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Grounding interaction in a CSCL environment

ABSTRACT OF MASTER THESIS IN PEDAGOGY

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- CSCL
- Sociocultural perspective
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1. Focus and research question

The context for the study is the Gene-Ethics Scenario: an ICT-mediated collaborative learning scenario for natural science education involving two geographically distributed junior high schools. This thesis investigates how technology transforms basic features of students' communication and collaboration in a telelearning scenario. In particular, my objective is to explore students' grounding interactions when collaborating in the Future Learning Environment (FLE3). The construction of a mutual understanding sufficient for the current purpose (grounding) is considered a basic process in collaborative learning. The research question I ask is:

> How does the FLE3 knowledge building forum support or constrain grounding interactions?

2. Methodology and data sources

When studying grounding processes at the activity level and utterance level I combine a sociocultural perspective with a micro-analytic approach. Relying on multiple sources of evidence, case study serves as a general research strategy. Prior to a more detailed analysis of students' grounding interactions at the utterance level, the case is described chronologically according to the progressive inquiry model that is the knowledge building platform of the scenario. The principle data sources are electronic logs, video recordings and scenario documents.

3. Conclusions

Students' grounding acts are divided into two distinct situations according to the qualitative nature of their collaborative interaction as co-located (face-to-face) or distributed (on distance). In the co-located situation, students grounding process progressed relatively unrestricted. The study concludes that the text-based asynchronous communication mode of the knowledge building forum constrained important aspects of students' distributed grounding interaction.

Constrains are associated with the additional effort required to complete grounding acts in the knowledge building forum. Grounding repair-sequences were repeatedly initiated, but not followed up properly. Instead of contributing to a joint understanding by providing repairs at the task level, the grounding process was interrupted by comments on a meta-level. On some occasions this resulted in "pre-mature meta-cognition" as the participants moved to a meta-level before mastering the basic categories. Processes of grounding were also constrained by display costs. When collaborating on distance the communication was primarily text-based and non-verbal clues were not observable. Timing of utterances turned out to be problematic and the messages frequently arrived out of sequence. This de-contextualized the meaning and partly constrained grounding interaction. However, the knowledge building forum can serve as a collective memory supporting the construction of a common ground that may last over time.

Some unexpected patterns have also emerged. Students adopted a pragmatic approach in their collaboration by using one of the knowledge building categories for short, social and coordinating messages. I have identified this as a form of pragmatic grounding; students built a mutual agreement on how to use the tool in a way that was sufficient for the current purpose, but different from the intentions postulated by the designers of the learning environment.

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1. INTRODUCTION

In his keynote address to the International Conference on Computer Support for Collaborative Learning 2003, Roger Säljö (2003) claims that "the most significant mechanism through which learning is transformed is technology" (p. 1). During recent decades, Information and Computer Technology (ICT) has influenced many aspects of our daily lives. As tools are developed for communicating, storing and representing information, new practices for learning in institutionalized forms have emerged. Representing an alterative to a traditional approach to learning and education, contemporary educational software environments such as FLE3 (Future Learning Environment) are based on pedagogical theories of collaborative knowledge building (Scardamalia & Bereiter, 1994) and progressive inquiry (Hakkarainen et al., 1999; Hakkarainen et al., 2002). Embedded in the knowledge building forum are inquiry-based views of learning. As a virtual space, a knowledge building environment can be said to dictate processes of learning. In addition, the communication modes allowed are partly defined by the technology available. How does this technology transform the basic features of students' communication and collaboration in a telelearning scenario? The communicative acts and processes of acquiring knowledge and skills when collaborating with peers in a computer-mediated environment are the general theme of this study.

This thesis is conducted as a part of the multidisciplinary research project DoCTA (Design and use of Collaborative Telelearning Artefacts), funded by ITU (Forsknings- og kompetansenettverk for IT i utdanning). The project aims to "bring a theoretical perspective to the design of ICT that support the sociocultural aspects of human interaction, and to evaluate its use" (Wasson & Ludvigsen, 2003:15). A general research interest is to understand how computer-mediated learning environments enable students to learn in collaboration with other students (Wasson et al., 2000). The DoCTA project has proceeded in two phases, DoCTA 1 and DoCTA-NSS. The first phase (1998-1999) focused on the design and use of telelearning artefacts for collaborative learning in teacher education (Wasson et al., 2000). DoCTA-NSS (Design and use of Collaborative Telelearning Artefacts - Natural Science Studios) is

the second phase (2000-2003) and is a continuation of the research commenced in DoCTA 1. The context for DoCTA-NSS is the Gene-Ethics Scenario (in Norwegian: Gen-Etikk), which is "an ICT-mediated collaborative learning scenario for natural science education at middle school level" (Wasson et al., 2000:21). This was comprised of a pilot and a main field trial where students from two classes (Bergen and Oslo) collaborated, co-located and distributed. While working in local groups, the students were physically together for purposes of co-located collaboration. Pairs of local groups from the two participating schools were matched to create a group for distributed computer-mediated collaboration, mainly by utilizing a specialized knowledge building forum (a customized version of Future Learning Environment, FLE3: http://FLE3.uiah.fi/). The educational software (FLE3) and didactic design of the Gene-Ethics scenario is motivated by the ideas of collaborative knowledge building (Scardamalia & Bereiter, 1993, 1994) and progressive inquiry (Hakkarainen et al., 1999; Hakkarainen et al., 2002). The scenario context is described in further detail in chapter 6.1.

The main conceptual approach underlying the DoCTA project and this thesis involves sociocultural theories and the research associated with Computer Supported Collaborative Learning (CSCL). A recent approach in CSCL is concerned with *processes of grounding*, or how students build up a mutual understanding that is sufficient for the current purpose (Baker et al., 1998, 1999; Clark & Brennan, 1991; Clark & Schaefer, 1989). However, the distributed, asynchronous dimension of grounding in collaborative learning lacks substantial research. Few contributions have been offered to understand different grounding interactions involved in computer-mediated collaborative contexts. The objective of my thesis is compatible with the intentions of the overall DoCTA project – namely, to contribute to the theoretical discussion in the knowledge domain of CSCL. I will explore concepts to enhance the understanding of students' interactions in a collaborative telelearning scenario, and in particular, I investigate grounding processes used by students when collaborating in the Future Learning Environment (FLE3). The FLE3 knowledge building forum is the main tool for computer-mediated communication in the scenario studied, and as such it is the channel for the distributed collaborative interactions studied. As a medium, the knowledge building forum is likely to convey potential resources for (and constraints

on) grounding. Therefore, the research question I ask is: How does the FLE3 knowledge building forum support or constrain grounding interactions? One of the main aims of this study is to gain an understanding of students' collaborative grounding interactions in a co-located and a distributed context; a subordinate goal is to explore how a micro-analytic approach to students' conversation and a social-cultural perspective can combine to form an analytic framework for studying grounding processes. Relying on multiple sources of evidence, the case study serves as a general research strategy (Yin, 1994). Data are triangulated to ensure sufficient validity, and the principle data sources are electronic logs, video recordings and scenario documents. I will argue that the problems identified are explorative, relying on non-experimental data. When screening videotapes, Interaction Analysis (Jordan & Henderson, 1995) is used as the instrument to identify significant interactions at the intra-group level.

To pursue the objectives outlined above, this thesis is organized into two main parts, the theoretical part (chaps. 2-4) and the empirical part (chaps. 6-8). Connecting the two parts is a bridge explaining how theory and data collection methodology are combined into a comprehensive research design that serves the purpose of this study (chap. 5).

A brief overview of the different chapters is as follows: *chapter 2* presents the conceptual background of the DoCTA-NSS project in general and my work in particular. The epistemology of CSCL and basic pedagogical principles utilized in the scenario are summarized here. In *chapter 3*, two divergent but interconnected models of grounding are discussed: Herbert Clark's contribution model (Clark & Brennan, 1991; Clark & Schaefer, 1989) and Michael Baker's model of grounding in collaborative learning (Baker et al., 1998, 1999). *Chapter 4* presents sociocultural theory as the specific conceptual approach of this thesis. *Chapter 5* explains how theory and data collection methodology are combined to generate a research design. *Chapter 6* is the central chapter of the empirical part. This chapter starts with a narrative case description as an organizing framework for further analysis of students' interactions in the scenario. In addition, a sociocultural approach is utilized to get a broader view of the collective and artefact-mediated aspects of the context. Next, transcripts and excerpts of co-located and distributed grounding interactions are

presented and interpreted. Findings are presented and discussed as an integrated whole to assist the reader in acquiring an overview of the logic used as the analysis progresses. Design implications and the quality of the study are reflected upon in *chapter 7*. *Chapter 8* summarizes and concludes the thesis.

2. BACKGROUND

2.1 Computer supported collaborative learning (CSCL)

The term CSCL emerged in the mid 90s and is commonly used to express a particular approach within Instructional Technology. Koschmann (1996) argues - from a Kuhnian perspective - Instructional Technology has undergone several paradigmatic shifts over a brief period of time. The term *paradigm* is associated with Thomas Kuhn's book, *The Structure of Scientific Revolutions* (Kuhn, 1962), and refers to a common set of assumptions, questions and methods shaping a field of inquiry at any given time (Calhoun, 2002). A paradigm shift is a fundamental and revolutionary change in an approach or the underlying assumptions of a research field. Kuhn himself applied the concept of paradigms to physical sciences (Kuhn, 1962). In the context of instructional technology and CSCL, the term may appear vague. Multidisciplinary research communities appropriate concepts, results and procedures from various fields, and it seems problematic to declare them as structured by a distinct logic. When it comes to instructional technology and CSCL, the term paradigm is probably more useful in a parallel sense where shifts emerge as a consequence of development in the research areas shaping the field rather than sudden revolutionary shifts in the field itself.

A general theme for CSCL is the focus on technology as a mediational tool in collaborative methods of instruction. Collaborative learning requires activity on behalf of the participants. Sharing of information, exchange of experience, discussion and solving joint problems are common activities in this type of learning. The group of participants and the interplay among them is often the focus for analysis, not the individual partakers isolated from the context. Scardamalia and Bereiter (1993; 1994) propose that the main aim of a CSCL environment is to provide students with computer tools for knowledge production in interaction with other users. The idea is to provide students with a shared working space to post their knowledge products and participate in a progressive discourse (Leinonen et al., 2002). Koschmann (2002) proposes that “CSCL is a field of study centrally concerned with meaning and the

practices of meaning-making in the context of joint activity" and "these practices are mediated through designed artefacts" (p. 20).

Theoretically, research on CSCL can be viewed as multidisciplinary, influenced by a mixture of areas from the social sciences. Among them are disciplines such as sociology, anthropology, linguistics, psychology, communication, psychology, etc. The primary underlying schools of thought influencing CSCL are referred to as social constructivism, Soviet sociocultural theories and theories of situated cognition. "Taken together these perspectives - social constructivism, Soviet sociocultural theories, and situated cognition - provide the intellectual heritage from which CSCL has emerged as a new paradigm for research in instructional technology" (Koschmann, 1996:13).

CSCL-related empirical research has undergone a shift to a more process-oriented view of learning (Dillenbourg et al., 1996; Koschmann, 1996). Instead of perceiving learning as an internal psychological matter, the focus of inquiry has shifted to socially constructed properties of interaction (Dillenbourg et al., 1996). Early research was more concerned with the outcome of collaborative learning, establishing whether learning by collaborating with peers was more effective than learning alone. For many years theories of collaborative learning were primarily focused on how individuals function in a group. Collaborative learning is a concept of consideration and needs to be further elaborated.

2.1.1 Collaborative learning

In the academic literature, the concept of "collaborative learning" is applied with a great span of meanings. The idiom "collaboration" is understood differently by many writers. No clear, unified definition is provided. To work jointly on some activity or project against a shared goal seems to be an essential dimension of the term. The idea of co-construction of knowledge and mutual engagement of participants is commonly stressed when defining collaboration (Lipponen, 2002). In this sense, collaboration can be considered "a special form of interaction" (ibid:73). I will briefly explore the aspects of this that are relevant for my study. To get a better understanding of the term, it will first be dissected in its basic components: *collaboration* and *learning*. What is meant by collaborative and what is meant by learning?

The word collaborate originates from the Latin word “collaborare,” meaning “work together” (Pearsall, 2001). Collaboration is consequently not an isolated act of one individual, but involves two or more actors. But for collaboration to be present, some mutual effort of shared understanding should occur. Roschelle and Teasley (1995) suggest that collaboration is “a coordinated, synchronous activity that is the result of a continued attempt to construct and maintain a shared conception of a problem” (p. 70). I consider this definition of collaboration useful for the problem raised in this thesis. Grounding-processes are to be studied in a collaborative learning scenario. The process of constructing and maintaining a shared conception of a problem can be interpreted as a grounding-process. When students interact in collaborative learning tasks, they need to maintain some degree of joint understanding of the problem at hand (Baker et al., 1999). However, a common effort of mutual understanding can also happen under non-collaborative circumstances (Dillenbourg, 1999), for example in a classic teacher–student interaction. Hence, the definition needs to be refined to include the situation in which the activity is embedded. The use of spoken or written dialog is likely to be present in a collaborative situation. A collaborative dialog is described by Swain (2001) as a “dialogue in which speakers are engaged in problem solving and knowledge building. It heightens the potential for exploration of the product” (p. 2). Yet, if participants are interacting and engaged in problem solving, is it reasonable to assume learning is the outcome of such a collaborative context?

Collaborative learning can be seen in the light of two metaphors of learning: Learning as acquisition and learning as participation (Lipponen, 2002). The *participation* metaphor regards learning “as a process of becoming a member of a certain community” (Sfard, 1998:6), which entails “the ability to communicate in the language of this community and act according to its particular norms” (ibid). Cognition and knowledge are distributed over both individuals and their surroundings (Lipponen, 2002). Learning is considered situated in these relations and networks of distributed activities. Contrasted with this view are learning models based on an *acquisition* metaphor. Anna Sfard (1998) argues that historically our accepted wisdom about learning has been determined by the acquisition metaphor. Learning has been considered collecting knowledge as if it was a commodity to be acquired. In the transfer process, the learner becomes an information processor and the teacher a dispenser of information. This metaphor is said to rely on a folk theory of seeing “mind as container” of knowledge. Learning, according to this view, is a process of filling up the container. A third,

alternative metaphor is presented by Hakkarainen and colleagues (2002). *The knowledge-creation metaphor* expresses learning as analogous to processes of inquiry. Learning understood as knowledge creation or knowledge advancement is a fundamental idea underlying the pedagogical models applied in the Gene-Ethics scenario. The inquiry-based pedagogical models relevant for this thesis are examined further in chapter 2.3.

A broad definition of collaborative learning describes it as "a situation in which two or more people learn or attempt to learn something together" (Dillenbourg, 1999:1). This reflects the common notion that collaborative learning includes a joint effort to learn. However, this general definition is unsatisfying and unable to describe the complexity of collaboration in a learning situation. The notion of group size is unclear; "two or more" could mean a small group of 2-5 students or a scientific community with thousands of participants. "Learn something" may be interpreted as completing a 2-hour workshop or lifelong learning. "Together" could involve interaction forms ranging from face-to-face to asynchronous computer mediated.

Dillenbourg reflects on the aspects mentioned above and provides an understanding of collaborative learning as "a situation in which particular forms of interaction among people are expected to occur, which would trigger learning mechanisms, but there is no guarantee that the expected interactions will actually occur" (Dillenbourg, 1999:5). Learning is, therefore, a possible outcome of such collaborative interactions.

2.2 Computer Supported Corporative Work (CSCW)

The multidisciplinary field of CSCW is considered an important source of inspiration for CSCL (Lipponen, 2002). The study of group activities and construction of computer technologies to assist cooperative work has been a prime concern for CSCW. With the introduction of internet technology in schools and other areas of society, digital text-based messaging has turned into a common form of communication (Dillenbourg et al., 1996). This includes asynchronous technologies such as e-mail/news groups and real-time synchronous chatting. As broadband technology develops more advanced solutions, two-way audiovisual communication and shared workspaces are possible. No common definition of the term CSCW exists at present. Grudin (1994) argues that CSCW is more like a forum, "an

undisciplined marketplace of ideas, observations, issues, and technologies" (p. 13). One of the founders of the expression CSCW – Irene Greif – identifies the field's research focus as the role of computers in group work (Grief, 1988). Social psychologists, anthropologists, organizational theorists and educators are among the contributors in the effort to understand group activity in this context (Grudin, 1994). The great span of disciplines involved makes it difficult to define the field and satisfy everyone concerned.

The term *groupware* is often used synonymously with CSCW (Ellis et al., 1991). Groupware is aimed to help groups communicate, collaborate and coordinate joint activities. It is "computer-based systems that support groups of people engaged in a common task (or goal) and that provide an interface to a shared environment" (Ellis et al., 1991:40). The notion of common task and shared environment shows that this concept is not clearly distinguished from CSCL. Groupware technology applied in a CSCW environment may also be used to facilitate learning in a CSCL environment. No rigid line to distinguish groupware in CSCW and CSCL exists. My impression is that the nametag assigned to the systems depends on the context in which they are used and which communicative processes they are intended to facilitate. Examples of groupware software are message-based applications such as discussion forums and electronic bulletin boards. However, even if CSCW and CSCL systems have many commonalities, they also have different requirements. Gerry Stahl (2002a) suggests that by converting a standard CSCW platform into an environment to support collaborative knowledge building, new functionality ought to be developed. To meet the particular educational and social setting, the original CSCW system should be extended into a CSCL application to assist processes of collaborative learning and knowledge building, e.g., by utilizing message categories from CSCL theories.

Groupware systems could be classified in a 2 x 2 matrix suggested by Johansen (1988). The Time-place matrix identifies four classes of corporative work situations along the dimensions of time and place. To fit the educational context in this thesis, Johansen's original matrix is slightly modified. The content of the four classes is adapted to possible situations where computers are involved in education.

	Same time (synchronous)	**Different time** **(**asynchronous)
Same place	Traditional classrooms and meetings	Electronic project rooms
Different place	Chat, videoconferencing	E-mail, Discussion forum (FLE3)

Table 2-1: Time and Place Matrix in education adapted from Johansen (1988).

Relevant for the scenario studied and the discussion in this thesis are the upper left and the lower right squares. The local focus group of students in the Gene-Ethics scenario were together physically, collaborating at the same time and same place (co-located). In the research project, local groups were paired to form distributed groups among the two participating schools. Students collaborated using a knowledge building tool for asynchronous communication (see chapter 6.1.1 for details). The dichotomies asynchronous – synchronous are applied as guiding categories for analysis, not as absolute distinctions. This dichotomy can be problematic and has been subject to criticism. For example, when students are collaborating same time, different places using news groups to exchange rapid messages on a topic, the distinctions in Johansen's (1988) matrix may seem too rigid. Is this synchronous or asynchronous communication? However, I find the Time – Place Matrix useful for framing some of the issues in this thesis. For example, previous research on grounding has primarily been occupied with the first square. Clark's contribution model is developed studying human interaction in face-to-face conversations (Clark & Brennan, 1991; Clark & Wilkes-Gibbs, 1986). Few contributions have been offered to understand the distributed, asynchronous dimension of grounding in computer-mediated collaborative learning (Baker et al., 1999; Fussell et al., 2002; Fussell & Kreuz, 1998).

2.2.1 Awareness

Awareness is a concept and technique in CSCW that has shown useful for ICT-mediated solutions for collaborative learning. A general definition of awareness is “an understanding of the activities of others which provides a context for one’s own activity” (Dourish & Bellotti, 1992:107). I comprehend the meaning of the term as being aware of own and group members’ activities and how they interact. It includes having a certain consciousness and knowledge about what’s going on in the group at different levels of abstraction. Gutwin et. al (1995) identifies four types of awareness in a student situation. *Social awareness* is the awareness of the social connections in the group. The awareness about how to complete joint tasks is referred to as *task awareness*. *Concept awareness* is the individual’s awareness of how a specific activity or knowledge-chunk incorporates into one’s own existing knowledge. Furthermore, *workspace awareness* is “the up-to-the minute knowledge about other students’ interactions with the shared workspace” (ibid:2). This could be the insight about where fellow students are working, their doings and what they have done.

Gutwin and colleagues (1995) stress the importance of awareness in educational groupware. They argue that the quality of a collaborative learning experience “depends on the informed involvement of curriculum designers, teachers, evaluators and students” (p. 1). This means that awareness is not only important for students, but the ones responsible for organizing the collaborative learning activity must also be aware of the students’ activity to provide necessary support. In everyday face-to-face interaction, awareness can be argued as optimal and unrestricted (Fjuk & Krange, 1999). Problems may transpire when mutual awareness should be maintained through a distributed groupware system. In a distributed, computer-mediated learning environment, students are not physically present. The distributed setting could constrain the creation of mutual awareness among the participants. However, different technological tools may possibly support such a process.

I find the notion of *social awareness* useful for my analysis to identify grounding interactions. This type of awareness is the information an individual maintains about others in a social or conversational context (Gutwin & Greenberg, 1995). Examples of this kind of behaviour are to monitor whether other group members are paying attention to what one is saying or checking out their emotional state. This kind of awareness is maintained through verbal or nonverbal cues such as facial expressions and body language. From a grounding

perspective, participants interacting in collaborative learning tasks need to maintain some degree of mutual understanding (Baker et al., 1999). Some general information-gathering techniques have been proposed for maintaining awareness among participants sharing a common workspace (Gutwin & Greenberg, 1995). One mechanism described is *direct communication* where people explicitly present information about their interaction in the workspace. This is mainly verbal communication, but gestures are also common. Actions, expressions or speech that is not explicitly aimed at group members – but are intentionally public – are named *indirect productions*. Another method for information gathering is *consequential communication*; watching or listening to co-workers as they carry out actions may possibly provide information about their interaction with the workspace. Information can also be assembled by examining the effect of others' actions on the artefact in the environment. This is referred to as *feedthrough. Environmental feedback* is gathered from perceiving higher-level feedthrough from the indirect effects of another's action in the larger workspace. For example in a collaborative learning session, seeing a paper with a sketch of a procedure can provide evidence that some of the group members have initiated a particular task.

One or more of these mechanisms may be present when supporting social awareness. For example: To achieve awareness of the social structure in a classroom, students can communicate directly with others, observe their activities and analyze the effects of their action on artefacts, e.g., computers.

2.3 Pedagogical models

O this learning, what a thing it is! (Shakespeare, 1564–1616)

Human learning can be seen as the acquisition of skills and concepts by a variety of processes (Philip, 2002). Numerous theories of how learning takes place have been proposed. In the CSCL research-community, particular problems of learning are commonly investigated, rather than formulating universal theories. Prominent researchers in the field have made efforts to capture the quality of scientific inquiry in the classroom (Bereiter, 2000; Hakkarainen et al., 1999; Koschmann, 2001; Scardamalia & Bereiter, 1994). This

paragraph is about the inquiry-based pedagogical models applied in the Gene-Ethics scenario. With the term *inquiry-based learning*, I understand forms of learning motivated by a process of inquiry involving meaningful engagement with a complex problem. In the evolution of CSCL as a research area, a multitude of learning theories has been applied in various contexts (Dillenbourg et al., 1996). Due to the limitations of this thesis, I find it necessary to restrict the discussion to focus on the models applied in the Gene-Ethics scenario. The models of *Knowledge Building* (Scardamalia & Bereiter, 1993, 1994) and *progressive inquiry* (Hakkarainen et al., 1999) played a significant role in the scenario studied. These models are not clearly distinguished, but they explain important ideas applied in CSCL epistemology. The pedagogical and epistemological framework implemented in the educational software (FLE3) used in the scenario is the one of Progressive Inquiry (PI) developed by Hakkarainen and colleagues (Hakkarainen et al., 1999). PI is a synthesis of diverse learning approaches and a model for implementation in a CSCL context (Lakkala et al., 2001). It's considered a general pedagogical and epistemological framework that can be used differently in various settings. In our scenario, students learned about genetics in a CSCL context.

