Complexity and deliberation in collaborative socioscientific issues (SSI) inquiry discourse

Philosophiae Doctor (PhD) Thesis

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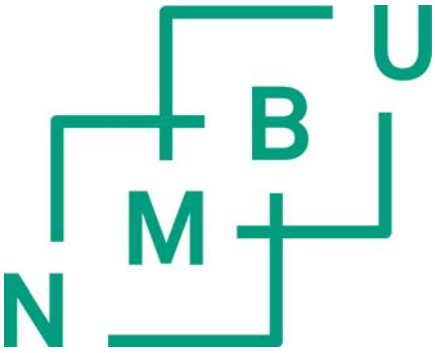

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Preface and acknowledgements

This thesis consists of three articles, reporting two case studies exploring complexity in social scientific issues (SSI) learning activities and students' argumentation and deliberation in group activity in particular. This Ph. D. thesis reports my exploration in several fields, including research in science education, language studies, rhetoric and argumentation. First and foremost it was a classroom study of 11th grade students and their teachers, whom I was given the opportunity to observe for two periods in spring 2010 and 2011. They gave me important and valuable experiences that I greatly appreciate.

Appended to this thesis are selected examples and traces of these observations. The appendixes are sequences drawn from a much greater body of empirical material, in order to illustrate how the analysis of the classroom talk was conducted, and to provide some transparency into my reasoning. The dialogue examples given in the appendixes are sequences including episodes from the second and third articles. The appendixes are further commented in section 3.7. of the following extended abstract of this thesis.

The three articles of my thesis are referred to in the extended abstract as A1, A2 and A3. A2 and A3 are accepted for publishing and A1 is in review. The three articles are provided in full text, after the extended abstract. Reference lists for the articles are according to author instructions from the publishing journals.

I want to thank the Norwegian University of Life Sciences (NMBU) (former UMB) for their financial support, and I am most grateful to all my colleagues at UMB who supported me every day during my Ph. D. period, and included me in the research group at Section for Learning and Teacher Education (SLL).

I am also grateful to the ElevForsk research group consisting of researchers and fellow Ph. D. students from NMBU, University of Bergen and University of Oslo, led by my supervisor professor Erik Knain, professor Stein Dankert Kolstø, and professor Ola Erstad, including Birgitte Bjønness, Gerd Johansen, Bente Klevenberg, Idar Mestad, Mette Synnøve Nordby: Their support and our discussions at the Finse-seminars were most important to me in developing my theoretical perspectives as well as the methodology.

The SSL vision of an Education for Sustainable Development and the project SUSTAIN led by Astrid Sinnes, gave me the opportunity to meet and discuss with Ph. D. students and reseachers from southern Africa.

Further, I also want to thank the N ATED research school community and my co-supervisor, professor Kirsti Klette. The Ph. D. student colleagues and senior researchers provided important feedback on my research and gave valuable comments on drafts for articles.

As part of my Ph. D. education I participated in courses provided by NorSEd (Nordic Science Education Network) and Rdid (The science education researcher school at the University of Oslo). During their seminars, and together with fellow Ph. D. colleagues and senior

researchers, I was given the opportunity to learn about and discuss issues of research in the science education community. This also included the field of education for sustainable development and socio scientific issues (SSI) that was particularly focused at a course in spring 2012 at the University of Iceland, School of Education, led by Allyson Mcdonald. At the NorSEd course with Phil Scott and Berit Bungum in Trondheim in spring 2011, I was given the opportunity to discuss important perspectives on science and SSI learning activities and the importance of classroom conversation and students' argumentation.

Further, you were always there when I needed to talk or had questions: Nina Arnesen, Hayley Bentham and Gudrun Jonsdottir, and my office mates Kirsti Jegstad and Snorre Nordahl.

I also want to thank university lecturer Karl Henrik Flyum at the University of Oslo for introducing me to the field of rhetoric, for important discussions on rhetorical perspectives and for challenging my sense of humor.

With the support from all of you, including family and friends, I was able to fulfill my accomplishment.

Last, but not least, I cannot fully thank my supervisor professor Erik Knain, who was always prepared to help me to proceed. Thank you for listening to my developing reasoning and giving me serious feedback and important critique in our discussions, and for giving me valuable feedback on my drafts. Further, I am most grateful for your support as co-author on two of the articles. Thank you for introducing me to the spirit and craft of research.

Oslo, June 23. 2014,

Anne Kristine Byhring

Abstract

Argumentation in science classrooms may be modeled on the practices of 'science proper', as in experimental work and inquiry learning. Consequentially, argumentation is oriented around matters of truth, or at least on matters of probability. Regarding less clear cut matters of opinion and of priorities of action, as is often the case when deliberating on socioscientific issues (SSI), neither science knowledge alone nor empirical evidence are able to provide sufficient grounds for solving the question at hand.

This Ph.D. study explores 11th grade students' oral use of textual and contextual resources: how do students handle complexity, how do they deliberate, and what happens over time in the students' collaborative sense making? The exploration of complexity and student deliberation takes as its point of departure an understanding of the multifaceted character of socioscientific issues (SSI). The framing of student argumentation in science, concerning SSI, is studied at the classroom level. The study consists of two case studies which have been reported in three articles.

In the three articles, the educational challenges of SSI are addressed. The empirical material originates from an open-inquiry student project with 11th grade students. Students chose an issue from the main curriculum area of *sustainable development* and conducted a related investigation in their local community. Finally, students submitted their group report on a wiki platform. Among the chosen topics were: hunting in Norway, transport and CO_2 emission, and forestry in Brazil.

Oral deliberation on task solving is pertinent during oral group activity. Scientific argumentation, as it is defined in this study, was scarce in these students' oral activity. Further research on teaching and student argumentation is suggested, to meet the need for supporting students' scientific argumentation, as well as argumentation and deliberation in general. It is further suggested that SSI learning situations can simulate the complexity of civic discourse, involving specific topical and more general levels of complexity. The role and potential of science education in civic education, however, is beyond the scope of this thesis.

This study provides a conceptualization of *low and high complexity*. The study also suggests a macro structure of students' deliberation, interwoven with three alternating patterns of reasoning focusing on *the content*, *the collaboration*, and the *composition* of oral and written deliberative argumentation. These components are also found to be the driving forces for sustaining complexity, inquiry, and meaning making in SSI activity. The conceptualizations of *complexity* and *deliberation* are the most important contributions of this Ph.D. study.

In *Part two* the three articles from the case studies are provided in full text in chapters 6, 7 and 8. In the first article, A1, the interplay between three levels of meaning are used to trace intertextuality and complexity in the students' collaborative reasoning. The second article, A2, further explores students' initiatives and responses within extended dialogues and identifies characteristics and functions of students' deliberation on task solving. The third

article, A3, suggests that the common ground is negotiated in the process of meaning making in the situated activity, and that it is driven by a need for decision making.

In *Part one,* the extended abstract, theoretical perspectives, the empirical material, research design and method are presented along with summaries of the articles. Finally, three issues are discussed, a theoretical issue, a design issue and an analytical issue. Theory on argumentation and deliberation, including Toulmin's argumentation pattern (TAP) formed the starting point for analysis. Analytical tools are further based on theories on language use: social functional linguistics (SFL), conversation analysis, and rhetoric.

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Part 1: Extended abstract

1 Introduction

Increasingly, a challenge and a central goal of compulsory science education has become to include issues linked to concerns on human behavior to prepare students for participation in society in a rapidly changing world. This includes both participation in democratic processes and debates and taking personal action on current societal issues. Many societal issues on the global as well as on the local level include a science dimension. Societal science-related issues, denoted socioscientific issues (SSI) in school science (Sadler, 2004) often concern the general well-being of our planet in relation to human activity in particular, an interplay between modern human lifestyle and nature. Examples are the debates about oil prospecting outside the Norwegian fjord area of Lofoten or the debate on deforestation in the rainforests of Brazil. The issue of the rainforest is one of the issues that was chosen as interesting to investigate by the 11th grade students included in the data of this thesis.

SSI strongly addresses scientific and technological knowledge as well as other domains of knowledge, such as economics, ethics, and aesthetics. Forestry affects the living conditions of the local people. Further, the biodiversity of the rainforests may relate closely to students' everyday lives on issues, for instance, regarding medical product development or health and personal welfare. SSI also include conflicts of interest, rising commercial and environmental interests, and the interests of local and indigenous people. Conflicts of interest regarding forestry occur on a local scale in Norway in public debates on the utilization of farmland for building new roads, for housing, or for developing businesses. Some of the students participating in this study chose to inquire into hunting and ethics, the law, and animal welfare. In addition to political and economic interests, there may be ethical concerns involved in SSI. Issues may be ill defined in terms of the knowledge domain. SSI tend to involve "wicked problems" (Murgatroyd, 2010) in that solutions are not true or false but rather good or bad, and several explanations may be considered. It is well known that established scientific knowledge can become problematic in dealing with such complex issues, e.g. as described in Jenkins (1994).

In this study, the term *complexity* (see A1) signifies a quality of the unfolding discourse observed, not an inherent characteristic of the issue itself. We thus focus on the complexity in students' unfolded and situated discourses, rather than the universal characteristics of any issue, or the characteristics of a specific issue. [For more on SSI, see also the introductions to Article 1 (A1) and Article 2 (A2).] Stewart (2009) emphasized the position of SSI at the intersection of the personal, the public, and the technical spheres. Information that is available from a variety of sources and meanings is negotiated in the public sphere, addressing different perspectives relative to interests, values, levels of participation, power relations, and positions.

This Ph.D. project studies empirical material from an open-inquiry student project with 11th grade students. The Ph.D. study explores students' use of textual and

contextual resources: how do students handle complexity, how do they deliberate, and what happens over time in the students' collaborative sense making?

The articles included in my thesis are referred to as A1, A2, and A3. For an overview of the articles, titles, and research questions, see section 1.2. For summaries of the articles, see chapter 4. This introduction to this extended abstract accounts for the educational challenges of socioscientific issues (SSI) that are addressed in the three articles that constitute my Ph.D. work. The empirical work providing data for the articles is briefly presented. Further, the research questions are presented, along with an overview of data collection, analytical perspectives on student conversation and deliberations at the classroom level, and a presentation of the research agenda. Analytical perspectives are elaborated on in section 2.5. Then the aims of the study and the contribution are presented. Concluding the introduction, three issues are presented that will be discussed in chapter 5. Theoretical perspectives are presented in chapter 2, and the empirical material, design, and method are presented in chapter 3. Summaries of the articles are presented in chapter 4. The three articles from the case studies are provided in full text in chapter 6, 7 and 8.

1.1 Educational challenges

SSI challenge traditional teaching approaches to science. Science as a school subject traditionally provides theory, models, and methods drawn from the field of the natural sciences, warranted by the principles of seeking truth and objectivity. Scientific models, methods, and arguments are based on rationality as adhered to in a community of informed scientists. Science and technology convey values as paradigms in science education. In the literature on science and SSI teaching, these value perspectives are addressed as school science teaching *about* science or teaching about the nature of science (NOS) (Driver, Asoko, Leach, Mortimer, & Scott, 1994; Kolstø, 2001; Ryder, 2001; Sadler, 2009). Scientific and technological knowledge plays an important part in SSI. However, science and technology participate together with a diversity of other resources, also conveying values and interests inherent in theories, models, methods, and uses of language from other domains of knowledge.

Thus, SSI confronts students with issues where established facts do not necessarily play a decisive role. Since environmental issues tend to be part nature and part society, usually embedded in ethical and political considerations (Sterling, 2001). SSI perspectives, particularly the urge to take action, for instance on environmental issues, can be in conflict with a science education focusing on the transmission of established knowledge (Hodson, 2003). The purposes of SSIs exceed scientific explanations and goals. The development of SSI literacy also includes the development of procedural skills for participation in community efforts and democratic processes. To contribute to the assessment of socioscientific reasoning (SSR), Sadler et al. (Sadler, Barab, & Scott, 2007; Sadler, Klosterman, & Topcu, 2011) defined (1) recognizing the inherent complexity, (2) analyzing an issue from multiple perspectives, (3) appreciating the need for ongoing inquiry, and (4) skepticism as important to socio-scientific reasoning (SSR). One conclusion from their classroom studies is that

conceptual tools for SSR to identify these competences need to be improved (Sadler et al., 2011, p. 72). Our investigation into complexity (see A1) takes Sadler et al.'s points 1 and 2 into account.

What competences are needed in dealing with SSI? When teaching SSI inquiry, the purpose, to a great extent, is to develop competencies that enable participation and collaboration and develop procedural skills, including inventive and critical capacities, rather than the acquisition of generalized canonical knowledge and facts. More emphasis is needed on how to enable student participation in communal efforts to contribute to knowledge development (Roth & Lee, 2004) and participation in decision-making process as citizens (Kolstø et al., 2006; Ryder, 2001). Roth and Lee (2004) argued that scientific literacy should not be thought of as properties of individual minds. Rather, scientific literacy is competency for participation.

Participation calls for *deliberation* since the participating interests and values cannot always be weighed on the same scale (Kock, 2006, 2007, 2009). When science arguments are weighed against, for instance, political, ethical, societal, and economics perspectives, communication is challenged. The ability to understand and to be understood is challenged. In science classrooms, this requires the development of discursive insight and competencies. It requires skills in comprehending and transforming a variety of science-related and other information in oral and written discourse. These insights and competencies are required to deliberate on what should count when decisions are made. *Deliberate* itself means *weighing on scales* and concerns issues attainable by actions (Kock, 2007).

In situations where scientific knowledge is a resource for handling multifaceted and often local issues of relevance to a specific community, what we may call *SSI literacy* or competency must be valued, as they are closely linked to the function and purposes of language uses and genres. Miller emphasized the rhetorical functions and purposes of *genre as a standardized social purpose* (Miller, 1994; Miller & Shepherd, 2004). Miller enhanced the role of genre conventions as legitimate and appropriate responses. The uses of genres as procedural skills frame collaborative sense making. Genres are social action and may thus also facilitate decision making in a community of discourse, such as a science community.

The exploration of complexity (see A1) and student deliberation (see A2) in this study takes its point of departure from the multifaceted character of SSI. However, what counts as attainable at school? At school, perhaps student deliberations primarily concern decisions on the classroom level in the context of a given assignment. In A3, we elaborate on the situated common ground for students' deliberation based on the framing of argumentation in science and SSI at the classroom level (for more on *common ground*, see 1.3.1 and 2.5.2, and also related material in 2.2.2, and 2.2.3).

1.2 A brief history of ElevForsk on Midtby

An interdisciplinary student project among 11th grade general-track students provided data for the articles comprising this thesis. The student project took place in 2008, 2009, 2010, and

2011 and was part of ElevForsk, "Students as Researchers in Science Education" (StudentResearch), an action research project funded by the Norwegian Research Council (grant 182875/S20) as a collaboration between the Norwegian University of Life Sciences (UMB), the University of Bergen (UIB), and the University of Oslo (UIO) (Knain & Kolstø, 2011). 2010 was the first year that I participated in the fieldwork and in the teacher-researcher group at Midtby. The Ph.D. study was funded by UMB, and I am grateful to have been invited as a member into the ElevForsk group and the teacher-researcher group at the Midtby school, an upper secondary school north of Oslo.

The primary goals of the overall ElevForsk action research project were to develop students' and teachers' inquiry learning approaches (for more, see section 3.1). The project addressed inquiry and literacy in accordance with the Norwegian curriculum Knowledge Promotion of 2006 focusing on basic skills in reading, oral activity, writing, numeracy, and in using digital tools. In the action research project at Midtby, SSI inquiry was particularly addressed connected to developing teaching and learning in the main curriculum area in the Norwegian science curriculum for upper secondary school, *sustainable development*. During 2011, the students were required to relate the issue and the investigation to *conflicts of interest*. (for more on the background and aims of the study, see section 1.4 and 1.5)

The action research project was initiated by a science teacher at Midtby in collaboration with my supervisor professor, Erik Knain, and their collaborative work became part of the ElevForsk project. At Midtby, the project was named the "wiki project" since a focus from the start was on developing teaching approaches with the use of a wiki tool. The innovation initiative was interdisciplinary. Teachers in social and natural science and Norwegian (native language) were invited to participate. During the three first years of the ElevForsk project at Midtby, teachers in all three subjects participated. During the fourth year, teachers in Norwegian and science participated. The teachers collaborated in supervising the students for four to six weeks during four to five lessons a week (45-minute lessons).

Students chose a topic, formulated a question on an issue that was interesting to them, and conducted an investigation in their local community based on the question. In addition to reading about the topic in textbooks and on the Internet, they either made a questionnaire or interview schedule, which they used to collect data from community members, politicians, professionals or people from organizations, or simply their peers and parents. The students investigated their issue and people's interests and involvement in or attitudes toward the issue. Finally, they submitted their group report on a wiki platform according to instructional guidelines and assessment criteria available on the wiki platform.

On the part of the teachers, the planning and development of this interdisciplinary student project had to fit into existing practices and school planning routines. On the part of the researchers, theoretical perspectives from inquiry learning and perspectives on scientific literacy development were provided (Duschl & Grandy, 2008; Scardemalia, 2002; Scardemalia & Bereiter, 2006; Wallace, 2004). The teacher-researcher group collaborated in developing the interdisciplinary student project. The aim of the teacher-researcher group was

to provide students with a learning environment with opportunities to be exposed to diverse authenticities and multiple discourses and to collaborate on knowledge building and meaning making in discussion groups (Wallace, 2004) (for more on the relation between the Ph. D. study and ElevForsk, see section 3.3 and 3.4).

1.3 Research questions and overview of articles and results

The first article (A1) is in review in *Research in Science Education* and titled "Intertextuality for Handling Complex Environmental Issues." The authors are Anne Kristine Byhring and Erik Knain. The research question is as follows: How do students construe complexity in SSI? Three sub-questions are answered: What language resources are important for analyzing complexity in students' discourses associated with SSI? How are these resources realized in discourses differing in degree of complexity? How can learning situations be designed to sustain high-complexity discourses?

The second article (A2) is accepted for publication in *Journal of Argumentation in Context* and titled "Characteristics and Functions of Sixteen-year-old Students' Collaborative Deliberation When Working with Socioscientific Inquiry Assignments." The author is Anne Kristine Byhring. The research question is as follows: What are the characteristics and functions of students' deliberation during inquiry into a socioscientific issue? Two sub-questions are answered: What kinds of perspectives and approaches are prevalent during group activity and for what purposes? How are decisions reached during the developing SSI project work in dialogic events, across events, and across lessons?

The third article (A3) is accepted for publication in *Nordina* and titled "Framing Student Dialogue and Argumentation: Content Knowledge Development and Procedural Knowing in SSI Inquiry Group Work. The authors are Anne Kristine Byhring and Erik Knain. The research question is as follows: How can SSI inquiry dialogues make space for both content knowledge development and the capacity and capability for deliberation and decision making?

