge (e.g. Rafal 1996; Baker 2002), building collaborative knowing (Stahl 2004), co-argumentation (Baker 2002), negotiating of shared meaning (Pea 1993), construction of common knowledge (e.g. Elbers & Streefland 2000; Crook 2002), exploratory talk (Mercer 1996), or coordination (Barron 2000). However, in closer inspection, the core of all these terms seems to refer to interaction of a similar type, which will be discussed in more detail in the following.

Baker (2002) defines collaboration as "a symmetrical and aligned form of co-operation in problem solving independently of whether the participants agree or not". Baker sees such collaborative activity as a prerequisite of collaborative learning. According to Baker, interaction is *symmetrical* if the participants adopt certain roles equally throughout the interaction, i.e. participate equally in problem solving. Even though Baker does not refer to symmetry of knowledge (Baker 2002), certain degree of knowledge symmetry is essential to enable equal roles (Dillenbourg 1999). If the knowledge level of the participants is very different, it easily triggers different (permanent) statuses

and roles in the learning situation (Cohen 1994). Also Van Boxtel (2000) sees that the essential prerequisite for co-construction is that all participants equally contribute to the elaboration and solution of the problem at hand. In her work she describes co-construction as an elaborative episode in which both (all) participants make a verbal and propositional contribution to the elaboration.

In Baker's (2002) definition the degree of *alignment* refers to the extent to which participants are 'in phase' with respect to different aspects of the problem-solving activity, that is, to what extent they are genuinely 'working together'. On the one hand, the degree of alignment depends on the extent to which the participants are focusing on the same stage in their problem-solving activity. One student may, for example, still be reading instructions while the other one has started to think about the problem at hand. In the case of complete non-alignment students are trying to solve the problem alone although with the physical presence of the others. Or students may divide the task to sub-tasks which individuals complete alone (Linn & Burbules 1993). This kind of division of labour is called vertical (Dillenbourg 1999), and in the literature it is typically referred to as co-operation (Cohen, 1994). On the other hand, working together is closely related to the term 'grounding', which refers to the process of constructing and maintaining mutual understanding (Clark & Schaefer 1989; Baker, Hansen, Joiner & Traum 1999). For example, interaction is non-aligned in a situation where students have no mutual (conceptual) understanding of the problem or the concepts at hand, and thus, are not genuinely able to work together (until they negotiate a shared understanding). Sfard and Kieran's (2001) term 'coherent communication' refers to a similar phenomenon. Communication is coherent when all the participants know they are referring to the same things when using the same words. Maintaining and constructing shared understanding requires continuous attention and reflection on one's own and other's understanding (Baker 2002). Baker's third dimension, the degree of *agreement-disagreement* describes the extent to which the participants have similar views with respect to the different aspects of the problem-solving activity. These three dimensions – symmetry-asymmetry, alignment-nonalignment and agreement-disagreement – in various combinations define different types of co-operation. Collaboration is manifested in symmetrical and aligned co-construction (agreement) and co-argumentation (disagreement) (Baker 2002).

Barron's (2000) term 'co-ordination' in some respect comes close to Baker's (2002) model in defining the essential establishment for mutual knowledge in the case of collaborative problem-solving. The extent to which a group works collaboratively de-

pends on the degree of co-ordination among the group members. In her study comparing the interaction of successful and less successful student triads, Barron (2000) found three forms of co-ordination by which the interaction of those groups differed. The group activity is co-ordinated in a situation where the students have *shared task alignment*. In such situation the students have collaborative orientation toward problem solving, and the activity is organised around joint problem-solving efforts. In groups' activities this is manifested in co-construction of solutions and referring to and expanding each other's ideas as opposed to individual solution paths and reference to one's own ideas. The success presupposes that participants have achieved common ground (Clark 1996) or alignment in the sense that students are working 'in phase' at the same conceptual level (Baker 2002). Barron (2000) adds that there may be some complementary role division in the activity as in a situation where the other person is generating ideas while writing and the other one is monitoring the documentation. Thus, there is some horizontal division of labour while the other person is acting at the task level and the other one at the meta (communicative) level (Dillenbourg 1999). In Baker's (2002) terms, this situation would not be considered symmetrical, as such. However, as Barron (2000) states, these functional roles are often interchanged. Thus, as a whole, such interaction can be considered symmetrical also in Baker's (2002) terms.

Mutuality, Barron's second form of co-ordination, refers to the extent to which there is reciprocity and balance in interaction with potential of all members to meaningfully contribute and to be heard. With this respect this comes close to Baker's (2002) notion of symmetry. Mutuality is reflected in the nature of dialogue; how the contributions of others are treated in the discussion, how the ideas offered are engaged by others. Barron refers to transactive dialogues, introduced by Berkowitz and Gibbs (1985), where one partner's reasoning 'operates on another partner's reasoning'. In interaction the content of the other person's turn of speech is taken into account and acknowledged, for example, by acceptance, clarification or elaboration instead of rejection without explanation. Even the conflicts that arise in the situation are productive (Barron 2000). It is also typical of mutuality that the turn-taking norms are respected.

The third dimension of co-ordination is the degree to which the *attention* is *jointly focused* during solution-critical moments. In the interaction there is high sensitivity to one another's attentional states. According to Barron (2000), joint attention is closely related to the notion of mutuality. Also the notion of joint attention has similarities with Baker's (2002) term 'alignment' in the sense that in the occasions of joint attention all the students are working 'in phase' with respect to the activities, and there is not

even horizontal division of labour. As a whole the three dimensions of co-ordination; shared task alignment, mutuality and jointly focused attention; can be regarded as different intertwined aspects of collaborative interaction. For example, co-construction of knowledge is not possible unless group members' have joint focus or mutuality in the situation.

Mercer sees shared knowledge construction as a social mode of thinking that is manifested in talk. *Exploratory talk* occurs when participants engage critically but constructively in each other's ideas. In exploratory talk statements and suggestions are offered for joint consideration. These are challenged and counter-challenged with justifications and alternative hypotheses. In exploratory talk, knowledge is made publicly accountable and reasoning is visible. *Cumulative* and *disputational talk*, instead, is talk that does not promote joint critical problem solving (Mercer 1996). In cumulative talk the participants build positively but uncritically on what the other has said. The participants use this type of talk to construct common knowledge by accumulation. Repetitions, confirmations and elaborations are typical in cumulative talk. Disputational talk is characterised by disagreement, competitiveness and individual decision making. There are few attempts to solve problems together or to offer constructive criticism or suggestions. Similar kind of division can be found in the study by Keefer and colleagues (2000) where they identified three types of talk – critical discussion, consensus dialogue, and eristic dialogue – that differed in their contribution to shared knowledge construction.

According to Mercer (1996), different types of talk each represent a different way in which the participants in a dialogue engage in the joint construction of knowledge. The exploratory and cumulative types of talk have similarities both to Baker's (2002) and Barron's (2000) descriptions of collaboration. Cumulative talk can be considered as constructing of shared knowledge, where the knowledge is constructed through sharing of (same) perspectives (Wegerif & Mercer 1997). However, the subject is not reasoned very deeply. Thus, in such situation the participants do not produce critically grounded knowledge. The ground rule of cumulative talk is to maintain the cohesion in the group (Wegerif & Mercer 1997). This type of interaction can also be referred to as a conflict-avoiding co-operation style (Fischer 2002). Baker's (2002) notion of co-construction can refer to the cumulative kind of knowledge construction, where different perspectives need not be considered, but the knowledge discussed is uncontroversial. Thus, the students' working is aligned and symmetrical and based on agreement (Baker 2002), and they complement or continue each other's ideas (Rafal 1996), but do not

engage in any deep reasoning of the subject. Also Barron (2000) states that students' activity can be high in degrees of mutuality, joint attention and shared task goals, but little progress is made. In contrast, the ground rules of exploratory talk (Mercer 1996) and co-argumentation (Baker 2002) are such that participants not only construct shared knowledge but also critically assess the quality of that knowledge being open to alternative perspectives. In exploratory talk and co-argumentation, competition may exist but between ideas rather than between people. Thus, the sense of co-operative identity is maintained as a framework in which different perspectives can be tested out (Wegerif & Mercer 1997). According to this view, the 'productivity' of collaborative situations varies thus depending on the cognitive quality of discussion and reasoning.

Most of the above-mentioned definitions of collaboration (Baker 2002; Barron 2000) are based on studies where collaboration occurs in a well-defined problem-solving activity, taking place in face-to-face situations in small groups. However, collaborative knowledge construction can also take place without a pre-formed problem for example in more open-ended discussions (Järvelä & Häkkinen 2002). In addition, in longer project works with different activities the tasks may change over time and be far from well-defined problem-solving tasks. Crook (2002) proposes that the definition of collaborative engagement could be phrased more aptly as 'a coordinated effort to build common knowledge' instead of 'coordinated effort to solve the problem together'. In this study collaboration is considered as a cognitively high-level coordinated effort to construct shared knowledge or understanding on the issue at hand, and it is studied in different project work contexts.

2.1.1 Collaborative interaction as a duality of social and cognitive aspects

The descriptions presented above illustrate well the dual nature of collaborative interactions. According to Barron (2003), in collaborative activity the participants have to develop and monitor both the content space and the relational space, or as Sfard and Kieran (2001) put it the object and meta level of communication. The content space refers to the cognitive aspect of collaboration: How the subject at hand is reasoned, how the ideas are developed in discussion, how the shared understanding is constructed. Relational space refers more to the way in which participants in dialogue (or monologue) orientate towards each other (and how willing they are to engage in interaction) (Barron 2003). In the joint activity the students may have collaborative orientation in

their working or the situation can be competitive, individualistic (Barron 2003; Sfard & Kieran 2001; Mercer 1996) or asymmetrical (Baker 2002). In a competitive situation individual participants define themselves through their difference from the others, each having their own competing interests, which they try to drive through (Wegerif & Mercer 1997). Thus, the participants easily end up with disputing rather than arguing for their case. In individualistic orientation each student follows his or her own paths of reasoning. Thus the interaction is more monological than dialogical. For example, in Barron's (2003) study the students in 'failed groups' each tried to present and construct their own solutions for the problem. In asymmetrical situations participants have no possibility to make an equal contribution to the discourse. Reasons may relate, for example, to knowledge (Dillenbourg 1999) or status differences (Cohen 1994). In their study Kumpulainen and Mutanen (1999) distinguished between individualistic, dominative, and collaborative modes of interaction according to the perceived degree of co-construction.

The content and relational spaces are negotiated simultaneously, and thus compete for limited attention. For example, if the relational space is more focused on competitive interaction or self-focused (individualistic) problem-solving, it prevents the participants from gaining joint attention and mutual engagement, and from reaching common ground on the same topic. At the same time success in the content space requires success in the relational space. The content and relational spaces thus have a reciprocal relationship, being part of the same collaborative process, and are hard to separate.

2.1.2 Emotional (and motivational) aspects of collaborative interaction

According to Van Oers and Hännikäinen (2001), the reason why collaborative activity ever leads to improved understandings is that the participants in the situation are willing to share their understanding and keep on doing so despite their disagreements and conflicts which inevitably arise in the course of comparing understandings. Thus, the participants feel an obligation to each other and stay together in this process. This notion of *togetherness* directs attention to the affective aspect of collaborative learning. Barron's (2003) notion of relational space can also be seen to refer to the affective dimension of collaboration, as well, although she speaks mainly about social or interpersonal aspects. That is because the relational space also has to do with the aspect of how willing the participants are to engage in interaction. This willingness to engage can be

seen related to emotional and motivational engagement in the situation (Crook 2000; Järvelä 2001). Van Oers and Hännikäinen (2001) suggest that studying the conditions and contradictions of personal involvement in a social activity might lead to a further understanding of the social affective dimension of learning processes based on collaboration. The basis for the tendency to togetherness is the personal sense that an individual attaches to a social activity.

Also Crook (2000) points out that the quality of experience felt is the variable we should study more carefully. He states that the affect that arises from the collaborative activity is related to the circumstances of the collaboration. Crook (2000) proposes a more *ecological* approach to the study of collaboration. Ecology refers to the immediate environments within which collaborative activity is supported – the artefacts, technologies and spaces for acting. The situation evokes more or less positive emotional reaction in us. This reaction is relevant to the motivation of greater or lesser task engagement. Crook (2000) criticises the study of collaboration for concentrating too much on short, self-contained occasions of arranged problem-solving. In these situations the participants are often volunteers who are readily interested to solve the agreed problems. Thus, emotional and motivational issues are in a way neutralised and the cognitive processes are stressed. However, positive collaborative experience may depend just as much on the participants' enthusiasm for engagement – or togetherness (Van Oers & Hännikäinen 2001) – as it arises from the positive experience of resolving a cognitive conflict (Crook 2000). Productivity of collaboration may also depend on events and experiences prior to the occasions themselves (Crook 1999). Students bring to an interaction a history of their shared experiences (Crook 1999). Awareness of common history may motivate engagement; it may be the driving force in the effort required for collaborative knowledge construction (Crook 1999). In studying collaboration one should orientate towards the social, cultural and material conditions surrounding the collaborative occasions, because it situates the collaborators within the larger system of activity (Crook 2000). This socio-cultural approach to collaborative learning is further discussed in the section 2.2.2.

2.2 Collaborative learning

The above-discussed definitions of collaboration describe the type of interaction that takes place in the case of (successful) collaborative activity. These definitions demonstrate the nature of collaboration, where cognitive, social and emotional aspects are

tightly intertwined. However, these definitions as such do not still explain how collaborative learning takes place. In the study of collaborative learning there are two main traditions that influence the way learning is seen to take place in collaborative interactions.

2.2.1 Socio-constructivist approach to collaborative learning

The research tradition building on the socio-constructivist perspective is interested in cognitive processes relevant to collaborative knowledge construction (Fischer, Bruhn, Gräsel & Mandl 2002). The underlying assumption of this approach is that the cognitive processes and outcomes of collaborative work are related. This type of research has focused on studying the relationship between the cognitive aspects of student interaction and individual learning. Positive results of collaborative interactions have been explained by the notion that peer interaction stimulates the elaboration of knowledge and hence promotes individual cognitive gains (Van Boxtel 2001). These individual gains are typically measured in pre and post test designs as refinement or change of conceptual knowledge structures. Thus, the main interest is in studying how collaboration contributes to individual knowledge construction, the mental content of individual minds.

The socio-constructivist perspective is based on the Piagetian view of learning according to which individuals actively construct knowledge by a process of equilibration. This means that individuals aim to hold a consistent, equilibrated conception of their world. Knowledge construction occurs when individuals accommodate cognitive structures to better represent the context. In accommodation the present knowledge structures or concepts are reorganised or new knowledge is constructed. From the viewpoint of learning, the state of disequilibrium of cognitive structures is important in enhancing the process of equilibration. According to neo-Piagetians (e.g. Doise & Mugny 1984), the socio-cognitive conflict, causing the state of disequilibrium, is one of the central mechanisms in collaborative knowledge construction (Kruger 1993). In many studies the students' difference in terms of knowledge or perspectives is stressed as a prerequisite for cognitive conflict (e.g. Dillenbourg 1999) and learning (Kneser & Ploetzner 2001). In peer interaction a socio-cognitive conflict may take place through another central mechanism of collaborative knowledge construction; namely externalisation (Fischer et al. 2002) or verbalisation (Van Boxtel 2001). By externalising their knowledge, ideas, values, presumptions, perspectives and views students may become

aware of their knowledge gaps and misunderstandings, and this pushes them to reconsider their conceptions to solve the cognitive conflict. Elicitation – asking questions and explanations – motivates externalisation further (Fischer et al. 2002). By receiving and giving explanations and answers, thus explaining and clarifying their own thoughts, students can complement their understandings and correct their misconceptions (Webb & Palinscar 1996). In order to enhance learning in collaborative situations, where the task is shared and usually a problem has to be solved, it is not enough to have a cognitive conflict but it must also be solved by coordinating different ideas, perspectives or views. Fischer and colleagues (2002) describes three types of such coordination; quick consensus building, integration-oriented consensus building and conflict-oriented consensus building. In many studies the negotiation to overcome a contradiction is reported to be a significant predictor of higher learning outcomes (Howe & Tolmie 1999; Light, Littleton, Messer & Joiner 1994; Chan 2001; Nastasi & Clements 1992).