2.3.1 Philosophy of inquiry

The theory of inquiry was proposed by Dewey (1933/1989; 1938/1991). Inquiry-based learning involves the learner as an active partner in the process of problem solving. Dewey was a pragmatic philosopher and is commonly regarded as the founder of the progressive education movement in the USA. In the text *How We Think* (1933/1989) Dewey presents a theory of inquiry for educators. He termed the process "the five phases of reflective thought" (Koschmann, 2001 cites Dewey, 1933/1989:200). The theory was further elaborated in *Logic: The Theory of Inquiry* (1938/1991). Dewey did not separate thinking and feeling from acting. He was a dedicated anti-dualist. Dewey projected that meaning is constructed within a socially and materially determined situation. The term "situation" is understood in a broad sense, also referring to the complex social matrix in which the learner is an integral component (Burke, 1994; Koschmann, 2001). Dewey postulated that the steps of a meaningful inquiry are not chronological and can not be completely distinguished. They are rather functional distinctions within the inquiry and are useful for analysis and pedagogy. The first step of effective inquiry involves the occurrence of a *problem* (Dewey, 1938/1991). In the spirit of pragmatism, inquiry begins with genuine doubt. Thereafter, the problem has

to be *specified*. “A problem well put is half-solved” (ibid:112). The students are to discover the problems from a challenging situation. Problems should not be placed upon the student by teachers, but introduced in a context of inquiry. Consequently, learners are not passive receptors of knowledge but active contributors. The third step is about introducing a suggestion or *hypothesis* assumed to solve the problem. To develop possible solutions requires creative use of imagination. Next, the hypothesis needs to be elaborated to possible consequences and *compared* with other hypotheses. It’s then time for the last step, to *test* the hypothesis experimentally. Operations are carried out to see if the idea actually works out in practice. If the hypothesis is confirmed, there is warrant for believing that the ideas are true. Dewey called this “warranted assertibility”. Popper (1962; 1972), on the other hand, would base truth on falsification rather than verification.

Dewey’s model of inquiry is linked to experimental scientific methodology. His ideas are commonly referred to as “learning by doing” and have been interpreted in different directions. Among them are constructionism and constructivism. A general constructivist view is that complex mental structures, i.e., perceptions, memories, are actively constructed or built by the learner’s mind rather than passively acquired (Colman, 2001). A more radical branch of constructivism derives from the writings of Jean Piaget (1953; 1960; 1977). He assumed that children construct mental structures by monitoring the effects of own actions on the environment. In this way, knowledge is not transmitted from one individual to another but actively constructed. In Papert’s (1991) terminology, constructionism “shares contructivism’s connotation of learning as ‘building knowledge structures’ [...] It then adds the idea that this happens especially felicitously in a context where the learner is consciously engaged in constructing a public entity, whether it’s a sandcastle on the beach or a theory of the universe” (p.1). To Papert, knowledge is fundamentally grounded in contexts. Computers are regarded as providing an especially wide range of contexts for constructionist learning. He stresses “the role of constructions in the world as a support for those in the head” (Papert, 1993:143). Connecting learning with constructs in particular contexts shows that Papert’s constructionism is more situated than Piaget’s constructivism.

Dewey’s progressive educational philosophy with emphasis on real life problems is apparent in contemporary educational movements. The acronym PBL (Problem Based Learning) is often used to express a problem-centred curricular approach rather than discipline centred.

PBL can be considered an illustration of a collaborative method of instruction. As a curricular reform, PBL originated at the Faculty of Health Sciences at McMaster University in the late 1960s (Koschmann, 1996). It was aimed to help pre-clinical medical students master the basic biomedical sciences. McMaster Medical School defines PBL as "any learning environment in which the problem drives the learning. That is, before students learn some knowledge they are given a problem. The problem is posed so that the students discover that they need to learn some new knowledge before they can solve the problem" (Woods, 1996:1).

As an instructional strategy, PBL is a framework to promote active learning (Barrows, 1996). This should support self-directed learning strategies and attitudes needed for lifelong learning (Bereiter & Scardamalia, 1989). According to Prawat (1989) "the advantage of such an approach is that students become much more aware of how the knowledge they are acquiring can be put to use" (p. 18). PBL is characteristically student- centred and learning occurs in small groups (Barrows, 1996). Teachers function as facilitators guiding the process. The components of PBL include *problem formulation, reflection, abstraction and application of knowledge* (Koschmann, 1996). Reflection and abstraction could possibly promote a more advanced understanding of the problem area.

2.3.2 Knowledge building

Knowledge building is regarded as an inquiry-based theory of learning and is frequently referred to in CSCL literature. The term was first introduced by Scardamalia and Bereiter (1994) who argue to reform the culture of classrooms and restructure schools into communities where construction of knowledge is a shared goal. In this model, the class is turned into a research team advancing collective knowledge through collaborative investigation (Hewitt et al., 1995). The intention is to provide a supporting culture for authentic discourse and encourage understanding rather than memorization. A culture where the participants of the inquiry-based discussion can reach a higher competence level than they can achieve by themselves. Knowledge can be said to circulate among the participants of the discussion in "multiple zones of proximal development" (Brown & Campione, 1994). The knowledge is thus distributed between the participants in multiple ZPDs. Ann Brown (ibid) suggests that communities of learners grow out of collaborative classrooms where the learners obtain and share a mutual knowledge base. Collaboration is in this sense vital for

the progress of a community of learners. A ZPD can consist of people with varying expertise, but it can also involve artefacts such as books, scientific equipment and computers (Brown & Campione, 1994).

Educational technology could aid the knowledge building process and replace traditional classroom discourse patterns, providing extensions to knowledge building communities outside the school (Scardamalia & Bereiter, 1994). A knowledge building community consists of a group of individuals devoted to sharing and developing collective knowledge. The inhabitants of the community are engaged in a collaborative process of advancing and creating knowledge (Bereiter, 2000). Research teams are applied as a practical example of this kind of workflow (Hewitt et al., 1995). Such a community represents "a commitment among its members to invest its resources in the collective pursuit of understanding" (ibid:1). The concept of knowledge building derives its intellectual heritage from the Austrian philosopher Sir Karl Popper, who proposed a model of knowledge where reality is divided into three worlds (Popper, 1962, 1972). The first world is the physical, external reality. Popper made a clear distinction between knowledge existing in individual minds (world 2) and abstract knowledge with existence above the individual level (world 3) (Scardamalia et al., 1994). Accordingly, world 2 describes the inner mental world of individuals. The objective ideas of world 3 exist as autonomous conceptual artefacts, independently of their source: the subjective mind of world 2. The matter constituting world 3 is thus man-made abstract artefacts such as concepts and theories. Popper (1972) perceived science as an industry of improving world 3 objects. The concept of knowledge building is formed on this idea of collective work, i.e., to advance and develop conceptual artefacts in world 3 (Paavola et al., 2002). The initiative of bringing the dynamism of a research team into the classroom has been proposed by a number of researchers (Brown & Campione, 1994; Dewey, 1938/1991; Hakkarainen et al., 1999; Scardamalia et al., 1994). However, Scardamalia and Bereiter (1994) argue that applications of the scientific model of knowledge building in classrooms mostly end up as world 2 projects. "The question is always to what extent do children think and act like scientists, not to what extent does a school class function like a scientific community" (p. 205). Can we really expect students to work with knowledge objects as skilled scientists do? Ludvigsen and Mørch (2003) propose an alternative version of Popper's world 3, introducing the idea of knowledge objects intended for students' localized scientific knowledge building. *Micro Third World (MTW) objects* are

referred to as localized knowledge building artefacts. They are equivalent to world 3 productions in a Popperian sense as they are shared resources. However, MTW objects are constructed and shared locally in small groups. This can be theories and explanations created by students in the classroom (ibid).

A theoretical distinction is drawn between learning and knowledge building (Scardamalia & Bereiter, 1994). Learning is a potential outcome of an educational effort, but students are not necessarily engaged in knowledge building. The latter requires a mutual effort to advance collective knowledge. Scardamalia and Bereiter claim that most social environments do not provide the necessary support for knowledge building (ibid). Traditional education is predominantly "first-order environments." This means that learning is asymptotic. The adoption to the environment involves learning, but students are integrated in a stable system of routines. Readymade doses of information are dispensed on a daily basis. In "second-order environments" learning is not asymptotic because the adoption involves making contributions to collective knowledge. Escalating shared knowledge entails contributions that go further than what is already known, hence producing non-asymptotic knowledge. Knowledge building communities are characterized as second-order environments. Gerry Stahl proposes that the "term knowledge building is more concrete and descriptive than 'learning' when we are interested in collaboration" (Koschmann, 2002:62). Knowledge is made up of objects that can be systematically produced and developed (Paavola et al., 2002). Characteristics of scientific research communities (and students acting as such) are their involvement with theories and models that may be understood as collective knowledge objects rather than representing mental states. Learning is, in this sense, a social practice of constructing collective knowledge.

It's evident that many models of curriculum design are compatible with collaborative knowledge building. The inquiry-based models mentioned in this chapter, i.e., PI, can be said to be a model within this tradition.

2.3.3 Progressive Inquiry (PI)

The educational software used in the Gene-Ethics scenario (FLE3) is designed to support collaborative knowledge building (Scardamalia & Bereiter, 1994) and progressive inquiry (Hakkarainen et al., 1999; Hakkarainen et al., 2002). The software package contains a

Knowledge Building (KB) forum, which provides a shared space for asynchronous dialogue (see chapter 6.1.1 for details). As a general pedagogical framework, the PI model is not considered normative and prescriptive, but multifunctional and guiding for design of learning environments in a CSCL setting. PI is defined as "the sustained process of advancing and building of knowledge characteristic to scientific inquiry" (Muukkonen et al., 1999:1).

As a collaborative learning environment, Future Learning Environment (FLE3) is designed to support a progressive approach to learning and problem solving. The model is developed by Kai Hakkarainen and colleagues at the Department of Psychology at the University of Helsinki (Hakkarainen et al., 1999; Hakkarainen et al., 2002). The framework of PI is primarily developed for conducting scientific inquiry in schools. The centre of attention is collaborative learning where a group of students work together and mutually construct conceptual knowledge. Lakkala et al. (2001) refers to James March (1991) who makes a distinction between *explorative* and *exploitative* actions. Explorations are understood to be activities like searching, discovering and innovation. Opposing this, exploitation is explained as fine-tuning, constructing and implementation of knowledge. It's argued that contemporary educational systems mostly deal with exploitation of existing knowledge (ibid). Instruction conducted with well defined questions and pre-existing answers is not likely to have sufficient qualifications to take part in a complex knowledge society. To assist higher-level processes of inquiry in education, a number of scholars have proposed that cultures of schools should more closely resemble those of a scientific community (Brown & Campione, 1994; Dewey, 1938/1991; Hakkarainen et al., 1999; Scardamalia & Bereiter, 1994). "Learning by doing science" could facilitate students' attempts to grow deeper in their abstract understanding and practice of scientific thinking. Typical for this type of inquiry is that new information is treated as something problematical that needs to be explained (Scardamalia & Bereiter, 1993). This may possibly prevent students from assimilating scientific knowledge as completed products and encourage a critical mind. It is necessary to engage in collaboration and peer interaction in the effort of improving shared knowledge objects (ibid). To work jointly and share resources as a learning community may smooth the progress of advancement of inquiry.

A model labeled “progressive” can be interpreted as being committed to continuous improvement, making use of or paying attention to new ideas, inventions or opportunities. The progression of the PI model is reflected in the process of asking and answering questions. The inquiry starts with an initial *question* or a main problem. This question is further divided into *sub-questions*. The initial problem is *progressively refined* by new questions and answered by *working theories*. Working theories are advanced and explained by scientific references to *deepen the inquiry*. The different elements and their relations are illustrated and shortly described below.

The elements of PI

According to Hakkarainen et. al (2001) the process should start with creating a context to anchor the problems to be investigated. The intention is to assist students in recognizing why the issues are important and meaningful to investigate. In the Gene-Ethics scenario, a trigger video about genetics was introduced to the students. The figure below is designed to illustrate the dynamics of PI. The wheel spins in the marked direction as the inquiry progress.

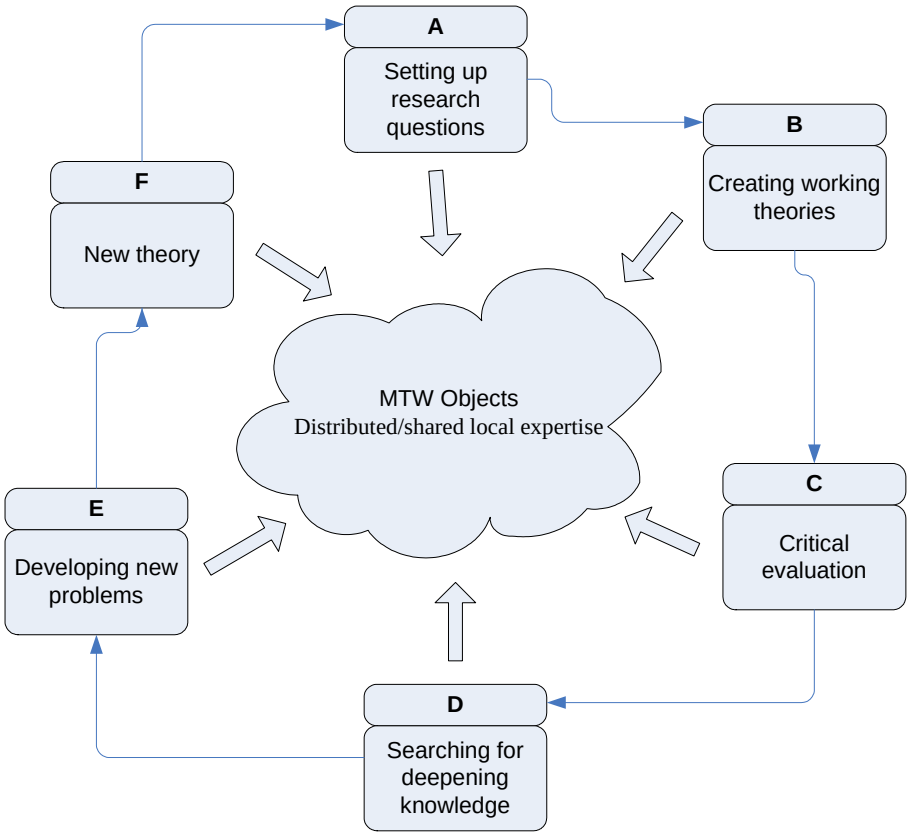


Figure 2-1: The wheel of progressive inquiry adapted from Hakkarainen et al. (1999) and Ludvigsen & Mørch (2003).

The elements of PI as presented in Figure 2-1:

A. **Setting up research questions:** A key part of the process is setting up questions and specifying problems to guide the course of the inquiry. Problems arising from students' own reflections and urge to understand are considered of particular value for the progression of the inquiry.
B. **Creating working theories:** For the students to develop conceptual understanding, it's crucial to generate their own speculation or interpretations of the phenomena (Lakkala et al., 2001; Scardamalia & Bereiter, 1993). The practice of building working theories can be seen as a process of constructing explanations. Constructing

their own explanations may guide students to perceive themselves as contributors to knowledge, not passive receptors. An intimate connection between explanation and understanding is proposed by Perkins et al. (1995). Individuals express their understanding by presenting explanations. Consequently, an authentic understanding requires students to participate in the process of explanation (Lakkala et al., 2001).

C. **Critical evaluation:** This step is about evaluating how well the formulated working theories explain the problems investigated. The groups consider strengths and weaknesses of different explanations, contradictions, gaps of knowledge and shortcomings of the intuitive explanation (ibid).
D. **Searching for deepening knowledge:** To advance the inquiry, new scientific information is necessary. This step is likely to be a direct continuation of the previous step. After a critical evaluation of the working theories, the search for deeper knowledge is considered a logical step. New questions could guide the knowledge-seeking process and help structure the search in a large body of information.
E. **Developing new problems:** A condition for the progress of the inquiry is that students focus on improving their theory and formulating more specific problems. This step is about developing more precise questions for investigation. Characteristic for pragmatic problem-solving is that students have to create general initial questions and tentative theories before all required information is on hand. The progress of the inquiry should be focused on improving theories by generating more specific questions (Lakkala et al., 2001). The inquiry advances by dividing the initial big and general questions into subordinate, more specific ones. By finding answers to sub-questions, the students gradually approach the initial question.
F. **New theory:** As the inquiry progress, the aim is for students to develop initial problems and working theories into new conceptual understanding. New theory transpires.

The experience and knowledge produced in the investigation should be shared with the other inquirers (Lakkala et al., 2001). Research questions, information searches and construction of working theories are to be distributed among the participants of the knowledge community. To account for the shared, localized scientific knowledge building in a classroom, I suggest integrating the concept of *Micro Third World (MTW) objects* in the PI-

model (Mørch et al., 2004). This dimension is rendered in the core of the figure above to illustrate the localized knowledge building artefacts produced in a collaborative telelearning scenario. MTW objects can be theories and explanations constructed and shared in small groups.

Research indicates that socially distributed cognitive resources can advance inquiry considerably (Lakkala et al., 2001). Learners' social interaction and collaborative efforts could provide conditions for shared understanding. From a grounding perspective, the construction of mutual understanding is assumed to be an important process in collaborative learning (Baker et al., 1998). Such collaborative interactions are relevant for the research focus of this thesis: the study of grounding interactions.

The idea of scientific inquiry as it has been adopted in the PI model also builds on Scardamalia and Bereiter's research (Bereiter, 2000; Bereiter & Scardamalia, 1989; Scardamalia & Bereiter, 1993, 1994; Scardamalia et al., 1994). They argued that schools should be reorganized into knowledge building communities. Scientific thinking could be promoted in schools by arranging classrooms to function like scientific research communities. The role of the teacher in this setting would be a facilitator, guiding students to contribute in a progressive scientific discourse. Previous studies have shown that a degree of teacher intervention or prompting is necessary to create the conditions for progress and conceptual talk (Hakkarainen et al., 2002; Ludvigsen & Mørch, 2003).

3. GROUNDING

A recent approach to research in the field of collaborative learning is aimed at the process of *grounding*. The concept of *common ground* has its roots in linguistics and arises from a model of conversation developed by Herbert Clark (Clark & Brennan, 1991; Clark & Wilkes-Gibbs, 1986). Similar notions like mutual belief, intersubjectivity, a shared conception or shared knowledge have been applied in theories of collaboration. In a broad sense, grounding is considered a process of adding information to the common ground between individuals while communicating. It is suggested that partakers in a conversation continually add and update information to the common ground (ibid). Accordingly, this process is indispensable for collaborating students to understand each other and solve problems jointly. However, few contributions have been offered to understand grounding processes involved in computer-mediated collaborative learning (Baker et al., 1999; Fussell et al., 2002; Fussell & Kreuz, 1998).

I this chapter I discuss two models of how collaborators can contribute to a common ground. Initially the essence of *Clark's contribution model* (Clark & Brennan, 1991) and the main critique of it will be presented. Thereafter, I find it natural to continue with Michael Baker's contribution, which is specifically aimed at grounding in collaborative learning (Baker et al., 1998, 1999).

3.1.1 Clark's contribution model

Clark and colleagues (1986) regard conversation as a collaborative process. The term *process* indicates some dynamics or changing state in the collaboration. The contribution model expands traditional models of communication, where conversations were perceived as sender-receiver turn taking. Clark and Brennan (1991) suggest that all collective actions (including learning) are built on a common ground. To coordinate content, the participants need to contribute and update their common ground moment by moment; they "cannot even begin to coordinate content without assuming a vast amount of shared information or common ground" (ibid:44). The grounding process where partakers create and maintain such a common platform is assumed to vary according to the context of interaction.

The notion of common ground is regarded as a set of mutual beliefs of conversational partakers with reference to the meaning of utterances. Communication can reasonably be stated as a collective activity; it takes two or more individuals to communicate. Furthermore, to have a conversation going, the participants need to understand each other at some level. They have to ground their communication. This idea is illustrated by the following hypothetical exchange:

Adam: Are the genes replicated when –um, cloning?
Eve: When cloning?
Adam: Yeah.
Eve: Yeah, copied.

Adam's first utterance in this example, "Are the genes replicated when –um, cloning?" is not yet grounded. Eve hasn't really understood the question. After Adam responds to her question (with "Yeah") she's disposed to reply to his original question ("Yeah, copied"). Now they both seem to believe that they have understood the meaning of each other's utterances and the conversation can be considered as grounded. According to Clark and Schaefer (1989) it's not crucial to fully ground every aspect of the interaction. It's often sufficient to reach a grounding criterion, which is obtained when "the contributor and the partners mutually believe that the partners have understood what the contributor meant to a criterion sufficient for the current purpose" (Clark & Schaefer, 1989: 262).

Grounding in this sense is the attempt of reaching a mutual belief. Conversation in these terms is more than merely to plan and issue utterances. Partakers in conversation try to sense if what has been said has been sufficiently understood. In Clark's theory, they attempt to ground what has been said, making it part of their common ground (Clark & Brennan, 1991; Clark & Schaefer, 1989).

Let's return to the above hypothetical exchange of utterances. What degree of mutual understanding can we assume that the conversation partners have obtained after reaching the grounding criterion? Do they have a level of mutual understanding of the word "cloning"? As analysts, can we grasp the meaning of a word introduced in conversation without

considering the different realities or reference frames participants bring to the context? Wittgenstein (1968) can be illuminating in this regard as he was concerned with the nature of language. In his view, it's how we make use of a word in a particular situation that gives the word its meaning. In this sense, words have no objective meaning isolated from the context in which they are used. The Norwegian social psychologist Ragnar Rommetveit represents a pluralistic approach to communication, merging ideas of scholars such as Mead (1934), Wittgenstein (1968) and Vygotsky (1962; 1978). Rommetveit (1974) argues that every communicative act builds upon the joint commitment to "a temporarily shared social world" (p. 29). He assumes that human "discourse takes place in and deals with a pluralistic only fragmentarily known, and only partially shared world" (Rommetveit, 1985:183). *Intersubjectivity* is, in his view, a construction that transpires within the interaction. This process is neither embedded in the prior knowledge of conversational partners, nor is it openly expressed in language. Following this reasoning, mutual understanding is not explicitly shared knowledge of the world or linguistically mediated meaning. The *meaning is emerging* in the interaction, jointly created from the social realities the participants bring to the situation, forming a partly shared social world. Some basic shared knowledge or common ground is thus considered necessary for the communicative act to persist. Thus, the individual partakers' different realities and sociocultural backgrounds are influencing the context-specific meaning making process as it unfolds. However, are we as analysts capable of understanding the real meaning of the utterances issued in the conversation? Studying what is meant by what is said raises profound philosophical issues about the nature of language as a tool for human communication. Due to the limitations of this thesis, these issues are not examined in depth.