In the articles, three different educational aspects of student reasoning are addressed. The articles are three separate analytical contributions that explore the same concerns in the sense that they share a focus on student conversation and collaborative reasoning and argumentation in SSI inquiry group work. In A1, it is explored how students construe complexity in SSI, their transformation of knowledge, and the use of intertextuality. The students' oral reasoning on content as well as interpersonal and textual aspects are traced. The result is a differentiation between situations of "high" and "low" complexity and an understanding of complexity as construed from the contextual and situated interplay of content and composition. Further, instructional strategies prove important to sustain complexity. In A2 and A3, the focus is on oral deliberative argumentation. In A2, the warranting of students' oral reasoning and deliberation is identified. The relevance of arguments is linked to the situated common ground (see 1.3.1) of the conversation. An emerging conceptual understanding of the macro structure of students' deliberation on task solving is presented.

The macro structure consists of students' alternation between different patterns of reasoning relative to developing *the content*, *the collaboration*, and *the composition*. A3 suggests framing of student conversation and argumentation according to different educational purposes. Thus, the situated common ground on the classroom level may be framed either to focus on scientific argumentation and conceptual development or on the development of more general deliberative skills associated with civic engagement. It is suggested that the development of deliberative skills support SSI inquiry processes as well as the development of competences for civic engagement. (For more on the articles, see chapter 4.)

1.3.1 Research agenda, data collection, and emerging analytical considerations — an overview

The research agenda of this study was to identify situated and contextual premises in SSI inquiry tasks, and to describe how students handle complexity. Further, it was to identify the characteristics and functions of deliberation by examining language uses in conversations during SSI inquiry across events and lessons.

The design of data collection for this Ph.D. case study was framed within an action research project at the Midtby school. 11th grade students' conversation and reasoning during SSI inquiry constitute the object of study (see 2.5.5). When I entered the fieldwork at Midtby, data had already been collected for the first two years (providing data for A1). Data collection during my first year of fieldwork was considered a pilot for the design of the data collection for the fourth year (providing data for A2 and A3). (For further details on the relation between the Ph. D. project and ElevForsk see 3.3 and 3.4. and more on the empirical cases of the Ph. D. project, see section 3.5.)

During the analysis, the dialogues were listened to, transcribed, and read through several times. The coding and categories were developed through analytical induction (Erickson, 2012). (See the articles for details on the analysis in each case study.) Perspectives from systemic functional linguistic (SFL), conversation analysis, and rhetoric provided analytical tools for interpreting the conversations and the emerging understanding of complexity and the students' deliberations (for more on analytical tools, see section 2.5). The discourse is analyzed on the classroom level and in the context of the assignment given within the student project of ElevForsk (see further details on empirical cases in section 3.5).

In the following paragraphs, some considerations on the analyses of student argumentation are presented concerning warranting and reconstruction (for more on analytical tools see section 2.5). The approach to argumentation in this study differs from many studies on argumentation in science education. Many studies have used argumentation models and schemes. For instance, Toulmin's argumentation pattern (TAP) was used by Erduran, Simon, and Osborne (2004) and by many others, as referred to by Osborne (2010) in his summary of the main features of the body of research on argumentation in science education (for more on TAP, see section 2.2.2). TAP can account for analysis from sentence to sentence, but it cannot provide sufficient analysis across events and lessons unless the text is heavily reconstructed, implying inferences of implicit meanings.

In TAP, the link between a claim and the data presented is conceptualized as the *warrant.* The concept of *warrant* is a key term: "rules, principles, interference-licences" (Toulmin, 2003, p. 91). The warrant is usually implicit. The warrant in TAP was a starting point for my analysis. In the analysis of data across events and lessons, there was a need to address the criteria for the relevance of warrants and how warrants develop across events and lessons. Argumentation schemes (Walton, 1996; Walton, Reed, & Macagno, 2008) are also commonly used in the analysis of student argumentation. Schemes address implicit premises and warrants. Like Toulmin's TAP model, the schemes may serve analysis as well as the teaching of argumentation, as, for instance, in Macagno and Konstantinidou's (2012) study. Likewise, recent pragma-dialectic models aim at explaining argumentation and deliberation within the dialectical frame. Topical choices, audience, and presentation awareness interplay in *strategic maneuvering* (van Eemeren, 2013). Schemes, to a great extent, may reconstruct the lines of reasoning and thus address the topical resources. The application of TAP, argumentation schemes, and strategic maneuvering models would imply reconstruction.

However, for the purposes of this study, reconstruction became very difficult without assuming empirical material that was actually not collected (for instance, what the students might have talked about "off the record" as well as their prior knowledge, family background, personal experiences, socio-economic details, and so forth). Adding assumed information could soon disturb the integrity of these empirical data.

On the other hand, implicit premises are common in conversations. We presuppose a lot. The term *situated common ground* is used here to conceptualize the implicit presuppositions of oral speech. The notion of common ground (Clark & Schaefer, 1989; Svennevig, 1999) involves implicit sources. The interlocutors construe utterances and provide legitimate language uses based on the common ground. The common ground of the discourse is a matter of context-dependent and situated negotiation on language use in expert panels, in politics, and in public debates (Svennevig, 1999), as well as in science classrooms. Students' language uses convey the warrants for their arguments (for more on warrants, see section 2.2.2, and for more on common ground, section 2.5.2, and related material in 2.2.3).

1.4 Background

Teachers have experienced problems with teaching argumentation (Osborne, 2010; Øgreid & Hertzberg, 2009). Argumentation in science education has been focused to a great extent nationally as well as internationally. A point of departure for the emergence of research questions in this thesis is the attention on argumentation in Norwegian classrooms in general, such as in the Norwegian KAL study evaluating the final assessment of lower secondary school at the end of grade ten. KAL is a Norwegian curriculum evaluation project: "Quality Assurance of Learning Outcome in Written Norwegian" (Kvalitetssikring av læringsutbytte i norsk skriftlig). KAL concluded that argumentation was scarce in writing instruction and showed that Norwegian students struggled with these kind of texts (Berge, Evensen, Hertzberg, & Vagle, 2005). Further, the Norwegian part of the Programme for International Student Assessment (PISA) study that focused particularly on science education in 2006

revealed a need to focus on skills in argumentation (Kjærnsli, Lie, Olsen, & Roe, 2007). Norwegian students' scores on the competence to be *able to use scientific evidence* proved insufficient, according to the PISA results. On the other hand, Norwegian lower and upper secondary students were assessed as well above average in performing democratic skills in the Norwegian part of the international quantitative study CIVIC Education Study (University of Oslo, Department of Teacher Education and School Research, 2002) and in the following International Civic and Citizenship Education (ICCS) 2009 study (IEA: ICCS, 2009). Norwegian classrooms are talkative, and Norwegian students are encouraged to be individual thinkers (Klette, 2004). Later classroom studies indicated that the Norwegian school system encourages students to be individual workers. The initiation-response-evaluation/follow up (IRE/F) pattern for classroom communication (Mehan, 1979) is dialogic and interactive. On the other hand, a high degree of individual seatwork means that the classroom as an oral and public communicative space is reduced (Calgren, Klette, Mýrdal, Schnack, & Simola, 2006). While Norwegian students perform above average concerning democratic skills, the Norwegian organization of learning environments at the same time seems to involve less oral plenary activity.

Moreover, as a Norwegian context for the contribution from this study, I want to mention three Norwegian classroom research studies. Mork (2006) in her study of SSI discussions explored the qualities of and further developed a Web-based learning material, the Viten program. Acknowledging that teachers need appropriate instructional strategies to promote argumentation, Mork identified content-specific as well as interactional aspects of whole-class discussions and the corresponding responses from the teacher: challenging the correctness of content, extending the range of a topic, getting the debate back on track, keeping the debate alive, involving more students, and focusing on debate technique. Mork's study addressed students' reasoning efforts to understand SSI content, the interactional and procedural aspects of student discussions, and instructional strategies to student argumentation.

Furberg (2009) in her studies on scientific inquiry in Web-based learning environments accounted for findings involving student dialogues on a socioscientific issue on genes. The complexity of SSI was challenging for students to handle. The tension between different foci extended the discussion and explicit sense making. However, in their final written work, the students extensively relied on familiar factual textbook genres and copy-and-paste strategies. Instructional strategies and teacher interventions addressing epistemic, interactional, and institutional concerns are thought to be necessary to support students' scientific content knowledge development. This includes facilitating discussions and guidance on how to solve a task, as well as assessment criteria.

The combination of basic skills and science inquiry among primary school children was addressed by Haug (2013) as part of the Norwegian Budding Science and Literacy project. A result from Haug is that conceptual learning in science inquiry depended on the teacher's awareness of critical moments for consolidation to create opportunities for discussion and further learning and theoretical understanding.

Results from PISA, KAL, CIVIC, ICCS, and Norwegian classroom studies have indicated that instructional strategies and the framing of learning environments promoting student talk, dialog, and argumentation are requested. The CIVIC and ICCS results are particularly interesting since they may indicate capacities and capabilities for arguing skills that are necessary for a certain level of reflection, in contrast to mere reproductive learning.

In the three studies mentioned (Furberg, 2009; Haug, 2013; Mork, 2006), argumentation is acknowledged as crucial among scientific literacy competencies and as a pertinent feature of the nature of science (NOS). The findings in the three studies are, to a great extent, confirmed in this Ph.D. study. However, scientific argumentation does not provide sufficient grounds for sorting out the questions at hand in SSI inquiry. My choice of theoretical perspectives and analytical tools has taken this challenge into account. This thesis particularly focuses on how SSI inquiry comprises multi-faceted perspectives and purposes (including societal, ethical, and political perspectives), which calls for the development of an awareness of, in particular, the complexity and multiple voices involved in SSI.

Within the Norwegian research in science education community, Sjøberg has conducted prominent research on pedagogical content knowledge development in science education (naturfagdidaktikk), particularly on scientific literacy (Naturfag som almenndannelse) (Sjøberg, 2002, 2009) and not least together with Schreiner on children and youth interest in science and science-in-society issues, the ROSE project—The Relevance of Science (Schreiner & Sjøberg, 2004; Schreiner, 2006). Sjøberg's work was an important inspiration and point of departure for my interest in SSI teaching and learning (Byhring, 2007, Byhring & Knain, 2009).

1.5 Aims

This study intended to explore and analyze 11th grade students' dialogues in group activity during SSI inquiry. In Knowledge Promotion (Kunnskapsløftet) (Kunnskapsdepartementet 2013), among the overall objectives of the science curriculum, we could read the following:

> Natural science shall also help children and young persons attain knowledge and form attitudes that will give them a considered view of the interaction between nature, individuals, technology, society and research. This is important for the possibilities the individual has to understand various types of natural science and technological information and shall give one the basis for participation in democratic processes in society (Utdanningsdirektoratet 2013).

Moreover, argumentation was described in the curriculum as an important part of science learning. On the main curriculum area of *sustainable development* (SD), an objective (competence aim) was that students should be able to "select and describe some global conflicts of interest and assess the consequences these might have for the local population and the global community." The wording of the competence aims were later revised and and now reads: "The aims of the studies are to enable pupils to investigate a global conflict of interests related to an environmental question and discuss and elaborate on the quality of arguments and conclusions in a forum of debate" (Utdanningsdirektoratet 2014). In both these texts, and

even more in the newest version, the science-society interface enhances the need for instructional strategies addressing more general skills in argumentation and students' capabilities and capacities to engage in societal issues related to local or everyday considerations. In addition to skills in scientific argumentation, skills in decision making are required. Decision making concerns the choices of actions to be taken on issues as diverse as, for example, local consumer-related issues or issues related to the debate on climate change. This also strongly concerns a link to civic education and the goal of developing critical skills and capabilities for participation in the public debate.

Zeidler and Sadler (2008) addressed the exigency of moral education related to SSI on the level of the individual student. On the communal level, the emphasis on SD in the Norwegian curriculum addresses purpose and action. The SD perspective in the curriculum builds on political and societal attitudes developed as a consequence of the work of the World Commission on Environment and Development (WCED), the Brundtland Commission from 1987. SD in my thesis relates to the main science curriculum area in upper secondary school in Norway. That makes exigent and justifies a need for considerations on pedagogical content knowledge development on SSI and teaching approaches to argumentation, deliberation, and collaborative decision making in SSI inquiry discourse.

Simenneaux and Simenneaux (2012) introduced acuteness to the SD perspective on science education through the notion of Questiones Socialement Vive [Socially Acute Questions (SAQ) in English] used in the French-speaking science education community. Simenneaux and Simenneaux (2012) noted that the notion of SD is surrounded by controversies. For the purpose and context of my study, SD may be viewed as a kind of responsibility program, a term that expresses an extended understanding of environmental concerns, addressing the urge to take action within a limited time space.

As a consequence, an aim of the study became to describe students' literacy practices to provide a better understanding of what happens during collaborative reasoning in SSI inquiry and to conceptualize tools for the further development of students' skills in argumentation. Another aim was to contribute to the development of teaching approaches and instructional strategies in the field of teacher education for sustainable development, a focus area of the teacher training program at the University of Life Sciences. The contribution concerns students' need for scaffolding on argumentation as procedural knowledge relevant to SSI inquiry.

Moreover, there is an aim to contribute to research by providing analytical tools that enhance deliberative aspects of oral reasoning and argumentation. The study aims at identifying characteristics and functions of students' collaborative deliberation on complex issues related to SD and SSI. This is in line with Bricker and Bell's (2008) suggestion that teaching approaches may capitalize on the everyday talk and practices that students bring with them to formal instructional moments.

In studies on argumentation in science education, reasons for developing students' argumentation skills have been that a) argumentation is an important feature of the disciplines

of science, often termed the nature of science (NOS); b) argumentation is important to develop skills and capabilities for higher-order thinking; and c) argumentation is needed to handle socioscientific issues and to participate as scientifically literate in democratic processes as citizens (Tiberghien, 2008). A common assumption is that argumentation is an essential part of the process of learning. Hence, the development of students' competences and skills in argumentation are viewed as central to developing scientific literacy related to the curriculum goals of science proper as well as to the goals of educating students to be participants in a democratic society.

1.5.1 Deliberation, collaboration, and emerging decision making

With a point of departure in complex SSI issues, the focus of my research interest in student argumentation became the students' deliberation and choices of actions.

An aim became to describe and explore the distinction between students' scientific and socioscientific argumentation. This distinction is discussed in the science education literature (Kolstø, 2001; Kolstø & Ratcliffe, 2008). These studies promote to a great extent the relevance of scientific dialectic argumentation in SSI contexts. However, deliberation in the rhetorical sense (Kock & Villadsen, 2012) aimed at decision making and civic action based on legitimate dissensus (Kock, 2007) (see section 2.1) is not an issue in these studies.

An assertion emerged during the hermeneutic process of reading and listening to the material at hand that students' oral deliberation during SSI inquiry was characterized by an alternation between different patterns of reasoning. Their way of handling choices of action first concerned situational and contextual purposes. They deliberated on how to understand content, on how to collaborate on inquiry, and on composing a piece of written work rather than reasoning on and providing justification on knowledge claims. Their resulting text, comprising traces of these oral deliberations, also provided justification to some extent on scientific knowledge claims as well as societal and ethical considerations and opinions (see A1 and A2). In A1, multiple analytical approaches were used (see section 1.2.1 and section 2.5). As accounted for in section 1.3.1, an understanding emerged through analysis that the data collected through the qualitative research design did not fit as well as expected into neat explanations. Based on literature on studies of argumentation in science classrooms, from the start, it was asserted by the teacher-researcher group that available analytical tools, such as TAP or Walton's schemes, would be suitable (Toulmin, 2003; Walton, 1996; Walton et al., 2008).

The teacher-researcher group of the ElevForsk action research project expected that students' scientific argumentation in group activity would be fostered during SSI inquiry activity and collaborative writing. However, it showed that reality was somewhat different. The description of what was going on during group activity became much more complex than expected; theory and practices did not fit; map and topology were diverging. Consequently, due to a mismatch between intention and practice, the theoretical approaches had to be broader and changed, and they became pluralistic to try to capture what was happening.

Even if the resulting analytical approaches could be described as fragmented, a consequence is that this Ph.D. study is a documentation of an important kind of mismatch. Acknowledging that the study has not succeeded in developing a fully satisfying and comprehensive explanatory model, a preliminary working model of a macro-structure of oral deliberation is suggested. Moreover, further research and refinement in later studies are suggested. The study elaborates on students' deliberation during the process of inquiry. Further, the study conceptualizes analytical approaches to an emerging understanding of oral practices as an alternation between patterns of reasoning on content, collaboration, and composition. The patterns of reasoning were identified to parallel the Aristotelian meta terms of *theoria*, *praxis*, and *poeisis*.

The statement that argumentation and deliberation as expected by teachers and researchers was not found or fostered during the inquiry activity may be explained in two different ways: either 1) there was something wrong with the students' ways of reasoning and talking during SSI inquiry or 2) there was something wrong with the teachers and the researchers' expectations. I prefer alternative number two.

The teachers confirmed in interviews that working with argumentation in science and SSI is difficult. That was why they were looking for better ways of framing and modeling argumentation and developing their instructional practices. Perhaps there is not much wrong with the teachers after all. Regarding research on student argumentation, the analytical tools may still need elaboration and nuancing to capture capacities and capabilities as well as constraints.

1.6 Contributions

Consequently, the study shows that students' and teachers' argumentative and deliberative practices in the science classroom are complex and dynamic. The study suggests that deliberative competencies on task solving in SSI parallel civic competencies on decision making. There is a need for robust, varied, and pluralistic instructional strategies and learning environments to promote SSI inquiry, including a methodology for developing students' argumentation and deliberation in speech and writing. Further, the framing of dialogues and argumentation could be explored more closely concerning the prospect of recreating in the classroom the process of scientific exploration and inquiry (Knain & Flyum, 2003) and connecting it more closely to scientific content development to frame appropriate learning environments for SSI inquiry. An interesting question is how teachers may develop approaches to deliberation as procedural knowing (see section 2.1.2 on *knowing*).

A model of deliberation in SSI is suggested, in A2, based on students' handling of alternating purposes in different phases of the inquiry processes. Hence, teacher education should support the development of more relevant competencies for teachers on argumentation and deliberation in SSI. The study prepares for future research questions, for instance to compare different teachers' development of relevant competencies over time or teachers' competencies relative to student outcome. Beginners and experienced teachers diverging in teaching

approaches and framing of learning environments could be studied in case studies, in intervention studies, or in action research studies to map and develop practices and perspectives on dialogue, deliberation, and argumentation in general.

One example of further research is our continued exploration of students' development of SSI literacy competencies in a recent case study of educational resources within the project Ark & App (Knain, Byhring & Nordby 2014). Students engaged in decision making in a pedagogical single player simulation game on environmental issues and energy supply. The teacher orchestrated a diversity of available resources: work sheets, web resources, and the textbook in addition to the simulator game. Results from my Ph. D. study can be used to further explore to what extent the teacher's interventions and teaching strategies supported students' argumentation and facilitated a space for students' engagement in talk about their decisions during activity.

A contribution of this Ph.D. study is to identify specific characteristics of high and low complexity (A1), and to suggest analytical perspectives on the macro structure of students' deliberation on task solving, drawing on Aristotelian meta terms and rhetorical perspectives (A2). Further, a framework for analyzing how students handle situated complexity is suggested (A1). Furthermore, the framing of student argumentation relative to a situated common ground is addressed (A3), in particular concerning the divide between argumentation in science content knowledge development and the more general deliberative skills associated with civic engagement. The evident potential and significance of science education in civic education, however, is beyond the scope of this Ph. D. project.