Much of research on collaborative knowledge construction from the socio-constructivist perspective has concentrated on studying different types of interaction and their relation to learning. According to many studies, productive interaction manifested in cognitively high-level discussion is related to high-level understanding and learning (Howe & Tolmie 1999; King 1999; Van Boxtel et al. 2000). According to Van Boxtel (2001), high-level discussion is elaborative in its nature. Asking and answering questions, argumentation and reasoning can be considered as elaborative types of talk. Similar to elaborative talk is Kruger's (1992) notion of transactive discussion, originally suggested by Berkowitz et al. (1980). Transactive statements are critiques, refinements, extensions or significant paraphrases of ideas. Transactive questions are requests for clarification, justification or elaboration. Transactive responses are clarifications, justifications or elaboration of ideas given in reaction to transactive questions. Thus, these types of talk enhance the mechanisms important to knowledge construction described earlier. The quality of collaboration has been studied through the questions of how much and which types of elaborative talk there occur. Typically the categories of talk are defined at the level of utterances, for example by analysing communicative or strategic functions of utterances (e.g. Fischer et al. 2002; Kumpulainen 1996) or at the level of meaningful sequences of utterances, for example analysing the cognitive level of episodes (e.g. Kumpulainen & Mutanen 1999; Van Boxtel et al. 2000; Veerman 2000). One difficulty of the studies focusing just on interaction is that high-level interaction does not necessarily guarantee a high level of understanding or lead to solutions. Students may negotiate new misunderstandings, as well.

There are also studies in where different variables, for example friendship (Azmitia 1998) or nature of task (Van Boxtel et al. 2000) have been studied in relation to the quality of discussion and learning. These studies are discussed in more detail in chapter 2.3. In addition, there have been efforts to establish causal relationships between learning outcomes and different variables suggested to affect working and learning in groups, such as group composition (size, gender) (e.g. Light, Littleton, Bale, Joiner & Messer 2000). However, as Dillenbourg, Baker, Blaye and O'Malley (1995) remark, the problem with these kinds of studies is that the variables interact in a way that makes it impossible to establish such causal relationships.

Most studies of collaboration under the socio-constructivist tradition are based on settings where students solve problems together and learning is measured on an individual basis as solving the problem or as conceptual progress indicated in pre- and post-tests. However, collaboration occurs also in situations where there is no possibility to know even the subject of discussion beforehand, not to mention the outcome. Thus, any pre- and post-evaluations of students' learning are impossible in such settings. The 'outcome' of the collaborative activity may then be described as a progress in an ongoing process at the group level rather than a solution in the form of a final answer or product. This means that learning has to be studied as comprised in collaborative knowledge construction activity. This is, in fact, how learning is studied under the socio-cultural approach discussed in the following section.

2.2.2 Socio-cultural approach to collaborative learning

The socio-cultural approach to learning, building on the Vygotskian framework (1978), emphasises the meaning of social interaction and activity in the process of knowledge construction, as well as the meditative role of tools and the historical and cultural settings in which the knowledge construction occurs. According to Wertsch (1991), it is not possible to study thinking and cognition independently of the social, interpersonal, cultural, and historical settings in which they occur. Cognition is a public, social process embedded within a historically shaped material world (Goodwin 2000) in the sense that it relies on conceptual and material resources and tools that originate in our culture (Bliss & Säljö 1999). To understand learning we have to study how people appropriate and master tools for thinking and acting that exist in a given culture or society (Wertsch 1991).

There are two different types of tools that mediate the human activity: psychological and physical (Vygotsky 1986). Psychological tools refer to mental tools; resources for thinking and acting that are stored in language or discourse (Säljö 1999). The most prominent medium for communicating everyday experiences is ordinary talk. However, there are also specialised forms of discursive practices for specific settings. For example, in school students learn to master psychological tools such as concepts, definitions and procedures relative to different areas like mathematics, history, language etc. (Säljö 1999). Physical tools refer to 'material', tools, for example computers, telephones, paper and pencil that people use to accomplish different activities. However, physical tools are not entirely distinct from psychological tools, because concepts are embodied in physical tools and they make physical tools meaningful for people (Bliss & Säljö 1999). In a sense people store their knowledge and experiences in physical (and psychological) tools (Bliss & Säljö 1999). According to Vygotsky (1978), the use and meaning of tools are first learned in interaction with others at the interpersonal level (externalisation) and after this they are internalised as tools at the intralevel. These internalised tools are used as a resource in all kinds of activities. For example, certain concepts are re-externalised in the new act of sense-making as in the case of collaborative knowledge construction through which new concepts or understandings (=tools) are built.

Understanding collaborative learning requires making sense of the conversation that students engage in and the tools that mediate their learning instead of studying the mental content of individual minds (Hmelo-Silver 2003). Stahl (2004) describes collaborative knowledge construction as a cyclical process where individual's tacit understandings – related to phenomena, concepts or material tools available and relevant to understanding the topic under discussion – are made explicit, i.e. interpreted in the discourse. According to Stahl, building on Polanyi (1966), tacit knowledge refers to knowledge that participants possess but may not be able to put in words. Tacit knowledge may include, for example, an ability to use some physical tools or unstated background knowledge about the world, about other people and objects referred to in discussion (Stahl 2004). Thus, in Vygotsky's terms, this tacit knowledge can be seen to be based on existing psychological or physical tools that may be used in the process of shared interpretation. In collaborative knowledge construction these tacit meanings are made explicit, clarified and negotiated in an interpretive process, and a shared understanding of the meanings is created as a result of this process (Stahl 2004). As discussion proceeds this explicitly stated and negotiated shared understanding, for example, about some concept, procedure or artefact becomes tacit knowledge that can be used as

a resource in developing understanding further, so that again something tacit is made explicit and in turn becomes a focus of attention. Collaborative knowledge about the subject at hand develops further and further by negotiating different viewpoints, perspectives and meanings in a continuous interpretive process mediated by psychological and physical tools. As a result of this process new tools are built. In their interpretive process the group construct a new degree of understanding about the topic they are discussing (Stahl 2004). This new knowing is something that the group creates, and it cannot be attributed to the mental processes of any one individual, nor to individual understandings. The resulting interpretation of group meaning can be made explicit by analysing the network of conceptual relationships constructed by the group discourse. Every object, action, word or utterance gets its meaning from its position within this interactive situation.

According to this view, learning is always situated and it must be considered in the context where it takes place. Thus, collaborative knowledge construction has to be analysed within the context of the group situated to a larger community, where the knowledge is distributed in the material and discursive environment in the form of tools, symbol systems, social practices and physical spaces (Crook & Light 1999, Goodwin 2000; Stahl 2004). The unit of analysis is the group and the whole activity system of interactions, artefacts (tools), tasks, and social practices (Stahl 2004). Thus, to study collaborative knowledge construction is to study group activity in a specific context. Context is not any predefined or objective environment (Goodwin 2000; Linell 1998) but only includes those contextual dimensions which are relevant to the participants in the activity (Linell 1998). Thus, the participants themselves produce and create the contexts in their joint activity (Goodwin & Duranti 1992; Linehan & McCarthy 2001; Linell 1998). The contexts produced involve those aspects of physical, social and cognitive environments that the participants perceive, believe, or know to be relevant. Only some contextual resources, or tools, of all potential and available resources are made use of, or in Stahl's (2004) terms, are made explicit in the production of joint meanings (Goodwin 2000; Linell 1998). For example, whenever something is said or done it is added to the pool of resources, but only some of these resources are made use of in new discursive actions (Linell 1998).

Linell's notion of contextual resources can be used in understanding collaborative knowledge construction activity and in particular as a description of possible resources that participants use in the meaning-making process. According to Linell (1998), contextual resources refer to aspects of potential contexts that the participants can make

actual and relevant through their activities in interaction. Linell (1998) defines three general categories of contextual resources. The first category of contextual resources, often called co-text, comprises the participants' previous actions and discourse that is actively used in the "new act of sense making" (p. 132). The second type of contextual resources consists of the surrounding concrete situation wherein the participants act. This includes, for example, other persons, objects and artefacts present. While the first and the second category deal with the immediate contextual resources, the third category deals with contextual resources that are mediate and abstract. The third category includes background knowledge, assumptions or beliefs about the things talked about in the discourse in question or about other persons involved in the discourse. It also includes socio-cultural contexts. These are, for example, the abstract situation definition or the frame of "what is going on" in the actual situation as well as the specific organisational context with its regulations and hierarchies. Similar to Linell's (1998) notion of the abstract situation definition is Hicks's (1996) notion of the socio-cognitive history of an activity setting. Thus, for example in the school context activities like 'writing texts', 'doing schoolwork' and 'using computers' have particular meanings for the students, depending on the previous experiences, attitudes and meanings they have attached to the activity through extended participation in their relevant (learning) communities (Crook & Light 1999). To study collaborative knowledge construction is to make visible the process of meaning-making mediated by tools used as resources.

Typical methods for analysing collaborative learning practises in the socio-cultural approach include discourse and conversation analysis as well as ethnographical and other qualitative methods (Cobb & Yackel 1996). In his work Stahl (2004) made an explicit analysis of the knowledge construction process of a student group. The analysis made visible the interpretive process on the psychological and physical tools used in constructing a new meaning. Both Roschelle (1992) and Moschkovich (1996) applied conversation analysis in examining the learning process that took place in a collaborative situation. A common finding in these studies was that at first the students negotiated a shared understanding about the concepts, phenomena and their relations by conversational means. The conversational means they used constructing shared meanings were, for example, questioning, clarifying, and elaborating as well as nonverbal means such as pointing or gesturing. At first the conceptions and descriptions were conflicting and indefinite. As the negotiation progressed, signs of shared understanding in the discourse were that turn-taking became fluent, there was no need to ask or give clarification, and students complemented each other's ideas. In the discourse the students used

this shared negotiated conceptual frame or joint problem space (Roschelle & Teasley 1995; Teasley & Roschelle 1993) to solve the mathematical (Moschkovich 1996) and physics (Roschelle 1992) problems they were dealing with in a computer simulation tasks. This joint problem space served as a tool for students, against which they were able to display, confirm and revise their shared understandings. Because both the studies dealt with computer simulations, an essential element in constructing shared meanings was a shared reference object on the computer screen, which the students were able to point at, manipulate and talk about. Another such element consisted of the metaphors they created for describing and explaining the difficult science phenomena concerned. Thus, they used everyday concepts as a tool for understanding science phenomena.

My own research work, presented in the four articles, has focused on understanding collaboration as an interactive phenomenon of student groups. Thus, there has not been any particular, chosen concept of learning guiding my work. However, my work as a whole can be regarded as a mixture of both socio-constructivist perspective and the socio-cultural perspective of learning. Looking back I now realise that my direction has been towards the understanding of collaboration and collaborative learning that is best understood in the sociocultural framework. From the first study through the latest one there is a gradual paradigm shift from the socio-constructivist perspective towards the socio-cultural perspective. However, this has not been a deliberate choice to lean on some particular learning approach. Rather my work is guided by the phenomenon of collaboration itself in its practical form. In all of the studies I have used group as the unit of analysis, thus individual knowledge construction as such has not been the focus of my studies. However, the search for cognitively productive interaction typical of the socio-constructivist perspective has been a major goal of the study. At the same time, however, the goal has arisen from the practice of my own research in quest of broader explanations for productive interaction than mere cognitive processes can offer. In all of my articles the cognitive aspect has been unified with some other aspects to better understand the process of collaboration; the social, emotional, material, and/or cultural aspects of co-construction. Thus, the studies can be seen as a reflection of my own developing understanding of the concepts of collaboration and collaborative learning, and as far as I can tell the development is still in progress.

2.3 Social and contextual features enhancing or restricting collaboration

2.3.1 Social relationships in relation to collaboration

2.3.1.1 Friendship

There is not much research about how students' pre-existing relationships within their peer group influence the nature and quality of their interaction in collaborative contexts (Miell & McDonald 2000). The study of collaboration has focused more on interactions as opposed to relationships (Azmitia 1998). However, it has been suggested that students' relationships affect their emotional and social responses to the cognitive working conditions and shows in their willingness to participate in collaborative learning contexts (Crook 1999; Kutnick & Manson 1998). Thus, processes and outcomes of collaboration are embedded within the larger context of peer relationships (Azmitia 1998). Azmitia (2000) points out that collaboration-related research relying on problem-solving tasks that have one correct solution or can be solved through systematic hypothesis testing has contributed to a rosy, calm picture of collaboration placing emphasis on cognitive development. However, in more open-ended and ill-defined problems collaboration is more stressful, because there is no clear 'script' for how to proceed. In these kinds of tasks, collaborators' personalities and relationships as well as the affective elements of interaction play an important role in managing collaboration.

There are reports about the positive effects of friendship on collaboration (e.g. Hartup 1996; Azmitia & Montgomery 1993; McDonald, Miell & Morgan 2000). Azmitia and Montgomery (1993) found out that collaborations between friends lead to more transactive discourse, greater equality in roles and larger increases in knowledge than collaborations between acquaintances. In their study, friends justified their proposals and elaborated on their partners' proposals more often and also engaged in transactive conflicts more frequently than acquaintances did. Also McDonald and others (2000) found out that in creative tasks friends engaged in more transactive discussions than non-friends and their musical compositions were rated more highly than those of non-friends. Hartup (1996) drew a synthesis on studies comparing friends and non-friends during collaborative problem solving tasks. According to these studies friends tend to

engage in more extensive discourse and task-oriented talk, offer suggestions more readily and be more supportive and critical than non-friends. In addition, mutuality is more evident and interaction is more positive and equally balanced between friends than between non-friends. Thus, according to Hartup (1996), social interaction between friends is of the type that is considered to facilitate cognitive development.

However, Berndt and colleagues (1988) did not find differences in the processes and outcomes of the collaborations of friends and acquaintances. One possible reason for the controversy between different studies is that the varied nature and difficulty of tasks may show in differences in the processes and outcomes of the collaborations (Azmitia 1998). In their study reported above, Azmitia and Montgomery (1993) found out that friends outperformed acquaintances in a post-test only on the most difficult tasks, because most friend pairs were able to sustain and repair the collaboration in dealing with difficult tasks whereas the acquaintances were not. Also McDonald and others (2000) suggested that in open-ended creative tasks non-friends have more difficulties than friends because they lack the advantage of shared knowledge and accustomed patterns of interaction that would help them maintain interaction and construct knowledge.

The relationship between friendship and successful collaboration is suggested to be due to different reasons. According to Azmitia (1998), mutuality, trust, respect, equality, and fairness often associated with friendship are qualities that help friends to be attuned to each other's needs, goals and points of view, and let them expose their views and also challenge each other. These qualities are beneficial in negotiating shared understandings. According to McDonald and others (McDonald, Miell & Morgan 2000), friends are used to establish and maintain a shared social reality in their everyday relationship and are also used to generate and develop ideas together. Thus, friends have a shared history to lean on (Crook 1999). On the one hand, this shared history shows in automatised interaction routines that help maintain interaction even in highly demanding tasks (Azmitia 1998), on the other hand, it shows as shared experiences and prior knowledge (Faulkner & Miell 2004) that facilitates establishing a common ground (Clark 1996). In addition, it has been suggested that friends are more motivated and willing to work together (Barron 2003).

There are, however, age-related developmental differences in the friends' ability to collaborate (see Azmitia 1998) as well as gender-related differences in the friends' quality of collaboration (e.g. Faulkner & Miell 2004; Kutnick & Kington, manuscript cited in Faulkner & Miell 2004). For example, Kutnick and Kington (manuscript) found out that girl friendship pairs outperformed boy friendship pairs in a scientific reasoning

task at the primary level of education. The pupils' interviews revealed that the boys excluded school collaboration as a legitimate activity within the context of their friendships, whereas the girls did not. The boys' friendships were action-oriented and based on activities with others outside the school classroom. Thus, Faulkner and Miell (2004) suggest that effective collaboration between friends occurs only when it is situated in an activity setting that is meaningful in the context of their relationship.