Some of the issues outlined above are addressed by Baker et al. (1999) who argues that the cultural dimension is frequently left out by approaches focusing exclusively on the inner dynamics of interpersonal interaction. Elements from linguistics and cultural-historical activity theory (CHAT) are combined in a theoretical perspective on grounding (see chapter 3.1.2).

Clark is aware that the grounding process in face-to-face conversations is unlike distributed forms of communication, such as personal letters or electronic discussion boards. This initiative is further elaborated in his work on grounding with different media for

communication (Clark & Brennan, 1991). My suggestion is that grounding in a co-located collaborative learning situation is of another character than in a computer-mediated distributed environment.

Compared to a traditional sender-receiver model of communication, Clark's contribution model goes further by broadening the analytic frame from a single message unit to a contribution developed in interaction (Koschmann, 2003). The production of contributions to conversation is divided into two components. Contributions are initiated when a potential contributor presents an utterance to a partner. The contributor specifies the content of his contribution with the intention for the partner to register it. But the contributor can not know if he accomplished anything unless the partner provides some clues or evidence of understanding. However, do these clues have to be linguistic productions? To what extent is language necessary or sufficient for establishing a common ground? Is non-verbal communication in some situations sufficient for reaching a joint understanding? Clark and Brennan's model is not clear on these issues. They label the two phases of contributing to conversation the *Presentation Phase* and the *Acceptance Phase* (Clark & Brennan, 1991:223).

> **Presentation Phase:** A presents utterance *u* for B to consider. He does so on the assumption that, if B gives evidence *e* or stronger, he can believe that B understands what A means by *u*.
>
> **Acceptance Phase:** B accepts utterance *u* by giving evidence *e* that she believes she understands what A means by *u*. She does so on the assumption that, once A registers that evidence, he will also believe that B understands.

Accordingly, both phases have to be completed to contribute to the common ground between A and B. But once both phases have been completed, is it reasonable to state that a common ground is mounting among participants? Did B really understand what A meant, or did she just provide some positive feedback "cheating" A into believing she understood? After A's production of an utterance *u*, the addressee (B) is described in one of the following potential states (Clark & Brennan, 1991:224):

State 0: B didn't notice that A uttered something

State 1: B noticed that A uttered something (but B was not in state 2)

State 2: B correctly heard the content (but wasn't in state 3)

State 3: B understood the meaning of A's utterance

The aim of A's utterance is thus for B to reach state 3. But for the utterance to be part of their common ground, B must provide A with evidence that the content is understood. On the contrary, if some content is not in state 3 after the presentation, B communicates this to A as part of a repair-sequence. During a conversation, a speaker is trying to make sure he or she was understood by the listeners (ibid). The speaker looks for evidence of understanding. This could be both positive and negative evidence. The latter are indications provided by the listener that he or she misheard or misunderstood. This includes both verbal and non-verbal clues. Clark and Brennan claim that if negative evidence is found, it's repaired. If no negative evidence is found, we assume that the utterance is understood. Negative feedback typically comprises a new communicative action from the listener. Examples are repetitions ("When cloning?") or asking questions for clarification. In view of the contribution model, people ultimately seek positive evidence of understanding, that is, positive feedback from the listener if the message is understood well enough for the current purpose. *Acknowledgements* are said to be the most obvious form of positive evidence. Continuers like "yeah," "mmhm" and head-nods are considered acknowledgements. Continuers are used by receivers of utterances to signal that they believe they have understood so far. Another common form of positive evidence according to Clark and Brennan (1991) is the initiation of the *relevant next turn*, contributions with a meaning that makes sense in the context and carry on the conversation. For the conversation partner to be able to perform a relevant next turn, some degree of understanding must have been obtained. In consequence, the initiation of such a relevant next turn could provide positive evidence of understanding. *Continued attention* is a third basic form of positive attention, to monitor the conversation-partner's action moment by moment. If the target-receiver of an utterance does not pay attention, i.e., looks another way, we can hardly assume that he or she understands the content. Some feedback must be provided to show that the person is paying attention (ibid). Eye gaze is one way of showing that you're attending to the speaker.

The principle of *least collaborative effort* (Clark & Brennan, 1991) is derived from the grounding criterion mentioned above. This notion is based on cognitive interactional economy (Baker et al., 1998). Speakers are likely to spend just enough effort as is needed for the current purpose. This is contrasted to classical efficiency principles that minimize effort on the receiver (Traum & Dillenbourg, 1996). The principle of least collaborative effort minimizes the total effort of all the conversation partners. Clark and Brennan (1991) state the principle as follows: “In conversation, the participants try to minimize their collaborative effort – the work that both do from initiation of each contribution to its mutual acceptance” (p. 135). In this sense, participants minimize the amount of collaborative effort they have to invest in the conversation to achieve sufficient understanding. They don't work harder than they have to in order to be understood.

The purpose of the conversation is assumed to influence grounding. Partners generally try to establish a collective purpose (Clark & Brennan, 1991 cites Grice, 1975). If students are collaborating on a task, the successful completion of the task may be their overall collective purpose. In individual sections of the conversation, their purpose may be to complete pieces of the task. In other situations their overall purpose may be social talk, i.e., discussing where to party this weekend. Following Clark’s grounding criterion, if listeners are to comprehend the meaning of an utterance “to a criterion sufficient for current purposes” (Clark & Brennan, 1991:262), the criterion ought to change as the collective purpose alters. It is proposed that techniques of grounding vary with what needs to be understood. Styles of grounding are thus likely to change with the content or purpose of the conversation.

In compliance with the principle of least collaborative effort, people will try to ground with as little joint effort as required for the current purpose. Clark asserts that grounding changes with different media, i.e., telephone, e-mail, video-teleconference. Different media bring various constraints and costs on grounding. For example, some media offers simultaneity and synchronism where users can send messages at the same time. Other media have a delayed asynchronous character where partners must take turns.

Clark and Brennan (1991) list eight possible constraints a medium may impose on communication and, consequently, affect grounding: *co-presence, visibility, audibility, co-temporality, simultaneity, sequentiality, reviewability, and revisability.*

Constraints	**Explained**
Co-presence	A and B share the same physical environment, i.e., if two people are in the same room they share the same surroundings and can easily observe what each other is doing and looking at.
Visibility	A and B are able to see one another. In a face-to-face conversation or a video conference, participants can see each other's movements and facial expressions.
Audibility	A and B communicate by spoken verbal communication. For example, in a face-to-face conversation or on the phone, participants can hear each other, take note of timing and intonation.
Co-temporality	B receives more or less the same time as A produces. In face-to-face conversation or on the phone, an utterance is generally produced immediately when it is received and understood, without delay. This is not the case in media such as electronic mail.
Simultaneity	A and B can send and receive utterances simultaneously. In a face-to-face communication, messages can be sent and received by both partners concurrently, i.e., when a hearer nods during a speaker's utterance.
Sequentiality	When A's and B's turns cannot get out of sequence. Misunderstandings can occur when electronic messages are read in a different order than they were sent. In a face-to-face conversation, turns typically form a sequence.

Reviewability	When B can review A's messages. Written material such as letters and e-mail can be reviewed later by either of the partners.
Revisability	When A can revise messages for B. In media such as e-mail, messages can be read and revised before sending them. In face-to-face conversation, self-repairs mostly have to be done openly.

Table 3-1: Constraints that a medium may impose on communication between two people A and B (Clark & Brennan, 1991:229).

What takes effort can change with the communication media and the grounding techniques available in the present media. Clark and Brennan (1991) predict "that people should ground with those techniques available in a medium that lead to the least collaborative effort" (p. 229). If a medium lacks one or more of the characteristics mentioned in Table 3-1, people are forced to use alternative grounding techniques because the costs of making contributions to the common ground change according to the medium (ibid). An example of costs on grounding is *production costs*. The costs involved in producing an utterance vary from medium to medium. For most people, less effort is needed to speak or gesture in a face-to-face situation compared to writing on a keyboard.

Clark's contribution model does not provide a deeper insight in how grounding in co-located, face-to-face environments differs from a distributed environment. Given that different media have different blends of constraints and affordances, Baker et al (1999) proposes the principle of least collaborative effort to predict different styles of grounding for use in different media. However, no agreed upon formulation of such styles is available in the literature. Focusing mainly on the specific interaction in conversation, Clark's model does not account for the different social realities participants bring with them to the partly shared context.

3.1.2 Baker's model of grounding in collaborative learning

This approach represents an attempt to combine elements from linguistics and cultural-historical activity theory (CHAT) in a theoretical perspective on grounding. Baker et al. (1999) argues that language science "provides fine-grained cognitive models of the grounding process, collaboration and how the two relate, within the short timescale on isolated verbal interactions" (p. 32). On the other hand, CHAT offers a concept of learning as an appropriation of tools, enabling us to get an idea of language's function in a CSCL environment. Based on the work of Vygotsky (1962; 1978), Leont'ev (1981) and Luria (1976; 1979), learning and development are perceived as a sociocultural activity in which individuals appropriate accumulated knowledge with the support of more competent people and available cultural tools, i.e., language and computers. Baker and colleagues (1998) proposes that the communication-oriented grounding model can contribute to the three levels of analysis provided by CHAT (see Figure 4-3) to get an enhanced perception of the level of operations and the transition connecting operations and actions.

When multiple participants interact in collaborative learning tasks, they need to maintain a degree of mutual understanding (Baker et al., 1999). Some common knowledge or reference-frame among the participants has been claimed as an important aspect of communication and collaboration (Baker et al., 1999). "Grounding is the process by which agents augment and maintain such a common ground" (ibid:3). Participants interacting or collaborating on shared tasks will generally already have reached a certain degree of common ground. However, grounding is considered necessary but not sufficient for collaborative learning. If students are to learn from grounding - from a CHAT perspective – the common ground of material and semiotic tools provided by culture have to be appropriated to some degree previous to the collaborative learning session. With the term *material tools* I understand tools to take a physical form such as chalk and blackboard (a world 1 entity). The topic of semiotics is sometimes limited to non-linguistic communication, i.e., body language, visual signs and symbols, but may also include language (Chalker & Weiner, 2003). Semiotic tools could thus be of both linguistic and non-linguistic nature including spoken language, gestures and artefacts such as books and various tools for computer mediated communication.

Furthermore, "grounding or 'intersubjectivity' must be situated within the ZPD if it is to lead to learning" (Baker et al., 1999). Accordingly, this cultural dimension is frequently left out

by approaches focusing solely on the inner dynamics of interpersonal interaction. They argue that one needs to consider both the role of culture and the inter-individual interaction to get an understanding of grounding in collaborative learning. I interpret this as an argument to broaden the unit of analysis beyond the given (speaker–listener) interaction. This brings foci for analysis further than Clark's grounding model (chapter 3.1.1) where the unit of analysis is the collaborative contribution to conversation.

Language is, in this framework, considered a significant instrument and an object of grounding in communication (Baker et al., 1999). The grounding processes should take care of effective communication, developing a shared platform of mutual understanding of utterances in the interaction. However, non-verbal clues such as gestures also play a role in this process. Even so, Baker and colleagues argue that the most important objects to be grounded are linguistic productions (utterances). Their position is that grounding in collaborative learning is primarily based on spoken language. In line with activity theory, language is considered a multifunctional tool, an instrument in individual and collective activity and thinking. Language, in this sense, makes interpersonal communication possible. Baker et al. (1999) claim that grounding can take place on pragmatic and semantic levels. The pragmatic level involves learning to collaborate, i.e., play roles in various tasks. At the semantic level grounding includes seeking mutual understanding of referents or meanings of terms. Learning to understand one another and adapt to semiotic tools are thus relevant facets of grounding in collaborative learning. This consideration is expressed in the following definition: "Collaborative learning will be associated with a gradual transition from the use of language as a medium for grounding communication (pragmatic) to grounding on the level of the medium itself (semantic), leading to appropriation of the medium (ibid:42)".

Why do students spend additional effort on semantic grounding? Baker et al. point out the prerequisite to analyse learner's goals and motivations in detail to understand collaborative interactions. Researchers and analysts ought to ask themselves why learners are grounding and what their main goals are. These questions can give us clues for understanding the grounding criterion mentioned above (p. 24), stating that participants try to achieve joint understanding to a degree that is considered satisfactory for the current purpose.

The reasoning above shows that the least meaningful unit of analysis must include language when studying grounding. Collaborative learning is viewed as an appropriation of semiotic tools, mainly language based (Baker et al., 1999). This involves the transition from learning to understand each other to learning to recognize the meaning of the semiotic apparatus. But to understand processes of grounding in a CSCL environment, the unit of analysis goes beyond the given speaker–listener interactionon at an utterance level. In addition, one needs to consider the role of culture, mediating artefacts and language (Baker et al., 1998, 1999; Koschmann, 2002). Furthermore, investigation of students' goals in the particular situations that trigger them to go further in their effort to gain mutual understanding can be useful to grasp the processes involved in collaborative learning. The unit of analysis for this study is discussed further and defined in chapter 5.1.

4. ANALYTIC APPROACH

Project DoCTA aims to bring a theoretical perspective to the design and use of collaborative telelearning artefacts (Wasson et al., 2000). There are numerous theories that have influenced the overall project. Sociocultural theories and Computer Supported Collaborative Learning (CSCL) are the main underlying conceptual approaches.

The theoretical frame of the research project and the specific analytic approach of this thesis are described and discussed in this chapter.

4.1 Sociocultural perspective

The evolution of CSCL as a research area in instructional technology partly builds on sociocultural theory (Koschmann, 1996). The idea is to use ICT as a tool to mediate high-quality learning processes. A sociocultural perspective is influenced by research from various fields representing alternatives to a standard cognitivist approach to learning. Thoughts from pragmatism, social constructivism and cultural-historical theory are among the most significant influence. The cultural-historical psychology was established by Soviet researchers such as Vygotsky (1962; 1978), Leont'ev (1981) and Luria (1976; 1979). Of general interest for sociocultural research is "to understand the relationship between human mental functioning, on the one hand, and cultural, historical, and institutional setting on the other" (Wertsch, 1996:56). Knowledge is considered constructed through activity where groups are interacting in a cultural community.

4.1.1 Cultural-historical psychology (Vygotsky)

The intellectual heritage from the Soviet cultural-historical psychology has influenced much of contemporary research on CSCL. In this school of thought it's assumed that there is an intimate relationship connecting the unique environment that human beings live in and primary mental processes (Cole & Wertsch, 1996). Vygotsky (1978) argued that instead of reacting directly to the environment, humans mostly react indirectly through *mediation*. This is illustrated in a mediating triangle:

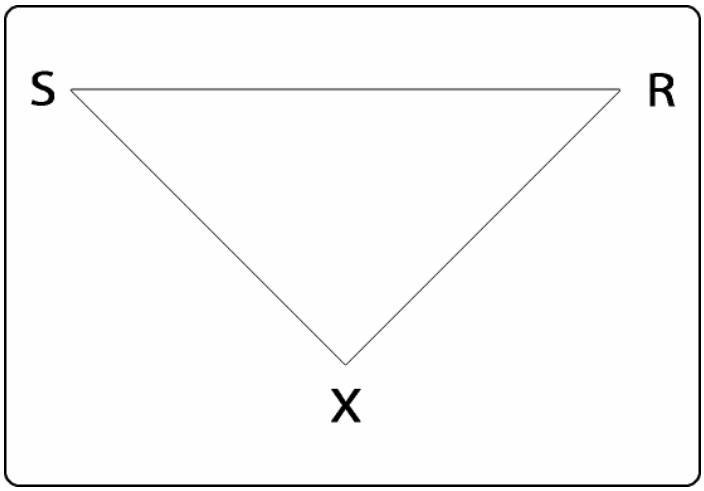


Figure 4-1: Vygotsky's mediating triangle (Vygotsky, 1978).

Vygotsky (1978) advocates that we have to consider the role of culture in psychological development to reach an understanding of consciousness that overcomes the limitations of behaviourism. In Figure 4-1, a mediating relation (X) between the stimulus (S) and response (R) is set up. Higher mental functions such as language are accordingly mediated by psychological tools. However, Vygotsky differentiates between technical and mental tools. The former are aimed at manipulating physical objects, and the latter are used by individuals to influence other people or themselves (such as language). Vygotsky thus extended Marx and Hegel's notion of physical artefacts to include linguistic artefacts, like language and symbols. Our ability to use physical and linguistic artefacts is a cultural development separating humans from other species. In this sense, artefacts carry qualities inherited from a specific culture. Tools can be said to "encode" the way we interact with reality. They typically reflect accumulated experiences and knowledge about a problem. Tools can be regarded as resources for accumulating and transmitting social knowledge. For example, a computer application for collaborative learning, i.e., Blackboard or Classfronter, can be seen to reflect a certain amount of accumulated experience about problems of learning (learning theories) and how we communicate in a computer-mediated collaborative environment.

According to the theory – General Genetic Law of Cultural Development (Vygotsky, 1978) – every function in an individual's cultural development appears twice: first on the social level, between people (inter-psychological) and later on the individual level (intra-

psychological). Language is considered an important mental tool in the interaction between adult and child for communicating and sharing actions. Language is gradually internalised and used as a tool for a child's own cognition and to control activity. The two planes are assumed to intersect when it comes to learning. Human interaction and the social aspect of learning are reflected in Vygotsky's Zone of Proximal Development which is defined as: "The distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978:86).

Learners interacting in the mentioned zone are participating in more advanced problem solving than they are capable of carrying out independently. In a computer-mediated collaborative learning situation, this could mean the student's participation in a more advanced tool mediated activity than they're capable of independently. Shared tools are then gradually internalised (Baker et al., 1999). In this social basis for learning, the joint construction of mutual understanding is assumed to be an important process. Within this context, the notion of intersubjectivity is relevant for identifying and analysing grounding interactions. The emphasis on intersubjectivity shows a relation among the sociocultural approach and relevant theories on grounding. For example, a scholar in the sociocultural tradition – Ragnar Rommetveit (1974; 1985) – views intersubjectivity as a construction that transpires from interaction. From a grounding perspective it's argued that a minimum of common ground between the participants has to be constructed to be able to interact and communicate in a learning situation. Baker (1999) holds that grounding is necessary, but not sufficient for collaborative learning. "Grounding or intersubjectivity must be situated within the ZPD if it is to lead to learning" (Baker et al., 1999:9).

It follows from this discussion that there is a relationship among the sociocultural approach and theories on grounding. The notion of common ground can be seen as an intersubjective construction. This relationship is elaborated in chapter 3 on grounding models.

4.1.2 Activity Theory

A student of Vygotsky – Alexander Leont'ev (1978; 1981) – developed the conceptual groundwork for Activity Theory (AT) as we know it today. Historical origins can be traced

back to classical German philosophy in the writings of Kant, Hegel, Marx and Engels. Human activity and development are viewed from a sociological or cultural-historical perspective. AT is considered a continuation of the cultural-historical school, emphasising the collective dimension of activity. According to Bannon (1997) AT is not a "theory" in the strict explanation of the term. It's rather a set of fundamental principles that make up a general conceptual system, which can be used as groundwork for more precise theories. Instead of being a predictive theory, it's a potentially clarifying and descriptive tool. This point is also stressed by Kuutti (1996), stating that this tradition is not a theory, but "a fixed body of accurately defined statements". Furthermore, its "a philosophical and cross-disciplinary framework for studying different forms of human practices as developmental processes, with both individual and social levels interlinked at the same time" (p. 25). Considering the loose borders of this analytic approach, I will not recommend a strict definition of AT. I find it more adequate to elaborate key concepts including, object-orientedness, internalisation/externalisation, artefacts and mediation, the hierarchical structure of activity, and the collective activity system. The basic principles of activity theory should be seen as an integrated holistic system, each principle connected as parts of the whole activity (Kaptelinin & Nardi, 1997). Hence, identifying the different parts of an activity becomes an essential tenet of the approach. Parts of an activity should be seen in relation to the complete activity system.

The idea of *object-orientedness* is one of the basic principles of AT (Bannon, 1997). The assumption that humans live in an objective reality descends from the materialistic philosophy of Karl Marx. We live in an objective reality that determines and shapes subjective phenomena. According to Leont'ev (1978; 1981) the concept of object cannot be limited to physical properties of things. He developed the concept to account for socially determined properties of things and the involvement of things in human activity. Thus we live in a reality that is objective in a broad sense. The substances constituting our world are not only objective from a natural scientist's point of view, but are also socially and cultural defined.

Activity theories distinguish *internal and external* characteristics of activity and discard the notion of an independent isolated mind (Kuutti, 1996). Hence, activities have a twofold character composed of both internal and external aspects. Inner mental processes should thus

be comprehended with references to external processes. What are internal and external are fused as part of the context. This is opposed to traditional cognitive approaches to psychology where the foci for analysis are individuals' internal cognition and mental processes. The idea of merging dichotomies like internal and external is also argued by anti-dualist philosophers such as Mead (1934) and Dewey (1933/1989; 1938/1991) who rejected sharp dualisms. They were criticizing the doctrine in philosophy and metaphysics that makes a distinction between two basic and independent principles such as mind and matter.

As mentioned above, the ideas of artefact-mediated and object-oriented action were first formulated by Vygotsky and his colleagues (Vygotsky, 1978). In AT, Vygotsky's mediating triangle (see Figure 4-1) is often reformulated with the S representing the subject, O the object, and M as the mediating artefact:

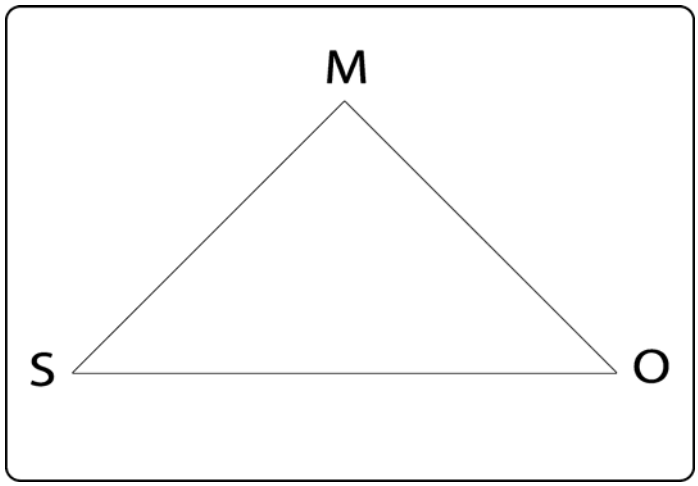


Figure 4-2: Reformulation of Vygotsky's triangle (Cole & Engeström, 1993).

Activity as illustrated in Figure 4-2 is directed to an object (O). The relation between the subject (S) and object (O) is mediated (M). Activity is generally directed to an object and mediated by artefacts like instruments, sings, procedures, laws, machines, etc (Kuutti, 1996; Nardi, 1996). Mark the word *generally*. This means that not all activity is mediated by artefacts. The figure can be slightly misleading; it's enticing to believe that at all mediated cognition will flow through the mediator. This clarification is also made by Cole (1996), stressing that even if action is mediated, it does not mean a natural path of cognition is replaced. The *object* is what the activity is directed towards and tells apart an activity from

another. In the Conscious Oxford dictionary, activity is described as “a condition in which things are happening or being done” or “an action taken in pursuit of an objective” (Pearsall, 2001). Evidently, activity is not an isolated event. The notion of activity implies an acting agent or subject (Bannon, 1997). It follows that activity is directed to an object or things in the environment. Activity mediates interaction between agents and objects. Vygotsky sees activity as a mental process in which the events are constructed by the participants based on their context of appearance (Kramsch, 2000). When participants are engaged in an activity, it means that they’re operating in a socioculturally defined context. Individuals bring their histories, goals and capacities to the situation.