1.7 Summing up the introduction

To sum up the introduction, I wish to conclude with some issues that will be examined in the following chapters. These three issues are up for a final discussion in chapter 5:

> *A theoretical issue:* In what sense can an alternation between different patterns of reasoning count as deliberative argumentation in SSI inquiry?
>
> *A design issue:* How does the case study design provide reliable and relevant data to answer the research questions?
>
> *An analytical issue:* Do the analytical tools account for data and findings and provide transparency and validity on *complexity* and *deliberative argumentation*?

2 Theory

The format and word limits of journal articles imply that in-depth theoretical and analytical arguments cannot be the subject of extended discussion. Hence, in this chapter, relevant theories addressing theoretical and conceptual issues are presented and analytical issues are elaborated on.

I will, in particular, situate the study in the context of theory on argumentation and deliberation (2.1) and present a background for my emerging understanding of the students' deliberation on task solving, that is presented in this thesis (2.1.1 and 2.1.2). I will give a brief historical overview of theory on argumentation (see 2.2 with sub-sections), including an account of Toulmin's argumentation pattern (TAP) and his work on practical argumentation. I will connect my analytical perspectives to modern theories on language uses as well as to rhetoric and philosophy. Moreover, perspectives on argumentation from studies in science education are presented to contextualize my study further (2.3). In section 2.4, argumentation in learning activities is linked to a sociocultural perspective on learning, acknowledging the situated, social, and reciprocal nature of language uses. Section 2.5 accounts for the development of theoretical perspectives and analytical tools drawn from systemic functional linguistic (SFL) and conversation analysis (CA) and how these tools have been used in this study to identify students' rhetorical and argumentative ways of connecting to the *common ground* (for more on common ground see section 1.3.1 and also section 2.5.2, and also related material in 2.2.2, and 2.2.3 in this chapter).

This presentation of theory is not meant to be exhaustive. The theoretical perspectives from literature are presented to enhance the understanding of deliberative argumentation employed. This implies that theoretical and analytical problems need to be accounted for and discussed.

2.1 Deliberative argumentation

My research interest primarily concerns deliberative argumentation in science education, particularly on SSI inquiry. Argumentation is viewed as a crucial procedural feature of science inquiry, as phrased by Driver, Newton, and Osborne (2000): "observation and experiment are not the bedrock upon which science is built; rather they are handmaidens to the rational activity of constituting knowledge claims through argument" (p. 297).

The understanding of argumentation in this thesis follows Andrews (2010) in that "we will want to maintain the critical aspect of argument that distinguishes it from discussion or conversation" (p. 3). Argument, whether in speech, writing or other modes, is *discussion with edge*. Andrews characterized argumentation as neither a genre in itself nor a mode of communication but "rather the result of a disposition toward the rational, toward exploring the nature of difference." (p. 11). What matters is distinction. Of course, we should not exclude evidence as justification. However, in the analysis of this study, *distinction* and *difference* will be more important to identify patterns and features of argumentation. Andrews further addressed the multimodal character of argumentation, the fact that arguments can take many forms. Other modalities than the oral and written may position statements and suggest arguments through persuasive features. The persuasive character of, for instance, the visual mode may create non-verbal tension in verbal modalities. In this study, the focus is primarily on verbal and in particular on oral deliberation, while acknowledging the implicit arguments (often unspoken) that are visual and action-based (gestures, for instance). In this study, it is suggested that alternation between levels of activity in inquiry may function in much the same way as alternation between modalities. Students' alternating foci in initiatives and responses

provide an interplay between utterances with the purpose of understanding the content, of collaborating and making decisions, and of composing a written text. The alternating patterns of reasoning create difference and "edge" (Andrews 2010, p. 3) during ongoing inquiry activity.

Kock (2007) used the notion of *legitimate dissensus* to distinguish rhetorical argumentation and deliberation from dialectical argumentation and emphasized that deliberative argumentation aims at the persuasion of a majority from different positions. Kock's understanding of deliberation implies that legitimate disagreement is more common than seeking truth or reaching consensus. Deliberation concerns issues of action (Kock, 2007, 2009). Taking opposing positions and different perspectives are particularly relevant to SSI and action in the societal and political domains. Deliberation involves matters that are viewed differently among people; it requires reasoning about matters that are not easily weighed on the same scale (Kock, 2007). Kock and Villadsen (2012) looked back to Aristotle as the first major thinker to connect deliberation and citizenship in his political, ethical, and rhetorical thought. Rhetoric and deliberation can provide tools for practicing citizenship in a modern democracy: "If we are to connect these two ideas, citizenship and deliberation, and reflect constructively on their meaning in present-day democracy, then we should talk not only about rights and freedoms but also about rhetoric" (Kock &Villadsen, 2012, p. 2).

In Kock and Villadsen's words, "Rhetoric is deliberation in public about communal choice" (p. 2). According to Aristotle, rhetoric is "to deal with things about which we deliberate, but for which we have no systematic rules" (*Rhetoric*, 1357a). What counts as an argument concerns the *exigency* for decisions to be made in an ongoing activity. The exigency is construed according to the situated and negotiated common ground among the participants. A focus on *deliberation* as functional, purposive, and addressing *choices of action* became necessary. Deliberation regards what is *desirable* and *good* or *bad* rather than what is *true* and *right* or *false* (Kock, 2006, 2007, 2009).

2.1.1 Function and purpose of language uses in deliberation

11th grade students, like those studied here, possess capacities, capabilities, and skills in argumentation from earlier educational experiences as well as from their reasoning in everyday life. They reason and use inferring and persuasive skills in all kinds of decision making that they are involved in. Their language conveys individual and social agency. In written text, the relationship between individual choices and social needs is connected by genre. "In its representation of and intervention in space-time, genre becomes a determinant of rhetorical kairos—a means by which we define a situation in space-time, and the opportunities it holds" (Miller, 1994b, p. 71). Moreover, the conventions of oral speech is influenced to a great extent by writing conventions and genres, and there are typified and institutionalized ways of choosing oral wording that resembles genre conventions. Concerning orality, Fafner (2011) emphasized that our culture is one of the written word (p. 65). The recurrent social needs or exigencies in different contexts and situations draw on topical structures or constraints and available resources. Hence, even if language in speech is flexible and dynamic and negotiated from moment to moment in the situation, language also

conveys genre features that provide stability depending on personal, institutional, and cultural capacities and capabilities.

In A1 and A2, excerpts from dialogues show how the students positioned themselves through initiatives and responses as a way of construing complexity and exploring alternatives. The exigency to speak or act occurred primarily relative to the fulfillment of the assignment given, and statements were warranted primarily in the students' ongoing schooling activities. To shed light on these students' argumentation patterns, the perception of what counts as argumentation in the science education literature had to be questioned.

What counts and the legitimate language uses in a science lesson can differ from what counts in an SSI inquiry lesson. Roberts (2007, 2011) discussed how curriculum goals, including the science-society interface differ in important ways from the curriculum goals of science subjects as traditionally taught. Relating students' scientific literacy development to the science in society debate, Roberts (2011) was lent a helping hand from Aristotle to draw the functional and purposive distinction between educational goals on science proper and educational goals on SSI. Aristotle (*Nichomachean Ethics*) differentiated between three domains of knowing: *theoria* is to be theoretically aware and sensitive, to see and understand; *poeisis* is to produce; and *praxis* is to act as an important feature of human nature.

In distinguishing between Visions 1 and 2 of scientific literacy, Roberts emphasized the difference between thinking patterns when science proper provides a common ground in Vision 1 and when science in society provides a common ground in Vision 2. Three patterns of reasoning are viewed as crucial to handle Vision 2. Vision 2 includes SSI education. Vision 1 is rooted in the discipline of science itself and focuses on theoretical reasoning. Vision 2 is rooted in the perspective that science plays a role in human affairs. Roberts related Vision 2 to the interplay between three different patterns of reasoning: theoretical (to understand), technological (to craft,), and practical (to make decisions). Roberts perceived all three patterns of reasoning as necessary to handle SSI. Vision 1 aims at theoretical understanding, that is, at enculturating students into the science community, whereas Vision 2 aims at developing students' capacities to use and evaluate scientific knowledge and technological problem solving in personal and public decision making.

Hence, it is suggested in this study that the Aristotelian meta terms may be traced in the warranting lines of reasoning in deliberative literacy practices. Remembering that deliberation concerns things that cannot be weighed on the same scale and what is desirable and good or bad (Kock, 2009), the deliberative decision making may serve other purposes and hence require different capabilities and competencies than a truth-seeking argumentative discourse. Roberts' suggestion of incorporating interplay of understanding, crafting, and decision making in SSI literacy can inform SSI inquiry and instructional strategies on students' deliberative argumentation.

2.1.2 Knowing

Merete Ligaard (2012) in her work on developing students' writing competences through the five-paragraph essay analyzed classroom situations, students' written work, and interviews.

Describing the process of transforming texts and collaborative learning experiences into written material, she referred to George Hillock's (1986) distinction between four types of knowledge: *declarative knowledge* is knowledge of "what," and *procedural knowledge* helps the writer to *do* something and *use* the declarative knowledge. Hillock defined three types of writing knowledge: 1) declarative knowledge on content, 2) procedural knowledge on content, 3) declarative knowledge on composition, and 4) procedural knowledge on composition. "Declarative knowledge allows us to identify phenomena and to name or recall information stored in memory. By contrast, procedural knowledge comprises the ability to produce, transform, or instantiate that knowledge" (Hillock, 1986, p. 72). Against this background, argumentation may be viewed as procedural knowledge. This perspective is interesting to have in mind to identify the transformation from oral argumentation in the resulting written text.

The term *procedural knowing* is used here to emphasize knowledge viewed as communal capabilities for proper action and procedure, as distinguished from knowledge seen as capabilities possessed independently by individuals. This article-based thesis incorporates three journal articles, and all of them are supported by a view of *argumentation as procedural knowing*. The *complexity* of Roberts' Vision 2 of scientific literacy and the deliberative multi-layered procedural knowing on content and on composition (Hillock, 1986) is construed by the *intertextual* interplay of the students' positioning in the discourse and resources in language for making ideas present (see A1). *Deliberation* in SSI inquiry is traced in student dialogues as the students' alternation of foci in initiatives and responses (A2). The students' positioning through taking different perspectives in the dialogues is suggested to parallel Roberts' different patterns of reasoning in Vision 2 of scientific literacy. This form of knowing concerns how to solve a task properly in a specific context.

2.2 Argumentation, rhetoric, language

Theories on argumentation have been developed at the intersection of different disciplines and shifting concerns throughout the history of western civilization. The reciprocal deliberative relation between citizen participation and expert knowledge contribution in civic debates has developed over time, and we know this as civic practice and democracy.

Theories on argumentation originate from ancient Greece. Aristotle's work on rhetoric and Plato's work on dialectical philosophy are topical landmarks or starting points for argumentative procedures. It is worth noting that Aristotle and Plato are two starting points. Hence, the theory on argumentation has been developed closely related to the interplay of rhetorical civic justification and philosophical dialectic trial. Moreover, theory on argumentation is closely connected to the development of theories on language uses and linguistics in modern times, concerning formal logic as well as informal and practical logic and reasoning.

Aristotle was the first to write systematically about the art of persuasion, in his work titled *Rhetoric*. Further, through his notion of the syllogism, he also invented the first concepts that

later became a fundamental principle of the science of logic. Argumentation theory was developed from the field of philosophy, driven by the goal of finding the grounds for claims (logical and factual) of a possible universal system of knowledge. This was based on Aristotle's syllogism and philosophy and the idealism of Plato and later Kant. However, the field of argumentation theory has broadened. It has been influenced by pragmatism and the linguistic turn. With or without empirical evidence as a requirement for establishing knowledge claims and drawing conclusions, theory on argumentation has developed in a wide range of fields as theories on informal logic and reasoning. Many of these theories focus on the substantial social grounds as a basis for constructing and adherence to knowledge claims. Hence, they do not focus so much on argumentation as on an analytical system. This does not mean that argumentation could be non-logical or anti-logical but that logical coherence relates to criteria of relevance in the actual community of discourse. For instance, in the resent research tradition of pragma-dialectic, the relation between rhetoric and dialectic is discussed under the term *strategic maneuvering* (Eemeren, 2013). The main aim of pragma-dialectic is to achieve consensual conflict resolution by way of critical discussion. However, strategic maneuvering is subordinate to ideal syllogistic rationality.

The so-called linguistic turn, at the start of last century, brought considerations on rhetoric practices back into the field of philosophical research. With his New Rhetoric, Chaïm Perelman (Perelman & Obrechts-Tyteca, 2008) became central in the renewal and transformation of a then-nearly forgotten classical discipline of rhetoric (Rosengren, 2006). The linguistic turn was a turn away from a positivist view. However, the linguistic turn at the same time opened up not in particular for a renewal of rhetoric or theory on argumentation but for several modern theories of language and discourse, not all of them acknowledging their ancestors in the old art of rhetoric. Most of them, in fact, operate within specific conceptual frameworks of their own. They are not necessarily easy to combine. This might not be a problem at all since they are concerned with different aspects of language uses grounded in different interests related to generic features of language. For instance, grammar focuses on language primarily as a global system. Pragmatics focus on the contextual functionality of language uses. Rhetoric is also pragmatic and situational. Rhetoric primarily concerns the function of language uses, addressing the audience at hand and the purpose of persuasion.

2.2.1 Framing the analysis of deliberation in SSI classroom discourse

Being at the intersection of disciplines and interests, SSI inquiry has an important potential in preparing students for civic participation. SSI incorporate different knowledge domains as well as different interests and values adhered to by participants in a civic debate. It is important to note that the contributing perspectives and interests often relate to diverging framing conditions. A frame—a mutually recognized space of interaction—gives a particular social characterization or shape to a situation and gets an audience to attend to certain elements (Goffman, 1974; Bazerman, 2013).

The Swedish philosopher Mats Rosengren (2008) suggested that we should operate with the rhetorical term *doxa* in plural, *doxai*, since the truths we adhere to are always situated in our human context. Doxa concerns common norms and will therefore differ between communities

and contexts. Thus, the relevance of an argument also depends on trust and adherence to certain situated common norms (see also section 1.3.1 and 2.5.2 on *common ground* and 2.5.3 for more on the rhetorical perspective).

In science education, argumentation requires warranting from the relevant science domain, appropriate justification, empirical evidence or documentation, and the performance of scientific skills and procedures. SSI however, are interdisciplinary. This is challenging to the evaluation of arguments. In everyday situations, in vocational life, in politics, and in different disciplinary fields, deliberation is not primarily justification through evidence but justification and decisions reached through deliberations on the most prudent action to be taken (Kock, 2006). In the analysis of student deliberation in SSI inquiry, there is a need for analytical awareness of the functions of language uses related to relevance in the field (Toulmin, 2003), as well as awareness on the purpose of the discourse, whether the concern is theoretical or whether it is a practical concern addressing action to be taken, as addressed by Kock. The analytical tools of this study are chosen to meet this need (see section 2.5).

2.2.2 Toulmin's argumentation pattern—the warrant—and implicit premises

In this study, presuppositions, purposes, and functions of language are viewed as closely linked to Toulmin's meta term *warrant* (see also section 1.3.1 on the terms *warrant* and *common ground*). The philosopher Stephen Edlestone Toulmin developed a model of practical argumentation and a conceptualization of elements of practical reasoning. This conceptualization has been termed Toulmin's argumentation pattern (TAP). TAP has been used extensively in analyses of students' argumentation in science, as well as on argumentation on SSI (Driver et al., 2000; Erduran & Jimenéz-Alexandre, 2008; Erduran et al., 2004; Newton, Driver, & Osborne, 1999).

With TAP, Toulmin addressed general features of argumentation. However, he also addressed context-dependent features of argumentation by emphasizing that argumentation is field dependent. Figure 1 shows Toulmin's TAP model of practical argumentation with an example. The example was presented by Toulmin (2003, p. 97).

Figure 1.

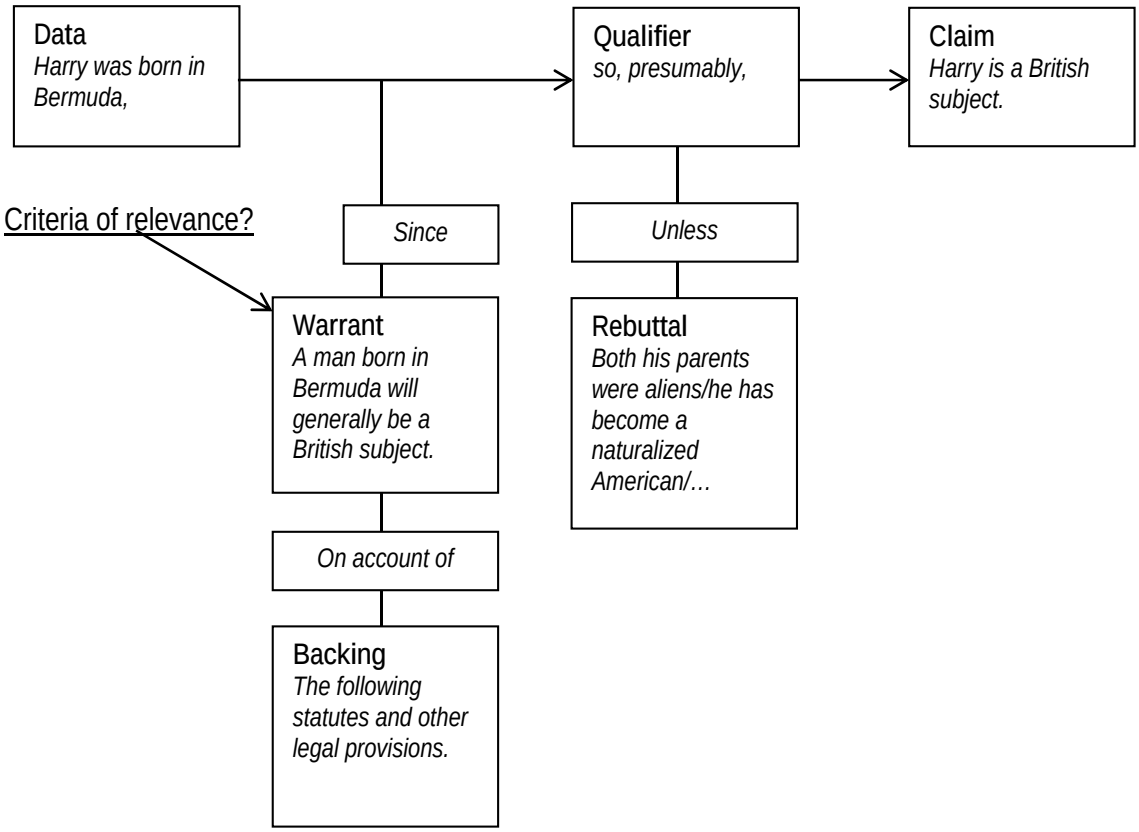

Fig 1. TAP contains the following elements: a *claim* (statements of assertions) and *data* (statements of facts), supported by *warrants* and *backings*. The elements may be nuanced and modified by *qualifiers*. TAP also includes *rebuttals*, or how we may refute possible counterclaims when constructing arguments.