2.3.1.2 Status

Several authors (e.g. Dillenbourg 1999; Baker 2002) have argued that in order to be capable of true collaboration, the participators must play symmetrical roles in the conversation. They must have the same opportunity to participate, and their level of knowledge must be broadly the same (Dillenbourg 1999). When the knowledge level among the participants is very different, it easily leads to different roles in the learning situation. These different roles, in turn, can have profound effects on the quality of interaction and learning (Basili & Sandford 1991; Cohen 1994; Linn & Burbules 1993; Richmond & Striley 1996). For example, Richmond and Striley (1996) found several leadership styles each with different effects on group interaction. An *alienating leader* had a negative effect on students' interaction, because the leader disregarded the input of others and restricted the discussion process. A *democratic leader*, however, prompted interaction owing to the open communicative atmosphere this leader created.

Differences in the perceived academic ability or knowledge level show as academic status differences between students. Academic status is a powerful status characteristic in the classroom because of its obvious relevance to the classroom activities (Cohen 1994). According to Cohen (1994), students with a higher status easily dominate group interaction and are more likely to be perceived as leaders. Knowledge differences do not even have to be real in the actual situation to raise differences in the roles assumed by the participators, as Cohen (1994) has noted. Differences in the persons' general academic status may affect interaction so that the power order of the group reflects the initial differences in status, even if the participators share the same level of knowledge in the actual situation or the task does not require the academic ability in question. Thus, students with academically high status are expected to be more competent than others, and this status may be generalised to a wide range of school tasks.

Peer status – that is, perceived attractiveness or popularity – may also act as a basis for inequalities in participation in the context of collaborative activity (Cohen 1994).

Popular children tend to get their 'voice' better heard in the group work context. However, the study by Murphy and Faulkner (2000) with preschool children also demonstrated that unpopular children benefited from interacting with popular children. Unpopular children had more elaborated disagreements when interacting with popular children than when interacting with other unpopular children. Cohen (1994) relates popularity to academic status but it has been found (Juvonen & Wenzel 1996) that at secondary level education popularity depends on qualities other than academic ability, whereas at the primary level popularity is often associated with academic ability. Social status factors such as gender can also affect interaction in the collaborative situation. For example, some studies have demonstrated that boys tend to dominate the work in science tasks (Petersen, Johnson & Johnson 1991) as well as in computer tasks (Underwood & Underwood 1990) based on the alleged superiority compared to girls (Underwood & Underwood 1990). There are contradictory results about the affect of gender per se on students' collaboration. Some studies indicate that the interaction of same gender pairs is qualitatively better and more collaborative compared to mixed gender pairs (Fitzpatrick & Hardman 2000; Tolmie & Howe 1993). Howe and Tolmie (1999) suggest that social unease occasioned by gender can have an influence on the qualitatively lower level interaction of mixed gender pairs. However, some studies also fail to demonstrate significant differences in interaction according to gender pairing (e.g. Howe & Tolmie 1999). These mixed findings can be due to different reasons; differences in tasks and instructions, in the way performance is measured as well as differences in wider classroom cultures and contexts (Fitzpatrick & Hardman 2000). In other words, the mixed findings can be attributable to the difficulty of gaining context-free results. Barron (2003) further argues that research on status has concentrated too much on studying status as a static phenomenon. Therefore, such research has failed to reflect the complexity of interaction and account for dynamic shifts in students' power relations during interaction, as was observed in Barron's study (2003).

2.3.2 Task nature in relation to collaboration

It has been suggested that complex tasks, dealing with ill-defined and open-ended problems, facilitate productive interaction, such as elaborative talk, more effectively than tasks with well-structured problems and closed questions with one right answer (Cohen 1994; Van Boxtel, Van der Linden & Kanselaar 2000). In addition, for example explanation-seeking tasks are more likely than fact-seeking tasks to trigger such activities as

reasoning, comparing, argumentation or explaining (Cohen 1994), thus enhancing the mechanisms important to knowledge construction. According to Cohen (1994), complex tasks with ill-defined problems can be featured as group tasks. Group task is a task that requires resources (e.g. knowledge, heuristic problem-solving strategies, skills) that no single individual possesses and is therefore probably unable to accomplish the task alone (Cohen 1994). In group tasks students are interdependent in a reciprocal fashion (Cohen 1994). Thus, exchanging ideas and information is vital to success. However, problems with one identifiable correct answer could often be accomplished by single individuals and the interaction would be in its nature more like helping each other understand concepts without a need for deeper level discourse. In addition, according to Chizhik (2001) a single-answer task more easily leads to one participant, perhaps a more knowledgeable person (Cohen 1994), to dominate the discussion. Instead, variable-answer tasks, which elicit knowledge from a wide subject domain, increase the possibility of many participants to contribute in discourse. In another study Chizhik (1999) found out that also gender differences in the participating group's working diminished in variable-answer tasks.

Also task characteristics influence the quality of students' interaction as Van Boxtel and others (2000) have observed. They compared a concept-mapping task with a poster task on the same physics phenomenon. According to their results, the concept-mapping task elicited more talk about concepts, elaboration of conflict and reasoning than the poster task. This may be due to the fact that concept mapping stimulates talk about meaningful relations between concepts at an abstract level whereas the poster task stimulates talk about concepts at a more concrete level. In addition, concentrating on making a concrete product for a poster elicits more action-oriented talk than conceptually oriented talk.

Most of the results cited in this chapter come from studies where relationships – such as status or friendship – and tasks in relation to collaboration are explored experimentally by manipulating the group composition according to different status or friendship qualities or manipulating the task by verifying the structure or type of the task. The gain for learning is measured in post-tests at the individual level. These studies reflect mainly the research tradition presented under the socio- constructivist perspective. There is a great need for studies that focus on social relationships and tasks from the socio-cultural perspective illuminating their dynamic, changing and negotiated nature in the context of shared knowledge construction as well as their historical nature in the form of practices and relations.

2.3.3 Teacher's role in promoting collaboration

It is clear that teachers have a significant role when it comes to issues presented in previous sections. In most cases the teacher assigns the learning tasks and influences group compositions. Moreover, the teacher also has an important role in promoting students' shared knowledge construction and productive discussion (Mercer & Fisher 1998; Meloth & Deering 1999; Rasku-Puttonen, Eteläpelto, Häkkinen & Arvaja 2002).

Traditionally, the role of the teacher has been understood in terms of knowledge transmission. As learning is conceived as an active process of knowledge construction, the role of the teacher has shifted towards supporting and guiding students' knowledge construction processes (Rasku-Puttonen, Eteläpelto, Häkkinen & Arvaja 2002). The role of the teacher in facilitating students' shared knowledge construction has been discussed in terms of the Vygotskian concept Zone of Proximal Development (ZPD) (Vygotsky 1978; Bliss & Askew 1996). Interaction between teachers and students includes scaffolding that enables students to engage in activities they are not able to do unaided (Rogoff 1990). As students become more competent in their activities, they need less help from the teacher. Thus, scaffolding is a kind of 'contingent' teaching, which however is very hard to sustain in practice (Wood & Wood 1996). For example, Rasku-Puttonen and colleagues (Rasku-Puttonen, Eteläpelto, Arvaja & Häkkinen 2003b) reported difficulties in teacher's effort of providing student groups with proper support at appropriate moments, because of the lack of time when guiding several student groups working simultaneously.

In their research Meloth and Deering (1999) identified some characteristics of effective scaffolding practices that promoted students' collaboration. First of all, teachers modelled their own thinking processes by focusing students' attention on the essential goals of the lesson. They also provided explanations and conceptualised students' activities in order to demonstrate the importance of effective communication. In addition, teachers asked few questions being highly efficient in getting to the point of the task. Also Mercer and Fisher (1998) specified similar teacher's scaffolding activities, such as encouraging students' own thinking, focusing their attention on the relevant details and important aspects of the task, and providing a structure which enables the students to help themselves.

In scaffolding, effective teachers shift the responsibility for managing the learning task gradually to the students, and the students experience a transition from other- to self-regulation (Rogoff 1990). In their research Rasku-Puttonen and others (Rasku-

Puttonen, Eteläpelto, Arvaja & Häkkinen 2003a) studied how discussions between student groups and their teachers changed during a long-term learning project and whether these discussions demonstrated shifting relations of responsibility and control. The analysis compared the activities of two different classrooms participating in the same project with two teachers who defined their roles in supporting students' learning processes differently (Rasku-Puttonen et al. 2002). The results demonstrated that an instructional approach of the teacher had influence on student groups' self-regulated activities. The "Guide-Teacher" defined his role as a facilitator of learning, aiming to encourage self-regulation of his students. However, the results indicated that his students did not take more responsibility for their learning towards the end of the learning project, but the teacher in fact increased his direct regulation and problem-solving activities with students. According to Rasku-Puttonen and others a possible explanation for this might be that the "Guide-Teacher's" students were uncertain about the goals of the learning tasks and had difficulties with the open-ended and unstructured task assignments. However, the "Controller-Teacher's" students showed an increase in their own self-regulation towards the end of the project, which was in accordance with the "Controller-Teacher's" opinion that clear instruction is a prerequisite for student's self-regulation. He emphasised that where task assignments are unclear, students increasingly need help from the teacher. The tasks assigned by the "Controller-Teacher" were more structured than those of the "Guide-Teacher".

2.4 Possibility of collaboration in computer-mediated interaction

Crook (1994) has named four kinds of interactive situations where computers are involved: 1) interactions at the computers, 2) interactions around computers, 3) interactions related to computer applications and 4) interactions through computers. The three first examples are based on situations where students interact face-to-face, for example on a computer simulation (e.g. Roschelle 1992), a word processing program (e.g. Kumpulainen 1996) or a game (Cognition and Technology Group at Vanderbilt 1992). From the perspective of research on collaboration, in these three situations technology is approached as a 'background' variable facilitating productive interaction (or not) (Light, Littleton, Messer, Joiner 1994; Howe & Tolmie 1999), or the mediating nature of technology is acknowledged and analysed in the process of knowledge construction (e.g. Roschelle 1992). In the fourth case some tool built in the computer networks may

facilitate collaboration, e.g. CSILE's thinking types (see Scardamalia & Bereiter 1994) or interaction takes place through the computer, but no specific tool for supporting collaboration is available.

Lipponen (2001) has made a distinction between the collaborative use of technology and collaborative technology. The collaborative use of technology refers to situations where the computer can serve in a face-to-face event as a referential anchor, coordinate joint attention and interaction, and be an object for manipulation and thus support collaboration (Lipponen 2001). In the case of computer-mediated interaction the technology may be used collaboratively, for example, so that people's thoughts and ideas are restored on a common platform, which serves as a public memory, and thus are made available and visible for reflection in long term. According to Lipponen (2001), collaborative technology refers to specific technological support for collaboration built in computer networks. According to Crook's (1994) division, this study focused on interactions around computers (2) and interactions through computers (4). In either case collaboration was not specially supported by technology.

Possibilities of instructional technology for facilitating collaborative learning through computers have been described in a number of studies (e.g. Koschmann 1996; Fischer, Bruhn, Gräsel & Mandl 2002). However, in the general climate of sometimes overoptimistic expectations for technology-based learning environments (Fabos & Young 1999), empirical studies have revealed also more pessimistic findings about the quality of interaction and shared knowledge construction on the web (e.g., Järvelä & Häkkinen 2002). Roschelle and Pea (1999) argue that the web has been over-rated as a tool for collaboration, and the term itself is in danger of losing its meaning while almost any web facilities for correspondence or co-ordination across distance are marketed as "collaboration tools". In this chapter interaction through computers, i.e. computer-mediated interaction, is considered from the collaboration point of view. The focus is more on computer-mediated or computer-based communication than on computer-supported collaboration in the sense that support for collaboration would be facilitated by some technological tool.

How is collaboration, as defined in section 2.1, at all possible in asynchronous computer networks, when these definitions mostly deal with synchronous face-to-face problem-solving activities? In face-to-face interaction the grounding process (i.e. the process of constructing and maintaining mutual understanding), which is an essential prerequisite for collaboration (Clark & Schaefer 1989; Baker et al. 1999; Dillenbourg 1999), is considered to require less effort compared to computer- mediated interaction

(Brennan 1998). Face-to-face interaction provides the participants with immediate cues about each other's understanding and perspectives (Krauss & Fussell 1991). For example, facial expressions convey effectively feedback about the state of common ground in face-to-face interaction. Also the affective tone is more easily mediated in face-to-face interaction, even though there are established practices in expressing emotions also through computer networks, such as emoticons (Mäkitalo, Häkkinen & Järvelä 2003). However, when the interaction is based on text in a web-based environment, the grounding process demands more and perhaps different effort. Optimal feedback is essential even to maintain interaction, e.g. to invite the other one to react to your message in the web-based environment (Mäkitalo et al. 2002), not to mention to construct knowledge through that interaction. Knowledge construction becomes even more complex if you have but limited knowledge about the other participants in the web-based environment. In order to interpret other people's perspectives correctly and thus to be able to collaborate in the sense of knowledge construction, it is essential that one have information about other participants' knowledge, expertise or group membership (Schober 1998). For example, students in the same classroom already possess a certain common ground due to previous work experience (Baker et al. 1999) compared to virtual university courses where students from different universities meet.

Thus, the biggest challenge in web-based discussion is how to maintain interaction and knowledge construction. Jeong and Chi (1997) point out that in order to facilitate co-construction over computer networks there has to be a social obligation to engage in active interaction. They build their argument on Clark's and Schaefer's (1989) notion, which accentuates that for co-construction to occur it is not enough to make a contribution but it also has to be accepted by the partner. Jeong and Chi criticise such computer-mediated learning environments where responding is based merely on the person's own interest, expressly for lacking this obligation for co-construction of knowledge. Also empirical studies have shown that in this kind of learning environments students often construct knowledge on an individual basis (e.g. Salo & Järvelä 2001). In order to create a sense of community in the web-based environment there has to be a real need to make contact and to collaborate with other participants (Mäkitalo, Salo, Häkkinen & Järvelä 2001; Rovai 2000).

Lipponen (2001) has stated that an approach to collaboration solely in terms of face-to-face encounters is a very limited approach to CSCL (computer-supported collaborative learning). However, if we want to study collaboration in the sense of shared knowledge construction, we should approach also computer-mediated interaction in some

terms that come from the research of face-to-face collaboration (e.g. Baker 2002; Dillenbourg 1999). As in face-to-face interaction, the basic nature of collaborative knowledge construction in the computer-mediated interaction is *engaging* in the process of constructing and maintaining shared knowledge or understanding. Yet, this is what has been missing when it comes to studying collaboration mediated through computers. There are only few attempts that have been made to reveal something that goes on *between* participants in computer-mediated interaction (but see Häkkinen, Järvelä & Byman 2001; Lally & de Laat 2002). Most of the studies claiming to investigate collaboration have actually concentrated on evaluating the quality of collaboration as isolated speech acts (individual notes or postings), even though it reveals little about the efforts for shared meaning (Crook 1999) as was stated earlier. The quality of web-based interaction has been evaluated by analysing and calculating the cognitive quality of discourse on individual messages (e.g. Gudzial & Turns 2000; Hara, Bonk & Angeli 2000; Lipponen 2000). In addition, social network analysis has been conducted to reveal who interacts with whom (e.g. Lipponen, Rahikainen, Hakkarainen & Palonen 2002). However, according to Stahl (2002), this kind of analysis discards the content and nature of knowledge construction that may take place in interaction. This kind of analysis reflects a research tradition where knowledge is thought to be situated only in the heads of individual students (Stahl 2002) instead of knowledge situated and distributed also in the discourse between collaborators.

Lipponen (2001) has offered a notion of participation in knowledge communities for a broader definition of collaboration. However, the term participation refers more broadly to learning, to the conception of how both individuals and groups learn, whereas collaboration is a term for a specific type of activity taking place at the group level, thus between the individuals. In addition, the participation metaphor has been criticised for seeing the learner enculturated into the ways of the community without attention to the diverse ways people can relate to communities and without attention to the particular relational activities through which this happens in particular settings (Linehan & McCarthy 2001; Packer & Goicoechea 2000). This means understanding that participation in knowledge communities is not a passive process of 'taking in' or attending the social discourses and practices of the community but involves an active response and agentive transformation as well as reconstruction of the social meanings (Hicks 1996; Linehan & McCarthy 2001). This brings us back to consider collaborative learning as a situated phenomenon taking place and analysed as an activity of group(s) of people situated in a specific social and cultural context.