The concept of *tool mediation* is central in AT and can be useful when studying collaborative settings. Generally, collaborative interactions are mediated by artefacts (Stahl, 2002b). Tools for mediation range from spoken language or gestures to physical artefacts like computers. Stahl refers to Marx and Hegel, defining an artefact as “a meaningful object created by people for specific use” (Stahl, 2002b:66). A fundamental quality of artefacts is their role as mediators. Nardi (1996) points out that to understand activity, the role of artefacts in everyday existence must be accounted for. Of special concern is how artefacts are integrated into social practice. This means that the background of material and semiotic tools provided by the culture should to some degree be appropriated by students to be able to collaborate. In the Gene-Ethics scenario, artefacts are present in the form of tools provided in FLE3 and external sources such as textbooks.

In the early work of the social cultural school of thought, mediation by other individuals and social relations was not included in the triangular model of action. By distinguishing between collective activity and individual action, Leont’ev (1981) provided a new dimension to the concept of activity. The differentiation between activity and operation is the basis of his three-level model of activity. The three levels of activity – subject, object and operations – are illustrated hierarchically in the model below:

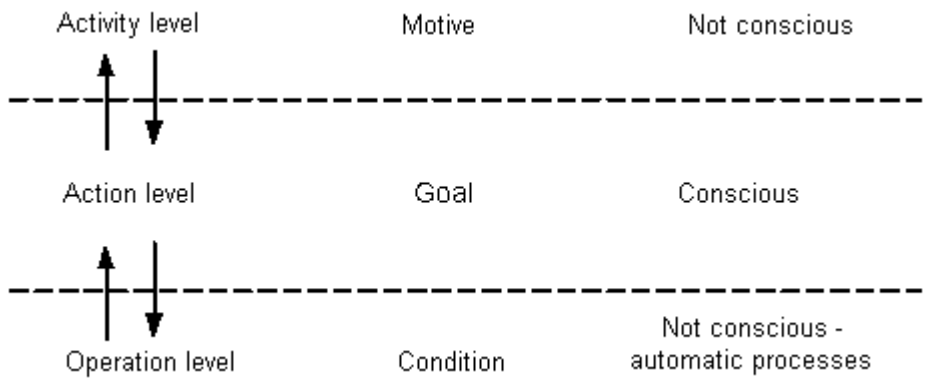


Figure 4-3: The hierarchical structure of activity (Leont'ev, 1978).

The logic of the model is as follows: The superior level of collective activity is driven by an object-related motive. It's the motive or object that separates one activity from another. Motives at this level are often unconscious. The middle level is driven by a conscious goal that directs the action and is achieved by the use of mediating tools (Zinchenko, 1995). Actions are goal-directed processes that must be carried out to accomplish the object. The inferior level is non-conscious, automatic operations driven by the conditions and tools present. Actions can become operations with practise if they're becoming routinised and unconscious. Leont'ev (1978) gives an illustration of the shifts between actions and operations in a car-driving example. I re-contextualized his original example to learning to operate a computer mouse. At first, using a computer mouse is an action with an explicit goal that requires conscious attention. After a while these skills become operational and do not distinguish themselves as a goal-directed process; the goal is not picked out and discerned by the computer operator. The action shifts to an operation and becomes automatic.

Activity, in the view of Leont'ev, is created by the object held by the subject. We should accordingly be able to single out one activity from another by identifying their differing objects (or conflicts in Engeström's terms, see below). The object (motive) can be transformed and can undergo changes throughout the process of activity (Kuutti, 1996). However, Nardi (1996) argues that objects have some stability over time and do not change on a moment-by-moment basis. The point here is that significant changes in objects can change the nature of an activity. When analysing an educational setting, such as the Gene-

Ethics scenario where new technology is implemented in the classroom, it's necessary to understand the objects of educators. Activity theory's notions of object orientedness and goals can be useful when investigating the scenario for this study and shed light on how the curriculum and teachers' intentions are influencing and shaping students' actions. These concepts help us view what students' objectives in the Gene-Ethics scenario are and how they are related to the objective in the school curriculum.

A more cognitive-oriented branch of psychology was mainly concerned with the inner mental activities involved in acquiring and processing information (Colman, 2001). This incorporated all forms of cognition including, perception, problem solving, thinking and learning. The situated action model is a framework related to the concepts discussed so far. This model has shown itself to be "an important alternative to purely mentalistic and computational notions of information processing" (Engeström et al., 1999:22). The focus for analysis in this approach is situated activity or practice, not the cognitive properties of artefacts or structured social relations (Nardi, 1996). The basic unit of analysis, according to Lave (1988), is the activity of individuals acting in a setting. However, research has shown that when it comes to accounting for collective and artefact-mediated aspects of object-oriented human behavior, an approach limiting the study to individual action is problematic (Engeström et al., 1999; Nardi, 1996). Situated action models can be constructive in their critique of restricted cognitive approaches. But to answer the problems raised in this thesis, I will explore the social/collective dimension to get a richer frame to study activity in its context. In the next paragraph I find it natural to step forward with the third generation of activity theory, emphasizing the collective aspect.

The *collective dimension* of an activity is expressed in Engeström's activity system (Engeström, 1987; Engeström et al., 1999). AT, as Engeström described it, evolved from Soviet psychology. Engeström expands Vygotsky's original triadic model, bringing the notion of activity further by integrating the collective aspect. He argues that "the problem with this classical representation is that it does not fully explicate the societal and collaborative nature of my actions" (Engeström et al., 1999:30). In other words, it does not describe actions as parts of a collective activity system. A mutual relationship is formed between the subject, object and the community (Kuutti, 1996). The various elements denoted in Figure 4-4 form what Engeström (1987; 1999) describes as a *collective activity system.* As

the model indicates, the relationship between subject and object is mediated by instruments. i.e., tools or signs. The *subject* refers to the individual or group chosen as a focus for analysis. A *community* is a group of people sharing the same object, for example, students working together on a project. The relation connecting the subject and community is mediated by *rules*. Hence, actions and interactions in the system are partly controlled by regulations, norms and conventions. The object-community relation is mediated by the *division of labor*. This refers to the organization of a community, the horizontal division of tasks and the vertical distribution of authority.

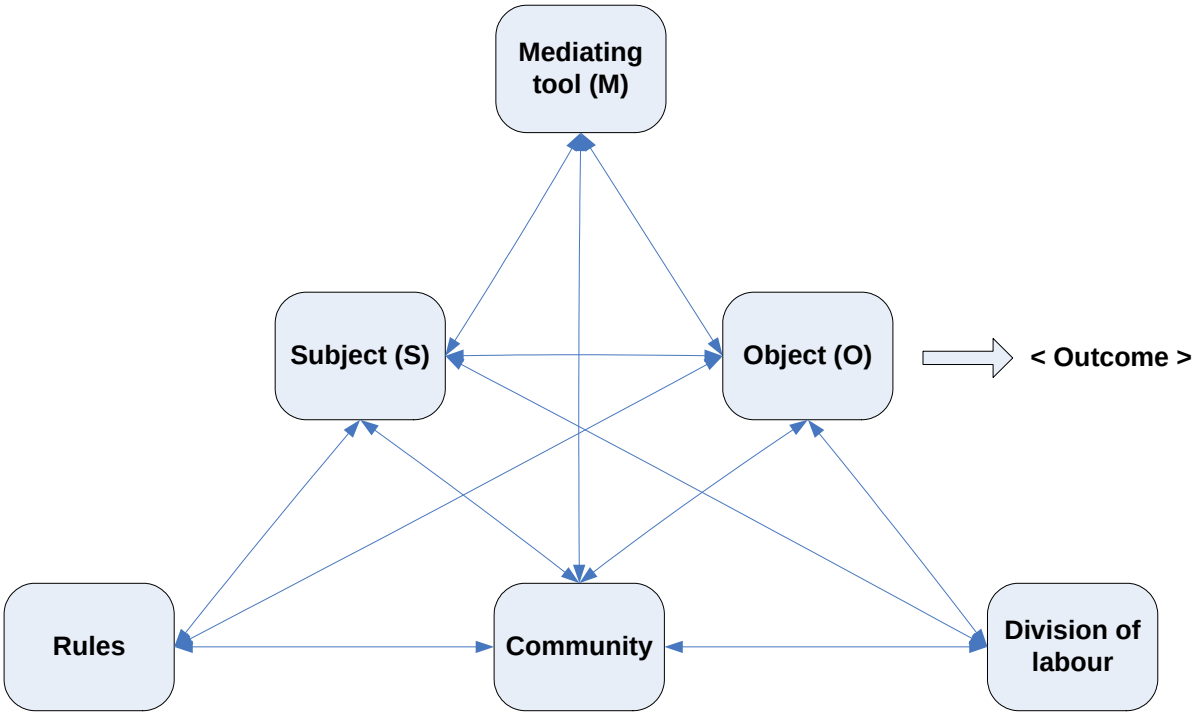


Figure 4-4: The collective activity system adapted from Engeström (1987) .

The dynamic nature of an activity system is said to be the result of *internal contradictions.* The term "contradiction" is used to indicate misfits between elements in the system. As activities are not considered isolated entities, but rather "like nodes in crossing hierarchies and networks" (Kuutti, 1996:34), they are liable to be influenced by external factors. For example, impact from other activities can alter elements of the original activity and cause imbalance. The idea of internal contradictions was first conceptualized by II'enkov (1982) as

the dynamic force of continuous development (Engeström, 1987). These forces represent latent tensions between all components of an activity system and are evident as problems, breakdowns, crashes, e.g., within the single activity system or in relation to other systems (Engeström, 1987; Kuutti, 1996). In the book *Learning by expanding: An activity-theoretical approach to developmental research*, Engeström (1987) elaborates four levels of contradictions in a human activity system.

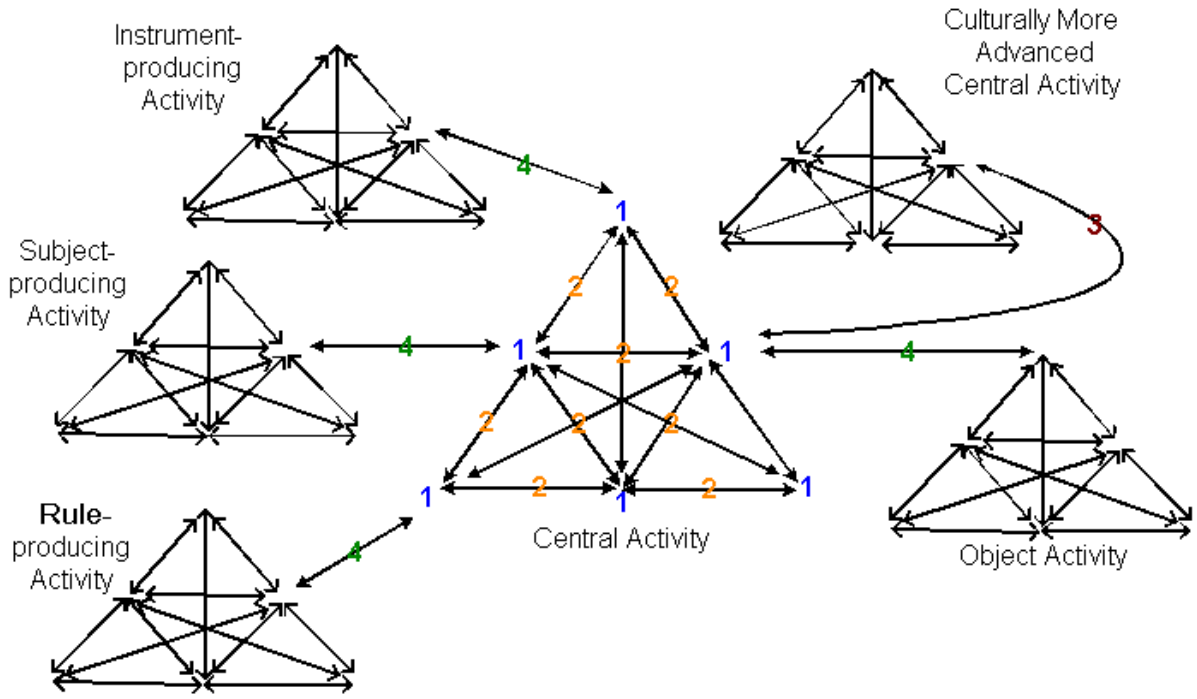


Figure 4-5: Four levels of contradictions within the human activity system (Engeström, 1987).

The first level is the primary inner contradiction within each constituent component of the central activity. This level may be analysed by putting the spotlight on any of the corners of the central activity. Next are secondary contradictions manifesting themselves as mismatches between the constituents of the central activity. Such conflicts may arise as new elements enter the system from outside. For example, an inflexible school culture (rules) could constrain the potential of introducing new technology (instruments) to the classroom. Furthermore, tertiary contradiction can emerge "*between* the object/motive of the dominant

form of the central activity and the object/motive of a culturally more advanced form of the central activity" (Engeström, 1987:68). For example, students want to chat and make friends on the internet (dominant motive), but the teachers try to engage them in knowledge building activities (culturally more advanced motive). Stuck between the central activity and its neighbour activities, quaternary contradictions may occur. Such neighbouring activities must be of concern as they are linked with the central activity (the original object of our study).

Engeström (1999) points out contradictions between externalization and internalization and argues that the collective activity system develops through expansive cycles. This process has its equivalent in Vygotsky's Zone of Proximal Development (see chap. 4.1.1, p. 37) at the individual level. The progress transpires as the activity system moves dialectically through expansive cycles; solutions and inventions are adopted to move the system toward a stabilising equilibrium. The collective activity system must thus innovate and solve problems to stabilise contradictions. The idea of systems moving towards equilibrium is well known in natural sciences, referring to a balanced state where forces acting on the system equal each other out so there's no net change in it (Isaacs, 2000). With this principle in mind, one can say that the moving force of an activity system is formed as a joint effort to reduce the tensions created by inner contradictions. The collective activity system learns by expanding, developing new qualitative forms of activity as solutions to contradictions.

4.2 Critical remarks

In the analytic approach outlined above, the unit of analysis is extended from viewing individuals as unique single learners to incorporating the learner's activity in relation to activities in communities of practice (Fjuk & Ludvigsen, 2001). The individual is hence no longer central as the unit of analysis in this perspective. In AT, the unit of analysis is an activity as a continuous, dynamic process (Kuutti, 1996). As such, they are not static, but dynamic units with history and development that need to be accounted for. In the sociocultural tradition, this includes the study of the context in which the activity is embedded. Kuutti (1996) notes that "activity theory and the concept of activity seem to be particularly suited to being used as the starting point in studying contextually embedded interactions" (p. 38). But what is a *context*, and why focus on it? The content of this concept appears differently in related theoretical frameworks where the study of context is focused

upon. In general terms I understand context as the conditions surrounding “something”. The elements in an activity system can be seen as being surrounded by a specific context. AT offers a particular notion of context were the activity itself is viewed *as* the context (Nardi, 1996). The idea of context as activity can appear vague as a theoretical guideline for an analysis on the micro level. This perspective suggests *activity* as the basic unit of analysis, but little is said about how to operationalise this.

Shortcomings in DoCTA have been recognized, and I intend to address and develop some of them in the present project, DoCTA-NSS. Experiences and results from the first phase showed that the sociocultural perspective has limited value when it comes to guiding a detailed analysis (Wasson & Ludvigsen, 2003). It is less beneficial for analysing human-human interaction at the utterance level. Bakhtin focuses on the utterance as a form of action (Wertsch, 1991). Utterances are perceived as links in chains of speech or writing. Bakhtin’s dialogical theory states that utterances are dialogical in nature, products of mulitvoicedness (Bakhtin, 1981, 1986). An utterance is essentially related to at least two voices: the one who speaks and the one addressed. The relevant unit of analysis for Bakhtin is not single words or sentences, but rather the *activity* of speaking as in a dialog (Minnis & John-Steiner, 2001). The Bakhtinian notion of utterance can seem narrow when studying the construction of meaning in a computer-mediated collaborative learning dialog. Utterances are viewed as meaningful only in terms of their references to foregoing utterances to which they respond and forward to projected addressees (Stahl, 2002b). To understand students’ local dialogs in a CSCL environment, it may be necessary to consider the utterances from a broader analytic viewpoint. Ritva Engeström (1999) proposes a methodological alternative where the instrumental reality is argued as the context for analysing talk and cognition in terms of action. This approach put together situational characteristics of dialog with the cultural-historical process of meaning construction. It is grounded on the idea of activity as a system developing from internal contradictions (Engeström, 1987; Engeström et al., 1999). To understand the meaning of utterances produced in a local dialog in the Gene-Ethics scenario, I find it useful to reconstruct what led to the specific interaction. The scenario with its complex collaborative learning interactions implies a holistic approach.

The notion of a collective activity system proposed by Engeström (1987) provides concepts and a structure to grasp the interconnected relationship between students (subjects), their

objectives for the assignment, the artefact mediation as well as institutional, i.e., school culture, aspects of the activity (see chap. 4.1.2.). Activity theory is valuable in this context, providing a broad perspective, including the use of artefacts that can be a computer system. Activity theory (Engeström, 1987; Engeström et al., 1999) can thus complement a micro-analytic approach (Bakhtin, 1981, 1986; Clark & Brennan, 1991) by providing concepts to understand cultural changes in a larger time scale and means to understand students' goals and tools for the group activity. Data collection procedures to capture both the situated features of student dialogs and the socio-cultural meaning construction at the activity level can be based on previous utterances (historical and biographical literature, various documents, interviews, etc.) and direct observations of the speaker's action and dialog (Engeström, 1999). In a collaborative learning activity, it may also be required to observe students' body language and gestures (Stahl, 2002b).

To get a richer analytic frame for studying grounding processes at the activity and utterance levels, I suggest extending the toolbox offered by the sociocultural perspective of collective activity (Engeström, 1987; Engeström et al., 1999) with a micro-analytic approach to conversation (Bakhtin, 1981, 1986; Clark & Brennan, 1991) and video-based interaction analysis (Jordan & Henderson, 1995). The rationale for combining these approaches is that the research questions addressed urges an enhanced framework to study the complex human interactions conducted in a CSCL environment. Sociocultural perspectives (with emphasis on activity theory) combined with a micro analysis of students' conversations at the utterance level provides a potential for analysing grounding processes in a real life context of actual collaboration. The analytic approach known as *video based interaction analysis (IA)* is outlined by Jordan and Henderson (1995). It's generally associated with the use of video-technology to aid in-depth micro analysis of human interaction in their physical environment. IA looks for regularities and patterns in people's routine interactions. In this study, video-based interaction analysis is applied as an instrument to capture and study relevant sequences in students' interactions. Practical consequences of using video as data are further outlined in chapter 5.2.1. The merging of a micro-analytic approach to students' conversation and sociocultural theories of activity to study interactions in CSCL environments is also argued by Gerry Stahl in the article "Contributions to a Theoretical Framework for CSCL" (Stahl, 2002b). The central role of mediation of digital and linguistic artefacts is underscored. In addition, when it comes to collaborative knowledge building,

“the unit of analysis for meanings should take into account the intertwining of personal and group perspectives by interpreting individual utterances as elements of the larger discourse and activity” (p. 70).

5. RESEARCH DESIGN

The main objective for this study is to explore grounding processes used by students when collaborating in the Future Learning Environment (FLE3). To address the specific aims and objectives of this thesis, a strategic plan is outlined in the following chapter. I will identify key features of the study and the work to be conducted, including methods of data collection.

To identify and study grounding interactions in the scenario, I find the categories implemented in the FLE3 knowledge building forum useful as a guideline. To carry on the inquiry one can argue that students have to make an effort to get a mutual understanding of the meaning of the categories and how to use them. In grounding terms, this understanding has to be sufficient for the current purpose, which in this case is to carry on a research-like process in collaboration with fellow students (co-located) and students from another school (distributed). If students successfully apply the categories on the basis of a mutual understanding sufficient for the current purpose, categories could be interpreted as a part of their common ground. On this foundation an initial research question is formulated:

How does the FLE3 knowledge building forum support or constrain grounding interactions?

There are two dimensions to this issue. From the Gene-Ethics scenario, we have data of local groups discussing the meaning and use of knowledge building categories. In the FLE3 system, categories are common to all participants, so the same set of categories were also used for distributed collaboration with students from the other school. The problem of reaching a common understanding of categories can be explored along the time-place scale, including grounding in distributed versus a co-located environment. As shown in chapter 3,

previous research has not sufficiently addressed this problem along the time-place scale (Table 2-1). When analysing the distributed grounding conditions in the FLE3 forum, I find the notion of pragmatic and semiotic grounding proposed by Baker and colleagues (1999) of relevance. Pragmatic grounding can be students' efforts to understand each other's communicative intentions. This level can thus be seen as a building block in the process of learning to collaborate, learning to understand what communication partners intend to tell them. Semantic grounding is about seeking out a common understanding of referents and the meaning of vocabulary applied among the actors in the knowledge domain. Baker et al. (1999) view learning by grounding as a "gradual transition from pragmatic to semantic grounding" (p. 12). Students' intersubjective efforts in learning to understand each other (pragmatic grounding) and to understand the implemented categories in FLE3 (semiotic tools) are regarded as relevant aspects of their collaborative learning in the Gene-Ethics scenario.

This study is conducted as a part of a large scale research project (DoCTA-NSS) where extensive material is collected but not yet analysed sufficiently. The distributed nature of learning and knowledge building in a CSCL environment requires methodology to capture the complexity of the activity in the real life context in which it is embedded. The problems raised and theoretical approach adopted (chapter 4) in this thesis have influenced my level of analysis. As the initial research question indicates, the analytic focus is on processes involved in social interaction (grounding) rather than on the outcome/effects of collaborative learning and technology. Studying (learning) effects of or effects with CSCL in the classroom is, therefore, outside the scope of this thesis. This reflects a fundamental shift in CSCL-research, what Dillenbourg (1996) calls the "interactions paradigm" (p. 12). As an alternative to seek out general effects of collaboration, attention is given to more micro-genetic features of interaction. The Gene-Ethics scenario is a complex learning environment with multiple actors. Collaboration among participants is partly technology mediated. With this in mind, it's possible to identify different analytic levels. To explore how students' grounding is accomplished in this environment, both the intra- and inter-group levels are of importance. At the intra-group level, the unit of analysis could be grounding processes and social interactions among students at micro level. On the other hand, the inter-group level can be interactions among different local groups (co-located) and artefact-mediated collaboration with the distributed groups (Oslo – Bergen). To narrow down and sharpen the

analysis, my focal point will be at the intra-group level of the Oslo-focus group and their computer-mediated interactions with their corresponding distributed group.

Another possible level of analysis is human-computer interaction (Preece et al., 1994). However, the analytic attention and theoretical frame of this thesis emphasize interaction among social actors, not the underlying human-computer aspect. The role of the computer is seen in the light of the mediation concept of later socio-cultural theory (Engeström et al., 1999; Leont'ev, 1978, 1981). This means that when studying the inter-group level, the spotlight will be on tool-mediated interactions among social actors rather than a human-machine interaction perspective.