I included the sentence "Criteria of relevance?" to emphasize that criteria are field dependent. The criteria of relevance are situated. For instance, in the example presented, the interlocutors could be international university students discussing the nationality of students at a coffee shop, considering whom to invite to a party. The interlocutors could also be people from the bureaucracy at an immigration office. They might also be geneticists. In any case, relevance rules.

In the classroom, as in public debates, arguments are considered trustworthy or strong according to criteria of relevance. Toulmin (2003) discussed questions about logic and how logic is applied in practice: how we actually assess the soundness, strength, and conclusiveness of arguments. He addressed the philosophical choices hidden behind the "general premise" in formal logic. He focused on the relation between statements of fact and statements of assertion in practical argumentation and the critical function of the reason. An important point of Toulmin's is that the justification of a claim and thus the soundness and strength of an argument is retrospective. It is when questioned that a justification and evidence are required to support a claim. Justification of a claim relates to the contextual

resources involved at the very moment when a claim is questioned and contested. The valid steps of the justification of a claim should regard field-dependent premises or warrants. Different groups of people and different disciplines may assess justification differently. Criteria for what counts differ from one field to another. "The statements of our assertions, and the statements of the facts adduced in their support, are, as philosophers would say, of many different 'logical types'" (Toulmin, 2003, p. 12). The concept of *warrant* is a key term: "rules, principles, interference-licences" (p. 91).

The elements of TAP are not necessarily explicitly uttered either in oral or in written texts. Further, what justification is needed and asked for is related to premises that are usually taken for granted and often implicitly understood among participants in a community of discourse. Furthermore, how an element is labeled according to the concepts of the TAP pattern is also situational and context dependent. Some kind of standard for the "best" argumentation may therefore not easily follow from a TAP analysis.

Another conceptualization of implicit premises, presuppositions, or a common place and source for argumentation was provided by Perelman in his New Rhetoric as *the universal auditorium* (Perelman & Obrechts-Tyteca, 2008). To Perelman, argumentation always addresses an audience on the basis of a perceived common ground. Toulmin's concept of warrant addresses the same implicit common place.

2.2.3 Analytical considerations on criteria of relevance across events and lessons

In this study, the criteria of relevance for warranting are important. Usually, when interpreting a piece of text or written dialogue, it is possible to attack it from a theoretical angle at a particular moment. However, student conversation across situations and lessons includes tacit moves that are unspoken when participants in a conversation take the initiative and respond. The unspoken is even interpreted in the reciprocal movement between interlocutors, sharing the history of the activity as a common ground. The meaning of spoken text moves as it stretches out in time and space, and the interpretation and meaning making emerges from moment to moment as participants' contributions shift and their foci differ.

In A1 and A2, I describe my experience of what was going on in the classroom talk in the student groups. By describing the dialogues with tools from SFL, CA, and rhetoric, I try to bridge the gap between what I experienced was going on as student deliberation and student argumentation as usually presented in research on argumentation in science education. An analytical bundle of theoretical perspectives was the result and my way of trying to translate between discourse communities. Thus, I was able to draw on inventive tools from different theories and create a nuanced view of what happened in student dialogues during an SSI inquiry.

2.3 Argumentation in science education relative to Scientific Literacy and SSI

In the following, some further perspectives on argumentation from the science education community are presented to position my work within the field of empirical and qualitative research on argumentation in science classrooms.

Classroom-based studies on argumentation in science education in Europe started in the 1990s. The first studies on argumentation in science education explored whether instructional designs favored argumentation, with negative results. Later, the field continued to evaluate the quality of students' scientific argumentation and to analyze competencies. Lately, there has been an emerging interest in the design of learning environments (Erduran & Jiménez-Aleixandre, 2012). Moreover, the debate on educational goals in science learning and citizenship is increasingly focusing on socioscientific issues and student participation (Hodson, 2003; Osborne, 2010; Sadler, 2009; Sadler et al., 2011; Zeidler & Sadler, 2008). Osborne (2010) presented a summary of the main features of the body of research in the field of argumentation in science education. His focus is research on teaching students argumentation as a means of enhancing students' conceptual understanding, as well as students' skills and capabilities with scientific reasoning. One of his concluding concerns is that we need to know more about the features of learning environments that support the best argumentation. Argumentation is still not prevalent in most science classrooms, though scholars urge more argumentation and debate in science classrooms. Kuhn (2010) confirmed this view, urging the need for more knowledge about students' argumentation skills and their development of such skills.

In an overview on methodological approaches to argumentation in science education, Erduran (2008) reported that science educators have experienced difficulties in applying Toulmin's model to classroom talk. She argued that these difficulties do not necessarily derive from this specific model but rather derive from difficulties in specifying the boundary markers that generate coding tools. She noted that methodological challenges remain and that aspects of argumentation are understudied. She viewed this as a gap in the literature. The gap concerns the learning environments, including the sociological, political, and psychological structures and processes that mediate argumentation in school science.

In a recent summary on European research on inquiry-based science education (IBSE), Erduran and Jiménez-Aleixandre (2012) presented a commonly accepted normative definition of argumentation in the science education research community: "the evaluation of knowledge claims in the light of available evidence" (p. 254). This definition implies that argumentation should include the presentation of some kind of evidence-based justification related to knowledge claims. In this respect, argumentation is a truth-seeking enterprise. It does not concern desire. Such definitions have been a starting point to identify students' argumentation and to assess and to prescribe the scaffolding of argumentation in science education. However, this definition may not comprise the justification of many decisions reached through deliberative argumentation. One definition of argumentation from Buty and Plantin (2008) referred to by Erduran and Jiménez-Aleixandre, however, addresses the procedural aspect: "argumentation as the process of contrasting two views or two incompatible meanings and of negotiation of a solution" (Erduran & Jiménez-Aleixandre, 2012, p. 256). This definition is interesting to keep in mind. Their emphasis on *process* and on *contrasts* may serve the purpose of finding appropriate analytical tools to identify relevant characteristics and functions of students' deliberation from a procedural perspective.

Assessment of the quality of argumentation in science classrooms usually serves the purpose of promoting scientific explanations and draws on the tradition of dialectical argumentation and empirical, truth-seeking, evidence-based justification. Argumentation in school science relates to field-specific explanations as well as practical decision making based on those explanations. In addition to or building on TAP, other analytical and instructional approaches and patterns for classroom-based argumentation have also been developed, rooted in the field of informal argumentation. One recent and interesting study is that of Macagno and Konstantinidou (2012), promoting argumentation schemes (Walton, 1996, 1998) as candidates for reconstructing the tacit premises of students' arguments and the development of teaching approaches based on critical questions. Walton's (1998) argumentation schemes classify dialogues into analytical categories: *persuasion, information-seeking, negotiation, inquiry, and eristic dialogue*; Walton later added *deliberative*.

Mercer and Littleton (2007) discussed how dialogues help children learn and categorized talks as *disputational, cumulative*, and *exploratory talk.* Their categorization was based on empirical studies on classroom talk in primary school. According to Mercer, exploratory talk is difficult to find in children's group work unless it is taught explicitly. Mercer (2008) emphasized the temporal aspect and the intertextuality and communal development of classroom talk. The temporality is interesting to keep in mind in the context of this Ph.D. study since it addresses the development of students' deliberation across events and lessons. The macro-structure described in A2 refers to a need for analysis that takes temporal development into consideration (for more on classroom talk in this study, see 2.5.5).

Bricker and Bell (2008) urged more knowledge about students' general reasoning competencies and how we can capitalize on everyday talk and practices to understand more about argumentative competencies and understandings that students bring with them to formal instructional moments. Newell et al. (2011) critically reviewed research and considered contributions to teaching and learning argumentative reading and writing from two perspectives, cognitive and social. One conclusion from Newell et al. was that the value of argumentative reading and writing has been an unexamined assumption in the study of literacy instruction related to students' knowledge building. They advocated for analysis of the use of discourse in classroom practices "as a window into the ways in which students are making sense of argumentative reading and writing tasks" (Newell et al., 2011, p. 297). They also urged relating reading and writing arguments to provide students with experiences that give a sense of the value of argument in shaping their lives.

Another aspect of SSI education linked to civic participation, the exigency of moral education and students' individual development of character, was addressed by Zeidler (2008). SSIs may concern how students position themselves in local or everyday considerations as well as to global questions.

Viewing argumentation as a "process of thinking and social interaction in which individuals construct and critique arguments" (Golanics & Nussbaum, 2008; Nussbaum, 2011, p. 84), Nussbaum's approach to argumentation focused on dialectical argumentation and students'

collaborative construction and critique of arguments. Noting that models of argumentation may serve different purposes—analytical, normative, or descriptive—Nussbaum's work addressed how the use of TAP could be elaborated, nuanced, and leveled for different purposes. Nussbaum (Nussbaum, Sinatra, & Owens, 2012) discussed problems concerning the application of the TAP model, reviewing Walton's theory and Bayesian models of everyday arguments. According to Nussbaum et al. (2012), students should be presented to "the two faces of Scientific Argumentation" (p. 17). They need to understand scientific argumentation, how scientists build theory, working from a set of premises, collecting and evaluating data, using logic and reasoning, backing and warranting their assertions and data—their evidence—to support or refute their findings. Students also need to understand deliberative, practical argumentation and how it differs from pure scientific argumentation, as well as the role of scientific argumentation in deliberations and in the socioscientific challenges in modern society.

To further position my work within the literature on SSI approaches, I will refer to Kolstø and Ratcliffe (2008) who noted two main types of contexts for argumentation in the science classroom. First, there is the goal to discuss issues related to explaining a scientific phenomenon (e.g. when interpreting experiments or doing fieldwork). Second, argumentation may aim at understanding and explaining issues where the science is involved in a social debate. On societal issues, justification may involve divergent values and criteria of relevance. Hence, according to Kolstø and Ratcliffe, argumentation in science learning environments may primarily occur in two main types of contexts: 1) argumentation may be framed by the discipline of science, often as a way to learn and explain science content in inquiry learning activities, or 2) argumentation may be framed in an interdisciplinary setting, which is the case in SSI inquiry.

In a recent overview, Erduran and Jiménez-Aleixandre (2012) concluded that there is still a need to explore further students' and teachers' perceptions of argumentation in science. Students as well as teachers struggle with incorporating the norm into their textual practices as well as supporting teaching approaches. Erduran and Jiménez-Alexandre also suggested that studies on argumentation in science education should interact more with the community of argumentation research in general. Further, interdisciplinary studies on science education might also contribute to argumentation studies in general.

The study of argumentation in science lessons may have three foci: first, argumentation skills relate to the development of scientific literacy in a narrow sense, much in line with Roberts' Vision 1 (Roberts, 2007, 2011): the competence of being able to use scientific evidence, which implies argumentation framed by the discipline of science. Students argue as a way to think and work and to explain subject content knowledge. Second, argumentation may relate to a broader understanding of scientific literacy, much in line with Roberts' Vision 2, aiming at competencies for citizenship and decision making. In civic decision making and to make progress in communal efforts, arguments cannot necessarily be weighed on the same scale, which calls for deliberative argumentation (Kock, 2006). It is important to identify multiple

voices, power, and rights. This concerns rhetorical agency and the ability to identify contextual factors and to use "the fluid nature of rhetorical force" (Kock & Villadsen, 2012).

In this respect, teachers and students need awareness of rhetorical features of their argumentation. Awareness of positioning and deliberation should play a role in developing student reasoning and argumentation as procedural collaborative knowing. Finally, in Isocrates' (436–338 B.C.) words, we "deliberate in our own thoughts":

> With this faculty we both contend against others on matters which are open to dispute and seek light for ourselves on things which are unknown; for the same arguments which we use in persuading others when we speak in public, we employ also when we deliberate in our own thoughts; and, while we call eloquent those who are able to speak before a crowd, we regard as sage those who most skilfully debate their problems in their own minds. (Norlin, 1980)

2.4 Collaborative learning—Sociocultural learning theories

Sociocultural learning theories comprise a variety of theories originating from the works of Vygtosky, Bakhtin, Dewey, and Mead. Mortimer and Scott (2003) and Scott, Mortimer, and Aguiar (2006) drew on a sociocultural perspective and showed how inclusive, goal-directed, and well-structured classroom talk may facilitate productive disciplinary engagement (Engle & Conant, 2002) in science learning (Scott et al., 2006). Referring to Bakhtin, they used the concepts of *social languages* and *speech genre*. They accounted for patterns of language in the science classroom that they denote *school science social language*. The teacher models *the speech genre of school science*.

Sociocultural learning theories are broadly associated with situated, social learning and knowledge development. Language uses mediate the learning and knowledge discourse. Learning happens in the interplay between the individual and the social context. In the science education literature, a perspective on learning often labeled social constructivist learning theories means an understanding of individual conceptual learning as originating from Piaget's constructivist theories. However, this perspective on conceptual learning is included in a sociocultural frame, with the addition that concepts are learned in social contexts. Scientific conceptual learning is social in the sense that the development of concepts is based on signs and interpersonal symbols shared by a discourse community and learned by individuals through interacting in that community (Sjøberg, 2008).

On the other hand, situated learning theories enhance the collaborative development of knowledge. Situated knowledge emerges as knowing happens. Social context-dependent practices are shared by groups in communities of practice (Lave & Wenger, 1991). Argumentation as a characteristic feature of the nature of science (NOS) may be viewed from a constructivist as well as from a situated perspective, argumentation as a way of constructing knowledge as a product and an individual enterprise and argumentation understood as procedural collaborative knowing. Both perspectives draw on Vygotskyan sociocultural theories of learning (Vygotsky, 2004). In this Ph.D. study, the cognitive and the social perspectives are viewed as complementary (see A3).

2.5 Analytical tools from systemic functional linguistics, pragmatic conversation analysis, and rhetoric

The choice of theoretical perspectives and analytical tools builds on an acknowledgement of the intimate connection between basic skills in reading, talking, writing, and inquiry learning in classroom practices (for more, see sections 1.2 and 3.1). To track students' language uses, in all three articles, analytical tools are based on systemic functional linguistic (SFL) (Halliday, 2013). Oral as well as written texts are viewed as traces of students' use of textual and contextual resources in the situation. The choice of analytical tools from SFL in A1 served the purpose of gaining access to different aspects of the text to identify textual and contextual resources when students construed complexity. Further use of SFL in articles 2 and 3 resulted from this first choice. Tools from SFL make possible descriptions of textual activity from different angles and to see how the different angles complement each other. The SFL analysis tracks on the one hand students' sense making of experiences and, on the other hand, how students carry out interactions and, further, how they do this through wording and sentences. These descriptions may also bridge to interpretations regarding the premises underlying explicit wording. However, the analytical tools are used somewhat differently in the three articles according to the focus of the research questions.

In A1, the analysis focuses on intertextuality (Pappas, Barry, & Rife, 2003) and multiple voices. Projection and modality (Martin & Rose 2007) are traced in particular. In A2, oral textual practices are further explored. SFL is used in combination with perspectives from conversation analysis (CA) and rhetoric. The dialogues presented in A3 are examples drawn from the same body of analyzed transcriptions as in A2, and they are analyzed using the same tools. The difference is that, in A2, the focus is on the students as speakers, while the focus in A3 is primarily on the teacher as listener and respondent to students' utterances. In the following sections, relevant concepts underlying the analysis from SFL, CA, and rhetoric are briefly presented to account for the use of analytical tools in the three articles.

2.5.1 Perspectives from Systemic Functional Linguistics—SFL

According to Halliday (2013), "a language is a resource for making meaning, and meaning resides in systemic patterns of choice" (p. 23), and further regarding the language as a system:

> Structural operations—inserting elements, ordering elements and so on—are explained as *realizing* systemic choices. So, when we analyse a text, we show the functional organization of its structure; and we show what meaningful choices have been made, each one seen in the context of what might have been meant but was not. (p. 24)

In SFL, the wording in a language system is structured by different ways of stratifying language uses. Using tools from SFL, it is possible to describe the interface of grammar and what happens in the world and what happens with the social processes that students engage in. The *meaning* is this interface. This is the stratum of semantics. This is, however, only the first step. The meaning is further transformed into wording. This is the stratum of lexicogrammar. With the stratum of phonetics (sounding) and of phonology (composing), the interface with the human body and the organization of speech sound into formal structures and systems may

also be described (Halliday, 2013, p. 25). The network of stratification represents the underlying potential of the language as a system and a meaning-making resource. The text, oral or written, is an *instantiation* of the system. Halliday used the relation between weather and climate as an example to illustrate the relation between the text as an instantiation and the language as a system: "the weather is the text: it is what goes on around us all the time, impacting on, and sometimes disturbing, our daily lives. The climate is the system, the potential that underlies these variable effects" (Halliday, 2013, p. 27). Thus, the transition of experiences and social relations into a relation among these strata—into spoken or written language—is *realization* (p. 25).

In Halliday's framework, language has components of meaning that are always simultaneously present in language; that is, language construes human experience (Halliday, 2013). Two very general purposes underlie all uses of language: (i) to understand the environment (ideational) and (ii) to act on the others on it (interpersonal). Combined with these, is a third metafunctional component, the "textual," which breathes relevance into the other two (Halliday, 1994, p. xiii). The term *metafunction* is used in SFL to show that the entire architecture of language is arranged along these functional lines. They are viewed as integral components within the overall theory (Halliday, 2013, p. 31). These metafunctions correlate with the context in different types of situations. Situation types are characterized in SFL in terms of field, tenor, and mode: the *field* is what's going on, including the "subject matter" or "topic." The *tenor* is who is taking part and their roles and values imbued by them in the domain of experience. The *mode* is the role that the language is playing, what the participants expect language to do for them in the situation (Halliday, 2013; Halliday & Martin, 1993, pp. 32-33), including the rhetorical mode: the orientation toward field (e.g., informative, didactic, explanatory, or explicatory) or tenor (e.g., persuasive, exhortatory, hortatory, or polemic), as well as turn (dialogic or monologic), medium (written or spoken), and channel (phonic or graphic) (Halliday, 2013, pp. 33, 34).

In A1, following Martin and Rose (2007), we identified projection on the ideational metafunction as a way of representing ideas or phenomena and modality on the interpersonal level. Modality allows for the participation of multiple voices by opening up a semantic space between yes and no. Chains of participants as well as chains of thematic patterns (for more, see A1) were tracked in and across oral and written texts. In SFL, the underlying premises are construed by the interplay of the levels of language uses—the stratifications, the metafunctions, and the context in each instantiation of any situation. In SFL, the term *genre*, linked to *register* (a functional variety of language uses), is used to account for a textual, social, and cultural common code in practical conversation. The common code, as implicit presuppositions among interlocutors, is also addressed in conversation analysis.

2.5.2 Conversation Analysis

Adding perspectives from conversation analysis (CA) resulted from the interest in exploring further the findings of extended types of dialogues in the second cycle of the ElevForsk project (see A1). As accounted for in A1, the students' written work on the wiki showed traces of their oral deliberations. SFL provided insights into the functions of students'

language uses and the students' choices during inquiry. In A2, perspectives from CA provide concepts that enabled the identification and descriptions of the characteristic reciprocity of initiatives and responses, which was particularly interesting since the focus was on oral dialogues in A2.