Gudzial and Carroll (2002) have offered the term 'vicarious learning' (see also Mayes & Neilson 1995) to describe the (learning) activity that takes place in asynchronous discussion forums. By this term they have defended the slow rates of discussion. According to them, students are engaged in shared understanding mechanisms but vicariously. Thus, for example there are few utterances in the discussion forum because the students recognise their own understanding in others and so they do not need to post a note to elaborate. According to Gudzial and Carroll (2002), the mechanism for each individual's learning is the same as in the shared understanding model described by Roschelle (1992). However, one might argue that the mechanism in this case cannot be the same as in the case of students engaged in shared knowledge construction. There may be learning mediated through tools, but it does not necessarily mean shared understanding. It is individual student's interpretation of the situation. Shared understanding requires *awareness* of each other's understanding. Basically, in reading another person's posting it is just your interpretation without a confirmation from the other. Thus, vicarious learning in this case is computer-supported (or -mediated) learning (CSL) instead of computer-supported collaborative learning (CSCL), if one wants to stick with the definition of collaboration described above. However, if we extend the web-based research to concern the classroom or learning communities more broadly, we may notice that computer-mediated communications have an important role in mediating shared understanding, for example in face-to-face interaction between the students or mediating individuals understandings (Gudzial & Carroll 2002) even though there is little evidence of constructing shared understanding *through* the computers.

However, this is not to say that collaboration is impossible in computer-mediated interaction. It is hard (as it is in face-to-face situations), but instead of inventing new definitions of collaboration that would suit better to the situation but have nothing to do with shared knowledge construction, this should be acknowledged. In addition, computer-mediated interaction should also be approached in terms that come from research conducted on knowledge construction activity (e.g. Barron 2003; Stahl 2004) and features supporting or hindering it (e.g. the role of the task, social relationships etc.). To ever reveal if there is collaborative activity (or not) we must go further than looking at single messages. It is also important to recognise what is the possible role of computer-mediated interaction in knowledge construction. Does the interaction take place just on a computer network or is it a part of other activities occurring, for example, in face-to-face situations in the classroom? One must take into account the broader

context of participants' activity. Quite often, at least in research concerning primary and secondary education, computer-mediated interaction takes place in the classroom context, where the students have an opportunity for face-to-face contacts. This has not been problematised, however, and the discussion that takes place through the computer is interpreted without considering the influence of the immediate classroom contexts for the discussion. For example, in such case the actual knowledge construction activity may take place elsewhere and by other means, for instance in face-to-face discussions, or the role of computer may be more in mediating understandings, as was discussed earlier. In addition, for example social network analysis, which has been recently used when studying computer networks, reveals who interacts with whom in the computer network (e.g. Lipponen, Rahikainen, Hakkarainen & Palonen 2002; Palonen & Hakkarainen 2000), but socio-metric analysis would moreover reveal if the interaction on the web is grounded to the interaction history of the students involved, and if so, what it might mean from the knowledge construction point of view. When the interaction occurs solely virtually, an important question is how students construct knowledge, but it is equally important to ask how they construct social relationships, because the two questions are related as was found earlier. For example grounding has received more and more attention in the study of computer-mediated interaction from the cognitive and linguistic perspectives (e.g. Mäkitalo et al. 2002). However, not until recently grounding has also been considered from the socio-emotional point of view (Mäkitalo, Pöysä, Järvelä & Häkkinen submitted) to see how students construct and maintain interaction not only at the cognitive and linguistic levels but also at a social level. However, even though the interaction takes place only through the computer, the knowledge construction activity is still grounded into wider contexts and mediated to the discussion by the history of individual students in the form of experiences, background knowledge, and attitudes.

3
The aims of the study

The general aim of the study was to explore collaboration in different kinds of lower secondary school learning projects conducted in authentic classroom settings. The aim was to study how collaboration is manifested in students' shared activities and especially what social and contextual features enhance or restrict successful collaboration. Thus, on the one hand the aim was to examine collaboration as a specific interactive phenomenon of student groups, on the other hand the aim was to approach collaboration from a pedagogical perspective. The study was based on theory of collaboration, which guided the research questions set and the data analysis conducted. However, the aim was also to accentuate the phenomenon and concept of collaboration, and new questions for research rose also from the data itself. Furthermore, one general aim was to find methodological tools for studying the process of collaboration and its intertwined social, cognitive and contextual aspects in students' ongoing activities.

Within this general framework there were specific aims and questions for each of the studies. *Article I* investigated how the different characteristics of learning tasks, which the teacher had set so as to guide students' working, were related to different types and qualities of student talk manifested in students' group activity. *Article II* continued the analysis of the same data to see how students' symmetry/asymmetry of knowledge-based roles as well as students' social relationships were related to the way students shared and constructed knowledge. In *Article III* the interaction analysed was computer-mediated interaction instead of face-to-face interaction analysed in Articles I and II. The aim was to analyse both the quality of individual messages as well as the

quality of shared knowledge construction on the web. Because there were two classrooms participating in the same project, the relation between specific social and contextual features of the different classrooms and the quality of web-based interaction was also considered. *Article IV* concentrated on studying how a student pair working face-to-face at a computer and engaged in a web-based discussion environment negotiated meanings for their learning activity and what contextual resources they used in this negotiation process. The aim was to understand how both the immediate concrete resources and more abstract resources, such as socio-cultural context, were manifested in students' negotiations.

4
Methods

4.1 Participants and instructional context of the study

All the studies concerned lower secondary education. Thus, the age of the students ranged from 13 to 15 years. Articles I and II were based on a same science learning project, and the participants were one student group working on a science report writing assignment. In Article III the main focus was on studying interaction between the students of two schools participating in a history project on Imperialism through a role-play in a web-based environment. Article IV dealt with a student pair's working on Cultural history project face-to-face at a computer and engaged in a web-based discussion.

The general feature in all of the four studies was that they were all conducted in authentic classroom settings. This approach was selected because the general aim was to find out the possibilities and restrictions of collaboration in everyday classrooms. Much of research on collaboration has been conducted on well-controlled studies planned together with expert teachers and researchers. However, this tends to fade out the complexity of collaboration as situated in real-life contexts. Thus, in this study the teachers planned and implemented the projects and I as a researcher acted in the field as an observer. However, even though I did not interfere in the teaching activities as such, I talked with the students and occasionally helped with the technology used in the projects. Thus, as such I cannot be considered an outside observer and for this reason I may have had some unintentional influence on some students' activities.

4.2 Data sources and analytical framework of the study

The challenges of current learning research have forced researchers to develop and use multi-methodological approaches, which are able to capture the relationships and dynamics between different variables within complex data in a systemic manner (Salomon 1997). The common feature in all of the four articles was that data were collected by various means. In all of the studies students' activity was videotaped, students' were interviewed and they filled out questionnaires. In addition, in two of the studies the material produced in the web-based environment was collected (Articles III and IV).

The general approach of this study is a case study approach, each of the three projects, presented in the four articles, representing an individual case on a same theme; how collaboration is manifested in students' activity. Case study is generally considered a research approach where, for example, some phenomenon is studied in depth in its unique environment. Thus, case study is not a methodological choice but rather a choice of what is to be studied (Stake 2000). The case study approach suits well for this study, where the aim was to explore the complex and situated nature of collaboration and its intertwined social, cognitive and contextual aspects. The central focus was on studying collaboration in depth through different cases using different kinds of methods. Thus, the case study approach used in this study can be called as a collective instrumental case study (Stake 2000). This means that rather than aiming at in-depth understanding of particular students' activity in a specific context as such, the aim was more to explore collaboration as a general phenomenon through these different cases. Thus, these several cases (collectively) served as instruments giving insight into collaboration in realistic contexts. They enabled highlighting the complexity of learning together and in identifying its key processes.

Another general feature linking the studies together was that in all of them collaboration was studied through students' interaction and the focus of analysis was more on groups' than individuals' activity. More specifically, all studies examined how well students were able to share and construct knowledge in their shared discursive activity and what features supported or hindered it. The analysis method used in the studies can be called qualitative content analysis (Chi 1997). The interaction was systematically and extensively analysed according to categorisations that arose both from theoretical and empirical, data-based contents. The nature of interaction analysis was process-oriented in the way that it aimed to reveal the relationships between social, cognitive and contextual features of collaboration by focusing on holistic episodic level activities.

5
Overview of the empirical studies

5.1 Article I

Arvaja, M., Häkkinen, P., Eteläpelto, A. & Rasku-Puttonen, H. 2000. Collaborative processes during report writing of a science learning project: The nature of discourse as a function of task requirements. European Journal of Psychology of Education 15(4), 455–466.

The aim of this study was to specify how the different aspects of task assignment were related to the different types of student discourse during the report-writing phase of a science-learning project.

5.1.1 Participants and instructional context

The subjects of the study consisted of one small group of students participating in an experimental science-learning project. The small group comprised four ninth-grade students of a Finnish lower secondary school: two girls and two boys (age about 15). The teacher selected the small group for the study from among four randomly established small groups. The aim of the learning project was to examine the phenomenon of autumn tints in forest evoked by frost. It is a typical natural phenomenon in which the leaves of deciduous trees change colours in autumn. The project was related to a broader framework examining the phenology of plants. The students worked on the

project 2–3 hours per week and the project was spanned over three months during a five-month period. The project had three phases, which followed the scientific inquiry typical of natural sciences. The first phase was dedicated to goal setting, orientation, and planning, and it involved whole-class and individual working. In this phase the students familiarised themselves with the topic through reading textbooks and articles about photosynthesis. The second phase was experimental work and involved whole-class and individual working. In this phase the students observed and chemically analysed the colour of different leaves. The third phase was interpretation and reporting and involved small group work. The teacher had given instructions for the structure of the report so that it was to comprise at least the following parts of the project: (1) the purpose of the project, (2) methods, (3) results, and (4) evaluation and interpretation of the results. The report-writing phase consisted of six sessions and the duration of the sessions varied between 19 minutes to 1 hour and 34 minutes.

5.1.2 Data sources and analysis

The data about the science project were collected by means of video and audio recording the whole project. Whole-class situations including individual working were also videotaped to get a holistic picture of the project, although the primary interest was in investigating small-group interaction. The students were also pre and post interviewed to find out their views on the project and the small-group activities. The teacher was (post) interviewed to find out his views on the project and to get background information about the students participating in the small group. Informal conversational interviews, direct observations and field notes were also made throughout the project to obtain information about the learning situations.

In the study the group discussions were analysed to see how the students shared and built knowledge about the subject at hand in the situation. Because small-group discussions were mainly present in the report-writing situation, a closer analysis was made on the basis of these small-group interaction data. The data gathered from the report-writing situation comprised approximately four hours of video and audio taped small-group interaction. Verbatim transcriptions of the students' talk were made from the video and audio recordings. Also nonverbal activity relating to conversation (e.g. head nodding, demonstrating by hands while talking) and other activity (e.g. writing, reading) during the report-writing situation was transcribed. Talk that was considered irrelevant in terms of knowledge sharing and construction was excluded from the analysis.

This kind of talk was either technical talk or off-task talk. In technical talk students were dealing with the technical issues while writing on a computer (opening or closing the file etc.). In off-task talk students were discussing, for example, about their personal affairs. The analyses focused on the ways the students talked about the subject and how the different features of joint discussion promoted or hindered construction of a shared understanding. In analysing students' talk Mercer's (1996) classification, which divides students' joint discussion into exploratory, cumulative and disputational talk, was utilised in addition to the specific features that arose from the data. Critical reasoning described in many studies (Mercer 1996; Mason 1998) was considered as a prerequisite for collaborative learning. In this study, two broad categories were extracted from the data. These categories remind Mercer's (1996) categorisations, and they were named *critical knowledge building* and *uncritical knowledge sharing*. The data were further analysed and processed to find out how the nature of the task students were performing was related to the emergence of these patterns of interaction in the students' ongoing activities.

5.1.3 Results

The results showed that critical knowledge building indicating collaborative knowledge construction was rare in the student group's interaction. The most common pattern of interaction was uncritical knowledge sharing. The analysis of the learning context and specific features of task assignments showed that the nature of students' discourse was closely related to the functions of the learning tasks students were working on. Task requirements seemed to have various effects, which influenced the way knowledge building evolved over time and in different situations. It seems that the task structure, manifested in the form of questions or instructions given by the teacher, bears a relation to the nature of building or sharing knowledge in social interaction. Critical knowledge building took place only when the students were answering complex and ambiguous questions that promoted reasoning, wondering, explaining and argumentation. In these situations, students had different viewpoints on the subject at hand, and the interaction turned into a mutual exchange process where ideas were shared and reasoned together. In the present study, however, most of the questions the students were supposed to answer in the reporting phase dealt with memorising facts related to experimental phases of the project, which promoted uncritical description of shared events. In addition, students often had to answer fact-seeking questions instead of explanation-

seeking questions or formulating the questions by themselves, which made them produce descriptive knowledge instead of finding deeper explanations for the phenomena under study.

5.2 Article II

Arvaja, M., Häkkinen, P., Rasku-Puttonen, H. & Eteläpelto, A. 2002. Social processes and knowledge building during small group interaction in a school science project. Scandinavian Journal of Educational Research 46(2), 161–179.

The aim of this study was to investigate how students' symmetry or asymmetry of knowledge-based roles was related to the way knowledge was constructed and shared in the student group's interaction. In addition, the study aimed to find out what social and contextual features were in relation to different patterns of interaction detected in the data. The participants, instructional context and data collection methods were the same as in Article I.

5.2.1 Data analysis

In this study the same transcribed video data as in Article I was further analysed to see how the symmetry of knowledge-based roles contributed to the nature of talk found in the previous study (Article I). Role symmetry consists of two factors: the symmetry of participation (Cohen 1994) and the symmetry of knowledge (Dillenbourg 1999). In participation symmetry everyone is participating equally i.e. the amount of conversational turns is equal in the learning situation. In knowledge symmetry the participators act at the same level of knowledge. The main interest was in analysing the symmetry of knowledge, which was, nonetheless, often related to participation symmetry. Knowledge symmetry was examined by analysing the contents and features of the discourse revealing the presence of real or alleged knowledge power in the situation. Apart from the transcriptions of students' talk and nonverbal activity, also transcribed interviews and field notes were used in the analyses.

5.2.2 Results

In the data four patterns of interaction were detected, which differed in terms of their knowledge symmetry and nature of talk. The context of high-level collaboration was realised in the framework of joint critical knowledge building, where the students had equal roles and where the task supported reasoning as was found out in the previous study (Article I). In this framework, students solved problems together and negotiated shared meanings and understandings about the subject at hand by critical reasoning. The most common pattern of interaction was joint uncritical knowledge sharing mainly because the questions of the task assignment did not support reasoning as was found out in the previous study (Article I). But the task structure did not always explain uncritical involvement. Uncritical joint knowledge sharing took place also when there were questions prone to support reasoning. In those cases it seemed that the norms and expectations prevailing in the group contributed to hasty, non-reflective decision-making. The students apparently felt a (social) pressure to move on and agree instead of considering various alternatives.

Two asymmetrical patterns of interaction – tutoring and leader-dominance – appeared quite as rare as joint critical knowledge building in this data. Tutoring was close to a high-level collaborative situation, although the students had asymmetrical roles. The students were engaged in building the advisee's knowledge and understanding, and the discussion was of a high conceptual level. The high level of conversation showed in the way that the tutor explained her ideas so explicitly that the advisee was able to reach an understanding. On the contrary, in leader-dominated situations the talk did not reach very high levels, because the leader presented one-sided information, which was not explicitly explained or substantiated. In the leader-dominated and tutorial situations the structure of the task itself did not seem to have much influence on the interaction. Rather, it derived from more permanent, real or alleged, asymmetry in knowledge.