Case study as a research strategy is recommended by Yin (1994) in the book *Case study research: Design and methods* when studying contemporary events within their real-life context and the phenomena are not clearly distinguishable from the context. This can be single or multiple case designs. The latter follows replication logic rather than sampling. A case study inquiry often relies on prior development of a theoretical proposition to guide data collection and analysis in a pluralistic mode. As an empirical enquiry, case study is also preferable when multiple sources of evidence are used (ibid). The rationale for using multiple sources of evidence is triangulation. Triangulation is a way of ensuring sufficient validity of research results through the use of diverse research methods and approaches (Calhoun, 2002). Theories, data, investigators and methodologies can be triangulated. Methodological triangulation can be attained by utilising multiple methods in the analysis of the same set of data.

Yin (1994) notes that “the case study strategy should not be confused with qualitative research” (p. 14). Accordingly, case studies can include both quantitative and qualitative evidence. The strict categorization of data as quantitative or qualitative is controversial and can be problematic. This issue is beyond the problem area of this thesis and will not be elaborated on further. For this study, the principle data sources are electronic logs of messages posted in FLE3, video recordings and scenario documents (see Table 5-1: Data sources). I will argue that the problems identified are explorative, relying on non-experimental data, whereas experiment is a research method where independent variables are manipulated to study casual effects. For valid results, this requires control of extraneous

variables that may influence the dependent variable (Hellevik, 1999). A learning environment is complex, constantly changing, and it is difficult to identify and study isolated variables. Theoretical and methodological problems arise that have to be addressed. However, the DoCTA-NSS research project as a whole can be seen as an *educational design experiment* (Brown, 1992). Classroom interventions have been engineered, constructing a new technology-rich learning environment. As the problems I address are descriptive and not coined to determine effects of different designs of learning environments, design experiment as a research strategy is incompatible with the focus of my inquiry.

A characteristic of an explorative case study is that data collection may be undertaken prior to the final definition of research questions (Yin, 1994). This study does not rely solely on existing theory, but seeks to discover features of grounding in a CSCL environment by partially approaching the field inductively. A crucial part of an explorative case study is to present clear statements about what is to be explored and the purpose of the exploration (Yin, 1994). I will also sketch out the criteria by which the exploration should be judged successful (Chapter 7.2: Evaluating the quality of the study). My study is limited to a single case design as no cases are available for replication.

To capture the interactions at the intra-group level, video-based interaction analysis is used as the primary tool. Practitioners of interaction analysis vary in their approaches towards video as a research tool. Jordan and Henderson (1995) provide a set of “foci for analysis” that have shown to be practical when analysing video material. The roots of video-based interaction analysis are shaped from various fields. The most significant influence comes from conversation analysis, ethnomethodology and ethnography. Ethnography is described as “observing directly the behaviour of a social group” (Marshall, 1998). The principal technique of ethnographic research is participant observation. Ethnographic research is characterized by the use of detailed observation in a “natural” environment and the endeavour to stay away from prior commitment to a theoretical model (Lincoln & Guba, 1985; Yin, 1994). The current study was conducted in the students’ own environment. However, the research project greatly interfered with the classroom. For a two-week period, the curriculum was re-designed to fit the pedagogy of the progressive inquiry model. New technology was introduced as tools for information gathering and distributed collaboration.

My point is that the Gene-Ethics scenario can hardly be regarded as the students' natural, everyday environment.

When employing video-analysis, the observation can be said to be indirectly available for analysis. Researchers not present at the site can study the material after it has been recorded. Even as the observation in this case have been done indirectly by screening videotapes, ideas of ethnography can be considered relevant to some extent as an integrated part of the interaction analysis (Jordan & Henderson, 1995). My video observations are not ethnographic in a pure sense of the word. The focus group is not studied in its natural environment, and my selection of interesting sequences is partly influenced by previous theories of grounding.

Methodical issues and reflections concerning reliability and validity are discussed further in chapter 7.2 (Evaluating the quality of the study). Important components of the case's design are the study question(s), defining the units of analysis, and the criteria for interpreting the findings (Yin, 1994). This will be addressed in the following sub-sections.

5.1 Unit of analysis

Fjuk and Ludvigsen (2001) argue that "changes in the area of collaborative learning caused by ICT and networked computers can only properly be understood by extending the unit of analysis from technology and pedagogy themselves to real-life social contexts in which ICT is used" (p. 237). The Gene-Ethics scenario was conducted *in vivo*, as a design experiment (Brown, 1992). To grasp the complex social context, concepts from the third generation of activity theory are used as a framework (Engeström, 1987; Engeström et al., 1999; Leont'ev, 1981). The scenario was organized in two classes (20-24 students): one in Bergen and one in Oslo. Each class was divided into six local groups. Local groups from each school were matched to form groups for distributed collaboration. Hence, the collaboration among pupils was both distributed and co-located. Teachers and researchers collaborated to select and match local focus groups at both sites.

When applying activity theory as a conceptual framework to describe a knowledge building scenario, students' activity can be analysed on both an individual and a collective level (Hill

et al., 2003). A *simple activity system* describes knowledge building activity at an individual level, focusing on the upper triangle of Figure 4-4. This system describes the context of a single subject's object-directed activity involving mediating artefacts. However, for the purpose of this study I find the level of a simple activity system restrictive. When describing the scenario context and students' grounding interactions, I propose a collective level of analyses. The Gene-Ethics scenario with its complex interactions and learning situations implies a holistic approach, not isolating the individuals and artefacts from the context as independent variables. Student engagement in knowledge building is seen as a collective practice, not reducible to the sum of individual actions (Engeström et al., 1999). Furthermore, I regard grounding processes at an utterance level as collective acts. Mead (1934) describes communicational processes as social acts involving at least two interacting individuals. Accordingly, it's within this act that meaning arises. As mentioned earlier, Bakhtin's dialogical theory states that utterances are dialogical in nature, products of mulitvoicedness (Wertsch, 1991). An utterance is essentially related to at least two voices: the one who speaks and the one addressed. In a collective activity system, the subject refers to the group of students working together in the activity sharing the overall object. Individuals are still parts of the collective activity, but to demarcate and sharpen the focus, single student's activity systems are not included as units of analysis. Individual students are defined as members of a group and labeled as a collective "subject."

This logic is in line with a case-study approach. In case studies, selecting the unit of analysis as a general framework typically involves a system of actions rather than an individual or group of individuals (Tellis, 1997). Hence, units of analysis in case studies are relevant groups of actors and the interaction between them, not just the voice and perspective of single actors. This notion is compatible with the third generation of socio-cultural theory, as agued in chapter 4.1.2. In contemporary activity theory, the basic unit of analysis is not just the activity of individuals acting in a given setting. Applying Engeström's (1987; 1999) activity system, the collective and artefact-mediated aspects of activity are accounted for when defining the unit for analysis.

In sum, activity theory is used as a conceptual framework to gain a broader view when exploring students' grounding interactions in the scenario. The unit of analysis is the activity system of the local focus group in Oslo, consisting of five students at Hovseter Junior High

School and their computer-mediated collaboration with the corresponding group in Bergen. This activity system is defined and described further in chapter 6.1.3.

5.2 The case data-base

For triangulation and to strengthen the validity of my conclusions, multiple sources of evidence are used. I have set up a unique case database to store accessible and relevant sources. Data consist of electronic logs of messages posted in the FLE3 knowledge building forum, video recordings of local focus groups' interactions, scenario documents and statistical information from FLE3 assistant (Chen et al., 2003).

Sources	**Type of data**	**Co-located/distributed**
FLE3 logs (conceptual artefacts)	FLE3 messages in text format	Distributed
Video recordings of focus group	Video; Transcripts of video sequences	Co-located
Scenario documents	Text (agendas, administrative documents)	Co-located
Physical artefacts	Tools used during scenario; Computers with access to FLE3	Co-located and distributed
FLE3 assistant	Statistical log functionality	Distributed

Table 5-1: Data sources.

5.2.1 Remarks on video as data

The principle source of evidence for this study is video-recordings. Videotapes provide a rich and relatively permanent record of a data set. An unlimited number of viewings and listening is possible (Jordan & Henderson, 1995). This can be an advantage when studying complex interactions such as grounding interactions. Repeated viewings and the use of slow and fast motion provides the potential of exposing otherwise unseen interaction patterns.

Furthermore, the audiovisual fixation of an event on a videotape can be accessible to other investigators who may inspect it to widen or disprove the original analysis. One primary reason for favouring video as a source of data collection in this case is that together with FLE3 logs it provides the opportunity to keep track of overlapping activities.

However, video-based analysis is not free from problems and costs. Researchers working with this kind of material report that it's time consuming and expensive (Ruhleder & Jordan, 1997). Video data is complicated to work with. A number of notation programs exist on the market. Among them are MacShapa (Sanderson et al., 1994) and VideoNoter (Roschelle & Goldman, 1991). No standard for annotating video has yet emerged. In my case, some practical considerations had to be made. The digital video software used to edit and track sequences from the site was AVID Express DV (http://www.avid.com). This application has a module for annotating and marking sequences of interest. However, this feature had some limitations. Transcripts were to be analysed sequentially, and the digital video files grew out of proportion. For these reasons, AVID was only used for the first scan of the videos, making an index of the material. Sequences of interest were later compressed to a portable format (MPEG) to be used at collaborative viewings and for further transcripts. To deal with the software's limited transcript feature, I developed a parallel transcription form for transcribing video data (See appendix D).

In sum, we experienced some difficulties using video as a data source. Despite the problems, video data together with content logs and statistic frequencies from FLE3 is considered a rich source for the research questions asked in this thesis. Issues concerning reliability and validity are discussed further in chapter 7.2 (Evaluating the quality of the study).

6. ANALYSIS

6.1 Scenario context

The Gene-Ethics scenario is part of the interdisciplinary DoCTA project. The scenario context is intended as a *design experiment* (Brown, 1992) with students from ninth grade, involving one school located in Bergen (the west cost of Norway) and one in Oslo (east part of Norway) over a two week period in Fall 2002 (Ludvigsen & Mørch, 2003). *Local groups* consisting of three to five students from each class were established for the project period. Two and two local groups in Bergen and Oslo were paired to form *distributed groups* for collaboration on distance. The scenario can be said to have two distinct collaborative learning contexts: co-located and distributed. While working in the local groups, students were together physically for co-located collaboration. In the distributed group, students collaborated by communicating through the FLE3 knowledge building forum.

One main objective of the DoCTA project is to study how an ICT- (Information and Computer Technology) mediated learning environment enables students to learn in collaboration with other students (Wasson et al., 2000). Due to its tailorability and theoretical foundation, FLE3 was chosen as the scenario knowledge building platform. Even though the progressive inquiry model (Hakkarainen et al., 1999; Hakkarainen et al., 2002) was adopted as a pedagogical model for the scenario, the goal with DoCTA-NSS is not to imitate other studies in this tradition (Ludvigsen & Mørch, 2003). Research goals for the current project hope to explore “the design space of the model and assess its impact on the students’ actions and use of categories” (ibid:70). As a knowledge domain for the scenario, natural science is preferred (Chen et al., 2003).

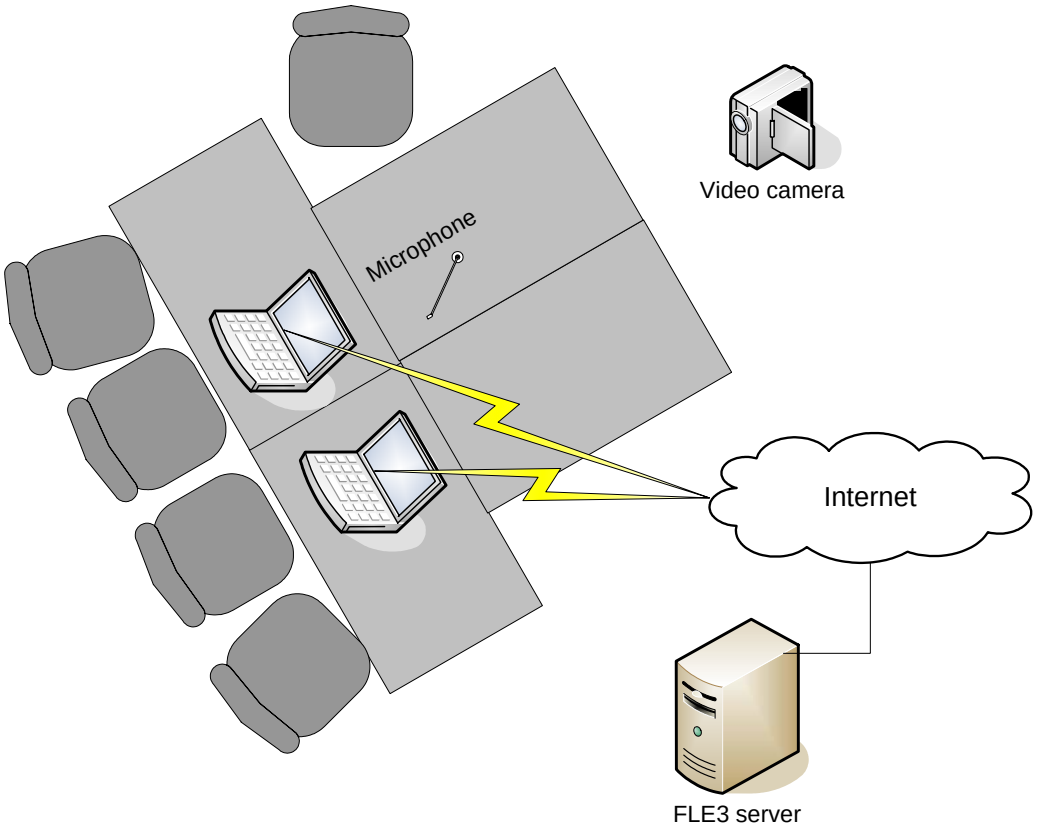


Figure 6-1: Local focus-group's (Oslo) typical configuration.

6.1.1 Future Learning Environment (FLE3)

FLE3 is the most resent version of the Future Learning Environment developed at UIAH Media lab, University of Art and Design Helsinki (Leinonen, 2003). More precisely, FLE3 is a groupware web-based learning environment. This system is a freely distributed open source server-software package for computer-supported collaborative learning (CSCL). The software is intended to support lectures or workshop courses. According to the developers of FLE3, it is designed with the progressive inquiry model embedded as a pedagogical foundation (see chapter 2.3.3). The idea behind progressive inquiry is to carry on a research-like study process (Hakkarainen et al., 1999; Hakkarainen et al., 2002). Students are encouraged to generate research problems, make a hypothesis and search for explanations. This objective is implemented in FLE3 and should provide the students with a shared space for inquiries, interaction and knowledge building trough pre-defined categories.

The original version of the FLE3 software has been tailored to fit the needs of the Gene-Ethics scenario. A localized version was adapted by translating the user interface into Norwegian and adjusting the categories for the purpose of the current study. The semantic meanings of the categories are slightly modified compared to the English version FLE3 (see Table 6-1 for the categories and their explanations). The modules existing in the original version were a WebTop, Knowledge Building and Chat. Our focus groups were provided with the asynchronous knowledge building module (kunnskapsbygging) and a WebTop (vår side).

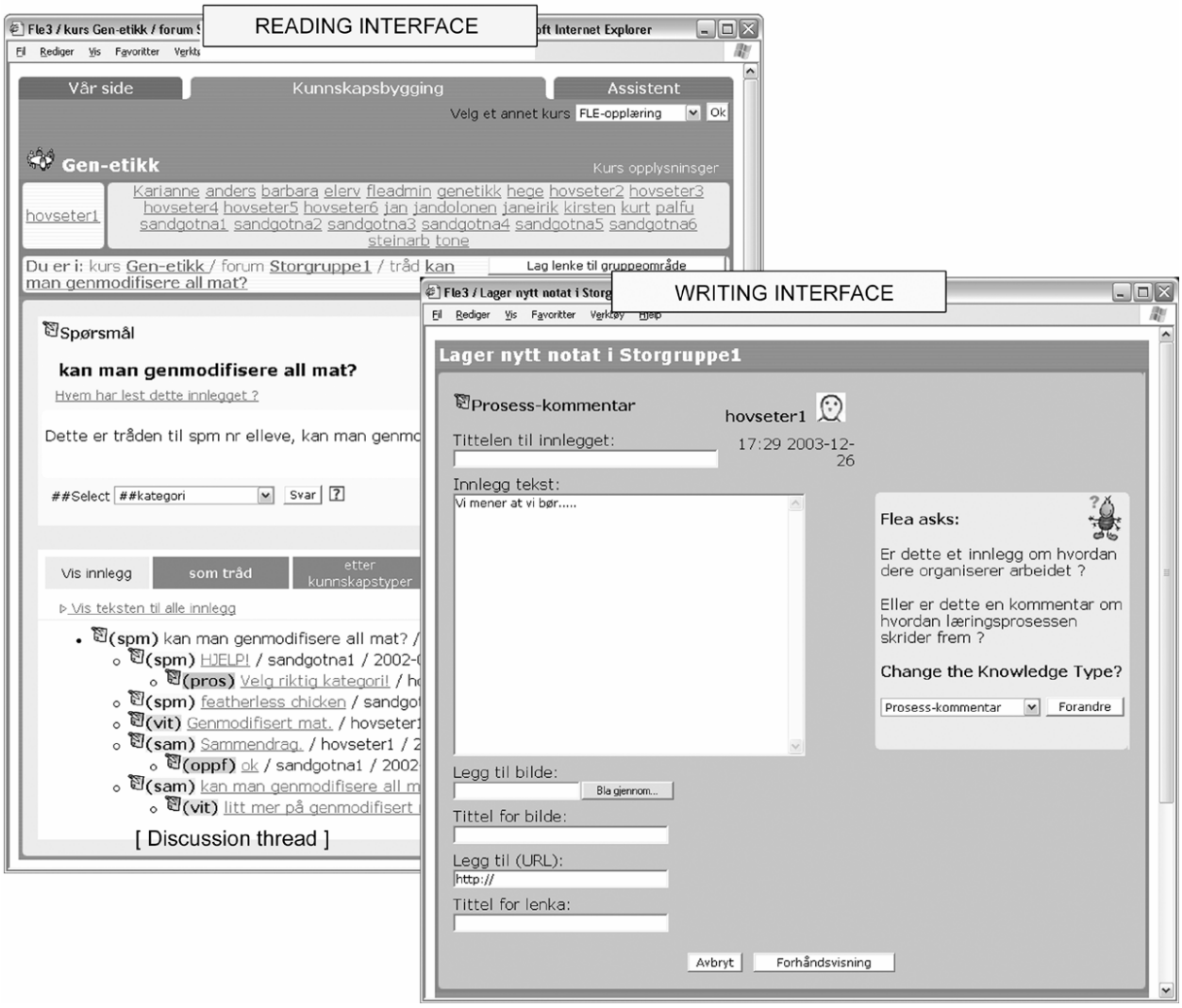


Figure 6-2: Discussion thread from the knowledge building module showing reader's and writer's interface. The two other modules: WebTop and Assistant are visible as clickable options.

The chat option from the original version was deliberately removed because of lessons learned from DoCTA 1 (Wasson et al., 2000). The “social talk” was substantial, limiting the inquiry progress (Mørch et al., 2003). The WebTop is a personal desktop for students and teachers to store digital items such as documents, files and links related to the inquiry. Files can be organized into folders and shared with others. The knowledge building module is an asynchronous web-based discussion forum. Pre-defined categories are available to scaffold and structure the discourse. Threads are stored in a shared database.

In addition to the tools provided by FLE3, students had access to ATEKST and other internet resources. ATEKST is a database containing archived articles from Norwegian newspapers. Selected hyperlinks were provided from the Gene-Ethics portal to relevant learning resources. This included an animation showing a cell division by mitosis, a web-based version of a Norwegian Encyclopedia (storenorskeleksikon.no), some articles and definitions on biotechnology and ethics. In addition to these quality assured resources, students had access to search the World Wide Web for information. The school paper can also be considered a learning resource, as students shared their conceptual productions in it.

The built-in support for knowledge building and progressive inquiry is reflected in the five categories provided in our tailored version of FLE3 (Mørch et al., 2003). Categories are incorporated in the knowledge building forum as a pre-defined set of meta-cognitive tools for students to label their postings (Omdahl, 2002). To post a new message, a category had to be selected. Categories are supposed to facilitate the knowledge building process and help the students to classify, articulate and to recognize their arguments, generating a mutual understanding within the community of learners. Applying the built-in posting categories, the course of inquiry follows a semi-chronological progression. I use the term semi-chronological because some of the categories, like meta-comments, can be used whenever they’re needed. The problem-option can also function as a marker for follow-up discussions as the inquiry advances. The categories are explained in Table 6-1.

Figure 6-3: Dropdown menu to select categories.

English	Norwegian	Explanation
Problem	Spørsmål	Discussions start by issuing a question, serving as a theme and a heading for a thread.
Our explanation	Vår oppfattning	What students believe as a tentative answer (personal hypothesis).
Scientific explanation	Vitenskapelig forklaring	Arguing for a hypothesis by searching for pros and cons (Mørch et al., 2004).
Meta-comment	Prosess kommentar	Meta-comments to other groups concerning the knowledge building process.
Summary	Sammendrag	The main problems for the inquiry should end up in a summary based on the most significant scientific facts posted by the groups. This summary serves as a source for publishing articles in the school paper.

Table 6-1: Explanation of the FLE3 categories.

Two pedagogical agents have been developed and implemented in FLE3 to monitor the collaboration process, produce awareness information, collect statistical data and provide advice to students and teachers (Chen et al., 2003; Wasson & Ludvigsen, 2003). The Student's Assistant (SA) is a pedagogical agent implemented to monitor the knowledge building forum and present feedback to the students (Chen et al., 2003). More precisely, it

gives advice on how to make use of the knowledge building categories following the progressive inquiry model. According to Johnson (1998), “pedagogical agents are autonomous agents that support human learning, by interacting with students in the context of interactive learning environments” (p. 13). Adapting to the progressive inquiry model and understanding the correct use of categories can be complicated. The SA agent in our version of FLE3 collects and presents statistical data from students’ activities in the knowledge building forum. It observes students’ collaboration and assists with the knowledge building process as it unfolds. Another agent integrated in FLE3 is the Instructional Assistant (IA) (Chen et al., 2003; Chen & Wasson, 2002). This agent monitors the collaborative learning process, producing statistical information for the instructor. In addition, it’s programmed to detect and inform the instructor about potential problems in the interaction.

As a general analytic strategy, in the next sub-section a narrative case description is developed serving as an organizing framework. The case is first described chronologically according to the progressive inquiry model implemented in the Gene-Ethics scenario. In addition, a socio-cultural approach is utilized to get a broader view of the collective and artefact-mediated aspects of the context. After the narrative, initial issues will be developed into a few key research questions for further analysis. Key issues are probed and reflected upon referring to relevant empirical data.