The notion of *common ground* (Svennevig, 1999) (see also section 1.3.1) became a key term. The common ground connects the purposes of initiatives and responses during the development of the conversations across situations and lessons. The common ground of classroom discourse thus provides the situated legitimate resources for warranting arguments (see also section 1.3.1 on the term *warrant*). In this respect, Mercer's (2008) discussion of the temporality of classroom talk is interesting. The participants' relation to a common ground may also explain how students, when encountering a new learning situation, will look for previous learning experiences as tools for solving the task. In the chain of large and small interpretations and decisions, students experience tensions that need to be negotiated and mastered. They will seek to transform the resources to the perceived task and try to transform the task into something that can be handled with the resources available. This is interplay between the here-and-now situation and a broader common cultural frame.

We may compare the students' situated contextual choices of language uses and the realization of strata as presented on SFL (2.5.1). The common ground is always situated and potentially open to negotiation.

2.5.3 Rhetoric

The situated common ground is created and recreated by the interlocutors in a conversation over time. The situated common ground is a resource for warranting. It is the rational support of arguments by criteria of relevance (Toulmin, 2003) (see section 2.2.2). Toulmin, who did his work within the philosophy of logic, did not himself characterize his work as rhetoric (though he has acknowledged links to Aristotle's). However, it is worth noting that Gabrielsen (2008) in his work on rhetorical topoi (*Silva Rhetoricae*, 2007a), related Toulmin's concept of warrant to cognitive facets of rhetorical topoi. Gabrielsen addressed how choices of topoi support reasoning and argumentation, such as the use of analogies and examples. Topoi are inventive resources shared by groups that share thinking patterns. In this respect, the students' inventive capacities are viewed as rhetorical capabilities. When they alternate during ongoing conversation between different positions and diverging perspectives, they draw on topical rhetorical resources.

In rhetoric, the term *doxa* (Rosengren, 2011) refers to the broader common cultural frame. Doxa is a resource, and it mirrors the common ground. Doxa may be applied to for justification, comprising the values and interests adhered to, though it is usually unspoken. We could say that arguments accepted without questioning are traces of doxa (see also section 2.2.1). Students choose language and arguments from situational criteria of relevance.

The cautious perception of a specific situation also involves the rhetorical *kairos*. Kairos (*Silva Rhetoricae*, 2007b) is the appropriate opportunity when resources are realized in the rhetorical situation, "the contextually situated call to persuade, whether it is oral or written"

(Ramage, Callaway, Clary-Lemon, & Waggoner, 2009, p. 209). According to Carolyn R. Miller (1994), individual choices of language uses in a particular situation are connected to broader patterns of discourse at a cultural level by genre:

> The rules and resources of a genre provide reproducible speaker and addressee roles, social typifications of recurrent social needs or exigencies, topical structures (or 'moves' and 'steps'), and ways of indexing an event to material conditions, turning them into constraints or resources. In its representation of and intervention in space-time, genre becomes a determinant of rhetorical *kairos*—a means by which we define a situation in space-time, and the opportunities it holds. (Miller, 1994b, p. 71)

Genres provide tools for particular purposes. When we know the situation, we know something about what to expect. Genres represent some typified ways of doing things by language and provide textual norms of how we are expected to talk and write. Moreover, genres shape students' expectations on what can or should be done (Knain, 2005). Genres connect the moment-to-moment interaction in a dialogue or a particular written text with social norms operating at longer time scales and across situations.

2.5.4 The dynamic speech flow

In oral activity, participants induce interruptions and shifts, and the dynamic speech flow may change or stop due to the participants' moves. Participants may change or develop the object of discourse (Albe, 2008). In debates, participants take turns. Change in the dynamic speech flow enables participants to change focus: they may stop talking or try to find a way to continue (Svennevig, 1999). Being *informative, relevant, clear*, and *truthful* (evidence based) in speech is viewed as critical to sustain communicative collaboration on meaning making (Grice, 1989). In analyzing students' argumentation in science and SSI, coherence and logic are valued, and they are criteria when assessing the "best" argumentation. When people talk and negotiate, however, utterances also express differences and willingness on the interpersonal level that may open up a space for different positions and diverging perspectives. There may even be good reasons for participants in a dialogue to not always be informative, relevant, clear, or even truthful (evidence based) in speech.

2.5.5 Object of study and unit of analysis—Classroom talk as literacy events

In this project, *classroom talk* is defined as talk between students in groups and pairs and between teachers and students. The teacher's talk with the whole class when the teacher is directing questions, for instance with the purpose of introducing, developing, summarizing, or reviewing, is also viewed as classroom talk. Classroom talk is a meeting place between the students' voices and the voices of the discipline. The discipline speaks both through the teacher's dissemination and the learning resources he or she provides, as well as through disciplinary texts and textbooks. Classroom talk is part of the process of seeking, finding, and building knowledge. Digital and Web-based tools, such as the wiki used at the upper secondary school where this study took place, may function as tools in knowledge building and may stimulate learning through collective processes and instructional strategies. Argumentation and deliberation on the use of sources and perspectives is an important part of the process of knowledge building and meaning making. Remembering the temporal aspect of

classroom talk (Mercer, 2008) (see section 2.3), which may itself be viewed as the students' collective knowledge product. The students' textual practices are described and analyzed as part of the classroom talk.

In this study, literacy events were identified in the classroom talk. Literacy events and literacy practices are social activities (Barton, 2007). According to Barton (2007), a literacy event involves "all sorts of occasions in everyday life where the written word has a role" (p. 35). For the purpose of this article, an event consists of a dialogue sequence of a minimum of three utterances belonging to the same chain of initiatives and responses. This chain is labeled according to a shared referential content.

Defining a fixed boundary markers for the object of study and of an event is difficult in oral texts since, in speech flow stretching out in time and space, meaning is emerging and reinterpreted moment to moment. Participants recreate the object of discourse. Roland Barth (2002) analyzed texts in a novel. Starring fragments of a text (by writing a star in the text to highlight a chosen fragment) as units of reading, according to Barth, boundary markers will always be somewhat arbitrary and related to possible interpretations. The interpretation of the signified implies no methodological responsibility since it will bear on the starred signifier. This will be the case for any text, including non-fiction, since, when the moment has passed, we only have access to what is recorded. It must be a matter of convenience to choose the unit. However, the fragment should be

> ...the best possible space in which we can observe meanings; its dimension, empirically determined, estimated, will depend on the density of connotations, variable according to the moments of the text: all we require is that each lexia [fragment] should have at most three or four meanings to be enumerated. (Barth, 2002, p. 12)

The research questions have guided the choices of units, the literacy events starred as units of reading. The units were identified during the hermeneutic process of interpretation. Analytical perspectives from SFL, CA, and rhetoric guided the interpretation.

3 Materials, design, and method

The Ph.D. study consists of two case studies, with one case study exploring complexity that compares student dialogues from two cycles of the ElevForsk project (2008 and 2009). A pilot study on argumentation was conducted with data collection in 2010. The second case study explores further students' argumentation and deliberation in group activity with data collection from the student project in 2011. The case study from the first two years provides data for article A1. The case study from the fourth year provides data for articles A2 and A3 (For an overview of articles and research questions, see 1.3, and for summaries of articles, see chapter 4).

The design of my Ph.D. project brings further core elements from ElevForsk. In the ElevForsk project, deliberative aspects of argumentation during inquiry were not particularly focused on from the start. However, a goal of ElevForsk was to relate the reading and writing

of arguments to the progress of the inquiry processes. The student project aimed at giving students experiences during inquiry that could give them a sense of the value of argument in decision making and how this may be shaping their lives.

The development of learning environments to promote student talk and argumentation are often linked to collaborative inquiry-based science education (IBSE). In IBSE, argumentation is an implicit part of inquiry. Teaching approaches to socioscientific issues through inquiry are supported by literature showing that competences developed through inquiry learning overlap significantly with those of scientific literacy for handling socioscientific issues (SSI) (Kirch, 2009; Kolstø, 2006; Roth & Lee, 2004; Ryder, 2001; Sadler et al., 2011). The ElevForsk project explored students' reasoning and argumentation during collaborative oral inquiry achievement (Johansen, 2013; Knain & Kolstø, 2011b).

In this chapter, the relation of my Ph.D. case studies to the ElevForsk action research project will be accounted for. An overview of empirical cases is given. Ethical issues and aspects concerning reliability and validity are discussed.

3.1 A study of inquiry—ElevForsk

It is therefore necessary to account for conditions and constraints concerning the design of my Ph.D. project as a part of ElevForsk (see also sections 1.3.1, 3.2, 3.3, 3.4, and 5.2). In the context of the ElevForsk project, *inquiry learning* refers to the ways of working and thinking that promote and stimulate the development of competencies, such as posing questions and developing answers that are supported by different kinds of evidence. Such evidence may involve data collected by the students themselves, data collected by others, and authoritative texts. In other words, the students were supposed to make claims and argue from first-hand experience (their own data), as well as from data collected by others and supported by theory, which also implies inquiry into a diversity of texts (Knain & Kolstø, 2011b).

In the Ph.D. study, the phases of inquiry are conceptualized with terms from Bell, Urhahne, Schanze, and Ploetzner (2009). They compared models of "collaborative inquiry learning" in the research literature and defined some main inquiry processes: *orienting and asking questions, hypothesis generation, planning, investigation, analysis and interpretation, model exploration and creation, conclusion and evaluation, communication, and prediction* (Bell et al., 2009, pp. 5-8). They noted that the process of communication encompasses all the other inquiry processes as a tool for both presenting and making sense.

Regarding learning from inquiry and the relation to collaborative argumentation, Bennet, Hogarth, Lubben, Campbell, and Robinson (2010) reviewed the body of research in a review article on studies of the uses of discussion in student group work in science, mainly from the United States. The authors reported positive results from all the studies on the development of students' understanding. They summarized that pupils strive to formulate and express continuous and coherent argumentation—and that students are not even very interested in doing so. Working in discussion groups seems to function better when pupils with different views work together. It seems that there is a need to train students effectively in group work

and to help in structuring discussions with cues. The authors concluded that their findings indicated that teachers and students need explicit teaching in argumentation skills and discussion. The studies reviewed were conducted by researchers who truly believed in the uses of group discussions, and the authors commented that their conclusions must be interpreted in light of this understanding. Bennet et al. also made some methodological considerations. The studies reviewed used video and/or audiotaping and triangulation by different methods. However, the methods are not often justified. Data are extensive in the studies, which attempt to produce detailed pictures of the dialogues. Often, the student groups exposed to analysis are chosen retrospectively, with the risk of the selective presentation of data. Though these are qualitative data, contextual data are sparse. The studies reviewed mainly use two kinds of strategies for data analysis: grounded theory or discourse analyses, with a majority of studies using grounded theory. Bennet et al. urged more discourse analyses. These challenges and methodological considerations became important to me in my decisions on data collection and in choosing the analytical tools and design of my Ph.D. study.

The data were collected during the open inquiry student project of ElevForsk at Midtby (see also 1.2). The teacher-researcher group designed the student project, aimed at exposing the students to diverse authenticities, multiple discourses, and collaboration on knowledge building and meaning making (Wallace, 2004). Wallace's (2004) framework provides three components for developing scientific literacy, assuming "that to be scientifically literate, a learner must be able to effectively read and write scientific texts, be a meta cognitive thinker, and be able to construct the elements of a scientific argument" (p. 902). The components of the framework are as follows: (1) a dynamic interplay between subject matter and situated and student authenticity, (2) exposure to various genres of science (multiple discourses), and (3) collaboration in the construction of scientific meaning by entering "Third Space as an area in which neither one of two different languages [scientific and everyday language] are dominant, but the meaning of both may be transformed according to new experiences" (Wallace, 2004, p. 908). The design of the student project aimed at providing students with learning environments that should include these components (Knain & Kolstø, 2011b).

3.2 My role as a researcher in ElevForsk

My role as a researcher in the first and second cycle of the ElevForsk project (providing data for A1) was related to the analysis of video data from students in group activity, audio data from interviews with teachers, and students' written discussion notes regarding their experiences with the wiki tool and the student project. I entered the ElevForsk project in the late autumn of 2009, when the planning for the third year of the student project was starting up. During the autumn of 2009, I participated in the preliminary analysis of data from the first two years. I participated in the teacher-researcher group and the planning activity regarding the design of the student project for the next two years, with support from Professor Erik Knain. I participated in the fieldwork during the last two years and was responsible for the data collection and emerging analysis, as well as for the refinement of research questions.

My role as a researcher and the purpose of my research to look closer into student argumentation in the ElevForsk project was presented to the students in the third and fourth year in an introductory session. The third year was regarded as my pilot and is briefly described in section 3.3 about the action research project as framing conditions for the Ph.D. study. In the third and fourth years, I was present during group activity, as an observer, collecting audio and video. The fourth year I participated and collected data during 11 lessons. During group activity, I walked between groups and was available to the students and the teacher for support when needed. The students' need for support was usually communicated to their teachers, and the presence of a researcher most likely did not interfere significantly with the dialogues during group work. My reflections on student activity and questions from teachers were usually communicated to the teachers after the lessons and at the teacher-researcher group meetings.

3.3 From an action research project to a case study

Before my entrance into the ElevForsk project, data on student activity in 2008 and 2009 were collected by Professor Erik Knain. Data were collected from one class in cycle one and from six out of 12 groups in two classes in cycle two. The second cycle of the action research project included a meeting schedule for the teacher-researcher group, with weekly meetings held prior to and during the project period. Thus, key issues that needed attention and were viewed as critical to the development of improved practice and further analysis were identified and addressed. Upon my entrance into ElevForsk, I participated in analysis and different ways of dealing with *complexity* caught our attention through early review of data from cycle 2 compared to cycle 1, and the groups selected for further analysis were typical of each cycle in this respect, based on a preliminary analysis.

During the preparation for cycle three, the Ph.D. study was initially described as an action-based classroom study, framed within the overall action research project. However, the ElevForsk project also bore many resemblances to case study research (Yin, 2009), such as complementary forms of data and a focus on contemporary events of rich phenomena in context. The design of ElevForsk aimed to improve practices, and the collaboration during the fieldwork in the teacher-researcher group focused more on improved practices than on generating general theoretical knowledge.

During the fieldwork in 2010, the data collection and my role as a participant observer were regarded as a pilot for designing the fourth cycle relative to my particular research interest in student argumentation. The purpose of the pilot was to become familiar with the school, to look for patterns, to address issues that were important to teachers and students, and to look for possibilities and constraints. The intention was to design data collection building on emerging analysis from the three first cycles and in pragmatic coexistence with the subsequent action research project.

As the fieldwork proceeded and preliminary analysis emerged, a need for grounding my focus on exploring some particularities found at the micro level of student dialogues became

pertinent. The Ph.D. study was finally redefined, and a case study design was applied. The aims of improving practices were left for arenas other than this Ph.D. project (Knain & Kolstø, 2011). Developing a theoretical understanding through what Yin called analytical generalization of the complexity of practices became an aim of my Ph.D. study, and in fact, this is the purpose of any case study, according to Yin (2009).

The action research program provided opportunities for open SSI inquiry and student-student and teacher-student dialogue and collaborative argumentation. Hence, teaching strategies and the learning environment that made room for the dialogues that constitute the object of this case study resulted from the action research program. Student-student talk and argumentation is discussed in A1 and A2. In A3, teaching approaches to student argumentation is discussed. To be precise, the body of collected material from four years resulted from the action research program. The action research program is an important background for the development of my research questions and choices of analytical tools for the case studies. However, in the following section, I will argue that the findings reported in A2 and A3 are not a result of the action research strategy and design.

Some questions on the relation between the action research project and my Ph.D. project may still be unresolved: to what degree did the action research strategies influence the teacher-researcher relation, and what was the influence on the teacher-student relation? Did the framing of dialogues in the ElevForsk project frame the learning environments as exceptional? Was the student-student talk and student-teacher talk very different from talk and argumentation in science lessons in existing practices?

I will not give an exhaustive answer to either of these questions but, rather, explain how the design and research questions for the Ph.D. project emerged from the overall ElevForsk project at this school and then return to these questions in the final discussion in section 5.2.

3.4 Participation and collaborative action

As framed within the ElevForsk project, the design of the data collection draws on principles described in participatory action research (Kemmis & Taggart, 2005) and methods usually utilized in action research in classroom studies. Participatory action research aims at social change and the empowerment of participants, as well as a wish to challenge traditional ways of thinking. Accordingly, also power relations should be challenged to make space for and invite minorities or weaker or particularly interesting voices to participate in the innovative work. As participants in the teacher-researcher group, teachers as well as researchers participated in developing the wiki platform that was used during the four years. Even if the teachers did not collect data themselves, the wiki was regarded by both teachers and researchers as an important potential source for data collection. Collaboration in constructing a wiki for instructional purposes was a substantial part of the teacher-researcher collaboration. The wiki may be viewed as a mediating tool allowing for diverging interests and perspectives to be elaborated on and discussed among participants (Bjønness & Johansen, in press).

In the ElevForsk action research program, it was acknowledged that participation and empowerment are important, particularly to secure the impact and sustainability of action learning strategies. Impact and sustainability depend on interaction between the societal, the institutional, and the situational level. Johansen (2013), also an ElevForsk researcher, emphasized that action research is context bound, and she mentioned the democratic aspect (p. 31). The different participants' contributions must be given serious deliberation in the process of knowledge generation. Diversity enhances the process of action (Bjønness & Johansen, in press). The ElevForsk action research approach could be described as pragmatic, drawing on traditions from Dewey (Johansen, 2013), understanding knowledge as constructed from practice and democratic participation. Accordingly, as I began my Ph.D. fieldwork, I was prepared, along with the teacher-researcher group, to identify existing teaching and learning practices and at the same time to challenge those practices to constitute new practices and develop SSI teaching and learning approaches in collaboration with teachers and students.

The ElevForsk project at Midtby was initiated as a result of the collaboration between a science teacher at the school and Professor Erik Knain as a researcher on the teacher training program at the University of Life Sciences. In the ElevForsk project at Midtby, the influence and ownership of participants and the effect and sustainability of the action research program is linked to a great extent to the anchoring of the project in this initiative, an initiative that was supported by the school's management. However, in the teacher-researcher group at the Midtby school, neither the teachers nor the researchers were appointed as leaders of the project. The teachers primarily wanted to participate in the project to develop their own practices and teaching methods and were excited by the possibility to try out a digital tool and teaching approaches to SSI together with colleagues and researchers.

The teachers joined to adapt their own practices to the new curricular requirements and to develop interdisciplinary collaboration. Hence, as researchers, we were reluctant to take too much control of the developing processes of designing the student project or the organization of the teachers' work. The ElevForsk study was not meant to be an implementation or a design study. The process of changing practices and the teachers' adjustment of their existing practices to the new curriculum required space for the equal participation of multiple voices. Disagreement as well as agreement was approved of (see section 5.2). An afterthought is that leadership that is well anchored in the institutional planning, formally appointed and addressed as collaboration between the school management and the research community, might have secured more robust resources, for instance in the schedules for the teachers who wanted to work with their changing practices. The problem was discussed among teachers and researchers at group meetings. However, the issue was not addressed to the school management as fundamental to the process of action research. One person from the school management was appointed our contact. However, on the part of the school management, the project was identified as the responsibility of teachers and researchers to accomplish.