It was evident that interpersonal relationships played a crucial role in the quality of interaction. Only the girls, who happened to be friends, were able to really reason, explain, wonder and argue and were able to engage in the problem solving and the task at hand. It seems that when the girls were working with the boys the social tension between the group members contributed to hasty, non-reflective discussion and non-engagement in the task itself. There is an indication that when both or either one of the boys were involved in interaction with the girls, the interaction was more asymmetri-

cal. In particular, in these cases the asymmetry was typically non-constructive leader dominance. The interaction between the girls was also more equal when they were not working with the boys. The only asymmetrical interaction mode between the girls was tutoring, which promoted shared knowledge construction.

5.3 Article III

Arvaja, M., Rasku-Puttonen, H., Häkkinen, P. & Eteläpelto, A. 2003. Constructing knowledge through a role-play in a web-based learning environment. Journal of Educational Computing Research 28(4), 319–341.

This study aimed to find out how and on what level the students of two lower secondary schools shared and constructed knowledge on imperialism by interacting through historical role characters in a web-based environment. Furthermore, the study explored social and contextual features in relation to the nature of knowledge sharing and construction.

5.3.1 Participants and instructional context

The participants were two lower secondary school classes (36 students, aged 13) from separate schools. In school A there were 16 students and in school B 20 students involved in the history project. The aim of the history project was to study the theme of imperialism through a role-play in collaboration with another school. The students chose different kinds of occupational or social roles (e.g. railway technician, farmer, Hindu priest) representing different perspectives. One school represented British society and the other school Indian society. The purpose was to encourage students to construct, share and seek knowledge about the lives of the Indians and the British in the era of imperialism in the 19th century from the perspective of each student's own fictional role character. The schools communicated via a shared web-based learning environment, FLE (Future Learning Environment), where the students were able to send messages to each other and participate in shared discussion. The students worked 1–3 hours per week on the project and it continued for six weeks. Although there were differences in the realisation of the project in the two schools, the overall frame of the project was the following in both schools: 1) Goal-setting, orientation, planning, 2) Choosing occupational or social roles with the help of the teachers, seeking knowledge from the

perspective of the role figure, role construction, 3) Contacts and communication between the role figures through the web-based messages (asynchronous communication) and 4) Final discussion on the shared discussion forum and evaluation of the project. The results reported in this study focus especially on the third phase: exchanging web-based messages between the students.

One difference between the schools in realising the project concerned the instructions given by the teachers about the messages. In school A, most of the messages were based on tasks that the teacher had assigned to the students. In contrast, in school B the teacher did not give any specific instructions for students to follow while writing the messages. He told the students to plan the messages themselves from the perspective of their own role characters. Both teachers stressed in their instructions that contacts should be made only between such role characters that would be feasible from the perspective of that historical time. For example, it was not feasible for a poor farmer to contact a British bishop. Another difference in the instructional arrangements by the teachers was that in school A many of the message writing tasks were assigned to student groups or pairs. School A students were also generally instructed to use their roles actively together with other students in face-to-face interactions. For example, the teacher instructed the students to visit other role characters. In addition, small groups of students were asked to discuss different subjects through the role characters. In school B the students worked individually in planning their messages. The teacher did not encourage peer collaboration generally either, but gave the students personal guidance during the individual planning and writing process.

5.3.2 Data sources and analysis

The data included transcripts of the students' web-based messages. The classroom working as a whole as well as the interaction of randomly selected small groups was videotaped. Students also filled out a questionnaire in the end of the project. Informal conversational interviews of the students and the teachers were also conducted throughout the project. Both the questionnaire and the interviews explored, for example, students' motivation towards the project and acting in their roles, as well as their opinions about the positive and negative features of the project and preferences regarding individual and collaborative work. Firstly, the web-based messages were analysed to find out the degree of their knowledge level. In analysing the knowledge level of the messages both the content and the quality of knowledge were considered. Content-wise the analysis

focused upon whether or not, and to what extent, the student succeeded in sharing historical knowledge about living in the 19th century in India and England through her/his role character. As regards the quality of knowledge the focus was on whether the student was sharing advanced level knowledge, e.g. by explaining the relationships between different phenomena, or communicating the knowledge on a more superficial level, e.g. by stating simple facts. Secondly, the analysis focused on the ways of interaction in the network (and classroom) environment. The aim was to find out the relations between different schools and students: who sent messages to whom, on what grounds (e.g. based on friendship, relevance to the role), whether the messages were sent individually or in a group.

Finally, the analysis focused on how the students were able to share and construct knowledge interactively through the messages and what means they used in this. When analysing shared knowledge construction in the web-based environment, an interaction cycle between two students was used as the unit of analysis. Interaction cycle refers to a chain of messages sent between two students. At first, the chain of messages was analysed according to the features that maintained the interaction and/or knowledge construction process. Typical maintaining features of the interaction process include questions and feedback, for example (Baker et al. 1999; Mäkitalo, Häkkinen, Leinonen & Järvelä 2002). After this, the interrelated messages (e.g. a chain of messages between two students) were analysed applying Baker's (2002) classification developed for describing the forms of co-operation in dyadic problem solving. From the interaction three dimensions – symmetry/asymmetry, alignment/nonalignment and agreement/disagreement – and their combinations defining different types of co-operation were analysed. Baker's classification was used in describing the type of knowledge construction activity that occurred between the students sending messages. The features maintaining the interaction process were used as a basis for this analysis. Based on the overall data possible reasons for supporting and hindering the knowledge construction process were surveyed.

5.3.3 Results

The results indicated that the knowledge level of the messages exchanged in the web-based environment was quite low. Mostly the students' messages lacked any relevant knowledge to be shared about the theme under study. High-level messages – explaining or reasoning different issues or phenomena about the theme under study – constituted

only 9% of the messages. The two schools differed in the knowledge level of the messages. In school A the students were able to share knowledge at a higher level than their peers in school B. One reason for this may lie in the teachers' differing instructional approaches. The teacher in school A guided his students' role-playing by giving them assignments so as to help decide about what and to whom to write, whereas the teacher in school B did not. These differing instructional approaches of the two teachers may be due to different perceptions on teacher's role (see Rasku-Puttonen, Eteläpelto, Häkkinen & Arvaja 2002). It seemed that the lack of a specific instructions concerning acting in the roles in school B sometimes led into quite irrational contacts within the web-based environment. Students sent a lot of messages based on their real social relations in the classroom rather than on their role characters. Thus, the lack of aim manifested itself in inadequate perspective taking. Also a difference in the role characters may explain the differences in the knowledge level of the messages in the two schools. The nature of some role characters in school B was not prone to trigger any higher-level communication and shared knowledge construction. In addition, in school A the students were encouraged to use the role characters more widely in the classroom in face-to-face contacts, and they worked on the messages also in groups, whereas in school B the students worked individually. Thus, in school A an effort was made to create a community of learners by taking account of the wider social context, instead of concentrating solely on the web-based environment as was done in school B.

In Baker's (2002) terms, the students reached collaboration, co-construction or co-argumentation in half of the interaction cycles. However, high-level collaboration, where students were able to explain and compare knowledge, occurred only in one interaction cycle. This was the only interaction cycle where the students had clearly different perspectives concerning the issue under discussion. In other collaborative interaction cycles the students had no clear differences in perspectives. The nature of interaction in these cycles was mainly equal surface-level knowledge sharing. Also the questions or suggestions students made maintaining the interaction in all but the high-level interaction cycle were apt to trigger factual knowledge sharing at the surface level rather than exploratory knowledge construction. Altogether, it can be said that the role of the web-based environment from the viewpoint of shared knowledge construction was rather weak. For instance, 36% of the messages were never answered. Also, the interaction cycles were quite short, containing only 2–4 messages. It can be argued that it takes much more than a few messages to co-construct knowledge at a deeper level.

5.4 Article IV

Arvaja, M. Contextual resources in the process of negotiating meanings in a web-based history project. Submitted for publication.

The study examined how a student pair negotiated meanings for their activity when working face-to-face at a computer and engaged in a web-based discussion environment with other students, and what contextual resources mediated the negotiation process and student activities. Furthermore, it was studied how the students interpreted their own learning activity.

5.4.1 Participants and instructional context

For the study one student pair from among 27 students was randomly selected for closer observation. The two girls were lower secondary school students (aged 15) participating in a web-based Cultural history project. The aim of the project was to study the cultural history of the students' hometown. The project activities lasted approximately two months with a rate of one hour per week. At the beginning of the project the students and the teacher discussed about the history of their hometown from the perspective of what were meaningful events, persons or buildings in general and what the students personally considered historically meaningful (1st lesson). In the second lesson the class visited a museum featuring an exhibition of their hometown. For the working in the class the teacher had selected seven themes for the students to choose from. The themes were divided along the time span: from Founding the city (1837) to the University town (since 1960). The students selected the theme they were most interested in and created a web-based working environment around that theme (3rd lesson). In practice, seven student pairs each created one theme environment to the web and other students were supposed to join in later by offering knowledge and participating in discourse. In the classroom there were not enough computers for all students, so the students worked mostly in pairs. The teacher helped the students in creating the environment if they asked for it. However, the teacher did not give any instructions directed to the whole class about working in these thematic environments. The girl pair addressed in this study selected the theme Growing to a big town since the 1940's and named their working environment *Into a big town*. The web-based environment was a working space consisting of different modules. The students could themselves select differ-

ent modules they wanted at their disposal: text, discussion, announcement, note, folder, navigation, link, and search module. The student pair addressed here selected discussion, note, search and navigation modules. From the fourth through the eighth lesson students were able to work freely in the environment on their selected theme. In his instructions the teacher did not give any specific tasks the students should do in the web-based environment. He stressed, however, the importance of collaboration and visiting other students' working spaces. He also instructed students to make use books about their hometown's history as an aid. In the fifth through the seventh lesson a number of experts, as the teacher called them, took part in the web working. These experts were university history students, who were supposed to answer the school students' questions and comment on their notes and writings on the web. The experts worked in the web-based environment through historical role characters relevant to the themes under study. The teacher guided his students mostly to ask questions from the experts.

5.4.2 Data sources and analysis

The student pair's working at the computer was videotaped. In addition, the student pair was interviewed twice during the project and informal conversational interviews were conducted throughout the project. At the beginning of the project all the 27 students filled out a questionnaire about their prior experience of the technology and project work in general. They answered another questionnaire in the end of the project, reporting their experiences about the project in general, about the web-based environment they used, and about the teacher's and experts' contribution. The researcher made direct observations in the classroom and wrote field notes. All the material produced in the web-based working environment was collected.

The video data gathered from the school project comprised approximately 4 hours (5 lessons) of the student pair's working. Verbatim transcriptions of the student talk were made from the video recordings. Nonverbal activity relating to conversation (e.g. head nodding, pointing at the computer screen) and other activity (e.g. writing, reading) was also transcribed. Along with the transcriptions of the students' talk and nonverbal activity, transcribed interviews and field notes as well as written web-based material were used in the analysis. The initial analysis of video transcripts consisted of reading through the transcript a number of times. For the purposes of this study, two lessons – one from the middle phase and one from the end phase of the project – were

taken under closer analysis. The two lessons were selected, because in those lessons the students actively used the web-based environment in their working. Linell's (1998) notion of contextual resources was used as an analytical tool in studying how students negotiated meanings in their activity. Contextual resources refer to those aspects of the potential context that the participants make relevant in the on-going activity: prior discourse, surrounding concrete situation (others, artefacts), and background knowledge used to interpret the present activity (Linell 1998). The main emphasis was on analysing what contextual features the students used in the moment-to-moment meaning negotiation process while working in the web-based working environment. Because contextual resources comprise not only the concrete material environment (e.g. books) but also more abstract and mediated contexts (e.g. socio-cultural history), the students' discursive activity was analysed to identify common features or patterns of interaction from the data. The strategy of looking for patterns gave insight to the general ground rules of organising joint activities in the classroom, which can be seen as normative features of students' social practice (Linehan & McCarthy 2001). A content analysis of the students' discursive activity and web-based messages was also made in order to find out what kind of knowledge the students constructed drawing on contextual resources. Along with the interaction and content analyses, the students' interviews were used in interpreting the meaning the students themselves attached to the classroom activity.

5.4.3 Results

The results showed that in the lack of clear educational goals the concrete physical situation directed students' situation definition. Students' meaning negotiation and knowledge construction activity was framed and mediated by their comprehension of (school) knowledge, which directed the way resources were used in the situation and which resources were considered legitimate for use in the school context. A history book was used as a resource in selecting factual information for the messages, whereas own ideas were not considered legitimate knowledge in the given context. In addition, students' habitual use of communication technology, which came outside the formal school activities, made up a situational frame and was manifested in the hectic communicative approach adopted in the situation. This was also supported by the physical presence of other students. However, these two situational frames (school knowledge vs. discussion orientation) were in contradiction and often restricted knowledge construction activity, leading to playful exchange of trivial knowledge to keep up the com-

munication with other close peers over the web. The contradiction also led to frustration and conflicts between the two students. However, in another analysed lesson the students were engaged in a symmetrical collaborative effort after shared understanding. First an expert's arrival to the web-based discussion created a positive atmosphere for the girls' working. Then an incidental message created a cognitive conflict and the students re-negotiated the goal for their working. In this instance the concrete physical environment, which had been so strongly present in the previous analysed lesson, now lost its meaning in this new context. Instead, earlier discussion and common knowledge about the subject were used as contextual resources in the students' meaning negotiations.

6
Main findings and general discussion

6.1 Quality of interaction and knowledge construction

The previous study of collaboration and collaborative learning has to a large extent concentrated on studying collaborative interactions in well-arranged problem-solving tasks, where the focus has been mostly on the cognitive aspects of collaboration. However, the problem with this kind of approach is that it simplifies the phenomenon of collaboration, and tends to neutralise the broader context of collaboration and the history of collaborative occasions. This study explored collaboration and its prerequisites through three different learning projects in authentic classroom settings at lower secondary schools. The aim was to study how collaboration is manifested in students' shared activities and especially what features in the learning context were enhancing or restricting successful collaboration. Furthermore, one general aim was to find methodological tools for studying the process of collaboration and its intertwined social, cognitive, and contextual aspects in students' ongoing activities.

Collaboration where students were engaged in cognitively high-level construction of shared understanding was rare in the light of this study. Instead, the nature of interaction both in face-to-face (Articles I and II) and computer-mediated situations (Articles III and IV) was mostly uncritical knowledge sharing, where the topic in question was not discussed very deeply. Thus, the students usually employed an everyday discourse strategy (Linn & Burbules 1993). The rules of everyday discourse help individu-

als make inferences about what other people mean, and rely on the expectation that it "makes sense", and thereby also helps them avoid conflicts and disagreements. These results are in line with the notion that collaboration, as a spontaneous phenomenon, is rare in school contexts (Crook 1999). In addition, some studies on the quality of computer-mediated discussion have found the level of such discussions as cognitively rather low (e.g. Järvelä & Häkkinen 2002).

In this study there was an underlying assumption that collaborative learning would be supported in the context of high-level knowledge construction activity, where the students would be engaged in cognitively high-level discussion (e.g. Mercer 1996; Van Boxtel et al. 2000). Thus, even though uncritical knowledge sharing would meet the criteria of co-construction in Baker's (2002) terms or could be considered co-ordinated effort after shared understanding according to Barron (2000), this would not meet the criteria of collaborative learning as deepening the participants' understanding of the issue in hand. This study was looking for 'productive' interaction in the sense that some progress, for example in terms of understanding some concepts, would take place as a result of engaging in such activities as reasoning or arguing. Indeed, this was the case in some instances of the projects: For example, understanding why it is beneficial for the plant to store the chloroplasts (Article I and II) or understanding some aspects of what it takes for a small town to grow into a bigger town (Article IV). There would have been much of collaborative learning in this project if reminiscing about shared events or describing factual information (Articles I and II) had been counted as collaboration, since in these instances the students' interaction was symmetrical, aligned and in agreement, which is one definition of collaboration (Baker 2002). However, even though the study was looking for cognitively productive interaction, it became clear in all of the studies that the context for productive interaction presupposed 'productivity' also at the social and emotional level. It presupposed mutual and equal (symmetrical) involvement and engagement to construct shared understanding. Thus, students were negotiating both at the content (cognitive) and relational (social) level (Barron 2003). Collaboration also presupposed a positive atmosphere for enabling engagement and for creating a safe environment for 'productive' conflicts and disagreement. However, in some instances 'too' positive an atmosphere seemed to lead to uncritical knowledge sharing, so that the main aim seemed to be to keep up the group harmony (Article I and II) or the playful activity (Article IV) without engaging in the task itself very seriously.