6.1.2 Inquiry progress

Prior to the inquiry, students were exposed to a motivation phase with a general introduction to the ideas of knowledge building and a trigger video on genetics. The whole scenario was structured around four courses set up chronologically in FLE3. The genetics course was followed by a mutual evaluation where collaborating groups made tests for each other to solve. The ethical course was intended for ethical issues around genetics. Finally, a course was set up for an electronic log for students to reflect on their experiences with the project. The e-log was not applied, but was conducted with pen and paper. The main events from the actual scenario progressed as follows (in chronological sequence):

Inquiry progress	**Hours**	**Activities**	**Co-located/ distributed**
Setting up context and research questions	1 to 3	- In the first hour students got a general introduction to the project. A task for the second hour was for individuals to write down everything they knew about cloning, genetically modified food or genetics in general and, thereafter, formulate 2-3 questions they're interested in learning more about. - A mini-video about genetics was presented to trigger the knowledge building process and students' curiosity about the subject. After watching the video, students started to formulate questions to be used as initiators in a knowledge building session with the other school. They also got a brief introduction to the scenario tools. - The classes at the two participating schools were divided (randomly, mixed sex) in *local groups*, with 3-6 students working together for the project period. Students were told to share their question with the group and identify unanswered questions.	Co-located
Presenting research problems	3-9	- Pairs of local groups from the two participating schools were matched to form *distributed groups* for collaboration. - In hour 8 the distributed groups collaborated to find 3 research questions	Co-located and distributed

		to work with. An integrated chat tool in a 'Mindmap' application (Dragsnes, 2003) was intended for this purpose. However, the program crashed and the knowledge building option in FLE3 was used instead. - Questions from all local groups were collected and presented at the blackboard (co-located). Lists of questions from the classes in Bergen and Oslo were merged by the teachers. Appling this list as a basis, teachers discussed and agreed upon the final research questions.	
Creating working theories	9	- Students started the knowledge building in FLE3 by presenting the study problems as threads. They were told to post their own opinion (working theory) after presenting and reflecting on the initial problem.	Co-located and distributed
Critical evaluation	9-12	- The knowledge building process continued. The paired distributed groups were evaluating their working theories using available resources and posting critical messages in FLE3.	Co-located and distributed
Searching deepening knowledge	9-12	- Searching for scientific explanations and information supporting their standpoint. Local groups argued *for* their research question while corresponding distributed groups argued *against.*	Co-located and distributed
Developing	13-15	- A final text was produced in the local	Co-located

deepening problems		groups to explain the research questions. Students were encouraged to use resources and experience from the other local groups and distributed groups. The results were published by local groups in the (internet) school-newspaper.

Table 6-2: The scenario workflow.

6.1.3 Activity system

In the course of my investigation of students' grounding interactions an effort is made to describe the important characteristics of the scenario context. To portray the collective and artefact-mediated aspects of students' activity, Engeström's (1987; 1999) activity system has been valuable. This framework has provided concepts to express a dynamic scenario context. Activity theory has a descriptive role in this case, defining the unit of analysis as a collective activity system and aiding the exploration of the scenario context. When analysing students' grounding interactions at the utterance level, I have argued to complement sociocultural theory with a micro-analytic approach to conversation (Bakhtin, 1981, 1986; Clark & Brennan, 1991) and video-based interaction analysis (Jordan & Henderson, 1995) to answer the research questions issued (see chapter 4).

Figure 6-4 illustrates the collaboration process of the local focus group as a collective activity system. Students in this system are identified as the unit of analysis in accordance with Engeström's model of the human activity system (Engeström, 1987; Engeström et al., 1999).

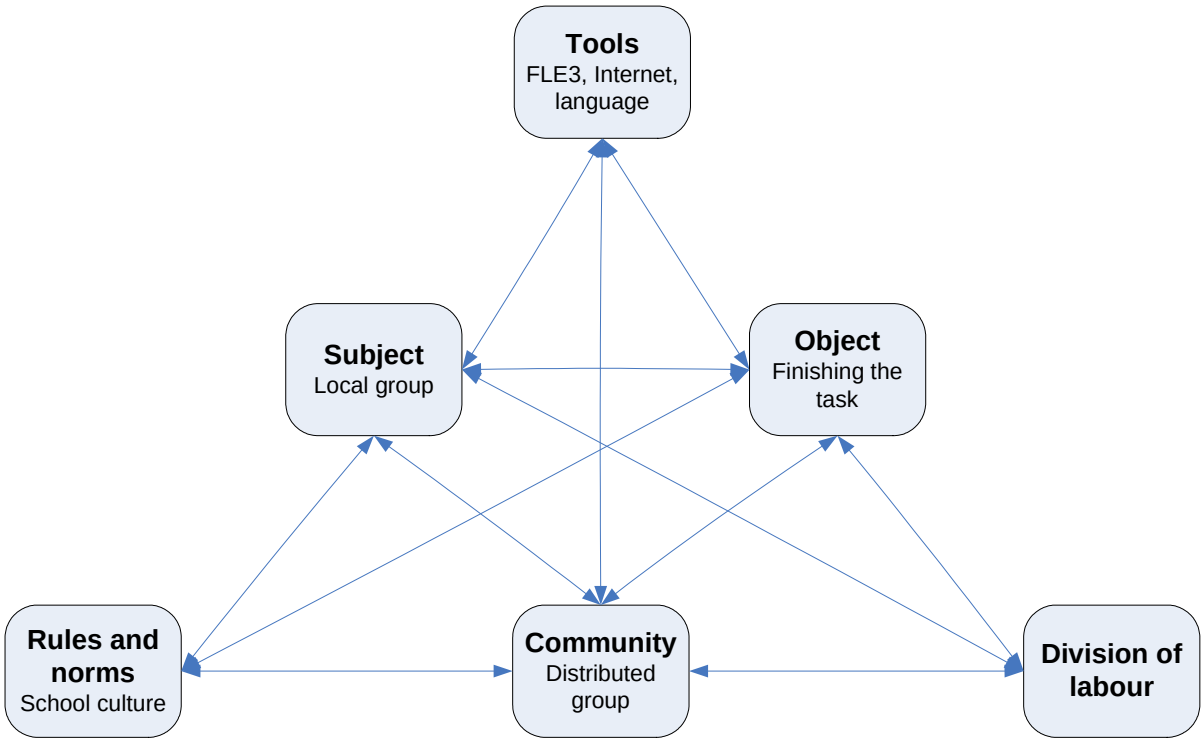


Figure 6-4: Activity system from the Gene-Ethics scenario (focus group).

The *subject* refers to a local group of five students at the Oslo school (Hovseter1). This is the local focus group working together throughout the scenario. The prime objective of the activity was for students to follow the progress of the inquiry and answer the issued problems. They were told that the overall aim was to explore gene technology and some ethical problems associated with it. A note was published for the students to read on the project's web page with semi-detailed instructions. In short, texts should be produced explaining the meaning of central concepts in genetics. About half of these texts should be produced while collaborating in local groups (co-located) and the other half collaborating with the distributed group (Bergen) using FLE3. In socio-cultural terms, the relationship between students and the objective of the inquiry was partly mediated by different tools. In this case, the central mediation tools are FLE3 and language (both in written and oral form). Some of the artefacts were shared among the local groups and their community and others were not. Resources like textbooks and various notes used in the local groups were generally not common artefacts for the whole community. Postings in the FLE3 knowledge building

forum and the school-paper are considered shared artefacts. This information was accessible to them through the common computer network and thus available to the whole community. "Available" does not necessarily mean that every posting is read and acted upon, but rather conceptual artefacts *intended* to be shared by the scenario designers (Ludvigsen & Mørch, 2003; Wasson et al., 2003).

When engaged in co-production of texts, the school classes in Oslo and Bergen participated in the same project with the objective of carrying on a progressive inquiry and finishing the assignment. The collaboration among the local focus group in Oslo and the corresponding group in Bergen can be represented as *community* in the logic of the model above. While interacting in the activity system, students are behaving according to rules and classroom culture as well as less formal interaction norms among peers. The subject-community relation is thus mediated by *rules and norms* defining acceptable and non-acceptable behavior (tacit or explicit). Data indicate that students in the focus group took on different roles according to the task. One of the girls took the role of the group leader and was able to coordinate the tasks of the other group members. Typically one of the students was operating in FLE3 while others discussed the theme and looked up information. Individual students tend to find a niche to work in at the cutting edge (Hill et al., 2003). The students recognized by others as fast typists were more likely to get access to the keyboard, producing text for the assignment. The collective activity system in Figure 6-4 presents the object-community relation as mediated by the *division of labor*. In the collaboration process, the corresponding local groups (Oslo – Bergen) organized the division of tasks to some extent.

The dynamic nature of a knowledge building activity may be explained from internal contradictions (see chapter 4.1.2). When analysing grounding interactions in this case, I find secondary contradictions proposed by Engeström (1999) of relevance. Such contradictions manifest themselves as mismatches between the constituents of the central activity. Conflicts may arise as new elements enter the system from outside. In the Gene-Ethics scenario, a new pedagogical model and technology were introduced to the classroom, generating a possible conflict between existing classroom interaction patterns (co-located) and the new instruments set up to mediate interactions on a different time-place scale (distributed). In a traditional classroom setting, students are used to interacting and communicating in face-to-face conversations. As suggested earlier, grounding process in face-to-face conversations

shows other characteristics than computer-mediated distributed forms of communication. How do students reach a mutual understanding in this new context? Do FLE3 tools constrain or support such grounding interactions?

It's proposed by Engeström (1987) that an activity system develops as it moves dialectically through expansive cycles. Solutions and inventions are adopted to move the system toward a stabilizing equilibrium. On the conditions of these issues, I will refine my initial research question: How does the FLE3 knowledge building forum support or constrain grounding interactions? Do students create solutions and inventions to solve problems of communication to stabilize the activity system? To answer the questions issued and gain an enhanced understanding of students grounding, I will progress by analysing their interactions in greater detail. A logical path for further investigation is to analyze how FLE3 tools support or constrain grounding processes compared to a face-to-face classroom setting. Transcripts and excerpts of co-located and distributed grounding interactions are presented and interpreted. The relative frequencies of knowledge building categories applied by students in the scenario are presented to determine if the label and content of messages correspond. This could possibly indicate their level of conceptual understanding of the inquiry process and if a joint understanding is emerging. To see if there is any development in category use throughout the scenario, I have divided students' activity into an *early and late phase*. The former begins directly after the introductory session and lasts for four days. In the late phase, students had gained some experience using the tools and the ideas of the progressive inquiry model.

6.2 Grounding interaction

In this section I will analyze students' grounding interaction. Language is regarded as the basic communication form in the scenario. Language makes interpersonal communication possible and serves as a tool for both individual and collective activity and thinking (Baker et al., 1999). The notion of language as a mediator is compatible with the socio-cultural conceptual approach argued earlier in this thesis (chapter 4.1). Grounding is a process mainly aimed at achieving a joint understanding of linguistic productions (utterances) (Baker et al., 1999). Language is therefore regarded as the primary medium of grounding in the Gene-Ethics scenario. A clarifying distinction has to be made at this point. When

collaborating in local groups, students were co-present and carried on conversations face-to face. The distributed collaboration was computer mediated through the FLE3 knowledge building forum. Students' grounding acts can thus be divided into two distinct situations according to the qualitative nature of their collaborative interactions as co-located or distributed. This dualism is not absolute, but serves as an analytic distinction reflecting the research focus: to study how the co-located and distributed environments support or constrain grounding processes. For the purpose of this analysis, I will refer to the local groups' face-to-face conversations as *co-located communication* and the computer-mediated postings in FLE3 as *distributed communication*. In the latter context, communication was in written form and had to be typed on a keyboard.

	Same time (synchronous)	**Different time (**asynchronous)
Same place	Local groups' face-to-face communication (co-located communication)	
Different place		FLE3 knowledge building forum (distributed communication)

Table 6-3: Communication in the Gene-Ethics scenario addressed in this thesis following a Time and Place Matrix adapted from Johansen (1988).

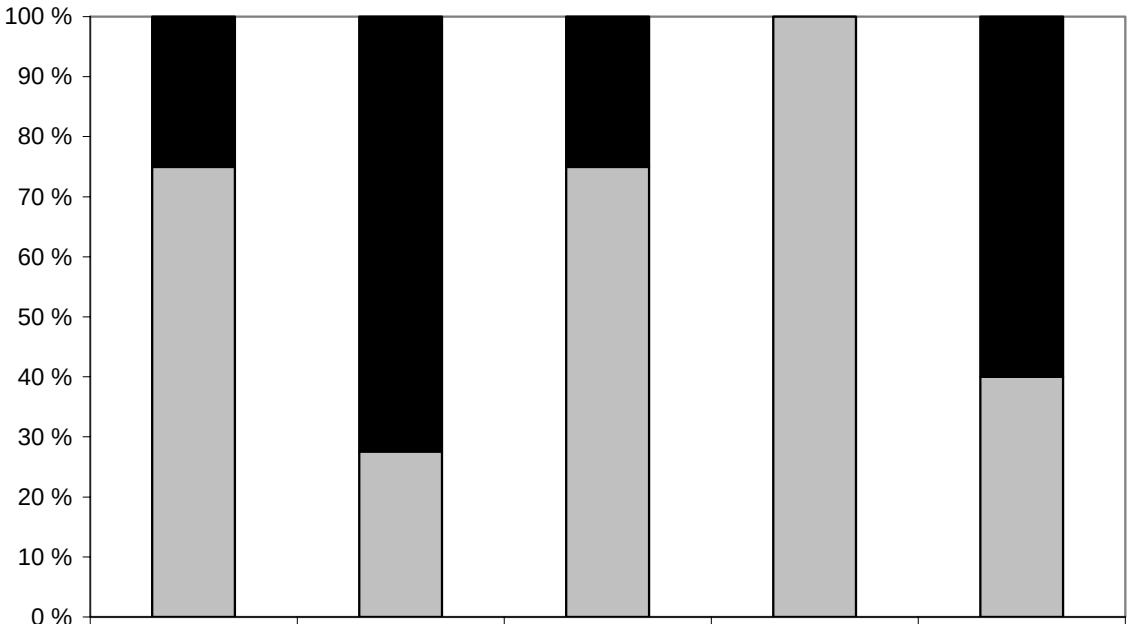
To identify grounding processes in the scenario, I have argued to use the categories implemented in the knowledge building module of FLE3. When screening video material and content logs, sequences showing explicit use of FLE3 categories have been selected and considered significant for further analyses. To carry on the inquiry and be able to collaborate in the two contexts mentioned above, one can argue that students have to make an effort to gain a mutual understanding of the pre-defined set of knowledge building categories. As

criteria for interpreting the findings, this understanding has to be sufficient for the current purpose, which in this case is to carry on a research-like knowledge building process in collaboration with fellow students (co-located) and students from another school (distributed). According to the principle of least collaborative effort (Clark & Brennan, 1991), students should try to ground with as little joint effort as necessary for the current purpose. What takes effort is said to vary depending on the context and the communication medium. Media may vary in what costs and constraints it puts on grounding (ibid).

Given that all students in the focus group completed the assignment, it's reasonable to anticipate that some level of joint understanding of the pre-defined categories has surfaced among the participants. The categories are conceptual implements (scaffolds) designed to facilitate the knowledge building process. Students' explicit use of categories could possibly serve as an indicator reflecting their level of conceptual understanding of the inquiry process. Prior to analysing the interactions on a detailed level, I will present the relative frequencies of actual category use and study how the label corresponds with content. Statistical information is gathered from the built-in software agent, FLE3 assistant (Chen et al., 2003), to get an overview of actual category use in the scenario. This information is applied in conjunction with other data sources. All messages posted in the knowledge building forum relevant to the activity system of the focus group are examined. This means the distributed communication between the local focus group in Oslo and the corresponding local group in Bergen. Postings are classified according to the utilized knowledge building categories to see if there are any patterns. The content of messages has been evaluated using the progressive inquiry model (see chapter 2.3.3) to see if there is a mismatch between actual and intended use of the implemented categories. For this purpose, I have chosen to study the threads of the two central knowledge building sessions of the scenario. These are the sessions where the main knowledge building activity is present. In the first session, the assignment was to explore the new tools and get to know each other. The content of postings in this session is mostly social and not considered relevant for the inquiry.

Did students correctly label their postings in the forum? Was there any progress from the first phase to the second? If so, this could indicate the emergence of a common ground, a level of mutual understanding building up among students concerning the knowledge building process and the use of categories. The content of threads has been evaluated

according to explanation of the pre-defined category set given in Table 6-1. Although some postings had content that qualified for more than one category, they were classified by evaluating the general meaning of the heading and message body in their respective threads. I recognize that my interpretation of the content is one of several possibilities. The diagram in Figure 6-5 illustrates the correspondence between the labels (knowledge building categories) and the content of messages in the scenario.



	Problem	Our explanation	Scientific explanation	Meta-comment	Summary
Incorrect	25 %	72 %	25 %	0 %	60 %
Correct	75 %	28 %	75 %	100 %	40 %

Figure 6-5: Total category usage: Hovseter1 and Sandgotna1 (Storgruppe1).

Glancing at the diagram above, the most obvious misconception displayed is the use of “our explanation.” The original ideas and intentions with the implemented knowledge building categories were to assist a research-like process in accordance with the pedagogy of inquiry-based learning (Hakkarainen et al., 1999; Lakkala et al., 2001). Following the workflow of this model, the content of postings marked with “our explanation” ought to be the students’ own explanation or tentative answer to the problem. 78% of the messages marked with the category “our explanation” did not contain students’ explanations or their tentative answers.

This knowledge building category is predominantly used for short messages with social or organizing content. The extract below shows a characteristic application:

Knowledge building forum excerpt 1:

> **Category:** Our explanation
> **Title:** Deal?
> **Time:** 11:08 2002-09-16
>
> […] Yeah, we've chosen
> 2, 9 and 11 ((questions to work with))
> We're off for lunch now.
> Talk to you later darlings…
> And yes it's really ok.

This message is part of a thread where short messages are posted within a few minutes interval. The two collaborating groups have been discussing what initial questions to focus upon during the later inquiry. In the utterance "and yes it's really ok," the Bergen group confirms by sending a message to the Oslo group that the questions they have agreed to work with are accepted. The message in excerpt 1 is partly task oriented, but the content is not a working theory according to the progressive inquiry model.

Creating working theories is argued to be an essential part of the inquiry process and for students to develop conceptual understanding (Lakkala et al., 2001; Scardamalia & Bereiter, 1993). Accordingly, it's crucial to suggest one's own speculation or interpretations of the phenomena studied. The fact that a large number of postings with the label "our explanation" did not have content corresponding with the intended use does not necessarily mean that students misunderstood the meaning of this category according to the progressive inquiry workflow. The correct 28% of the postings were placed at an accurate level in the threads and may have been sufficient for the overall progress of the inquiry. The lack of tools for instant, short messaging can possibly explain the high number of faulty "our

explanation" postings. They did not have the opportunity to communicate synchronously in the distributed groups. Data indicate that students used this specific category in the asynchronous knowledge building forum partly as a substitute for an instant communication system to send short, social and organizing messages. This can be interpreted as a solution to a conflict in the collective activity system (Engeström, 1987; Engeström et al., 1999). The activity can be said to have developed as a result of contradictions between externalisation and internalisation. Internally, students' activity is restricted by external factors such as technological tools lacking the possibility to send short instant messages. Students in the local focus group openly expressed their frustration about the slow communication when collaborating in the knowledge building forum with the distributed group. One of the students is waiting for the other group to reply and articulates her dissatisfaction by calling the teacher: "Hey teacher, nothing is happening here. Do we just have to wait?" Another student articulates the need for instant communication with the utterance: "I wish there was more chatting."

Inventions are adopted as students start using the asynchronous knowledge building forum to send chat-like messages, attempting to stabilize this conflict. The collective activity system move forward as students develop a pragmatic solution to a contradiction by applying one of the categories for short coordinating messages. Since this practice is picked up by both groups during the scenario, it can be interpreted as a mutual understanding. I suggest this as a form of *pragmatic grounding*. As an effort to understand each other's communicative intentions, students mutually agree to use a communication channel in a way that is sufficient for the current purpose, but different from the intended application. The process of developing this practice happened silently among the two collaborating groups. They did not discuss the use of "our explanation" explicitly, but observed each other's posting activity in the forum. A related practice is observed earlier in the DoCTA-project by Arnseth and Ludvigsen et al. (2001), suggesting that the technology involved in distributed collaborative learning does not determine action following a simple logic but is closely intertwined with students' activities. By analyzing students' collaboration and problem solving in a groupware system called Team Wave Workplace, they showed how the collaboration process is continually negotiated by the participants. Due to the slight delay between the production and posting of utterances in this system, students developed a pragmatic solution and started to use the integrated electronic Post-It notes to conduct synchronous

communication. In both cases (Team Wave Workplace and FLE3 knowledge building forum) the technological tools are used for a purpose that they were not necessarily designed for.

To see if there is any change of category use throughout the DoCTA-NSS scenario, I have separated students' activity in two phases. The *early phase* begins directly after the introductory session and lasts for four days. Gene technology is the theme for this period. In the *late phase*, students had hands-on experience using the tools and the ideas of the progressive inquiry model. Knowledge building threads from this phase contain fewer messages with social content and are more task-oriented. The theme is centered on the ethical part of gene technology. In Figure 6-6, the frequency of categories utilized in the two knowledge building sessions is illustrated.

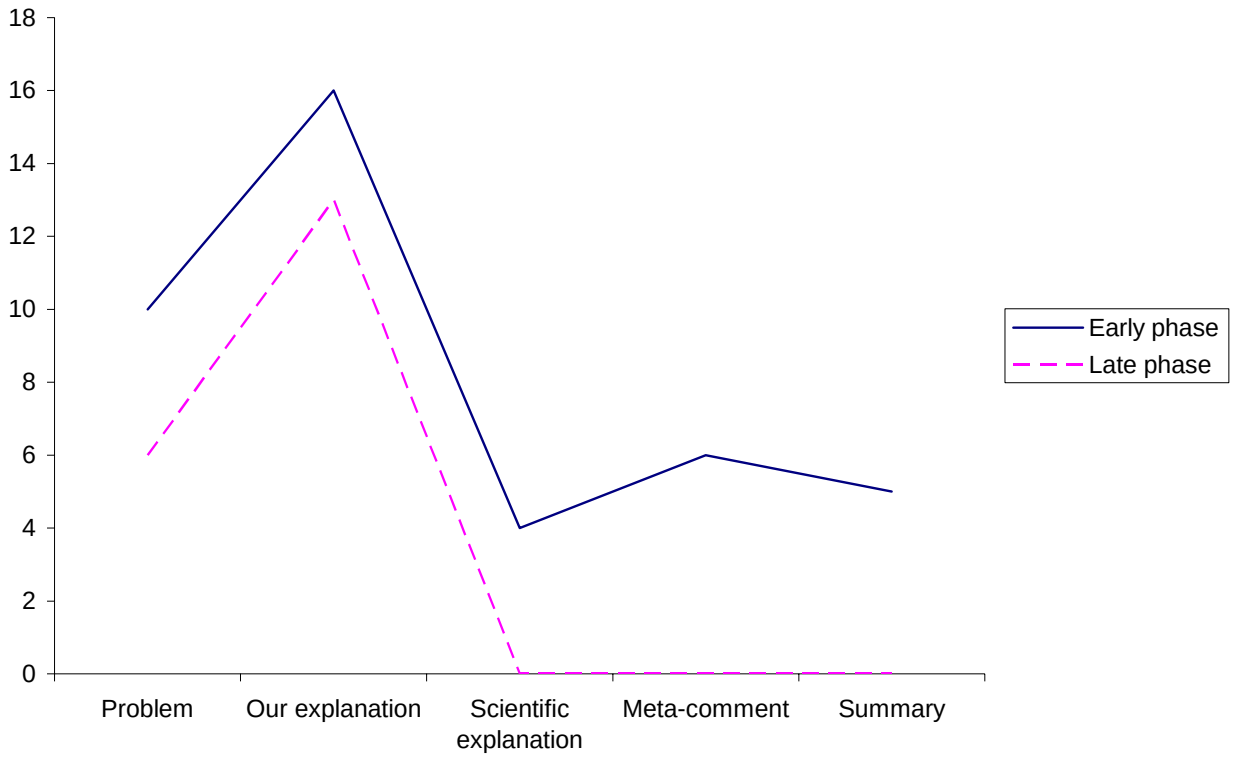


Figure 6-6: Category usage in two phases of the scenario.