There is a need for an institutional ability to respond to teachers' initiative for change. When Kemis and McTaggart (2005) described action research as a cyclic process, they argued that this way of conducting research does not in itself constitute action research. In action

research, certain crucial relations between participants are necessary to define the research as action research. There are characteristic types of goals connected with action research.

> The criterion of success is not whether participants have followed the steps faithfully, but rather whether they have a strong and authentic sense of development and evolution in their *practices*, their *understandings* of their practices, and the *situations* in which they practice. (Kemmis & Taggart, 2005, p. 277)

The institutional level influence to a great extent the structure and progression at the classroom level. Consequently, the identification and handling of power relations are crucial to the development of collaborative work between the research community and the school if developing practices are to be sustained.

The distributed leadership of the ElevForsk project at Midtby, creating institutional tension, actually resulted in the teacher-researcher group meetings becoming a merging of existing practices. The tensions resulted in discussions on collaborative ways of developing practices at Midtby on the institutional and the classroom levels and in the teacher education research community at UMB in the ElevForsk research group. The tensions between diverging points of view and different ways of working and making sense became resources for inventive, creative, and critical processes to take place, for instance in initiatives to create the tools in the wiki platform to support the students' inquiry.

My approach to the teacher-researcher group's work and the data collection became a practical pragmatic approach focusing on interpretation as construed by students and teachers during situated activity. My approach was practical, in an Aristotelian way, to act well and wise in any situation. According to Bent Flyvbjerg (2006), the Aristotelian virtue of phronesis from the *Nichomachean Ethics* has been variously translated as practical wisdom, practical judgment, common sense, and prudence (p. 284). Prudent practical reasoning guided the work of the teacher-researcher group. During discussions on instructional strategies for the development of the student project, the wiki tool was constructed. My role as a participant implied sharing the group's responsibility for establishing the time and space for collaboration, not least for the development of a common understanding of the purposes and content of the collaboration (Knain & Kolstø 2011).

Participating as an observer and in the teacher-researcher group, I audiotaped team meetings before, during, and after the student project, audio- and videotaped students' group work, and audiotaped interviews with student groups and teachers after the student project. I also took field notes in the form of collaboration notes to the ElevForsk project leader as a co-researcher. Material from piloting and data from previous data collection (spring 2008 and 2009) was also available.

Due to institutional constraints regarding the meeting schedule for the ten teachers participating in cycle three, the coordination of activity became difficult, and teaching strategies were unresolved regarding how to facilitate groups of students during the inquiry process. At the end of cycle three, researchers and teachers concluded that the difficulties had

resulted in uncertainties among the students concerning teachers' expectations. Different epistemological presuppositions among teachers from different disciplines may have led to different interpretations of the assignment among the teachers. Such tendencies were also reported by Øgreid and Herzberg (2009). Such differences were identified in the first cycle (see A1), resulting in discussions and outlining of instructional strategies for the second cycle, including assessment criteria. Further, interviews with students and teachers and the audiotaped group work activity showed that, in critical phases of the open inquiry learning process, the students felt that the teachers were withdrawn. We may conclude that discussions among teachers on epistemological aspects of criteria for assessment are crucial in interdisciplinary work. Results from the analyses of the pilot guided the criteria for the refinement of the research design and research questions and for the choice of student groups for audio- and videotaping in spring 2011.

I will leave to other arenas a further account of and discussion on the action research, influence and power relations, and aims for the student project. These issues relate to discourse particularities of macro genesis (primarily institutional and societal concerns), while the focus of the three articles in this thesis relate to micro genesis (primarily situational concerns) addressed in the research questions of the three articles.

The teachers were engaged in teaching and in their students' work. They basically framed the students' learning environment through existing practices and institutional and societal constraints and affordances of traditional schooling. As a researcher, I was available as a provider of theoretical perspectives and as a discussion partner linking the teachers' developing practices to the ongoing research discourse on inquiry learning, and I was responsible for the data collection, the analysis, and the presentation of results of my Ph.D. case study.

During fieldwork in 2010 and 2011, I collected an extensive number of audio and video recordings. I collected data from students' group work, interviews with student groups and teachers, and recordings of discussions in teacher-researcher group meetings. Interviews and in particular the discussions in the teacher-researcher group, together with theoretical considerations, initiated the hermeneutical process of preliminary interpretation and analysis and guided the choice of the development of research questions and analytical perspectives for the case studies (see section 2.5.). The material collected from teacher-researcher meetings has not yet been analyzed. Preliminary analysis of the interviews from years three and four has been done.

3.5 Overview of data for the empirical cases

In the articles, relevant information is presented for each case: on data collection and on the choices of classes, groups, students, and the unit of analysis. In the following, I will present the context from which the data for in the three articles are drawn.

In case 1, the case study covering 2008 and 2009 (see Table 1 below), video recording is a main data source. During the pilot in 2010, I also tried video recording. However, I finally

chose audio recording as the main data source for case 2, the case study covering 2011 (see Tables 3 and 4 below). The quality provided by the audio recording equipment was regarded as better suited since, when several groups worked simultaneously in the classroom, the audio recording devices were able to record the group conversations in greater detail. Audio recording devices were placed on the groups' desks. In 2011, almost all the sessions of the student group project were covered with audio recording devices on all six groups' desks (for details, see Table 4 below). Group 5 was pre-selected (see A2), and some sessions with group 5 were also video recorded. Further, six teacher-guided student-student meetings were video recorded in high quality (for more details, see Tables 3 and 4 below).

The data for A1were collected before I entered the ElevForsk project. I examined videos and recordings from the two years and transcribed and analyzed central parts of the material, in collaboration with the co-author of A1, including interviews with teachers and students' dialogues during group work. In the pilot in 2010, four classes participated in the student project. However, classroom recordings were collected for only two of the classes due to schedule and anonymity constraints. In 2011, two classes participated, but for the same reasons, only one class participated in the data collection providing data for A2 and A3.

Overall, videos from lessons and students' group work were watched and audio material from lessons and meetings were listened to, much of it several times. Central parts were transcribed. Central transcripts were shared and discussed among researchers in the ElevForsk researcher group. The following tables give an overview of the types of data. The overview is given to provide an impression of the empirical context for the data chosen for the articles.

Case 1, providing data for A1

Cycle 1 (2008): Data were collected from all groups in one class.
Cycle 2 (2009): Data were collected from six out of 12 groups in two classes.

Table 1

Data type	Details
Field notes	Cycle 1 and cycle 2: - Reflection note from project group and group activity - Websites used during group activity
Video recording	Cycle 1: - What: During class and group activity. - Duration: Nearly 4 hours - The selected group: 1:40 Cycle 2: - What: During class and group activity. - Duration: 4 hours - The selected group: 2:30
Audio recording	Cycle 1: - Post interviews with three teachers from the first year Cycle 2: - What: Group activity - Duration: the selected group: 14 minutes
Wiki project page	Cycle 1 and cycle 2: - Submitted group assignments - Project page editing history - Project page discussion notes

Pilot 2010

Table 2

Data type	Details
Field notes	- Research notes written by researcher and project leader
Audio recording	Planning: - 9 teacher-researcher group meetings before, during, and after the student project period Student group activity: Class A (6 groups in total): Group 1: 5 sessions Group 2: 4 sessions Total: 9 sessions Class B (7 groups in total): Group 1-6: 6 sessions (1 per group) Group 7: 2 sessions Total: 8 sessions Post interviews: - 6 teacher interviews - 6 student group interviews
Wiki project page	- Submitted group assignments - Project page editing history

Case 2: Providing data for A2 and A3:

Data collected in 2011

Table 3

Data type	Details
Field notes	- Research notes written by researcher and project leader - Researcher's reflection notes from project planning, student group activity, and teacher-researcher group meetings - Websites used during group activity
Audio recording	Planning: - 11 teacher-researcher group meetings before, during, and after the student project period Student group activity: Group 1: 9 sessions + 2 meetings with group 5 Group 2: 10 sessions + 2 meetings with group 4 Group 3: 10 sessions + 2 meetings with group 6 Group 4: 10 sessions Group 5: 11 sessions (*see details in Table 4 below*) Group 6: 6 sessions Total: 56 sessions - Episodes from group 5 are used in the analysis for A2 and A3. - One episode from teacher-guided student-student meetings between group 1 and 5 is used in A3. Interviews: - 4 teachers interviewed before the student project period - 3 teachers interviewed after the student project period - School leader interview after the student project period - Student groups 1, 3, and 5 after the student project period
Video recording	Student group activity: Group 5: 3 sessions Teacher-guided student-student meetings: 6 sessions
Wiki project page	- Submitted group assignments - Project page editing history
Teacher notes	- Teachers final assessment of submitted assignments

Group 5. Audio recording details, 2011

Table 4

Date	Schedule	Time session	Time recorded	Transcribed pages (12-pt Times New Roman, 1,15 line spacing)
02/07 *		45 minutes	40 minutes	13
02/09	12:45	45 minutes	23 minutes	19
02/11	9:50	45 minutes	43 minutes	11
02/14	9:50	90 minutes	30 minutes	15
	11:50	90 minutes	60 minutes	
02/16	12:45	45 minutes	27 minutes	7
02/28	9:50	90 minutes	78 minutes	32
	11:50	90 minutes	73 minutes	
03/07	9:50	90 minutes	80 minutes	25
03/09	12:35	45 minutes	23 minutes	7
03/16	12:35	45 minutes	35 minutes	9
Total:	11 sessions of 45 minutes	12 hours	8 hours and 12 minutes	138

Table 4 shows an overview of the audio recordings for group 5 during the student project in spring 2011. The sessions from March 7th and 16th are video recorded. A camera covering whole-class situations recorded the sessions from February 9th, February 11th, February 28th, March 9th, and March 16th. The episodes analyzed in article 2 are from February 7th and 9th and March 7th.

*For details on session 02/07, see Figures 1 and 2 in A2. More details as background material for the figures are provided in Appendix 4.

3.5.1 Selection of groups

In the case study presented in A1, the groups were selected retrospectively. In the case study presented in A2 and A3, the group selected for in-depth analysis was a particular focus in the data collection from start. The dialogue episodes were chosen retrospectively for further analysis. Because of the risk of the selective presentation of data, one should be cautious about the post selection of groups to be exposed to analysis (Bennet et al., 2010) (see section 3.1). However, the quality of the results of these case studies does not involve the general occurrence or typicality of the language uses identified and discussed. Rather than collecting extensive and thin data, the selection of groups and episodes leaned toward the collection of

thick and narrow data. In the first case, complexity caught our attention, and in the second case, the intention was an in-depth analysis of argumentation.

3.6 Ethics

Before the start of my Ph.D. project and as a researcher participant in the ElevForsk project, I adhered to the ethical concerns of ElevForsk regarding the protection of the participants' privacy. The ElevForsk project had already been approved by Norwegian Social Science Data Services (NSD—Norsk samfunnsvitenskapelige datatjeneste). NSD is the Privacy Ombudsman for all Norwegian universities, university colleges, and several hospitals and research institutes, managing the approval of research, ethics, and data handling and storage.

The project involved students 15–16 years of age. To provide informed consent (Erickson, 2012), students and parents received an information letter where the focus of the ElevForsk study was described, as well as the data collection methods and how the video recorded material would be used. Written approvals were collected before audio and video were recorded. During transcription, names were replaced. The name and the location of the school has been changed in the published material. Video- and audio-recorded material has not been published outside the ElevForsk researcher group. I have undertaken to make the data corpus anonymous when the project is finished, and the data will be securely stored as required by NSD.

Data for the first article were collected within the ElevForsk project during the two years first and before my entrance. In the third and fourth years, when data collection was my responsibility, the students and teachers were informed of my role as a researcher. They were informed about my participation in the lessons during the student project, about the focus of my study, and about my particular interest regarding classroom talk and argumentation. In addition to the information letter, this information was given to the students in an introductory session where the students were encouraged to pose any question they might have. The intention of informed consent is that the participants can understand what they are part of (Derry et al., 2010).

To the students, my appearance in the classroom was related to a great extent to recording and observing, not to teaching or supervising, unless I was asked specific questions and the teacher was not available. The observations of the students were discussed with the teachers. However, what was said was presented in general terms if it concerned, for instance, students' off-task talk or the teachers' assessments. As a participant observer, a number of ethical issues were necessarily raised, and I was always aware of the need to protect the participants' privacy during data collection as well as during discussions on the analysis and presentation of the research.

Of course, not all of the students may have realized to the full extent what they were part of, and during the student project, questions about recording and the use of data were sometimes raised. On request, I answered that I would be viewing and listening to the recordings to understand more about how they talked and argued on the SSI and the task given. I told them

that I would look at and listen to how they proceeded during the project and how they solved the task of writing up the report. To some extent, the presentation of my focus and role may have affected the participants' behavior, at least in the beginning. The effect probably decreased when they became accustomed to me. In any case, I decided that my approach to students ought to be based on openness to clarify the relation as a basis for mutual trust and focus on the task to be done for the researchers as well as for the participants.

3.7 Reliability and validity of the Ph.D. study

Any impact of this Ph.D. study on teaching in schools or on teacher education would be difficult to measure even if practices change as a result of the ElevForsk action research project. However, by exploring qualities of student talk and argumentation from new positions, the Ph.D. study resulted in suggestions for analysis and perspectives on framing of learning environments to promote argumentation in SSI inquiry. Even if the analyses of student-student dialogues and teacher-student dialogues presented in the three articles cannot provide any statistical generalization, the knowledge claims that are provided, drawn from existing classroom practices, are justified and warranted by "the power of the example" (Flyvbjerg, 2001).

The reliability, the trustworthiness of the measurements, in this Ph.D. study is difficult to assess. The conceptualization of complexity and deliberation was developed through the emerging understanding of the phenomena studied. However, the resulting concepts, as well as the resulting description by those concepts of the situated low- and high-complexity (A1) and deliberative argumentation (A2) proved appropriate to describe not only the particular episodes presented but also deliberation across events and lessons. Analyses of deliberation are not presented across cycles even if preliminary analysis were done. Hence, to strengthen the results, there is a need for further studies where coding and the analytical tools can be used with even more empirical material. (Examples of coding tools and examples of details from the the data analysis for A2 are given in Appendix 1-4).

The analysis of audio and video of group activity from the first two years (A1) was triangulated with the analysis of interviews with teachers and the analysis of students' written discussion notes. The notes concerned the students' experiences with the wiki tool and with the student project. Data for the first article were analyzed by the two authors separately before the analyses were compared and discussed (for more details, see A1).

In the following, some details on the process of data analysis resulting in the conclusions in A2 are presented to make transparent and strengthen the credibility of the data used to analyze argumentation and, in particular, *deliberation on task solving*.

Based on the analyses from the first two years exploring and identifying complexity (A1), the analyses of student conversations from the fourth year identified characteristics and functions of deliberation in the students' SSI inquiry group work (A2). In addition to data on students' conversation during group activity, teachers and students were interviewed, and teacher-researcher group meetings were audio-recorded (see section 3.5, Table 3). These data were

not coded and analyzed systematically. However, the data were important as background and support and fill in the bigger picture of the institutional context for the classroom talk. The discourse is analyzed on the classroom level and in the context of the assignment given within the student project of ElevForsk.

The analyses of the 11 lessons (see Table 4) developed from a process of several stages of hermeneutic reading of transcripts and listening to recordings. Sections with dialogue from audio recordings of group work from 11 lessons for one group were transcribed and coded for *interruptions* (*change of theme or perspective, something happens that interrupts the dialogue, or the talk comes to an end*) and for *dynamic speech flow* (*the talk is sustained and engage participants focus on a theme for some time*). Transcripts were also coded to identify the ongoing activity, with contextual empirical coding.

Contextual empirical coding was used at an early stage to give as rich as possible a mapping of the material regarding traces of controversies and students' handling of agreement, disagreement, distinctions, and differences. The developing coding and analysis of group activity from the fourth year is documented in a protocol that was used as a tool to support the emerging analysis and interpretation. Details on analysis are provided in the appendixes. (see Appendix 1 for an explanation of *the protocol as a tool*. A detailed example extracted from the protocol is provided in Appendix 2). The transcribed lessons were entered into the protocol. Three lessons (providing data for A2 and A3), were coded in detail in the protocol since they were particularly rich in data. For an overview of the lessons see table 4, section 3.5. The lessons that were entered into the protocol was from February 7th, February 9th and mars 7th.

The coding was an inductive labeling of utterances that seemed to induce extended speech flow or was the cause of an interruption or change. Further, the coding became a mixture of theory-driven assertions and coding based on assertions from preliminary analyses from the three prior years. The process of coding was part deduction and part induction (Derry et al., 2010; Erickson, 2012). Overall, a diversity of assertions was made, labeled with terms covering analytical perspectives from SFL, conversation analysis, theory on argumentation, and rhetoric. A second layer of the protocol was made for three of the lessons. In this layer, transcripts were coded with SFL on the categories of what, who, how, and why (for more on SFL, see 2.5.1). Validity and reliability issues are further discussed in sections 5.2 and 5.3 (see also reflections on the unit of analysis in section 2.5.5).

In order to give an insight into details of analysis, appendixes are provided. A template of the protocol is shown in Appendix.1. An detailed example from the first level of the protocol is given in Appendix 2, and an example of the second level of the protocol is given in Appendix 3.

In A2, two figures are presented that give a visual overview of the macro-structure of events and alternating foci in the first lesson. In Appendix 4, a table is given presenting in greater detail the data underlying Figures 1 and 2 in A2. These details are provided to give further transparence to how the analyses were conducted.

4 The articles: a brief presentation

This thesis explores 16-year-old general-track students' conversation and reasoning during SSI inquiry group work. The three articles (see the research questions in section 1.2) in the thesis are as follows:

A1: "Intertextuality for Handling Complex Environmental Issues." The authors are Anne Kristine Byhring and Erik Knain.

We identify language resources realized in low- and high-complexity social practices. In the high-complexity event students take on different roles. We show how a fact-reproducing discourse may conceal complexity. We also show how complexity is construed in the interplay between the students' roles in the discourse and resources in language for making multiple voices present. Handling complexity is demanding, and explicit scaffolding is necessary to prevent a potentially complex challenge from becoming transformed into a simple one. The students' sense of purpose and the scaffolding offered were important factors to sustain complexity. Students' dialogues in two group work episodes were analyzed in detail with tools from systemic functional linguistics.

Students' use of modality and projection as grammatical resources opened up for different positions, multiple voices, and various contextual resources. However, making a complex question manageable by fact-orienting and by simplifying the issue may sometimes be the obvious right solution. Finding the right level of complexity (authentic but manageable) is largely a question of finding a balance between scaffolding and allowing for multiple voices. Further research is needed to identify this balance in teaching practices and for the development of SSI learning environments.

The contributions from the two authors

Data were collected during 2008 and 2009 by the second author. Data were transcribed partly by the first author and partly by the second author and analyzed in collaboration between the first and the second author. The text of the article was written as a collaborative project over quite a long period, 2009–2014. The second author started the collaboration with an interest in the uses of the wiki platform. The wiki platform was used in the ElevForsk project to support SSI inquiry learning environments. The first author started with an interest in classroom conversation and civic engagement. A common starting point was argumentation as an important aspect of the nature of science (NOS). Both authors were interested in exploring the educational challenges and the complexity of SSI. During the process of writing the article, the remaining fieldwork for the Ph.D. period was completed by the first author. Experiences from this fieldwork and data analysis resulted in follow-up analysis. The first author's developing theoretical understanding resulted in further rewriting of the analysis and strengthened conclusions. The second author contributed to the further development of the analytical framework. The first author's further studies and analysis of new material with new findings in the ongoing ElevForsk project strengthened earlier findings.