6.2 Social and contextual factors enhancing and restricting collaboration

All the studies demonstrated that shared knowledge construction typically occurred in situations where students had a clear task assignment and where the task itself triggered reasoning. These results are in line with studies demonstrating the relation between the task nature and quality of interaction (Cohen 1994). In addition to task nature, the level of structuring students' activities seemed to have an effect on the quality of students' interaction (Article III). Students were able to better engage in working and constructing shared knowledge when the task was clear and well defined, whereas too general tasks made the engagement and orientation to the task difficult (Articles III and IV). However, the complexity of working together was well demonstrated in students' activity in a situation where the task itself would trigger reasoning, but students' interpersonal relations restricted this (Article II), or in a situation where the task itself did not support reasoning, but collaborative knowledge construction took place as if by chance in the course of interaction as a consequence of different social, emotional and contextual features (Article IV).

In addition to task nature (Articles I and II) or teachers' differing practices in structuring the educational activities (Article III), another essential feature influencing the nature of interaction, as was found out in all of the four studies, was students' interpersonal relations. Interaction between friends was more collaborative than between non-friends (Article II). It seemed that in the context of close relationship students were able to communicate more openly with each other. In such contexts, as opposed to the working between non-friends, they were able to safely disagree and were less inclined to give up their opinions for the sake of group harmony. In addition, friends were able to continue interaction even after severe conflicts (Article IV), whereas conflicts among non-friends easily led to total breakdown in communication (Article II). These results are in line with the findings of Azmitia and Montgomery (1993) and Hartup (1996) stating that collaborations between friends lead to more transactive discourse than collaboration between acquaintances. It should also be noted that in my studies students' web-based interaction, when not otherwise instructed, was based on their existing relationships (Articles III and IV). Thus, interpersonal relationships and history of previous interactions with other students were important features bearing influence on students' shared activities. According to Azmitia (2000), personal relationships are one of the most important social and cultural contexts that students bring into interaction.

Another social issue studied was the symmetry of students' knowledge-based roles in the activity (Article II). There are studies that demonstrate that even an alleged knowledge power, based on students' general academic statuses, can turn into permanent asymmetrical roles in a group's working (Cohen 1994). Although in this study the asymmetry in knowledge in some issues was obvious, this asymmetry did not turn into permanent asymmetrical roles in the group's working but symmetrical relations changed depending on the other influential social and contextual factors in the situation. Thus, this study demonstrated that status, when defined as a typically static phenomenon, does not capture the complexity of interaction and cannot explain the dynamic shifts and changes in students' symmetrical relations.

In two of the projects, a technology-based environment was used as a part of the learning activities (Articles III and IV). In both of these projects technology was used mostly for interaction between participants. However, the technology used was not collaborative technology as such (Lipponen 2001). Partly because of lacking structuring or guidance by the teacher or by the technological application, students' web-based interaction remained superficial and aimless and was obviously motivated more by personal entertainment than by the school task itself. However, in the school where an effort was made to structure the activity and to integrate the activity in the web-based environment as part of the other classroom activities, students' web-based interaction took place at a higher level than in the other school where the activity concentrated solely around the technology-based environment and the working took place on a non-structured and open-ended basis (Article III). However, the value of technology in these two projects seemed to be more in entertaining students than in supporting collaboration.

In planning and implementing technology-based projects it would be important to consider the added value these environments bring to students' activity. Thus, one should not just move face-to-face activities to computer networks, because as a plain interaction tool computers are in many respects inferior to face-to-face interaction (Brennan 1998; Jeong & Chi 1997). However, computer-mediated interaction has certain advantages, for example in externalising thoughts and storing them for further reflection, even though it may be less suitable to intensive knowledge construction activities. From the methodological point of view, the analysis of collaborative activity reported in Article IV showed how important it is to move away from analysing only the web-based activity, especially in cases where interaction between students occur also in face-to-face situations in the classrooms. The meanings and motives behind

some messages exchanged over the web got new light when being interpreted within the wider context of students' activities (Article IV).

Important feature that influenced students' collaboration was the socio-cultural context manifested in students' activities. In collaborative situations there are some prerequisites that have to be met in order to enable shared knowledge construction. For example, exploratory talk is a type of talk that enhances thinking, reasoning and learning. However, if the classroom practises – for example types of interacting, typical tasks performed, resources used or allowed to be used in learning activities – do not support this type of talk in general, there is no reason to wonder why it may not occur in the well-arranged situations, either, or why it is so hard to sustain even though it is occasionally encouraged in individual projects. Thus, students internalise certain ways of (inter)acting in specific contexts, which is a result of social learning and participation in certain communities. For example, the student interviews and questionnaires conducted in all of the projects (Articles I–IV) indicated that group and project works were rare in these schools. However, many students reported that group and project working had been more common in the primary school. Many studies have shown that when students move from the primary to the secondary level of education such values as individuality and competitiveness gain importance (Juvonen & Wenzel 1996). Furthermore, in the case of the cultural history project (Article IV) the researcher evaluated the two girls' collaborative interaction as productive by the criteria that the two girls made progress in their discussion about the phenomena to be addressed and they were engaged in high-level discussion. However, the two girls themselves did not regard this situation as important for their learning, because they had not relied on formal "school" knowledge, which could be found in the book, but on knowledge that was 'in their heads' as the students put it. Thus, this kind of knowledge did not count as real or legitimate knowledge by their standards, not in the school context, anyway. How do such conceptions affect students' learning in school? If students do not value their own thinking and thoughts, as they may have learned through their participation in school activities, it will severely undermine the idea of constructing grounded, reasoned knowledge together with peers, the very idea of collaborative learning. And yes, according to the findings of this study the traditional school culture is well alive and in fact strongly present in schools and students' activities, which shows in the high emphasis and appreciation for facts and authoritative knowledge and also as uncritical sharing of this factual knowledge as was found in all of the three projects. Thus, fostering successful collaborative learning requires a broader change in the whole classroom culture.

Altogether, the results of these studies suggest that there is not any single factor that could be pointed out as the reason for successful or unsuccessful collaboration in school contexts. Rather, it is a sum of many intertwined cognitive, social, emotional and contextual features involved in the specific situations. The students' activity changed, sometimes very dramatically, as the interaction proceeded and different social and contextual features came into play and interacted with each other. The quality of students' interaction, and consequently their collaboration and non-collaboration, was changing all the time depending on what were the influential factors in the social contexts at the given time (Articles I, II and IV). Even though there is no single pathway for successful collaboration, this study revealed some basic processes and reasons for success and failure in students' shared activity in the light of these different cases. This would have been hard to capture by concentrating only on the cognitive aspect of collaboration, which still is the dominant mode when it comes to studying collaborative learning.

6.3 Methodological challenges of studying collaboration

Typically, issues that were important factors in promoting or restricting collaboration in these different cases, such as task nature or social relations, are studied through experimental designs and treated as single variables (Salomon 1997; Dillenbourg, Baker, Blaye & O'Malley 1995). However, the present set of studies demonstrated that these factors may actually interact in a very complex manner and cannot thus be separated as individual variables. In the area of collaboration there is a need for more process-oriented research that reveals not only the core process of collaboration, as such, but also those features in the learning context that support or hinder it. Process-oriented research of collaboration is needed to capture the situational dynamics of learning together and thereby shed light on collaborative knowledge construction as a temporally evolving context-bound phenomenon. Under the socio-constructivist approach, studies on collaboration typically evaluate the cognitive level of interaction and its relation to individual learning (e.g. Fischer, Bruhn, Gräsel & Mandl 2002). However, Crook (1999) points out that interaction that gets high ratings in terms of the number of high-order speech acts may actually be a failure in terms of collaboration as regards creating common knowledge. However, an analysis that concentrates more on 'narrative structures' instead of isolated speech acts provides a better view on the process of collaboration (Crook 1999).

There is previous research of collaboration documenting the features of successful or unsuccessful collaboration in a more 'narrative' and process-oriented way. For example Barron (2000, 2003) has illustrated collaboration as a two-dimensional phenomenon, where both social and cognitive aspects are tightly intertwined and collaboration is manifested in a shared activity as negotiation at the content (cognitive) space as well as at the relational (social) space. However, in her study Barron (2003) has not speculated why some groups are able to coordinate the social and cognitive space better than others in the first place. Certain features have been pointed out that make some groups better than others, but the why-questions have been missing. As was demonstrated in this study the reasons why these specific groups fail or succeed may be more situated and contextualised in the broader classroom community and perhaps the answers could be searched there. Thus, the challenge for research is to widen the repertoire of methods and instruments for studying collaboration and collaborative learning as contextual and cultural phenomena embedded within specific classroom communities. For example Azmitia (1998) has stated that much of the research on collaboration has concentrated on students' interactions instead of their relationships. This is true; research on collaboration has somehow tried to neutralise the broader context and history of collaborative occasions. For example, according to the results of this study the community of peers seemed to be an important context for students' collaborative activity (Articles II–IV). Hence, the analyses should not only focus on the ongoing activity of the students, but should also shed light on their past; for example through the socio-cultural context manifested in different learning practices or students' prior knowledge about others, objects, or concepts. Thus, at the same time the analyses should give information about the broader reasons for the potential failure or success of collaboration. For example, the analyses of students' interaction in Article IV not only demonstrated how knowledge was constructed and gradually evolving in the course of interaction but also revealed how the participants interpreted the whole learning situation. Thus, these analyses gave at the same time a great deal of information about the wider context; the use and assigned meanings of concrete and abstract contextual resources (Linell 1998) in the students' activity, and also what tools or resources were used in the process of meaning-making.

6.4 Evaluation of this study

The focus of analysis in this study was on group activities and by focusing on the group it was possible to capture the dynamic interplay in meaning-making over time in the discourse between participants; what they understood, the resources they used, the type of contribution they each made, and how they were taken up or not in a given discourse. However, as such the analysis did not consider participants and their learning or progress in the course of interaction on any individual basis. Rather the individual was associated with the group in the analysis. Thus, the lack of an individual perspective is an undeniable limitation of this study. The type of analysis used in this study might have enabled following the individual reasoning paths in the course of interaction as Stahl (2004) has suggested, but it was not the focus of this study. However, pre- and post-test measurements of individual students would have been impossible given the setting in general: students' tasks were quite loosely structured and without any predefined, measurable objectives or expected outcomes. In fact, one specific aim of this study was to develop methods for capturing the situational dynamics of learning together in more open-ended learning contexts, which are lacking in studies with well-controlled designs and well-defined tasks. In addition, the purpose was to question whether it is even reasonable to measure individual learning in collaborative situations in the first place. Does the instance of shared knowledge construction, where knowledge is being distributed in the material and discursive environment within a specific context transfer into individual minds and cognitive structures so that it would be measurable afterwards?

Another limitation of this study was that because of the small number of subjects in all of the studies the research provided little evidence of how representative a single group's interactions were relative to all of the groups in the classroom or beyond the classrooms studied. However, the main findings of each of the cases were similar. Thus, the cases supported each other. According to Stake (2000), single or a few cases are poor representation of a population of cases and provide questionable grounds for advancing grand generalisation. Yet, "because more than one theoretical notion may be guiding an analysis, confirmation, fuller specification, and contradiction all may result from one case study" (Vaughan 1992, p. 175).

An advantage of this study was that it was conducted in authentic classroom contexts. This enabled gaining knowledge not only about the basic processes of collaborative knowledge construction, but also about the wider reasons for the failure or success

of collaboration in real-life classrooms. Thus, the analysis of collaboration was extended to consider also the influence of a specific classroom context and community on students' collaborative activity, which is unusual in more controlled experimental studies. In addition, Azmitia (1998) has questioned whether the results obtained from relatively controlled problem-solving contexts or tasks can be generalised into the wilds of authentic classrooms, and whether these results can be replicated without completely restructuring the classrooms.

Even though this case study is not suited for making broad claims about collaboration, it helped to identify phenomena that need to be studied more extensively. Thus, in future, the dynamics of collaborative processes and the supportive and restrictive factors of collaborative learning need to be studied with larger populations in various learning contexts. Because of the situational nature of learning, the ideal circumstances for learning are very difficult to gain in schools. A teacher cannot possibly consider all the factors involved in the learning situation. However, it is hoped that this study provides knowledge of some factors affecting learning in social interaction, and hence offers aid and tools for planning, implementing and evaluating collaborative learning situations, thus helping to make learning culture more collaborative. In addition, this study serves as a guide for designing instructional interventions in collaboration with teachers (Brown 1992).

Yhteenveto

Kollaboratiivinen tiedon rakentaminen kouluprojekteissa

Johdanto ja tutkimuksen tarkoitus

Kollaboraatiosta ja kollaboratiivisesta oppimisesta on tullut yleisiä termejä opettajien ja tutkijoiden arkipuheissa. Kollaboraatiosta käytetään usein suomenkielisiä vastineita yhteisöllinen tai yhteistoiminnallinen oppiminen. Yhteisöllisestä oppimisesta puhuttaessa viitataan yleensä tiedon rakentelun ja kehittelyn kulttuuriin, jossa oppimisella tarkoitetaan lisääntynyttä kykyä osallistua pienryhmää laajemman yhteisön toimintaan (esim. Lave & Wenger 1991). Yhteistoiminnallisella oppimisella taas viitataan yleensä siihen, kuinka pienempi yhteisö, esim. pienryhmä, rakentaa yhteistä ymmärrystä oppimisen kohteena olevasta ilmiöstä (esim. Dillenbourg 1999). Tässä tutkimuksessa kollaboraatiolla ja kollaboratiivisella oppimisella viitataan yhteistoiminnalliseen oppimiseen. Koska termi yhteistoiminnallinen oppiminen kuitenkin usein yhdistetään yksittäiseen opetusmenetelmään, joka perustuu työnjakoon, käytetään tässä tutkimuksessa termejä kollaboraatio ja kollaboratiivinen oppiminen. (Häkkinen & Arvaja 1999).

Koulujen opetussuunnitelmissa kollaboratiivinen oppiminen on mainittu yhtenä opetuksen ja oppimisen kehittämiskeinona. Tätä voidaan pitää osittain vastauksena haasteeseen, jota työelämä asettaa tuleville työntekijöilleen. Nykyinen työelämä vaatii entistä enemmän työntekijöiltä kykyä toimia tuottavasti toisten kanssa, sillä työtä teh-

dään paljolti ryhmissä, tiimeissä ja laajemmissa verkostoissa. Lisäksi on väitetty, että nykyinen työelämä vaatii yhä enemmän kykyä keskustella ja neuvotella työn suunnittelemisesta ja toteuttamisesta kuin vain pelkästään kykyä tehdä itse työ (Iedema & Scheeres 2003). Kuitenkin opettajan näkökulmasta kollaboratiiviseen oppimiseen liittyy läheisempiä ja ajankohtaisempia arvoja kuin tulevaisuuden työntekijöiden harjoittaminen. Oppilaat oppivat usein paremmin ryhmissä kuin itsekseen. Yhdessä tekeminen on motivoivaa. Kollaboraatiota pidetään lisäksi keinona tukea oppilaiden itsenäistä tiedonrakentamista – joka on vallitsevan konstruktivistisen oppimiskäsityksen perusteesejä – sen sijaan että opettajat 'kaataisivat' tietoa oppilaillensa.

Mitä kollaboratiivinen oppiminen oikeastaan on? Sekä tutkimus- että kouluyhteisöissä kollaboraation käsitettä käytetään vaihtelevasti ja löysästi. Sillä saatetaan viitata hyvin yleisesti oppilaiden yhteiseen toimintaan, oppilaiden väliseen vuorovaikutukseen tai oppimisyhteisön toimintoihin osallistumiseen. Kuitenkaan toiminnan, vuorovaikutuksen tai osallistumisen luonnetta ei näissä viittauksissa määritellä tarkemmin. Tässä tutkimuksessa kollaboraatiolla tarkoitetaan oppilaiden yhteistä vuorovaikutustoimintaa, jossa oppilaat ovat sitoutuneita kognitiivisesti korkeatasoiseen yhteisen tiedon tai ymmärryksen rakentamiseen käsillä olevasta asiasta.