The relative number of postings labeled with "problem" and "our explanation" is quite similar in the early and late phase. However, there are significant differences when it comes

to the other categories. In the late phase of the scenario, students limit their category use by excluding “scientific explanation,” “meta-comment” and “summary.” Postings with these labels are not used once. Hence, students are not working in accordance with the intentions of the progressive inquiry model in the late phase, but they are simplifying it. It appears that they are reducing the amount of collaborative effort by limiting category use. In a pragmatic, task-oriented style, they applied only “problem” and “our explanation” to solve their assignment. The nature of the discussion theme may explain this difference. The first phase was about gene technology, and the second about the ethics of gene technology. Ethical issues are associated with subjective interpretations or moral principles and do not necessarily require scientific referencing. “Our explanation” may be easier to select as a label for reflections of this kind.

The actual products of students’ knowledge building in the form of conceptual artefacts are not evaluated in detail. The research question of this thesis is focused on student’s grounding interaction; less attention is given to the actual cognitive content. The frequencies in Figure 6-5, showing the correspondence between the labels and content of messages are not necessarily indications of high (or low) quality knowledge building. Evaluating the content and products of students’ learning is considered outside the scope of this study.

Even if students did not always apply the right labels on the postings, they were able to complete the task, their primary aim for the activity in both phases of the project. This demonstrates an ability to operate with available technical tools in a way that was sufficient for the current purpose. But here we see a possible conflict in the activity system. For students’ activity, the main goal was to solve the given tasks while the overall aim according to teachers and researchers was for students to follow a research-like process in accordance with a progressive inquiry model. This means setting up research questions, creating their own working theories, critical evaluation, searching for new scientific knowledge and sharing expertise with other inquirers (Hakkarainen et al., 1999; Hakkarainen et al., 2002; Lakkala et al., 2001). Even if students’ conceptual understanding of the pre-defined knowledge building categories is not equivalent to the pedagogical model of the scenario, their pragmatic and task-oriented application of the forum indicates a degree of mutual understanding among collaborators that proved sufficient for their purpose.

How did students contribute to each other's understanding? Was the process constrained or supported by the computational environment? At this stage in analysis, it's time to have a more detailed look at the students' interactions in the scenario.

6.2.1 Co-located grounding interaction

As indicated in Table 6-3 on page 69, participants of the local focus group were physically present at the same place (classroom) at the same time. In the local groups' face-to-face conversations, spoken language and body language were used for communication among the students. Body language and non-verbal communication are the process of communicating through gestures and body positions, conscious or unconscious (Abate, 1999). Spoken language can be defined as a medium by which language is transmitted (Matthews, 1997). The words spoken in local groups are transmitted through the medium of sound (phonic medium) and the written postings in FLE3 are transmitted through a digital medium and graphically rendered on computer monitors. Clark and Brennan (1991) list eight possible constraints a medium may impose on communication and, consequently, affect grounding: co-presence, visibility, audibility, co-temporality, simultaneity, sequentiality, reviewability, and revisability (see chapter 3.1.1). If a medium lacks one or more of these characteristics, alternative grounding techniques are assumed to transpire. When collaborating in the local groups, students were sharing the same physical environment. Sitting at the same table and working together, they shared the same surroundings and could observe what each other was doing and looking at. In Clark and Brennan's terms they were *co-present*.

An empirical example of co-present face-to-face grounding interaction in the local focus group is given in the following transcript (see appendix A for transcription conventions and appendix B for the original Norwegian dialog). Three days prior to this interaction, students received training in using the tool. They also have been practicing their skills in two sessions by collaborating and discussing initial questions in the knowledge building forum. Students from the corresponding group in Bergen were online earlier the same day, posting messages in FLE3. The extract shows an interaction where two students in the local focus group (Oslo) are collaborating to post a meta-comment in the knowledge building forum.

Video transcript 1:

Line no.	Student	Dialog
1	Student 1	What are we going to do now?
2 3 4 5 6 7 8 9 10	Student 2	Now, we're only (.) can write, go to [Student 1: no, wait. We have to write something here] Genetically modified food (.) HEY. And then write a meta-comment at the bottom of that here ((pointing at the monitor)). Tell them they mustn't use our questions, the inquiry thread to eh (.) nonsense, because in a way then we really don't know where.
11	Student 3	Do you want to try?
12	Student 1	Yes.
13 14	Student 2	NO, change the knowledge type ((pointing to the monitor)) to meta-comment. (3)
15	Student 1	Here ((mouse gesture))?
16	Student 2	Yes. Meta-comment.
17	Student 1	Meta-comment.
18	Student 2	Yeah, yeah.
19	Student 1	Click
20	Student 3	You should've learned this yesterday.
21 22	Student 1	Yes, then (3) category. [Student 2: Then category]
23	Student 2	Meta-comment.

The local students in this sequence correctly chose to use "meta-comment" for their response to the other group's nonsense answer. By providing feedback on the knowledge building process, students demonstrate accurate use of the built-in posting category "meta-comment" as it is intended by the scenario designers (Ludvigsen & Mørch, 2003; Wasson et al., 2003).

In grounding terms, one can say that students have understood the use of categories sufficient for the current purpose. To get a better understanding of the characteristics of this complex communication, I will continue with a more detailed analysis of co-located and distributed grounding interactions.

On line 13, student 2's utterance is followed by a gesture, pointing to the drop-down menu on the computer screen, showing student 1 where to select the right category.

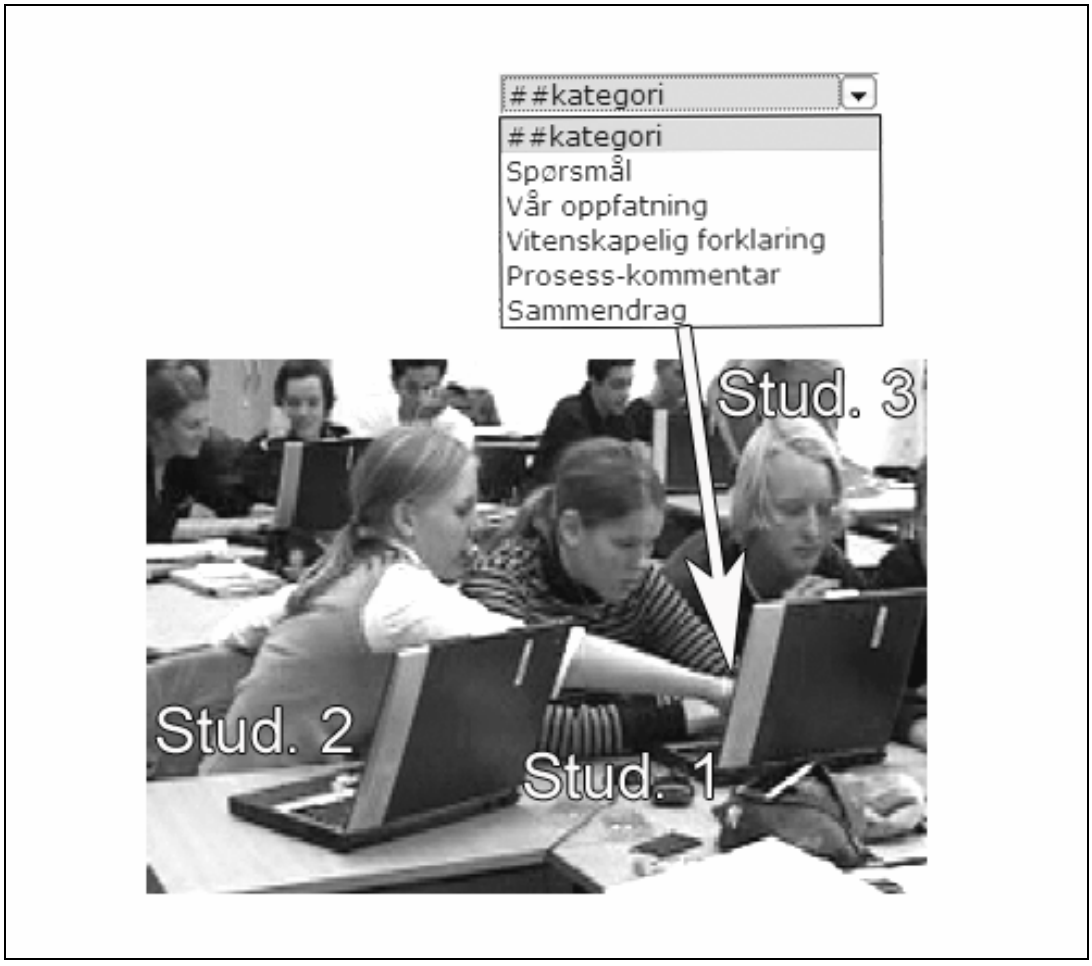


Figure 6-7: Student making a gesture showing another student how to select the proper category to post a message.

Body movements and facial expressions facilitated the verbal meaning. Student 1 receives the utterance and produces the response "here?" within a couple of seconds. Now, how can these utterances contribute to a common ground in this interaction?

Student 2 presents an utterance for student 1 to consider on line 13: “No, change the knowledge type ((pointing at the monitor)) to meta-comment.” Following Clark’s theory (1991), she does so on the assumption that, if student 1 gives some evidence *e* or stronger, she can believe that her utterance is understood. However, both the presentation and acceptance phases have to be completed for an utterance to contribute to the common ground. Student 1’s reply “here?” indicates that she heard the content of the message but is not yet sure that she comprehends the meaning. Hence, she’s in Clark’s state 2 and the grounding act is not yet completed.

The pointing gestures in this interaction can be interpreted as a *grounding reference technique*. Students seek to establish a common reference for the conversation. The object they are referring to in this case is the drop-down menu for selecting knowledge types in FLE3. This is an example of a specific grounding technique declared by Clark and Brennan (1991) as *indicative gestures*: “When a speaker refers to a nearby object, the partners can give positive evidence that they have identified it by pointing, looking or touching” (p. 227). As the target receiver of the utterance, student 1 shows signs of paying attention by looking at the artefact that is focus for the conversation. Aware that they are sharing the same view of the computer screen, student 1 moves the mouse cursor as a gesture to show student 2 the exact location she’s referring to while uttering “here?”. By providing this clue, she indicates that she correctly identified the object referred to in the conversation (pointing the cursor at the right category). Student 2 uses this information as a positive evidence of understanding by confirming with the reply on line 16: “Yes. Meta-comment.” According to Clark’s model, the interaction can be interpreted as grounded at stage 3 when student 1 indicates that she understood the meaning of the utterance. But can we be sure that they have a mutual understanding of the meaning of “meta-comment”? The empirical evidence is not adequate to provide a valid conclusion about the unique, individual understanding of the meaning of categories. I will not attempt to draw these conclusions here. However, the positive evidence provided in the conversation indicates a degree of mutual understanding of the meaning of the “meta-comment” category among students 1 and 2. The understanding seems sufficient for the current purpose. Following the progressive inquiry process, they successfully applied the right knowledge building category for the meta-comment in the FLE3 forum. Their mutual understanding was therefore sufficient to choose the proper knowledge type. Some

information can be said to have mounted on their common ground. The two participants established a common reference for how to use “meta-comment” as a category and how to use the drop-down menu on the computer screen when selecting knowledge type for postings in FLE3.

In this co-located interaction, the participants communicated mainly by speech and body language. Utterances were produced and received with little or no delay, and evidence of understanding was provided without any significant interruption. The dialog in transcript 1 shows signs of both co-located and distributed grounding. Locally, student 1 and student 2 are working up an agreement on how to label the posting in progress. Furthermore, the content of the message shows an effort to contribute to a joint understanding with the collaborative group in Bergen concerning the use of categories in knowledge building threads. The process of adding to the common ground in the distributed dimension of the context is the theme for the next step of the analysis.

6.2.2 Distributed grounding interaction

The FLE3 knowledge building forum is described as the main tool for computer-mediated communication and considered the channel for distributed grounding interaction in the scenario. As a medium, the forum is estimated to convey potential resources for and constraints on grounding. The knowledge building forum can be seen in relation to several of the eight possible constraints a medium may impose on grounding (see chapter 3.1.1; Clark’s contribution model). When collaborating in a distributed manner in the FLE3 knowledge building forum, students can not see each other’s movements nor listen to each other’s voices. Messages can not be sent and received simultaneously, but with a delay. Hence, the forum does not offer the dimensions of co-presence, visibility, audibility and simultaneity as the co-located context does. When the medium is constrained by one or more of these factors, it’s likely that students will make use of alternative grounding techniques. “These constraints lead to different associated ‘costs,’ in terms of the effort required of interactional participants” (Baker et al., 1999:10). For example, how intricate is it to repair a misunderstanding in the knowledge building forum? Communication costs and constraints can perhaps be understood as difficulties in appropriating the tools. The pre-defined knowledge building categories are abstract tools and are considered important facets of the medium. If categories are too complex to appropriate as an instrument for distributed

collaboration, grounding interaction among the groups may be restricted because too much effort is required on task-level understanding.

In the next paragraphs, I will present excerpts from distributed grounding interaction and continue analysing how the FLE3 knowledge building forum as a medium supports or constrains the process of adding contributions to the common ground. To grasp the complexity of the interactions involved in the distributed collaboration, information from different data sources is utilized. Excerpts from discussion threads are used in conjunction with video transcripts to see the students' grounding interactions from different angels.

One of the initial research questions identified by the students to guide the course of their inquiry was about genetically modified food. This particular problem arose from students' own reflections earlier in the scenario. A new thread with the title "Is it possible to genetically modify all kinds of food?" is posted by the focus group and marks the beginning of a knowledge building session. Start-up costs are the costs associated with starting up a new discourse (Clark & Brennan, 1991). These are the costs of getting the conversation partners to initially notice that the sender is uttering something of relevance. In the face-to-face situation, this means getting the conversation partners' attention and then speaking. When starting a new discourse in the knowledge building forum, the initiator must first log on to FLE3, chose a course, start a new thread, determine the accurate category, type the message on the keyboard and then send it. Therefore, it's reasonable to conclude that communication in the forum takes more effort to initiate than in a co-located, face-to-face situation.

The corresponding group in Bergen had problems understanding the meaning of the initial question issued by the Oslo group and replied with the following posting:

Knowledge building forum excerpt 2:

> **Category:** Question
> **Title:** Help
> **Time:** 10:50 2002-09-17
>
> Hey! We are wondering about something. We are struggling with understanding where you are heading with this question. Because, “Is it possible to genetically modify all kinds of food?” is really hard to answer. That’s why we are wondering if you maybe could inform us a little about this in more detail. We didn’t really understand it properly.

At this stage, the initial question has evidently been read and discussed in the Bergen group. In the local focus group, student 2 is operating the FLE3 computer as the above message is received. The message is read and reflected upon together with one of the other group members (student 3) sitting next to her.

Video transcript 2:

Line no.	**Student**	**Dialog**
1 2	Student 2	How did they answer? Did they answer with “our explanation”?
3 4 5 6 7	Student 3	No they answered with “question”. You have been using the question-category in your answer ((reading out loud while typing on the keyboard)). This is mistaken; you should use either meta-comment (.) or something else.
8	Student 2	They are asking questions.
9 10 11	Student 3	=You are using the question-category (9) in the answers ((continues typing))
12	Student 2	Then you have to choose another category (.) or

13 14		to do that you have to choose another category. If you want to ask question you have to select.
15 16 17 18	Student 3	If they want to ask questions then they must use question. If they want to answer then they have to use another. When you're going to answer, you have to use something else.
19	Student 2	When answering.
20	Student 3	You must use another category.
21	Student 2	Must use another category.

This dialog results in posting of the following message in the knowledge building forum:

Knowledge building forum excerpt 3:

> **Category:** Meta-comment
> **Title**: Choose right category!
> **Time**: 10:56 2002-09-17
>
> You are using the question category in your answers. When answering use another category. Please do not send messages that are not related to the task. This is a school project.

Excerpt 3 is not an answer to the initial research question issued by the other group, but a meta-comment concerning the knowledge building process.

Now, what techniques for grounding does the FLE3 knowledge building forum afford? How are distributed grounding processes constrained or supported by this medium?

Compared to the co-located situation discussed earlier, some characteristics of the communication are distinct and may possibly affect grounding. A central feature of the knowledge building forum is that it's designed for text-based asynchronous communication.

As illustrated in the 2 x 2 matrix in Table 6-3, senders and receivers of messages are separated in time and place. The corresponding local groups in Oslo and Bergen are collaborating in a distributed manner to solve the given tasks and do not share the same physical surroundings. As students are separated in time and space and the communication is primarily text-based, non-verbal clues in form of body gestures can hardly be transmitted through this media unless dedicated computer-supported awareness mechanisms are implemented in the environment (Dourish & Bellotti, 1992; Gutwin & Greenberg, 1995; Gutwin et al., 1995). Clark and Brennan (1991) refer to the problem of non-visibility in a grounding situation as *display costs.* Students are not visible to observe each other's gestures and body language, nor can they hear each other's voices. The computer-mediated communication is typed on a keyboard. It generally takes more time and effort to plan and issue written utterances than spoken ones. The act of producing text-based messages in FLE3 is, therefore, constrained by *production costs* compared to the face-to-face situation. However, the use of smiley faces in the typed messages can be interpreted as a crude approximation to substitute for facial expressions. Furthermore, the chosen category serves as a pre-defined label for reading messages, indicating the type of knowledge associated with the content. This can be seen as a non-typed form of communicating in the forum.

Another possible cost associated with the process of adding to a common ground is that students have to wait while turns are produced in the forum. After posting the question presented in excerpt 2, it takes 6 minutes for the Oslo group to reply and a few additional minutes before it's received. In the face-to-face conversation, students could time their utterances by starting them just as the former speaker finishes his or her turn. As FLE3 is a medium not including the dimensions of co-presence, visibility, audibility or simultaneity, timing can be problematic. Messages can get out of sequence. The asynchronous nature of the distributed communication thus generates potential costs on grounding.

In a conversation, the presenter of an utterance typically looks for evidence of understanding (Clark & Brennan, 1991). The speaker seeks evidence to determine if he or she has been understood by the listeners. In the co-located situation described in chapter 6.2.1, positive evidence of understanding is provided on line 18 with the acknowledgement "Yeah, yeah" followed by a click at the right category. How does the process of presenting and interpreting evidence of understanding function when mediated through the FLE3

knowledge building forum? Empirical data suggest that postings in the knowledge forum can contain grounding evidence in the form of both positive and negative feedback. Examples of negative feedback are repetition or asking clarifying questions. The group in Bergen replied to the focus group's initial question stating that "we haven't really understood it ((the question)) properly." By doing this they provide negative evidence; they haven't really understood the meaning of the initial research question issued by the Oslo group. From a grounding perspective there are costs associated with producing a faulty utterance (Clark & Brennan, 1991). According to the grounding model, the sender needs assurance that the message has been understood as it was intended. In the knowledge building thread presented above, the Oslo group does not start a repair sequence to patch up the misunderstanding, but chose to comment on the use of categories instead. The inquiry process is thus interrupted by a comment at the meta-level. The Oslo group's effort to correct the other group's use of knowledge building categories cuts off the initiated semantic grounding interaction and moves the discussion to a pragmatic level. The negative evidence provided by the Bergen group in excerpt 2 is not repaired in the subsequent postings or later in the scenario. The lack of repair sequences in this example can perhaps be a consequence of the costs associated with issuing repairs in a computer-mediated distributed environment. The costs of producing faulty utterances and subsequent repairs are assumed higher in the knowledge building forum than in the co-located situation. I have earlier argued that communication in the forum is coupled with startup costs and problems with messages getting out of sequence.

Data also indicate that messages in the knowledge building forum can communicate positive feedback in the form of acknowledgements. Continuers like "yeah" and "ok" are used by receivers of messages as a signal that they believe they have understood a message. Due to the asynchronous nature of the medium, there is a significant delay from the time the message is produced until it is read. However, distributed and delayed communication gives students a chance to reflect and prepare their response. As instant reply is not required; they have the opportunity to plan and revise messages more carefully before executing them. So the delay is not solely associated with costs on grounding. This can support the process by creating greater room for reflection.

The FLE3 forum offers some dimensions not present in the co-located situation that can possibly support the process of grounding. The published postings are stored in a database so

that both senders and receivers can review them later. Utterances remain in the respective thread in which they were embedded. As speech fades away, text in the knowledge building forum is preserved as an artefact for later use. This can possibly support grounding processes of another kind than speech can afford as students can go back and review earlier discussions threads. Having the opportunity to look back at knowledge building threads can possibly assist students in getting a meta-cognitive perspective of the inquiry. A potential pitfall of this, however, is “premature meta-cognition” where students go directly to the “meta-level” without first having understood the other (basic) categories.

In excerpt 3, the utterance “You are using the question category in your answers” refers to earlier messages. As the database is shared, both the producers and receivers can go back and re-evaluate their postings. In this sense, the knowledge building forum serves as a collective memory or a persistent grounding reference supporting the continual construction of a common ground. However, it is shown that threads in the forum are not always posted in the right sequence. If contextual clues are missing, it can be hard to understand the meaning of the message because the addressee has to imagine the context.

7. IMPLICATIONS AND DISCUSSION

The following paragraphs sketch some possible implications of the study and suggest an evaluation on its quality.

7.1 Design implications

The design aspect of telelearning artefacts is reflected in the title of the latest CSCL-conference: “Designing for Change in Networked Learning Environments” (Wasson et al., 2003). In my analysis of the Gene-Ethics scenario, I have seen a close interdependence of students’ grounding interaction and the mediating artefacts that support this process, especially in the distributed collaboration. On the basis of my empirical observations, I will shortly sketch some general design implications for coming versions of the “Future Learning Environment” (Leinonen, 2003).

A central tenet of activity theory is the mediational aspect of human conduct (Engeström et al., 1999; Leont'ev, 1978). The FLE3 knowledge building forum is described as the main channel for computer-mediated distributed grounding interaction in the scenario studied. Patterns in students’ interaction emerged in a collaborative learning context partly defined and mediated by a telelearning artefact. The design of the FLE3 knowledge building forum following a progressive inquiry model (Hakkarainen et al., 1999; Hakkarainen et al., 2002) has to some extent influenced and shaped the way students grounded their distributed communication. Following socio-cultural ideas of activity, the design of computer artefacts for collaborative learning can be seen as an activity directed to *change* students’ activity through the construction and implementation of new artefacts (Bertelsen, 2000). A design issue emerging from my analysis is based on empirical evidence indicating that important features of the mediating tool in the Gene-Ethics scenario partly constrained students’ collaborative activity by inhibiting grounding repair sequences in the distributed setting. Is it possible to solve this problem with improved technology in the context of FLE3?

Flexible tools for communication and a mix of various artefacts for different purposes are argued in previous studies to provide good interactional conditions (Fjuk & Ludvigsen, 2001).