A2: "Characteristics and Functions of Sixteen-year-old Students' Collaborative Deliberation When Working with Socioscientific Inquiry Assignments. The author is Anne Kristine Byhring.

The second article focuses on argumentation. The perspectives from A1 are further developed by exploring in greater detail the alternating perspectives and foci in students' initiatives and responses during group work. The students' argumentation in their report was traced in their oral collaborative reasoning. However, the students' oral deliberation was first warranted in situated purposes of completing the assignment given.

In these students' oral dialogues, deliberative aspects of argumentation in SSI inquiry are documented as distinctively different from strictly scientific argumentation. A complex alternation between reasoning patterns that relate to different activity layers was found. This understanding of deliberative argumentation emerged when analyzing student dialogues, developing the categories of theme (theoria), inquiry (praxis), and inscribing (poeisis). Analyses are presented to account for this emerging understanding. Roberts (2011) used the terms *theoria*, *praxis*, and *techne* to characterize similar reasoning patterns in his Vision 1 and 2 of scientific literacy. In civic deliberation, all patterns of reasoning are necessary to handle SSI, whereas in strictly scientific argumentation, theoria is dominant. I suggest that, such distinctions should also be considered when analyzing and developing instructional strategies for SSI inquiry.

A3: "Framing Student Dialogue and Argumentation: Content Knowledge Development and Procedural Knowing in SSI Inquiry Group Work." The authors are Anne Kristine Byhring and Erik Knain.

This article discusses the negotiation of the *situated common ground*. Decision making on socioscientific issues (SSI) includes norms of diverse funds of knowledge and diverse interests. Arguments and justification may include warrants that cannot necessarily be weighed on the same scale. This calls for deliberation. Common ground refers to the shared knowledge and meaning constructed, construed, and negotiated in the conversation.

Different ways of framing student argumentation are discussed relative to development of scientific literacy in light of Roberts' Visions 1 and 2, when science proper provides a common ground for justification, and when science in society provides a common ground. Our analysis connect the individual and the collaborative, which enables us to examine what goes on in the thematic content as well as at the interpersonal level of language use. The negotiation of the situated common ground is illustrated by two teacher-student dialogue episodes. We suggest that instructional strategies to SSI inquiry should provide a space for students' emerging scientific conceptual development as well as for deliberation as an emerging procedural way of knowing.

The contributions from the two authors

The first author was responsible for the data collection and preliminary analysis of the data that constitute of the body of material from which the episodes for this article are drawn. The

first author wrote a draft of the article and the preliminary analysis were discussed with the second author. The second author and the first author collaborated on the in-depth analysis and the choice of excerpts. The first author took the main responsibility for writing the final article; however, with important contributions from the second author on the detailed analysis of the dialogue episodes.

5 Discussion and conclusion

The research questions of the three articles all explore students' SSI inquiry dialogues and what happens over time in the students' collaborative sense making.

Students' inquiry work and SSI learning issues as well as argumentation skills have been the subject of many research initiatives in the science education community in recent decades (Erduran & Jiménez-Aleixandre, 2012; Jiménez-Aleixandre & Erduran, 2008; Osborne, 2010; Osborne, MacPherson, Patterson, & Szu, 2012; Sadler, 2011). For instance, suggestions for learning environments supporting student participation (Hodson, 2003), moral education (Zeidler & Sadler, 2008), providing out-of-school learning experiences (Roth & Lee, 2004) have been developed. Features of students' socioscientific reasoning (SSR) have been identified (Sadler et al., 2011). In the field of argumentation in science education, teacher training programs have been developed concerning science and SSI content (Erduran et al., 2004; Simon, Erduran, & Osborne, 2006)., The need for teaching approaches to take complexity into account in SSI seems to be an implicit premise in all of these initiatives. The present study contributes to the debates on learning environments and the quality of student talk and argumentation by offering some elaboration of the analysis of complexity and of deliberative argumentation on task solving.

The results presented in the three articles of this study contribute to the development of a methodology regarding the analysis of collaborative student talk, and provide elaboration on the understanding of *complexity* and *deliberation*. Analytical perspectives are suggested to improve the understanding of functions and purposes of student-student conversations in open SSI inquiry group work. A1 provides an elaboration on complexity in students unfolded discourse and present a framework for analysis. A2 addresses theoretical and methodological challenges on the analysis of students' deliberation. A macro-structure of students' developing oral deliberation on task solving across events and lessons is suggested. A3 discusses the common ground and warrants of student argumentation, providing suggestions for further refinement of the framing of SSI as a follow-up of the findings reported in A1 and A2.

As mentioned in the introduction, complexity may occur on three levels, the last of which is the focus of this thesis: 1) topical complexity, related to what concerns true knowledge on a particular field; 2) general complexity, related to the more multifaceted public debate that includes diverse domains of knowledge, or 3) complexity as a characteristic of the situated and unfolding discourse. SSI learning tasks at school usually imply interdisciplinary considerations. SSI also implies personal and ethical as well as societal, economic, and

technical levels (Sterling, 2001; Stewart, 2009). In the present study, the students' language uses and their sense making in classroom situations in and across events and lessons are studied. The students construed complexity during their collaborative inquiry in the different phases of the inquiry process. They deliberated to make decisions on how to solve the task: on how to understand the content, how to collaborate on the proceeding inquiry, and how to compose their writing tasks. A final discussion is provided in section 5.3. on the use of the term complexity in this thesis.

As a concluding result of the studies presented in A1 and A2, it is suggested that certain deliberative skills that are necessary during inquiry on choices of action parallel civic skills in decision making. That is to say that the students' capacities and capabilities for handling complexity and weighing arguments in general can be exercised in collaborative SSI inquiry. These deliberations on task solving may convey important qualities that are necessary in civic engagement and in out-of-school situations. Teaching approaches to argumentation in SSI are needed to develop students' scientific argumentation. However, in this study, it is found that deliberative argumentation must be included if the aim is to address civic engagement.

The complexity of the scientific content was not essential to the students' inquiry in these case studies. This may be due to a lack of content-specific support in the teaching instructions and in the design of the student project. Nonetheless, it was presupposed from the teacher-researcher group that scientific argumentation would be part of students' conversations during inquiry. The intervention in cycle two (see A1) addressed the issue of complexity, but it did not address students' argumentative skills in particular. The focus in the student project was support for the given open inquiry task. The data collection for the case study did not include data on student outcomes from talk and argumentation other than teachers' grading (see A1 and A2).

Future studies on outcomes and the connections between oral and written argumentation could trace more thoroughly the outcome of content knowledge development as well as deliberative and argumentative skills. Nonetheless, the present study shows that students' and teachers' argumentative and deliberative practices in the science classroom are complex and dynamic. There is a need for robust, varied, and pluralistic instructional strategies and for further developing strategies for teaching and learning SSI inquiry. Development of a methodology for teaching deliberation in speech and writing tasks should address support of reasoning on the content, as well as on the collaboration and the composition of oral speech and written texts.

The main research questions of the articles are as follows (for sub-questions, see section 1.2):

> A1: How do students construe complexity in environmental issues in dialogue and wiki texts?

In A1, it is suggested that complexity is not inherent in the content-specific challenges of the given assignment. The complexity concerns, rather, the purpose of the task at hand; that is to say that complexity is construed by the interplay between ideas and their shared

representations by students' discourse roles and resources in language for making them present.

> A2: What are the characteristics and functions of students' deliberation during inquiry into a socioscientific issue?

In A2, students alternating patterns of reasoning regarding the *content*, the *collaboration*, and the *composition* were identified as characteristic features of their deliberation. The alternation between these patterns of reasoning that parallel the Aristotelian terms *theoria*, *praxis*, and *poeisis* is suggested as a macro-structure of deliberation. Tools for analysis may be further developed, as well as tools for educational purposes to prepare students for civic engagement.

> A3: How can SSI inquiry dialogues make space for both content knowledge development and the capacity and capability for deliberation and decision making?

In A3, as a consequence of the findings in A1 and A2 on complexity and deliberation, the common ground of student argumentation is elaborated on, suggesting that instructional strategies for argumentation should concern scientific conceptual development as well as support deliberative and civic argumentation.

Consequently, teacher education should support the development of competencies more relevant for teachers to teach argumentation and deliberation in SSI. This Ph.D. study also point towards future research questions and towards comparing teachers' development of competencies over time. This will concern teachers' competencies relative to student outcomes. The evident potential and significance of science education in civic education, as previously mentioned, has been beyond the scope of this Ph. D. project. Further studies could be, for instance, case studies, intervention studies, or action research studies with beginners and experienced teachers. Teachers diverging in teaching approaches and diverging learning environments may participate to map and elaborate on dialogue, deliberation, and argumentation in SSI and to develop teaching practices on argumentation in general.

5.1 A theoretical issue: In what sense can an alternation between different patterns of reasoning count as deliberative argumentation in SSI inquiry?

For students' conversations during SSI inquiry to count as deliberative argumentation, their conversation ought to be identified as *discussion with edge* and "a disposition toward the rational, toward exploring the nature of difference" (Andrews, 2010). That is to say that it cannot be mere copying, iteration, or continuation. There must be choices of action prevalent, decisions or changes made, drawn from their reasoning. On the other hand, oral conversation is iteration to a great extent. Participants' choices of words and expressions invite the other participants to give the utterance meaning. The responder may provide expansion, repetition, or greater precision. Vague forms of expressing conflict and disagreement sustain a discussion since unsettledness in one event often reappears several times across events. This developing understanding is deliberated on recurrent occasions (see A2) as an ongoing process in events and across events and lessons, resulting in decisions on collaboration and composition.

Argumentation is characterized by a critical aspect. A common understanding in the science education literature is also that at least some evidence ought to be presented, remembering the definition of argumentation: "the evaluation of knowledge claims in the light of available evidence" (Erduran & Jiménez-Aleixandre, 2012). Further, counter argumentation addresses the criteria of exploring the nature of difference. This study has not tracked students' uses of evidence or counter-arguments. To count as relevant argumentation when decisions were made, it had to fit into the perceived common ground. It also had to be supportive of the overall intention of the conversation, namely to complete the assignment. Any utterance leading in this direction was on track and was legitimate as an argument.

First, the students' conversations were informal pal-to-pal dialogues, and to a great extent, the students did not request justification from each other. The purpose and often implicit justification was to complete the assignment. Hence, heavy reconstruction would have been necessary across events and lessons if justification and support were identified on the micro level of the sentence. Therefore, I turned to the purpose of their initiatives and responses in the conversations and found three main patterns of reasoning warranting their deliberation on the macro level: to understand the scientific and thematic content of their chosen issue, to proceed in the collaborative inquiry work, and to compose a report according to assessment criteria and conventions of written work in science lessons. The three purposes were framing conditions for the conversations and decisions on what to find out, as well as on how act at the interpersonal level during collaborative inquiry and on what to include in their written work. The conversations proceeded as a weaving of the three foci, like three threads always present in initiatives and responses.

Students' statements concerned the demonstration of conceptual or theoretical understanding as well as the clarification of interests and beliefs. However, the students' deliberation and statements to proceed with the inquiry or on how to write up a report properly, was even more dominant. Nonetheless, the students' reasoning on collaboration and composition were driving forces for the students' decisions on when to dive deeper into the content and vice versa. Transformation of knowledge across reasoning patterns is essential in inquiry learning as well as in handling complex environmental issues. An understanding of deliberation as an interplay between domains of knowing *theoria*, *praxis*, and *poeisis* may conceptualize these processes.

In section 2.1., similarities are noted between argumentation as alternation between modalities (Andrews, 2010) and these students' deliberation as alternation between different activity layers to understand content, to collaborate, and to compose. The alternating patterns of reasoning create difference and "edge" during the ongoing inquiry activity. In this thesis, a situated context-dependent alternation among three foci is presented as crucial in collaborative argumentation and the transformation of knowledge in SSI inquiry.

5.2 A design issue: How does the case study design provide reliable and relevant data to answer the research questions?

A question is whether the framing of dialogues in the ElevForsk project provided learning environments that were exceptional and whether student-student talk and student-teacher talk emerged as something very different from talk and argumentation in science lessons in existing practices at this school. This question concerns validity and whether the particularities and processes found are representative of recognizable practices, for instance, in a traditional school setting, or to put it in the opposite way, does the framing of this open SSI inquiry student project include affordances to and constraints on the learning environment that makes dialogues and argumentation and teacher support extraordinary or rather common compared to what teachers and students usually experience in science classrooms? Does the analysis of the chosen sequences represent student talk and teacher support during dialogue activities in science classes to such an extent that some analytical generalizations on student talk and argumentation in SSI inquiry may be drawn from this study?

An extensive amount of data has been collected. The audio- and video-recorded student-student conversations that are primary data for the studies presented in the articles are drawn from a body of many hours of recordings. The characteristics and functions of complexity and deliberation accounted for are based on an ongoing hermeneutic interpretation of the material from four years of recordings of student-student conversations. About 150 pages are transcribed (for details on the data, see section 3.5). The recordings share similarities across student groups and cycles of the action research project. The recordings are also supported with field notes and interviews.

As mentioned in the introduction, in Norwegian classrooms, the interactions are dialogic and interactive. However, the school system encourages students to be individual workers. Thus, a high degree of individual seatwork means that the classroom as an oral and public communicative environment is reduced (Calgren et al., 2006). A lack of elaborated whole-class discussions was also pertinent in the student project at Midtby. However, the student-student interaction during group work was extensive. To a great extent, it was the responsibility of the students to conduct and organize their inquiry activities. Perhaps approaches and strategies could have been implemented more systematically to support the students' development of deliberative skills or to compare the effects of different strategies and approaches. It is interesting to note that the student project was conducted in much the same way regarding teacher support during the four years. There were similar kinds of learning environments across different classes and teachers during the four years of the student project, and the characteristics and features of the student dialogues may be traced across, groups, classes, and cycles. This may indicate that the procedural characteristics of group work discussions found in the student project are quite common and familiar to the students.

Regarding the fieldwork and data collection, the following question may be asked: to what degree did the action research strategies influence and frame the Ph.D. case study design? The

studied practices could be characterized as part of the action research development, particularly regarding the teacher-student relation (see also sections 3.3 and 3.4). The data for the case study are recorded material from an open SSI inquiry student project that was a collaborative enterprise between teachers and researchers. The collaborative enterprise was also a follow-up of a curriculum implementation, the Norwegian curriculum Knowledge Promotion of 2006. The study may just as well be characterized as a case study of the teachers' duty to implement a policy agenda and curricular changes, imposed upon the students and teachers by the authorities, and with a helping hand to the teachers from the researchers. In this respect, the action research strategies were not the main driving forces for developing the student project. Accordingly, the development of the student project would be perceived as the teachers' local adaptation to changing curricular goals.

Distributed leadership (see 3.4.) may be perceived as a weak or unclear leadership or as if nobody really wants to be the leader. To some extent, this was the case in the student project of ElevForsk at Midtby, particularly during the last two years. During the first two years, the science teacher who initiated the project together with the researchers from ElevForsk was a natural leader of the team with the researcher from UMB. In the last two years, when this science teacher had resigned as a pensioner, the other teachers continuing the project said that they were short of time. During teacher-researcher meetings and in interviews, they confirmed engagement in developing teaching and learning practices on SSI inquiry. However, during the last two cycles, when I participated in the teacher-researcher group, the teachers did not participate in the data collection or in the writing of articles or book chapters on the ElevForsk project (Knain & Kolstø, 2011). This was partly due to institutional constraints, particularly schedules, lac of time resources for teacher collaboration, and new management at the school after the second year. Consequently, the teachers, to some extent, left the leadership of the action research project to the researchers.

On the one hand, coming from the teacher education community as researchers, we were expected to participate as "experts," and we did so by providing theoretical perspectives and teaching approaches to inquiry described in the literature. On the other hand, we wanted to develop our own practices during the action research as teacher educators, and we felt that we had much to learn from the teachers and their existing practices. In other words, each group had their own agenda for not wanting to take on too much leadership. Teachers and researchers interpreted participation, practices, and aims differently. Kemmiss and Taggart (2008) pointed to this as a common order of action research teamwork; all participants interpreted the practices differently relative to their participation in different communities of practice. As Kemmiss and Taggart described, we found that the researcher's role as an expert in the collaboration work in an action research design became somewhat problematic.

The collaboration was an expression of a wish to promote democratic processes, to develop a local research community at the school, and to explore existing practices to understand what happened better. The collaborating team allowed for different interpretations, as well as for diverging emotional experiences, thus creating a common ground for reflection and discussion and for the development of common practical wisdom.

During the developing collaboration, my research interest in student talk and argumentation was refined into the case study design and the research questions as reported in the three articles. The relevance and reliability of the data required to answer the research questions should be strong, taking into account the richness of the data, due to the extensive amount of time spent on students' group work during the four years of the ElevForsk project at Midtby, including many teachers and several classes. My participation as a researcher in the initial action research project provided opportunities to observe and discuss and to collect data on student talk and deliberation and on learning as it happened.

The crucial role of argumentation in the learning process and knowledge development was nicely phrased by Andrews (2010): "to understand the event itself—the moving spirit and fire of learning as it happens, and knowledge as it is created—requires a willingness to enter the fire, to get to the centre of intellectual inquiry. There is where argument operates" (p. 219). The authenticity of the data as collected examples of existing practices should provide necessary relevance to answer the research questions.

The research questions emerged through the development of the student project and the follow-up of instructional interventions on the wiki platform. Preliminary analyses were discussed in the teacher-researcher group. The final refinement of research questions, however, is the result of my general interest in argumentation as a driving force of collaborative knowledge development.

5.3 An analytical issue: Do the analytical tools account for data and findings and provide transparency and validity on complexity and deliberative argumentation?

The validity and reliability of the analysis at the classroom level as presented in the articles are discussed in section 3.7. However, in concluding this discussion of my Ph. D project, I want to examine the validity of the most central concepts a bit further, in particular those that concern the relevance of the study to civic engagement.

The present Ph.D. study does not provide a discourse analysis on the overarching issue of how situational, institutional, and societal concerns interplay in students' and teachers' language uses, nor does it provide an analysis of how students and teachers are enculturated into institutional norms or how instructional constraints may be resolved at the institutional level. In this respect, theories on organizational learning and studies on learning in communities of practice could inform future analyses of empirical material similar to this study. However, this kind of discourse analysis would exceed the size limitations of this Ph.D. study.

The analytical tools from SFL presented in section 2.5 primarily address the classroom level. Hence, the link from the classroom level to civic debate must be provided. The analyses of intertextuality, topical resources, and situated contextual constraints and affordances exploring complexity in A1 and deliberation in A2 provide insight into the framing of the dialogues and the common ground of initiatives and responses in the classroom as discussed

in A3. In a similar way Johansen (2013) described the rhetorical framing as the conditions mediating institutional regulatory and instructional norms of the science classroom. The norms of public debates, expert panels, or politics frame the discourses in similar ways. It is a matter of context-dependence and situated negotiation on legitimate language uses relative to a common ground.