Tämän tutkimuksen tarkoituksena oli selvittää kollaboraation eli yhteisen tiedonrakentamisen ilmenemistä ja sen edellytyksiä peruskoulun yläasteella kolmessa erilaisessa oppimisprojektissa. Tavoitteena oli tutkia yhtäältä kollaboraatiota oppilaiden yhteisessä toiminnassa ja toisaalta selvittää niitä tekijöitä, jotka estävät tai edistävät korkeatasoista yhteisen tiedon rakentamista. Tutkimuksella pyrittiin pureutumaan kollaboratiivisen oppimisen prosessiin ja erityisesti niihin sosiaalisiin ja kontekstuaalisiin tekijöihin, jotka ovat yhteydessä korkeatasoiseen tiedonrakentamiseen. Tutkimuksen tavoitteena oli lisäksi löytää metodologisia välineitä kollaboratiivisen oppimisprosessin ja siihen yhteydessä olevien kognitiivisten, sosiaalisten ja kontekstuaalisten tekijöiden tutkimiseen.

Tutkimus koostuu neljästä artikkelista. Artikkelissa I tutkittiin, kuinka erilaiset oppimistehtävän piirteet olivat yhteydessä oppilaiden pienryhmäkeskustelun laatuun ja luonteeseen. Artikkeli II jatkoi saman aineiston analysoimista ja tavoitteena oli tutkia, kuinka oppilaiden tiedollinen tasa-arvoisuus tai epätasa-arvoisuus keskustelutilanteessa oli yhteydessä tiedon rakentamisen ja keskustelun laatuun. Artikkelissa III tutkittava vuorovaikutus tapahtui verkkokeskusteluna. Tavoitteena oli tutkia sekä yksilöllisten viestien että yhteisen tiedonrakentamisen tasoa verkkokeskusteluissa. Koska tutkimukseen osallistui kaksi koululuokkaa, tarkasteltiin kummallekin luokalle erityisten sosi-

aalisten ja kontekstuaalisten tekijöiden yhteyttä verkkokeskustelun laatuun. Artikkelissa IV tavoitteena oli selvittää, kuinka oppilaspari rakensi tietoa ja neuvotteli merkityksiä toiminnalleen työskennellessään yhdessä tietokoneen ääressä ja osallistuessaan verkkokeskusteluun luokan muiden oppilaiden kanssa.

Metodit

Tutkimuksessa tarkastelun kohteena oli kolme erilaista peruskoulun oppimisprojektia. Yhteinen piirre kaikissa projekteissa oli se, että ne toteutettiin autenttisissa luokkatilanteissa. Näin ollen opettajat suunnittelivat ja toteuttivat projektit ja tutkijana toimin pelkästään havainnoijana. Kuitenkin vaikka en osallistunut tutkijana suunnitteluun tai opetustoimintaan, keskustelin oppilaiden kanssa ja autoin oppilaita silloin tällöin teknologisissa kysymyksissä. Näin ollen, minua ei voida pitää täysin ulkopuolisena havainnoijana ja saatoin tahattomasti vaikuttaa joidenkin oppilaiden toimintaan. Autenttisten projektien tutkimisen valitseminen mahdollisti kollaboraation tarkastelemisen todellisissa oppimistilanteissa. Tämä lähestymistapa ei ole yleinen kollaboraation tutkimuksessa, jossa suurin osa tutkimuksista perustuu kontrolloituihin opettajien ja tutkijoiden yhteistyönä suunnittelemiin oppimistilanteisiin. Nämä tutkimukset kuitenkin yksinkertaistavat kollaboraation prosessia ja siihen yhteenkietoutuneita sosiaalisia, kognitiivisia ja kontekstuaalisia tekijöitä sekä kollaboraation sidoksisuutta ympäristöönsä ja sen toimintahistoriaan.

Kahdessa ensimmäisessä artikkelissa tutkimuksen kohteena oli neljän oppilaan pienryhmä, joka osallistui yhdeksännen luokan biologian projektiin. Ryhmässä oli kaksi tyttöä ja kaksi poikaa. Oppimisprojektin tavoitteena oli tutkia kasvien fenologiaa ja erityisesti ruskaa ilmiönä. Biologian projekti kesti kolme kuukautta ja oppilaat työskentelivät 2–3 tuntia viikossa. Oppimisprojektissa oli kolme erilaista vaihetta, jotka noudattivat luonnontieteellisen tutkimuksen kulkua. Aluksi oppilaat tutustuivat tutkimaansa aiheeseen lukemalla mm. artikkeleita. Toisessa vaiheessa oppilaat havainnoivat ja analysoivat kemiallisesti erivärisiä puiden lehtiä. Kolmannessa vaiheessa oppilaat kirjoittivat tutkimusraportin pienryhmissä. Tässä tutkimuksessa tarkastelun kohteena oli raportinkirjoittamisvaihe, johon käytettiin kuusi kokoontumiskertaa.

Kolmanteen tutkimukseen osallistui kaksi seitsemättä luokkaa eri kouluista. Koulun A luokassa oli 16 oppilasta ja koulun B luokassa 20 oppilasta. Oppilaat osallistuivat historiaprojektiin, jonka tavoitteena oli perehtyä Imperialismiin roolipelin avulla yhdessä toisen koululuokan kanssa. Toinen kouluista edusti Intiaa ja toinen Englantia.

Oppilaat valitsivat kukin itselleen roolihenkilön, jonka kautta he toimivat projektissa. Koululuokat olivat toistensa kanssa yhteydessä verkkoympäristön avulla, jossa he lähettivät toisilleen viestejä ja osallistuivat yhteiseen keskusteluun. Vaikka projektin toteuttamisessa oli eroja koululuokkien välillä, yleiskehys projektin toteuttamiseksi oli sama: 1) Oppilaiden orientoiminen työskentelyyn, 2) roolihenkilöiden valinta, tiedon etsiminen oman roolihenkilön näkökulmasta, 3) viestien lähettämien luokkien välillä verkkoympäristössä sekä 4) yhteiskeskustelu verkkokeskusteluna ja projektin arvioiminen. Tässä tutkimuksessa tarkasteltiin erityisesti projektin kolmatta vaihetta. Suurin ero projektin toteuttamisessa kahdessa koulussa koski opettajan tehtävänantoja. Koulussa A suurin osa viesteistä perustui opettajan antamiin tehtäviin. Sen sijaan koulussa B opettaja ei antanut erityisiä ohjeita viestien lähettämiseen. Lisäksi koulussa A opettajan antamat tehtävät kohdistuivat pääasiassa oppilaspareille tai ryhmille. Koulussa B oppilaat työskentelivät yksin viestejä suunnitellessaan ja kirjoittaessaan. Oppimisprojekti kesti kuusi viikkoa ja oppilaat työskentelivät 1–3 tuntia viikossa.

Neljänteen tutkimukseen osallistui yksi yhdeksäsluokkalainen oppilaspari, joka valittiin satunnaisesti luokan 27 oppilaan joukosta. Tyttöpari osallistui Kulttuurihistoriaprojektiin, joka käsitteli oppilaiden oman kotipaikkakunnan historiaa. Projekti kesti kokonaisuudessaan kaksi kuukautta ja oppilaat työskentelivät kerran viikossa. Luokkatyöskentelyä varten opettaja oli valinnut seitsemän eri teemaa, josta oppilasparit tai ryhmät saivat valita mieleisensä. Teemat sijoittuivat aikavälille kaupungin perustamisesta (1837) nykypäivään. Tässä tutkimuksessa kohteena oleva oppilaspari valitsi teema-alueen 'Isoksi kaupungiksi 1940-luvulta lähtien'. Teema-alueet valittuaan oppilasryhmät loivat oman työskentely-ympäristönsä verkkopohjaiseen ympäristöön. Työskentely-ympäristönä käytettiin Pedanetin Verkkoveräjää (http://www.peda.net/veraja), jonne oppilailla oli mahdollisuus valita erilaisia työvälineitä. Tämän tutkimuksen oppilaspari valitsi ympäristöönsä työvälineiksi keskustelu-, muistiinpano-, linkki- ja hakumoduulit. Työskentely-ympäristön luomisen jälkeen oppilaat saivat vapaasti työskennellä aiheensa parissa verkkoympäristössä. Opettaja ei antanut teema-alueita koskevia erityisiä tehtäviä, mutta korosti yleisohjeissaan yhteistoiminnan merkitystä ja vierailemista muiden oppilaiden työskentely-ympäristöissä. Lisäksi hän neuvoi oppilaita käyttämään historiankirjoja apuna tiedon etsimiseksi kotikaupungista. Projektin loppupuolella asiantuntijat, jotka olivat historianopiskelijoilta yliopistosta, osallistuivat verkkoympäristössä työskentelyyn. Asiantuntijat vastasivat oppilaiden kysymyksiin sekä kommentoivat oppilaiden kirjoituksia ja viestejä työskentely-ympäristöisissä.

Yhteinen piirre kaikissa tutkimuksissa oli se, että aineistoa kerättiin usealla eri tavalla. Kaikissa projekteissa tutkimuksen kohteena olevien oppilaiden toimintaa videoitiin, oppilaita haastateltiin sekä kaikki oppimisprojektiin osallistuvat oppilaat täyttivät kyselylomakkeita. Myös opettajia haastateltiin oppimisprojektien aikana. Tein myös kenttämuistiinpanoja kaikkien projektien aikana. Lisäksi kahdessa tutkimuksessa verkkoympäristöihin tuotettu materiaali tallennettiin ja kerättiin (Artikkelit III ja IV). Tällä monipuolisella aineistonkeruulla haluttiin vangita kollaboratiivisen oppimisprosessin moninaisuus aineiston analysointia varten.

Tämän tutkimuksen yleinen lähestymistapa oli tapaustutkimus. Tällöin kaikki kolme projektia edustivat yksittäistä tapausta samasta tutkimusaiheesta eli siitä, kuinka kollaboraatio ilmeni oppilaiden toiminnassa. Tapaustutkimusta pidetään yleisesti lähestymistapana, jossa jotain ilmiötä tutkitaan syvällisesti sen ainutlaatuisessa ympäristössä. Näin ollen, tapaustutkimus ei ole niinkään metodologinen valinta vaan ennemminkin valinta siitä, mitä tutkitaan (Stake 2000). Tapaustutkimusote sopi hyvin tähän tutkimukseen, koska tarkoituksena oli tutkia kollaboraation toteutumista autenttisissa ympäristöissä. Kollaboraatiota tutkittiin erilaisten tapausten avulla käyttäen erilaisia menetelmiä. Tästä tapaustutkimuksesta voitaisiinkin käyttää nimitystä 'kollektiivinen välineellinen tapaustutkimus' (Stake 2000). Siis kolme eri projektia toimivat välineinä kollaboraation ymmärtämiseksi autenttisissa koululuokissa. Ne auttoivat yhdessä oppimisen moninaisuuden selvittämisessä ja sen avaintekijöiden tunnistamisessa.

Toinen tekijä, joka yhdisti nämä neljä eri tutkimusta toisiinsa, oli samantyyppinen analysointitapa. Kaikissa tutkimuksissa kollaboraatiota tutkittiin oppilaiden vuorovaikutuksen kautta ja painopiste analysoinnissa oli pikemminkin ryhmän kuin yksittäisen oppilaan toiminnassa. Kaikissa tutkimuksissa pyrittiin selvittämään, kuinka hyvin oppilaat jakoivat ja rakensivat tietoa yhdessä ja mitkä tekijät oppilaiden toiminnassa tai toimintaympäristössä tukivat tai vaikeuttivat tiedon rakentamista ja jakamista. Analyysimenetelmiä voitaisiin yhteisesti kutsua laadulliseksi sisällönanalyysiksi (Chi 1997). Vuorovaikutusta analysoitiin systemaattisesti erilaisten luokitusten avulla, jotka perustuivat sekä teoreettisiin oletuksiin (Baker 2002; Linell 1998; Mercer 1996) että aineistolähtöisiin luokituksiin. Kaikissa tutkimuksissa vuorovaikutuksen analysointitapa oli prosessiorientoitunut siinä mielessä, että pääpaino oli kokonaisvaltaisen episoditasoisen toiminnan analysoimisessa ajallisesti etenevässä kehyksessä.

Ensimmäisessä artikkelissa oppilaiden keskustelun tiedonrakentamisen laatua analysoitiin Mercerin (1996) luokituksen avulla. Mercer jakaa pienryhmävuorovaikutuksessa tapahtuvan puheen tutkivaan, kumulatiiviseen ja kiistelevään. Näistä kolmesta

puhetyypistä tutkiva puhe edustaa kollaboratiivista vuorovaikutusta. Tutkivassa puheessa oppilaat osallistuvat kriittiseen tiedonrakentamiseen. Toisessa artikkelissa saman aineiston analysointia jatkettiin tarkastelemalla oppilaiden roolien symmetrisyyttä keskustelun aikana. Roolisymmetrisyydellä tarkoitetaan yleensä osallistumisen tasaista jakautumista (Cohen 1994) tai tiedollista tasa-arvoisuutta (Dillenbourg 1999) keskustelutilanteessa. Tässä tutkimuksessa roolisymmetrisyydellä tarkoitettiin tiedollista tasa-arvoisuutta. Analysoimalla puheen sisältöä ja keskustelun piirteitä voitiin päätellä, toimivatko osallistujat tiedollisesti samalla tasolla. Kolmannessa artikkelissa oppilaiden verkkokeskustelun tiedonrakentamisen laatua arvioitaessa sovellettiin Bakerin (2002) luokitusta, joka on kehitetty kuvaamaan erilaisia yhteistoiminnan muotoja ongelmanratkaisutoiminnassa. Luokituksessa osallistujaparin vuorovaikutus jaetaan kolmeen eri dimensioon: symmetrisyyteen/asymmetrisyyteen, yhtenäisyyteen/epäyhtenäisyyteen ja yksimielisyyteen/erimielisyyteen. Vuorovaikutus analysoidaan näiden kolmen ulottuvuuden suhteen ja ulottuvuuksien erilaiset yhdistelmät muodostavat erilaisia kollaboratiivisia tai ei-kollaboratiivisia yhteistoiminnan muotoja. Kollaboratiivinen toiminta toteutuu symmetrisessä ja yhtenäisessä keskustelutilanteessa, jossa oppilaat ovat joko yksi- tai erimielisiä. Neljännessä artikkelissa oppilaiden tiedonrakentamista ja merkitysneuvotteluita analysoitiin Linell'in (1998) kontekstuaalisten resurssien avulla. Kontekstuaaliset resurssit viittaavat niihin toimintaympäristön tekijöihin, joita osallistujat käyttävät toiminnassaan ja merkityksiä neuvotellessaan. Näitä ovat aiempi keskustelu käsiteltävästä asiasta; ympäröivä konkreettinen tilanne ja siihen liittyvät ihmiset ja artefaktit; taustatieto, olettamukset ja uskomukset, jotka voivat koskea muita keskusteluun osallistuvia ihmisiä tai käsiteltävää asiaa sekä sosio-kulttuurinen konteksti, jolla tarkoitetaan abstraktia tilanteen määrittelyä tai toimintakehystä. Tässä tutkimuksessa tarkasteltiin, mitä kontekstuaalisia resursseja oppilaat käyttivät merkityksiä neuvotellessaan keskustelussaan.

Tulokset ja johtopäätökset

Tulokset osoittivat, että kollaboraatio, jossa oppilaat olivat sitoutuneita kognitiivisesti korkeatasoiseen yhteisen tiedon rakentamiseen, oli tutkituissa projekteissa harvinaista. Sen sijaan sekä kasvokkain tapahtuvassa keskustelussa (Artikkelit I ja II) että verkkokeskustelussa (Artikkelit III ja IV) vuorovaikutus oli pääosin luonteeltaan epäkriittistä tiedonjakamista. Näin ollen voidaan sanoa, että oppilaat käyttivät keskustelussaan 'jokapäiväistä keskustelustrategiaa' (Linn & Burbules 1993). Tulokset ovat samansuuntai-

sia aikaisempien tutkimusten kanssa, joiden mukaan kollaboraatio spontaanina ilmiönä on harvinaista koulukontekstissa (Crook 1999). Myös verkkokeskustelun laatua analysoineet tutkimukset ovat osoittaneet verkkokeskustelun olevan kognitiivisesti heikkotasoista (esim. Järvelä & Häkkinen 2002).