To better support distributed grounding interaction among students, additional awareness and meta-information mechanisms may be necessary. When working distributed in FLE3, collaborating groups had difficulties keeping track of each other's moves and the discussion threads came out of sequence. When messages are issued in the wrong sequence, contextual clues can be missing, making it difficult for responders to understand the meaning (Clark & Brennan, 1991). Compared to the co-located, face-to-face setting, students had problems with completing grounding repair sequences. Dedicated awareness mechanisms can be implemented to provide collaborators with greater understanding of each other's activities (see chapter 2.2.1). *Workspace awareness* is referred to as "the up-to-the minute knowledge about other students' interactions with the shared workspace" (Gutwin et al., 1995:2). This kind of awareness can be supported by providing additional clues in the virtual environment to monitor the collaborating groups' moment to moment interaction. However, this may be difficult to achieve in an asynchronous workflow where students are working on a different time-place scale. A re-design of the curriculum may be necessary. If the participating classes (in Oslo and Bergen) were working online during the same time intervals each day of the scenario, i.e., from 10-12, the collaboration among the corresponding groups could follow a more "semi-synchronous" work mode in the knowledge building forum. Shorter time intervals between messages will possibly make it easier to monitor the other group's activity and understand the context and meaning of the discussion. However, this must be balanced against the rewards of the greater room for reflection a larger time frame offers in an asynchronous knowledge building context. An implication for the current design could be to implement an intelligent agent to monitor the knowledge building process and remind students that messages should be answered within a pre-defined time limit at the proper level of the discussion. This could perhaps support grounding interaction by preventing repairs from being lost. Some of this work has already been started in the context of DoCTA-NSS (Dolonen, 2002; Nævdal, 2004).

The knowledge building categories may be too complex to appropriate as tools for distributed collaboration. Students were on several occasions engaged in pre-mature meta-cognition, discussing the process at a high level of abstraction before mastering the basic categories (Ludvigsen & Mørch, 2003). This could imply a re-categorization of the existing category set with fewer and more precise knowledge building categories. To assist students in mastering the basic application of knowledge building, the students could be introduced gradually to the

categories, e.g., working with one category at a time in a specified sequence (first research question, then working theory, etc.). The category set can also be user adapted, allowing more advanced students to work with a larger collection and low achievers to work with a restricted set of the knowledge building categories, i.e., problem and answer. In this way they can concentrate more on learning the content and less on understanding the process. This identifies a possible area for future work in the design of educational software.

7.2 Evaluating the quality of the study

What are the nature, limits and validity of the reasoning and findings presented in this thesis? I have aimed to gain an understanding of students' grounding interaction in a CSCL environment. Relying on multiple sources of evidence, case study has served as a general research strategy (Yin, 1994). Theories, data and methodologies are triangulated to ensure sufficient validity of the research results. To understand students' grounding interactions in a co-located and distributed setting, a micro-analytic approach to students' conversation at an utterance level was attempted (Bakhtin, 1986; Clark & Brennan, 1991; Jordan & Henderson, 1995) and merged with sociocultural theories of activity systems (Engeström, 1999; Engeström, 1987). The reason for this combination was that in a complex computer-mediated environment, it is necessary to see grounding interactions beyond the utterance level, not merely studying chunks of talk isolated from their context. Concepts from activity theory proved useful to get a broader view of students' interactions in the scenario, providing a framework for the narrative description and informing a more detailed analysis of co-located and distributed grounding at the utterance level.

The case database (see Table 5-1: Data sources) contains both numeric and non-numeric information. The different data sources are electronic logs of messages posted in the FLE3 knowledge building forum, video recordings of local focus groups' interactions, scenario documents, and statistical information from the FLE3 assistant (Chen et al., 2003). Statistical frequencies are applied in conjunction with other data sources to look for patterns in students' grounding. Transcripts of video sequences and logged messages from the knowledge building forum are verbal, non-numerical records. By focusing on students' interactions, joint understanding and meaning making, this study relies heavily on interpretative epistemology and less on analysis of numerical data. The research questions are focused on investigating

specific phenomena concerning students' grounding interactions when collaborating in a computer-mediated learning environment. Higher priority is thus placed on direct interpretation of students' intersubjective understanding, communication and the meaning of events rather than measurement. The emphasis on direct interpretation and less focus on non-numerical data are typical features of a *qualitative study* (Guba & Lincoln, 1982; Stake, 1995). But as previously mentioned, I regard my work as a case study containing multiple sources of evidence and find the dualistic distinction "quantitative/qualitative" problematic.

Studying students' interactions and meaning making in a CSCL environment raises several methodological and epistemological issues. I will first position the quality of the reasoning leading to my conclusions. Next, some general evaluation criteria are presented and discussed in light of this examination.

When investigating the problems issued in this thesis, my approach is argued to be explorative, attempting to describe patterns in students' collaborative learning interactions. My interpretations of data and cautious analytic generalizations can hardly be characterized as following a strict inductive or deductive logic. The conclusions of this thesis are likely to be somewhere in between the two classical paths of scientific reasoning. The term *abduction* is described by Peirce and others (Alvesson & Skøldberg, 1994; Chomsky, 1968; Peirce, 1903, 1965) as a form of reasoning that draws a conclusion on the grounds that it explains available evidence. The evidence at hand is used to describe an interference pattern as a proposal to the best explanation. Abduction is defined as "the process of forming an explanatory hypothesis" (Hoffmann, 1997 cites Peirce, 1903:5.171). According to Peirce, it is the only logical operation that can introduce a new idea (ibid). As with inductive reasoning, abductions are construed from empirical data, but theoretical pre-assumptions are not necessarily rejected (Alvesson & Skøldberg, 1994). Existing knowledge and references are used to find theoretical patterns or deeper meaning structures in data. Abduction is described as a process related to scientific discovery, while induction is about testing what is discovered. When analysing data from the Gene-Ethics scenario, I have applied concepts from previous theories of grounding combined with my own interpretations to "lift" the observations above the empirical level and suggest underlying patterns in students' interactions, i.e., pragmatic grounding. In such an interpretive approach, my own research interest and personal theoretical perspective may have influenced the observations. According to Hanson's *thesis of theory-laden perception*,

"the theory, hypothesis, or background knowledge held by an observer can influence in a major way what is observed" (Phillips, 1992:53). To minimize individual researcher's preconceived biases, collaborative viewings of the material were conducted together with other researchers involved in the project.

The criteria by which the "goodness" of research is to be judged are subject for extensive dispute in scientific communities. Some writers advocate that case studies ought to be judged credible and conformable as opposed to valid and reliable (Merriam, 1985). Validity commonly refers to what degree the analysis is properly conceived to address the problems of the study (Calhoun, 2002). The concerns are about whether a technique is a suitable measure of the phenomena studied. Reliability refers to what extent a research technique yields identical results over repetitive attempts of application and if conducted by different researchers (ibid). Depending on the nature of the problems investigated and the evidence collected – internal, construct and external – validity can be relevant.

Internal Validity is about the certainty of conclusions regarding cause-effect relationships (Yin, 1994). Hence, internal validity is relevant when aiming to establish a causal relationship. As this study is observational and descriptive, not on relying cause-effect relations, reflections on internal validity will not be discussed further.

Construct validity refers to the closeness of fit between a measure or a concept and the reality it is supposed to represent (Marshall, 1998). My research has been aiming to represent phenomena (grounding interactions) in a real world scenario. A fundamental problem in educational science and related research is that we are dealing with different concepts or constructs concerning human behaviour and processes of learning (Kvernbekk, 2002; Marshall, 1998). These constructs are often not directly observable, but can manifest themselves in various ways. To identify students' grounding processes as part of their collaborative learning, I have set up certain indicators to look for on the basis of previous theories. The focus groups actual use of knowledge building categories in their co-located dialogs and in distributed communication with the other group is argued to reflect their process of constructing a common ground. To identify contributions to a joint understanding at an utterance level, dialogs are analyzed following Clark's (Clark & Brennan, 1991) contribution model. The theory asserts two phases of contributing to conversation

(Presentation Phase and Acceptance Phase) and what clues to look for to identify the potential states of grounding. The relation between theoretical constructs and the reality they are supposed to represent is a fundamental problem and can always be disputed (Woolgar, 1988). A potential threat to construct validity in my case can be preconceived notions and over-interpretation of the empirical observations. The idea that all observations are theory-laden is argued by several philosophers of science (Feyerabend, 1970; Hanson, 1958).

The notion of *external validity* refers to what extent conclusions of an empirical investigation are generalisable (Colman, 2001). Single case studies are frequently criticized for being incapable of providing valid generalisations. However, this criticism is commonly directed at statistical, rather than the analytical, generalisation (Tellis, 1997). The single-case design of this thesis does not imply generalising from a sample to a population as in a survey. According to Yin (1994), external validity is only relevant in multiple case studies, following replication logic. My conclusions rather rely on cautious analytic generalisations, not statistical generalisations from a population to a universe. When exploring students' grounding interaction in a CSCL environment, this study has been sensitive to detail and multiple meanings of the activity. I have not only described the events, but interpreted the relationship between students' interactions and their context on several levels. *Thick descriptions* are proposed by Geertz (1973) in his "interpretive anthropology" for intensive, dense descriptions of observations from which broader cultural interpretations and generalisations can emerge (Marshall, 1998). In my study, I go further than merely describing students' activity (thin descriptions). When analysing students' joint meaning construction, I interpret the meaning behind the activity by proposing "thick descriptions" of their communicative acts (grounding interaction) in the scenario. A relevant question then is: To what degree do students' grounding interactions vary according to the pattern described in this thesis? Is it possible to generalise across cases? As this is a single case study, there is a balance between understanding the generality of the interaction pattern observed without reducing the particularity. As no related cases are available for replication, my conclusions rather rely on cautious analytic generalisations within this particular case.

As already mentioned, the classroom was heavily influenced by the presence of the research project. With the everyday life of the classroom altered, students were not in their natural environment. Stake (1995) stresses that case studies should be non-interventive and empathic,

trying not to disturb the ordinary activity. In the first couple of hours in the scenario, students peeked nervously at the camera and played with the microphones. The students in the focus group seemed to take little notice of the cameras and researchers as the scenario progressed. The focus was mainly on project tasks and classmates rather than researchers and their tools. However, there is a possible weakness due to some occasions where investigators actually interfered in the local focus groups' collaboration. Interventions of this kind have the potential of biasing data sources in a case study by manipulating and disturbing the ordinary activity (Stake, 1995; Yin, 1994). Such interventions must be accounted for when studying students' efforts to build up a joint understanding and add contributions to a common ground. On the other hand, students' grounding interactions can hardly be considered isolated from the social contexts in which they are embedded. The context for this study is a real-life school situation; prompts and assistance from more competent others (teachers/peers) are commonly an attribute of students learning.

Another potential limitation of this study is that it lacks interviews of key informants from the Gene-Ethics scenario. Interviews are regarded as an important source of case study information (Stake, 1995; Yin, 1994). I first joined the DoCTA-NSS project spring 2003 as a research assistant, several months after the actual scenario. I did not have the opportunity to get reliable interviews of the local focus group. However, the various sources utilized in this study have shown quite complementary (see Table 5-1: Data sources). Video data in combination with electronic logs and scenario documents provided relatively rich documentation of the events, allowing me to study the material after it has been recorded. In "video-based field notes," data are represented in a processed form. The real event is reproduced. In the process of recording a video, the representation of data is partly automated and is said to have the potential to lower the reconstructive bias of the individual researcher (Jordan & Henderson, 1995). Videotaping is argued to produce data much closer to the event than any other kind of representation (ibid). Yet, post-scenario interviews of students in the focus group could have corroborated findings from the other sources by questioning students on issues directly related to the research focus of this thesis.

8. CONCLUSIONS

This thesis has been concerned with exploring students' grounding interaction in a CSCL environment. The research question asked is: How does the FLE3 knowledge building forum support or constrain grounding interaction? No simple answer has emerged from the analysis. The knowledge building forum turned out to be double-edged, providing both resources and constraints on students' grounding interaction. The construction of a mutual understanding sufficient for the current purpose (grounding) is regarded as a basic process in collaborative learning. Findings identifying constraints on grounding are therefore important. In students' co-located interaction, utterances were produced and received with little or no delay and evidence of understanding was provided without any significant interruption. On the other hand, it is apparent that the tool mediating collaboration in the Gene-Ethics scenario influenced important aspects of students' grounding processes. In particular, the FLE3 forum was found deficient in the dimensions of co-presence, visibility, audibility, co-temporality, simultaneity and sequentiality. Furthermore, several associated constraints on students' grounding were found. The most relevant constraints are summarized as follows:

- The analysis of students' interaction implies that processes of grounding are constrained by *startup and production costs*. Students demonstrated considerably more effort when initiating and producing grounding acts in the distributed knowledge building forum than in the co-located situation.
- Data also indicate that students' grounding interactions were constrained by *display costs.* When collaborating on distance (distributed) the corresponding groups did not share the same physical surroundings. Communication was primarily text-based and non-verbal clues (body-gestures) were not visible.
- Timing of utterances was problematic for students as a result of the delayed communication mode of the FLE3 forum. *Messages frequently arrived out of sequence*. Threads showing misplaced messages de-contextualized the intended meaning and partly constrained grounding interaction.
- The effort associated with issuing grounding repairs was higher in the distributed setting than in the co-located situation. Grounding repair sequences were repeatedly initiated, but not followed up in successive postings. Instead of providing repairs on

> the task level, the *grounding process was interrupted by comments on a meta-level*. Students' grounding interaction was constrained as repairs were not properly followed up. Occasionally this resulted in "pre-mature meta-cognition" as students moved to the meta-level before mastering the basic categories.

I find it reasonable to conclude that the text-based asynchronous communication mode of the knowledge building forum constrained important aspects of students' grounding interaction.

Yet, the knowledge building forum can serve as *a collective memory or a persistent grounding reference library* supporting the construction of a common ground that may last over time. Empirical data suggests that messages in the knowledge forum can contain grounding evidence in the form of both positive and negative feedback as contributions to a common ground.

When interpreting students' grounding processes through the lens of the theoretical perspectives taken in this thesis, some unexpected patterns have emerged. In the distributed setting, students developed a *pragmatic invention* to stabilize a contradiction in their collective activity system by adopting one of the knowledge building categories ("our explanation") for short, social and coordinating messages, hence giving it a new meaning. I have proposed this as a form of *pragmatic grounding*; students built a mutual agreement to use the tool in a way that was sufficient for the current purpose, but different from the intentions behind the learning environment's design.

A subordinate goal of this study was to explore how a micro-analytic approach to conversation and a social-cultural perspective (emphasizing activity theory) can combine to form an analytic framework for studying processes of grounding. This eclectic theoretical and methodological approach has shown to be fairly flexible. A narrative description of the scenario and the integrated parts of a dynamic collective activity system made it possible to perform a more detailed analysis of grounding interactions at the utterance level. This approach illuminated important aspects of students' grounding interactions in the co-located and distributed contexts. The notion of a collective activity system provided a structure to explore the interconnected relationship between students, their objectives, artefact-mediation and institutional aspects of the activity. Activity theory thus complemented micro-analysis on

the utterance level, providing concepts to understand students' grounding interaction from a broader analytic viewpoint (beyond the utterance level).

When evaluating the quality of this study in chapter 7.2, I identified some limitations. These limitations are not repeated here. Considering the thesis from a retrospective point of view, I recognize ways my research could have been improved and pursued further. More analytic effort could have been placed on the relation between students' grounding interaction and individual students' cultural, historical background. A potential weakness associated with much of the contemporary CSCL research is the focal point on process, giving less attention to the individual learner. A proposal for future work on this subject is to follow up Ragnar Rommetveits' (1974; 1985) pluralistic approach to communication. Rommetveit (1974) argues that every communicative act builds upon the joint commitment of "a temporarily shared social world" (p. 29). The meaning emerging in interaction is considered mutually created from the social realties participants bring to the situation, thus forming a *partly* shared social world. How do the individual students' different realities and sociocultural backgrounds influence the context-specific meaning making in a CSCL environment? I'm also enticed to ask the question: How can a virtual environment that partly constrains students' grounding interaction generate high-quality learning processes?

As a part of the DoCTA-NSS project, my research attempts to contribute to the theoretical discussion in CSCL. Experiences, findings and implications of this study will be presented in a paper and hopefully published in a relevant journal to raise the extent of my knowledge above an individual level and contribute to the general CSCL discourse.

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APPENDICES

Appendix A: Transcription conventions

This is a simplified version of the notation system developed by Gail Jefferson (1978).

Annotation		**Explanation**
[ ]	Brackets	Marks the beginning and end of overlapping utterances/speech.
=	Equal sign	Used when one speaker follows another with no noticeable pause.
(2)	Timed silence	Pauses in seconds.
(.)	Micro pause	A timed pause less than 0.2 seconds. Too short to measure.
<u>text</u>	Underlining	Signals a vocal emphasis.
TEXT	Capitals	Marks speech that is delivered louder than surrounded talk.
,	Comma	Indicates that the speaker has not finished.
.	Period	Marks falling, stopping intonation.
( )	Parentheses	Text enclosed in parentheses marks transcriber’s doubt.
(( ))	Double parentheses	Additional comments from the transcriber.

Appendix B: Norwegian originals of translated Video transcripts

Video transcript 1 (dialog in Norwegian):

Line no.	Student	Dialog
1	Student 1	Hva skal vi gjøre nå da?
2 3 4 5 6 7 8 9 10	Student 2	Nå skal vi egentlig bare (.) kan vi skrive gå inn på [Student 1: nei vent a vi må skrive noe her] Genmodifisert mat (.) DU. Også kan du skrive en prosesskommentar på slutten av den der der ((peker på skjermen)). Å si til de at de ikke må bruke ta å bruke spørsmål våre, de faglige trådene til eh (.) tull, fordi da blir det liksom på en måte da vet man ikke helt hvor..
11	Student 3	Skal du prøve?
12	Student 1	Ja.
13 14	Student 2	NEI, change the knowledge type ((peker på skjermen)) til prosesskommentar. (3)
15	Student 1	Her ((mus gest))?
16	Student 2	Ja. Prosesskommentar.
17	Student 1	Prosesskommentar.
18	Student 1	Ja ja.
19	Student 2	Klikk.
20	Student 3	Det kunne du lært i går.
21 22	Student 1	Ja så (3) så kategori. [Student 2: så kategori]

23	Student 2	Prosesskommentar.

Video transcript 1 (English translation):

Line no.	**Student**	**Dialog**
1	Student 1	What are we going to do now?
2 3 4 5 6 7 8 9 10	Student 2	Now, we're only (.) can write, go to [Student 1: no, wait. We have to write something here] Genetically modified food (.) HEY. And then write a meta-comment at the bottom of that here ((pointing at the monitor)). Tell them they mustn't use our questions, the inquiry thread to eh (.) nonsense, because in a way then we really don't know where.
11	Student 3	Do you want to try?
12	Student 1	Yes.
13 14	Student 2	NO, change the knowledge type ((pointing to the monitor)) to meta-comment. (3)
15	Student 1	Here ((mouse gesture))?
16	Student 2	Yes. Meta-comment.
17	Student 1	Meta-comment.
18	Student 1	Yeah, yeah.
19	Student 2	Click
20	Student 3	You should've learned this yesterday.
21 22	Student 1	Yes, then (3) category. [Student 2: Then category]
23	Student 2	Meta-comment.

Video transcript 2 (dialog in Norwegian):

Line no.	**Student**	**Dialog**
1 2	Student 2	Hva er det de har svart med, har de svart med ”vår oppfattning”?
3 4 5 6 7	Student 3	Nei de har svart med ”spørsmål”. Dere har brukt spørsmålskattegoriene i svarene deres ((leser høyt mens skriver på tastaturet)). Det er feil og dere må bruke enten prosesskommentar eller (.) ett eller annet annet.
8	Student 2	Dere stiller spørsmål.
9 10 11	Student 3	=Dere bruker spørsmålskategorien (9) I svarene deres ((fortsetter å skrive)).
12 13 14	Student 2	Da må dere velge en annen kattegori (.) eller for å gjøre dette må dere velge en annen kattegori. Dere vil stille spørsmål (må) dere velge.
15 16 17 18	Student 3	Hvis de vil stille spørsmål så skal de jo bruke jo bruke spørsmål. Hvis de vil svare så må de bruke en annen. Når dere skal svare må dere bruke en eller annen annen.
19	Student 2	Svare må.
20	Student 3	Må dere bruke en annen kategori.
21	Student 2	Må dere bruke en annen kategori.

Video transcript 2 (English translation):

Line no.	**Student**	**Dialog**
1 2	Student 2	How did they answer? Did they answer with “our explanation”?
3 4 5 6 7	Student 3	No they answered with “question”. You have been using the question-category in your answer ((reading out loud while typing on the keyboard)). This is mistaken; you should use either meta-comment (.) or something else.
8	Student 2	They are asking questions.
9 10 11	Student 3	=You are using the question-category (9) in the answers ((continues typing))
12 13 14	Student 2	Then you have to choose another category (.) or to do that you have to choose another category. If you want to ask question you have to select.
15 16 17 18	Student 3	If they want to ask questions then they must use question. If they want to answer then they have to use another. When you’re going to answer, you have to use something else.
19	Student 2	When answering.
20	Student 3	You must use another category.
21	Student 2	Must use another category.

Appendix C: Norwegian originals of translated knowledge building forum excerpts

Knowledge building forum excerpt 1:

Norwegian original	English translation
Kategori: Vår oppfatning	**Category:** Our explanation
Tittel: Deal?	**Title:** Deal?
Tid: 11:08 2002-09-16	**Time:** 11:08 2002-09-16
[…] jah, vi har valgt:	[…] Yeah, we've chosen
2, 9 og 11 ((spørsmål å jobbe med))	2, 9 and 11 ((questions to work with))
Nå har vi spisepause..	We're off for lunch now.
Snakkez babyene mine..	Talk to you later darlings…
jammen det er greit det az, ok ok...	And yes it's really ok.

Knowledge building forum excerpt 2:

Norwegian original	English translation
Kategori: Spørsmål	**Category:** Question
Tittel: Hjelp!	**Title:** Help!
Tid: 10:50 2002-09-17	**Time:** 10:50 2002-09-17

Heysann! vi her fra sandgotna lurer på noke greier.... vi sliter litt med å egentlig skjønne helt hvor dere vil hen med dette spørsmålet--ffor , kan man genmodifisere all mat..-. det er veldoig vanskelig å få svar på dettte... derfor lurer vi på om dere kunne kanskje informere litt om akurat det.. vi har rett og slett ikke skjønt det helt...	Hey! We are wondering about something.. We are struggling with understanding where you are heading with this question. Because, "Is it possible to genetically modify all kinds of food?" is really hard to answer. That's why we are wondering if you maybe could inform us a little about this in more detail. We didn't really understand it properly.

Knowledge building forum excerpt 3:

Norwegian original	**English translation**
Kategori: Prosess-kommentar **Tittel:** Velg riktig kategori! **Tid:** 10:56 2002-09-17 Dere bruker spørsmålskategorien i svarene deres. Når dere skal svare må dere bruke en annen kategori. Helst ikke send meldinger som ikke har med det faglige å gjøre er dere snille. Dette er et faglig prosjekt.	**Category:** Meta-comment **Title**: Choose right category! **Time**: 10:56 2002-09-17 You are using the question category in your answers. When answering use another category. Please do not send messages that are not related to the task. This is a school project.

Appendix D: Columnar Parallel Transcription-form

Tape:

Logged clip name:

Sequence track mark:

Meta comments:

Video track marks	Student	Transcript of dialog	Activities	Messages posted in FLE3 (discussion log)	My comments