Tässä tutkimuksessa oletuksena oli, että kollaboratiivista oppimista tapahtuisi sellaisen korkeatasoisen tiedonrakentamisen aikana, jossa oppilaat osallistuisivat kognitiivisesti korkeatasoiseen keskusteluun (Mercer 1996; Van Boxtel 2001). Korkeatasoiselle keskustelulle tunnusomaisia piirteitä ovat mm. argumentoiminen, järkeily sekä selitysten antaminen ja pyytäminen. Vaikka oppilaat eräiden määritelmien mukaan (esim. Baker 2002) osallistuivat kollaboratiiviseen toimintaan epäkriittisesti tietoa jakaessaan keskustelun ollessa symmetristä, yhtenäistä ja yksimielistä, tämä ei täyttänyt kollaboratiivisen oppimisen määritelmää, joka tässä tutkimuksessa nähdään osallistujien tiedon syvenemisenä käsiteltävästä asiasta. Tämä tutkimus etsi nimenomaan 'tuottavaa' vuorovaikutusta siinä mielessä, että keskustelun aikana tapahtuisi edistymistä esimerkiksi jonkin käsitteen ymmärtämisessä. Näin ei kuitenkaan tapahtunut epäkriittisen tiedonjakamisen aikana, joka oli luonteeltaan asioita ja ilmiöitä kuvailevaa, faktoja luettelevaa tai yhteisiä tapahtumia muistelevaa toimintaa.

Vaikka tässä tutkimuksessa etsittiin kognitiivisesti 'tuottavaa' vuorovaikutusta, kaikki tutkimukset osoittivat, että tuottava vuorovaikutus edellytti 'tuottavuutta' myös sosiaalisella ja emotionaalisella tasolla. Kollaboratiivinen vuorovaikutus edellytti molemminpuolista ja tasa-arvoista osallistumista sekä sitoutumista yhteisen ymmärryksen luomiseen. Näin ollen oppilaat neuvottelivat sekä kognitiivisella että sosiaalisella tasolla (Barron 2003). Kollaboraation onnistuminen edellytti myös positiivista ilmapiiriä, joka mahdollisti sitoutumisen ja loi turvallisen ympäristön käsitellä konflikteja ja erimielisyyksiä. Kuitenkin joissakin tapauksissa 'liian' positiivinen ilmapiiri näytti johtavan epäkriittiseen tiedonjakamiseen, jolloin päähuomio oli enemmänkin ryhmäharmonian (Artikkelit I ja II) tai leikillisen toiminnan (Artikkeli IV) ylläpitämisessä kuin oppimistehtävään sitoutumisessa.

Kaikki tutkimukset osoittivat, että korkeatasoinen yhteinen tiedonrakentaminen tapahtui yleensä tilanteissa, joissa oppilailla oli selkeä oppimistehtävä tai he pystyivät asettamaan selkeän tavoitteen työskentelylleen ja joissa oppimistehtävä oli luonteeltaan pohtimista tukevaa. Tällaisissa tilanteissa oppilaat vastasivat esimerkiksi kysymyksiin, jotka peräsivät selityksiä ja johtivat erilaisten näkemysten pohtimiseen. Sen sijaan esimerkiksi faktatietoa peräävät kysymykset johtivat helposti epäkriittiseen tiedonjakamiseen (Artikkeli I). Tämä tulos on yhdenmukainen tutkimusten kanssa, joissa on

havaittu vuorovaikutuksen laadun ja tehtävän luonteen olevan yhteydessä toisiinsa (Cohen 1994; Van Boxtel ym. 2000). Tehtävän luonteen lisäksi oppilaiden toiminnan strukturoinnin aste näytti olevan yhteydessä oppilaiden välisen vuorovaikutuksen laatuun (Artikkeli III). Oppilaat näyttivät sitoutuvan paremmin työskentelyyn ja tiedonrakentamiseen kun tehtävä oli tarkasti määritelty, kun taas liian yleiset tehtävänannot tekivät sitoutumisen tehtävään vaikeaksi (Artikkelit III ja IV). Kuitenkin kollaboraation kompleksisuutta ja sidoksisuutta oppimisympäristöönsä kuvaa hyvin se, että vaikka esimerkiksi eräässä tilanteessa oppilailla oli pohtimista tukeva tehtävä, oppilaiden väliset henkilökohtaiset suhteet estivät korkeatasoiseen tiedonrakentamiseen sitoutumisen (Artikkeli II). Tai vaikka oppimistehtävä ei tukenut pohtimista, kollaboratiivista tiedonrakentamista tapahtui erilaisten sosiaalisten, emotionaalisten ja kontekstuaalisten tekijöiden yhteisvaikutuksesta kuin lähes sattumalta (Artikkeli IV).

Tehtävän luonteen ja oppilaiden toiminnan strukturoinnin lisäksi kaikki tutkimukset osoittivat, että tiedonrakentamisen laatuun vaikuttivat oppilaiden väliset henkilökohtaiset suhteet. Ystävien välinen vuorovaikutus oli kollaboratiivisempaa kuin pelkästään luokkatoverien (Article II). Näytti siltä, että toisilleen läheisten oppilaiden oli helpompi keskustella avoimesti toistensa kanssa. Tällöin he pystyivät olemaan turvallisesti eri mieltä eivätkä luopuneet erilaisista näkemyksistään ryhmäharmonian ylläpitämiseksi, mikä taas oli tyypillistä ei-ystävien vuorovaikutukselle. Lisäksi ystävät pystyivät vakavienkin konfliktien jälkeen jatkamaan vuorovaikutusta (Artikkeli IV) kun taas ei-ystävien väliset konfliktit johtivat helposti vuorovaikutuksen täydelliseen katkeamiseen (Artikkeli II). Nämä tulokset ovat samansuuntaisia Azmitian ja Montgomeryn (1993) sekä Hartupin (1996) tutkimusten kanssa, jotka osoittavat ystävien välisen vuorovaikutuksen olevan vastavuoroisempaa kuin tuttavien. Verkkovuorovaikutuksen osalta tämä tutkimus osoitti myös sen, että jos opettaja ei määrännyt kenen kanssa verkossa tulisi keskustella, oppilaat olivat yhteydessä ystäviinsä ja parhaisiin kavereihinsa (Artikkelit III ja IV). Azmitia (2000) toteaakin, että oppilaiden vuorovaikutushistoria on yksi tärkeimmistä sosiaalisista ja kulttuurisista konteksteista, jonka oppilaat tuovat mukanaan vuorovaikutukseen.

Toinen sosiaalinen tekijä, jota tutkittiin sosiaalisten suhteitten lisäksi, oli oppilaiden vuorovaikutuksen tiedollinen symmetrisyys/asymmetrisyys (Artikkeli II). Oppilaiden vuorovaikutus oli kollaboratiivisempaa, kun oppilaat toimivat tiedollisesti samalla tasolla. Toisaalta tiedollisesti epäsymmetrinen tutorointitilanne oli korkeatasoisempaa keskustelua kuin tiedollisesti tasa-arvoinen epäkriittinen tiedonjakaminen. Lisäksi se johti tutoroitavan ymmärryksen syvenemiseen keskusteltavasta asiasta. Jotkut tutki-

mukset osoittavat, että jo oletettu tiedollinen ylivalta, joka perustuu yleiseen akateemiseen statukseen, voi johtaa pysyviin asymmetrisiin rooleihin ryhmän työskentelyssä, vaikka itse tilanteessa tiedollinen ylivalta ei todellista olisikaan (Cohen 1994). Vaikka tässä tutkimuksessa tiedollinen asymmetrisyys oppilaiden välillä oli selvästi havaittavissa joissakin tilanteissa, tämä asymmetrisyys ei ollut pysyvää vaan vaihteli muiden sosiaalisten ja kontekstuaalisten tekijöiden vaikutuksesta. Näin ollen tämä tutkimus osoitti, että tiedollinen status, joka yleensä määritellään staattiseksi ominaisuudeksi, ei pysty selittämään niitä dynaamisia muutoksia oppilaiden symmetrisissä suhteissa, joita tapahtuu vuorovaikutuksen aikana.

Tieto- ja viestintätekniikkaa käytettiin osana oppilaiden toimintaa kahdessa projektissa (Artikkelit III ja IV). Näissä molemmissa projekteissa teknologiaa käytettiin lähinnä oppilaiden väliseen vuorovaikutukseen. Koska näissä projekteissa oppilaiden vuorovaikutusta ei useimmiten strukturoitu eikä ohjattu opettajien toimesta tai teknologian avulla, oppilaiden verkkovuorovaikutus oli yleisesti luonteeltaan pinnallista ja tavoitteetonta. Sitä motivoi ennemminkin oppilaiden keskinäinen viihtyminen ja viihdyttäminen kuin itse koulutehtävä. Kuitenkin koulussa, jossa opettaja strukturoi oppilaiden toimintaa verkossa sekä integroi verkkotyöskentelyn osaksi oppilaiden muuta toimintaa, vuorovaikutus oli korkeatasoisempaa kuin koulussa, jossa toiminta tapahtui pääasiassa teknologisessa työskentely-ympäristössä ja jossa toiminta oli vapaampaa ja ei strukturoitua (Artikkeli III). Kuitenkin teknologian arvo yleisesti näissä projekteissa oli enemmänkin oppilaiden viihtymisessä kuin kollaboraation tukemisessa. Tietoteknologian tukemia projekteja suunniteltaessa ja toteutettaessa olisikin tärkeää miettiä, mitä lisäarvoa teknologia tuo opetukseen ja oppilaiden toimintaan. Esimerkiksi kasvokkain tapahtuvan keskustelun siirtäminen verkkoon sellaisenaan ei ole mielekästä, koska teknologian välittämä keskustelu on monin tavoin 'vaikeampaa' kuin kasvokkain tapahtuva keskustelu (Brennan 1998; Jeong & Chi 1997). Sen sijaan verkkokeskustelussa on etuja, jotka puuttuvat kasvokkain tapahtuvasta keskustelusta. Verkkokeskustelu tuo ajatukset näkyväksi ja säilyttää ne myöhempää reflektointia varten. Näin se toimii ikään kuin osallistujaryhmän kognitiivisena muistina.

Eräs tärkeä tekijä, joka vaikutti oppilaiden kollaboraatioon, oli sosio-kulttuurinen konteksti, joka ilmentyi oppilaiden toiminnan kautta. Oppilaat sisäistävät koulussa tiettyjä säännönmukaisia toimintatapoja. Esimerkiksi tutkiva puhe on sosiaalisen toiminnan muoto, joka edesauttaa pohtimista, ajattelua ja oppimista. Jos koulun käytännöt – esimerkiksi vuorovaikutusmuodot tai oppimistehtävät – eivät yleisesti tue tämän tyyppistä keskustelua, sen esiintyminen myös satunnaisissa projekteissa on epätoden-

näköistä. Kaikkien neljän tutkimuksen perusteella voidaankin päätellä traditionaalisen koulukulttuurin olevan vahvana läsnä oppilaiden toiminnassa. Tämä näkyy faktaja asiantuntijatiedon arvostamisena ja omien ajatusten väheksymisenä (Artikkeli IV) sekä epäkriittisenä tiedon jakamisena (Artikkelit I, II ja III). Voidaankin sanoa, että korkeatasoisen kollaboratiivisen toiminnan tukeminen edellyttää lähes koko koulukulttuurin muutosta.

Kaiken kaikkiaan tämä tutkimus osoitti, että ei ole olemassa yksittäistä tekijää, joka voitaisiin osoittaa kollaboraation onnistumisen tai epäonnistumisen syyksi autenttisissa luokkatilanteissa. Kollaboraation onnistumiseen tai epäonnistumiseen vaikuttavat monet yhteenkietoutuneet kognitiiviset, sosiaaliset, emotionaaliset ja kontekstuaaliset tekijät kussakin spesifisessä ympäristössä. Kuitenkin tämä tutkimus paljasti joitakin kollaboratiivisen oppimisen perusprosesseja ja sitä tukevia ja estäviä tekijöitä. Tämä olisi ollut mahdotonta, jos tutkimuksessa olisi keskitytty pelkästään kognitiivisiin tekijöihin, mikä kollaboratiivisen oppimisen tutkimuksessa on yhä hallitseva tapa. Lisäksi tyypillistä on tutkia kollaboraatioon vaikuttavia tekijöitä, kuten tehtävän luonnetta tai sosiaalisia suhteita, kokeellisten tutkimusasetelmien kautta, jolloin niitä kohdellaan yksittäisinä muuttujina. Kuitenkin tämän tutkimuksen tulokset osoittivat, että nämä tekijät ovat yhteydessä toisiinsa hyvin kompleksisella tavalla eikä niitä voi erottaa yksittäisiksi muuttujiksi menettämättä samalla kollaboratiivisen oppimistilanteen monimuotoisuutta.

Metodologisesti kollaboratiivisen oppimisen tutkimusta olisikin suunnattava enemmän prosessiorientoituneeseen suuntaan, jolloin voitaisiin paremmin vangita sekä kollaboratiivisen oppimisen perusprosesseja että niitä tukevia tai estäviä kullekin ympäristölle ominaisia tekijöitä. Analyysin pitäisikin keskittyä enemmän oppilaiden vuorovaikutuksen 'narratiivisiin rakenteisiin' (Crook 1999) kuin yksittäisiin puheakteihin ja niiden laadun ja määrän mittaamiseen. Tyypillisesti kollaboraatiota on arvioitu mittaamalla esim. kognitiivisesti korkeatasoisen puheen esiintymistä lausetasolla (esim. Fischer ym. 2002). Kuitenkaan tämän tyyppinen analyysi ei kerro mitään yhteisestä tiedonrakentamisesta, siihen sitoutumisesta, emotionaalisesta ilmapiiristä eikä sosiaalisista suhteista. Eli vaikka tulokset kertoisivatkin keskustelun tapahtuneen korkealla kognitiivisella tasolla, keskustelu saattaisi kollaboraation näkökulmasta olla epäonnistunutta, esim. kunkin yksilön omia ajatuspolkuja noudattavaa monologia ilman yhteistä perustaa ja yhteistä tiedonrakentamista. Kollaboraation tutkimuksen haasteena onkin laajentaa tutkimusmetodeja, jotta kollaboraatita voitaisiin tutkia kontekstu-

aalisena ja kulttuurisena ilmiönä ottaen huomioon kunkin luokkayhteisön ainutlaatuiset piirteet.

Tämän tutkimuksen avulla ei voida tehdä laajoja päätelmiä kollaboraatiosta autenttisissa koulukonteksteissa tutkimusjoukon pienuuden takia. Kuitenkin jokaisesta tapauksesta saadut tulokset olivat samansuuntaisia. Näin ollen tämän tutkimuksen avulla saatiin viitteitä niistä kollaboraatiolle olennaisista tekijöistä, joita seuraavissa tutkimuksissa voidaan tutkia laajemmilla oppilasjoukoilla ja erilaisissa konteksteissa. Tutkimuksen toivotaan antavan myös opettajille apua ja välineitä kollaboratiivisten projektien suunnitteluun, toteuttamiseen ja arviointiin eli kollaboratiivisen koulukulttuurin luomiseen.

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Collaboration and collaborative learning have become common terms occurring frequently in discussion among teachers and researchers. In school curricula collaboration and collaborative learning are mentioned as an important means for developing learning and instruction in schools.

The publication presents a case study that explored collaboration and its prerequisites in three different school projects conducted in lower secondary education. The aim was to study how collaboration is manifested in students' shared activities and especially what features in the learning context were enhancing or restricting successful collaboration.

This study provides knowledge of some important factors affecting learning in social interaction, and hence offers aid and tools for planning, implementing and evaluating collaborative learning situations in different school contexts.

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