In this study, *complexity* and *deliberation* in student discussions on SSI inquiry resemble complexity and deliberation as part of common civic debates. Hence, a final remark is necessary on the use of the term *complexity* in this thesis. Complexity is explored in this study at the classroom level as an unfolding discourse, but it should be noticed that the use of the term complexity is not absolutely consistent through all three articles. Sometimes, complexity is also used in a more general way, for instance when speaking of SSI as involving "wicked problems" (Murgatroyd, 2010). Further, complexity may also regard the difficulties of evaluating claims of true knowledge within for instance a complex science topic.

In fact, the term complexity may seem somewhat inconsistent here. However, the characteristic complexity of the unfolding classroom discourse may indicate how SSI learning situations can simulate the complexity of civic discourse. The complexity of the civic discourse also comprises both specific topical and more general levels of complexity. It should be possible to trace complexity, in civic debates as with classrooms, as low- or high complexity events (see the table on low and high complexity in A1).

The students' alternating foci in initiatives and responses (A2) with the purpose of completing the given assignment was the students' way of dealing with the complexity of the SSI task at a manageable (low/high) level. The conceptualization of a macro structure of deliberation on task solving as alternation between activity layers and reasoning patterns was developed through the emerging understanding of the studied phenomena. The students' situated reasoning on content, collaboration, and composition was found to be the driving force behind student deliberation. Identifying alternating reasoning patterns linked to decision making and causes of action would be appropriate to the analysis of any civic engagement as well.

The analysis of the complexity and the deliberation presented revealed the urge not only to consider science within societal issues but also to consider society within the science lesson discourse, The democratic discourse ought to be prevalent in SSI activities in science classrooms.

5.4 Summary

Theory on argumentation and deliberation, including Toulmin's argumentation pattern (TAP) formed the starting point for analysis of student argumentation in this Ph. D. project. However, analysis using TAP became displaced. During the process of analysis, an understanding of deliberation as alternation between different foci or patterns of reasoning emerged. The alternation concerned the content, the collaboration and the composition. Perspectives on analysis were gleamed from theories on language use: social functional linguistics (SFL), conversation analysis, and rhetoric. The "wicked" (Murgatroyd 2010)

character of socioscientific issues (SSI) may be one reason for the difficulties encountered in analysis. Argumentation in science classrooms may be modeled on the practices of 'science proper', as in experimental work and inquiry learning. Consequentially, argumentation will be oriented around matters of truth, or at least on matters of probability. Regarding less clear-cut matters of opinion and priorities of action, as is often the case in deliberation on socioscientific issues (SSI), neither science knowledge alone nor empirical evidence may provide sufficient grounds for sorting out the question at hand. These are onsiderations on the one hand of truth-seeking argumentation and on the other hand argumentation as conflict management. This is also an undertow of a long-standing issue in the field of argumentation: the relation between dialectical philosophical aspects and rhetorical aspects of argumentation.

The Ph. D. study explores 11th grade student's inquiry dialogues in an open SSI inquiry student project. Complexity and deliberation are traced in use of language. The exploration of complexity and deliberation takes cognizance of the multifaceted character of SSI. Complexity is explored at the classroom level as a characteristic of the unfolding discourse. Students deliberate on task solving by alternating between reasoning patterns relative to the focus of the activity. In this study, complexity and deliberation in student discussions resemble complexity and deliberation in civic debate. The study consists of two cases, reported in three articles. Referential, interpersonal textual and contextual features of students oral language uses are identified and discussed.

In the first article specific characteristics of situated high and low complexity are identified. In the high-complexity events students take on varying roles. We show how a fact-reproducing discourse may conceal complexity. In the second article a macro structure of students' deliberation on task solving is described as an alternation between focus on the content, the collaboration and the composition. The conceptualization of students' patterns of reasoning in this thesis parallel the Aristotelian terms *theoria*, *praxis* and *poeisis*. Roberts (2011) linked the Aristotelian terms to different undertakings of scientific literacy, Vision 1 and 2. Vision 1 addresses theoretical scientific concerns, and Vision 2 addresses practical and technical societal concerns as well. In the third article we discuss the framing of the situated common ground of the dialogues. The criteria that constitute a common ground for argumentation and decision making may be part of what is negotiated in the process of meaning making.

The analysis of complexity and deliberation revealed the urge not only to consider science within societal issues but also to consider society within the science lesson discourse. The democratic discourse ought to be prevalent in SSI related activities and exploration in science classrooms in order to stimulate skill development in decision making aimed at authentic civic engagement. Oral deliberation on task solving is pertinent during group activity. Scientific argumentation as often defined in the literature on argumentation in science education was scarce in these students' oral activity. Further research on teaching and student argumentation is suggested to meet the need for supporting students' scientific argumentation, as well as argumentation and deliberation in general. It is further suggested that SSI learning situations can simulate the complexity of civic discourse, involving specific topical and more general levels of complexity.

The study provides a conceptualization of *low and high complexity*. The study also suggests a macro structure of students' deliberation interwoven by three alternating patterns of reasoning focusing on *the content*, *the collaboration*, and the *composition* of oral and written argumentation. These components are also found to be the driving forces for sustaining complexity, inquiry, and meaning making. These conceptualizations and suggestions concerning the understanding of SSI inquiry dialogues and the understanding of students' argumentation in SSI are the most important contributions of this Ph.D. study.

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Part 2: The articles

6 **A1:** Intertextuality for handling complex environmental issues

'This is the essence of intuitive heuristics: when faced with a difficult question, we often answer an easier one instead, usually without noticing the substitution.'

(Kahneman, 2010, p. 12)

Abstract

Nowhere is the need for handling complexity more pertinent than in addressing environmental issues. Our study explores students' situated constructs of complexity in unfolding discourses on socio-scientific issues. Students' dialogues in two group-work episodes are analysed in detail, with tools from Systemic Functional Linguistics. We identify the significance of intertextuality in students' realisation of low- and high-complexity discourses. In the high-complexity event, students take on different roles and use modality and projection as grammatical resources for opening up, for different positions, multiple voices, and various contextual resources. Successful handling of complexity is construed by the interplay between the students' roles in the discourse and resources in language for making multiple voices present. In the high-complexity event, the handling of complexity is guided by the students' sense of purpose and by the instructional scaffolding offered. Handling complexity is demanding, and explicit scaffolding is necessary to prevent a potentially complex challenge from being treated as a simple one.

Keywords:

Socio-scientific issues; reasoning; complexity; intertextuality; student dialogues; inquiry

6.1 Introduction

An important goal of education is to prepare students for participation in a rapidly changing world, for sustained inquiry, responsible action, and decision making in out-of-school contexts. Education must transcend the knowledge advancement that is relevant only in a school setting and help students become users of knowledge for specific social purposes (Jenkins, 1994), which implies participation in democratic processes and taking personal action on complex societal issues. However, as Kahneman (2010) notes, when a problem becomes complex, our human intuition often simplifies into understandable tasks that are manageable, but that does not always mean that we deal with the complexity of the problem.

Nowhere is the need for handling complexity more pertinent than in addressing environmental issues. Environmental challenges consist of interconnected clusters of profound challenges, as identified by (Gore, 2013): an interconnected economy with changing capital flows, labour and consumer markets; a planetary communication and information grid connecting people, devices, and robots; shifts in economic, military, and political power; and rapid and unsustainable growth. These challenges are further framed by global warming. Gore points

out, 'There is a clear consensus that the future now emerging will be extremely different from anything we have ever known in the past. […] There is no prior period of change that remotely resembles what humanity is about to experience' (Gore 2013, Introduction). In news media, students are already confronted with complex issues related to the local and global environment. These issues challenge communities and make complexity part of citizens' everyday life.

Part of complexity is that the issues may be ill-defined in terms of knowledge domain: they have ethical and political dimensions and are significantly part nature and part society. They tend to be 'wicked problems', in that solutions are not true or false, or good or bad. Several explanations may be considered. Wicked problems have no definitive formulation. They are symptoms of a higher-level problem (Murgatroyd, 2010).

In science education, there is a sustained effort to develop teaching practices to cope with such socio-scientific issues (SSI) (Kolstø, 2001; Sterling, 2001; Sadler, Klosterman, & Topcu, 2011; Sadler & Zeidler, 2005; Zeidler, Sadler, Applebaum, & Callahan, 2009). Established scientific knowledge is problematic in such complex issues (Jenkins, 1994) when risk and uncertainty come to the forefront (Giddens, 2009; Kirch, 2009, 2012). Further, teachers are insecure on how to deal with environmental issues, and perhaps science teachers even more so than others (Borg, Gericke, Höglund, & Bergman, 2012). These problems challenge the practices focusing on the transmission of established knowledge (Hodson, 2003; Roberts, 2007).

In this study we explore student dialogues in an open-inquiry student project in an attempt to understand how students construe complexity. Our aim is to develop SSI-literacy competences that enable participation, collaboration, and procedural skills, rather than mere acquisition of generalised canonical knowledge and facts (Kolstø et al., 2006; Ryder, 2001; Sadler, 2011).

Our research question and sub-questions are as follows:

- How do students construe complexity in SSI?
  - What language resources are important for analysing complexity in students discourses associated with SSI?
  - How are these resources realised in discourses differing in degree of complexity?
  - How can learning situations be designed to sustain high-complexity discourses?

The first of the sub-questions is answered primarily by our methodological approach; the second through our data analysis; and the third in our discussion of the results.

Socio-scientific reasoning (SSR) has been defined as constituting of: (1) recognising the inherent complexity, (2) analysing an issue from multiple perspectives, (3) appreciating the need for ongoing inquiry, and (4) scepticism. This definition of SSR is an effort to operationalise SSI research into teaching practices and student outcomes (Sadler, Sasha, & Scott 2007; see also Sadler, Klosterman, & Topcu 2011). Our research questions, in

particular, focus on recognising the inherent complexity and what complexity looks like in situated practice. Equally important is What happens in students' discourses when students fail to recognise an issue as complex?

6.1.1 Complexity and intertextuality in SSI

Various notions of complexity in SSI can be found in the literature, in various degrees of generalisability. On the generalistic side, Walters, Aydelotte, and Miller (2000, p. 354) list six attributes of complex issues: (1) the degree of conflict over the issue, (2) the number of stakeholders, (3) the level of confidence in the information on the issue, (4) the number of alternatives, (5) the knowledge of outcomes, and (6) the probability of the outcomes. Characterised along these attributes, a problem may be well-structured, moderately structured, or ill-structured. On the more interactional and situated side, Bravo-Torija and Jiménez-Aleixandre (2012) base different degrees of higher and lower complexity on how students apply theoretical models. Higher complexity means being able to integrate two models offered to the students (of marine resources management) into the students' own solutions. We understand complexity as a quality of the unfolding discourse rather than an inherent characteristic of the issue. Complexity can legitimately be considered in three levels of specificity: universal characteristics of any issue, characteristics of a specific issue, and complexity in students' unfolded and situated discourses. Our focus is the latter level. Little research has been done into how complexity is construed in unfolding discourse. Our exploratory study is a contribution to fill this gap.

The range of possible perspectives to draw on is much larger in SSI than in established scientific knowledge, and the criteria for selecting and judging various sources are harder to define. In order to investigate how students construe complexity, we need to identify certain characteristics of language use. To achieve this, we have chosen to analyse the presence of multiple voices in students' texts. This bears directly on the SSR competencies referred to previously. For more than one solution to be considered, multiple voices must be made present in students' meaning making. Multiple voices may open up a space for negotiation and the judging of evidence. Further, when different perspectives are recognised, diverging interests and potential biases become legitimate, and choices of action may be deliberated.

Further, we investigate multiple voices as the presence of intertextuality. It is by intertextuality that multiple voices can be brought into discourse. In the methods section, we describe a theoretical framework that allows us to analyse intertextuality, and to analyse students' dealing with complexity as a feature of language use in ongoing discourses.

Note that intertextuality is of general importance in education. Intertextuality is how texts and situations that are not immediately present can be made present by language in interplay with context. This is generally considered important in students' writing (Scollon et al., 1998). Intertextuality enables students to connect practical experience and everyday language with the particular linguistic features of scientific knowledge (Fang, 2006; Pappas, Barry, & Rife, 2003; Varelas, Pappas, & Rife, 2006) so that 'spontaneous' concepts are connected with 'scientific concepts' (Vygotsky, 1986). Intertextuality as a dialogue between a multitude of

perspectives, explanations, interpretations, claims, and foundations is important to sustained inquiry (Scollon, Tsang, Li, Yung, & Jones, 1998; Wells, 1999).

Moreover, we consider complexity as construed by participants, in acts of meaning, as interplay between the demands of the situation, the dispositions of the individual, and the individual's previous experiences with similar situations. Thus any act of meaning can be considered as the transformation of experiences into meanings according to the interests of the speakers, the resources available, and the speakers' competence (Kress, Jewitt, Ogborn, & Tsatsarelis, 2001).

Complexity, however, has no self-evident place in these transformations. To the contrary, there are important aspects of human cognition that tend to downplay complexity. Coping with complexity may be contrary to intuition (Kahneman 2010). Kahneman describes System 1 thinking as intuitive thinking and System 2 as a more effortful mode of thinking. System 1 is based on associations and coherent patterns of norms and the prototypical, familiar responses, and challenges. System 2 comprises more complex deliberations, concentration, agency, and choice. When we have no skilled solution available, in situations of uncertainty, when confronted with difficult questions, a complex problem tends to get transformed into a simpler one. Thus it can be managed largely with System 1 thinking. We point out that uncertainty may not arise only in relation to the issue and how to go about it, but also in familiarity with texts, tools, and participants' roles and purposes in the school context. By analysing complexity as an aspect of discourse, both types of uncertainty can be analysed.

Further, students draw on a broader interpretational framework of genre. *Genre* is the social norm that provides an overall script for how to act in a particular situation. In familiar and predictable situations, genre takes the shape of common-sense assumptions, and it is consistent with prior beliefs and values (Miller, 1994). Following Kahneman, the familiar genre could be handled by System 1 thinking.

In the following section, we investigate how students include and transform multiple voices by intertextuality. We do this by presenting detailed analysis of two learning-episodes in which students were expected to experience a need to transform textual resources into new texts. We show an example of how a potentially complex challenge gets construed as a 'low-complexity' issue, and another example of how a potentially complex challenge was sustained in students' inquiry.

6.1.2 An interdisciplinary school project with 11th-grade students in general track

The empirical material was collected during two years, within two cycles of an open-inquiry student project. The school is a combined vocational and general track school located near to Oslo, Norway. The project group consisted of the authors and a group of teachers, and the aim was to implement several competence goals in the Norwegian curriculum in social and natural science and Norwegian (native language). The main goals were as follows:

- Approach interdisciplinary issues within the realm of sustainable development with an interdisciplinary approach (Norwegian language, natural sciences, and social sciences)

- Provide teachers and students with an experience of collaborating on a collective product by creating a wiki
- Avoid passive 'copy-and-paste' strategies in text production and promote transformation of textual and contextual resources by inquiry into interdisciplinary problems.

An important ambition from the start was to confront students with a complex challenge that could not be solved by cut-and-paste strategies, strategies which, in particular, the science teacher found problematic. The following year, an adjusted project started with two new classes and an expanded group of teachers, labelled 'cycle 2' in this article. For practical institutional reasons and constraints (e.g., teachers allocated to different subjects and grades, and each cycle running once a school year), different groups of students and different teachers (except for the science teacher) participated in the two cycles.

6.2 Method

Our methodological tool is based on M. A. K. Halliday's functional theory of language. In Halliday's (2013) framework, language has components of meaning that are always simultaneously present in language as metafunctions. Human experience is construed by the ideational metafunction into patterns of meaning that constitute a model of some real or imagined world. While doing that, we always also enact to other people in the interpersonal metafunction. However, we would not be able to do this without means for organising discourse into meaningful chunks – that is, texts. This is done in the textual metafunction.

Each metafunction has contextual correlates. The contextual correlate with the ideational metafunction is the *field* (*what is taking place, what the participants are engaged in*); the contextual correlate with the interpersonal is *tenor* (w*ho is taking part and the nature of the participants and their status and roles*); and the contextual correlate with the textual metafunction is *mode* (*what role language plays and what the participants expect language to do for them in the situation*) (Halliday & Martin, 1993, pp. 32–33). Our approach to analysing multiple voices by intertextuality is within this overall framework. In the following analysis, we describe specific aspects of the metafunctions in unfolding language, and we interpret and describe them in the contextual categories of field, tenor, and mode.

This situational analysis need to be connected to a broader contextual frame of experience and meaning potential. Individual choice in the situation is connected to broader patterns of discourse at a cultural level by genre:

> The rules and resources of a genre provide reproducible speaker and addressee roles, social typifications of recurrent social needs or exigencies, topical structures (or 'moves' and 'steps'), and ways of indexing an event to material conditions, turning them into constraints or resources. In its representation of and intervention in space-time, genre becomes a determinant of rhetorical *kairos* – a means by which we define a situation in space-time, and the opportunities it holds. (Miller, 1994b, p. 71)

Werlich (1983) analyses text types as part-text structures related to contextual foci, as description, narration, exposition, argumentation, and instruction. According to Werlich, genres are realised by mixtures of text types.

In the research literature, intertextuality is connected to terms such as *voice*, *style*, *appropriation*, and *discourse role*. Pappas et al. (2003, p. 443) define four categories of intertextuality based on an investigation of 'read-alouds' of science information books: (1) intertextual links that involve connection to written texts, other texts orally shared, other media, and prior classroom discourse; (2) connections to hands-on exploration; (3) connections to recounting events; and 4) connections to 'implicit' generalised events. In our analysis, students' use of explicit text in category 1 is examined, as this kind of intertextuality is important to SSI, and it was the focus of the task provided to students.

It is, however, specific aspects of Halliday's framework that are utilised in analysis, as developed by Martin and Rose (2007). There are two important resources in language for introducing multiple voices. *Projection* is a way of representing ideas or phenomena by making a clause represent the content of another clause, as a resource for reporting, representing views, constructing dialogue, and framing questions. Another important resource for introducing multiple voices is that of modality. Modality opens up a semantic space between yes and no, either by negotiating services (meanings between do it/don't do it) or for negotiating information (meanings between it is/it isn't).

This approach can be supplemented with notions from Scollon et al. (1998), who differ between 'boundaries marked' and 'boundaries unmarked' ways of representing discourse in text. Discourse is marked by quotation marks, indirect speech, and quotation marks. Projection is a marked type. The unmarked type is presupposition, negotiation, metadiscourse, and irony. Modality belongs to this group (negotiation). In the marked ways of representing, the perspective is from the represented context of discourse, whereas in the unmarked way of representing, the perspective is from the representing context, and the speaker takes a larger responsibility for the represented meanings (Baldry & Thibault, 2005). In our analysis, irony has also been identified.

Further, we also trace chains of lexical words as thematic patterns (Lemke, 1990) Such pattern may be intertextual by including the ideas and knowledge domains from various discourses.

Our methodological approach can thus be summed by the WHAT, WHO and HOW categories from Macken-Horarik (2002).

Table 1

Aspect of situational context	**Resource for intertextuality**
WHAT is taking place; what are the participants are engaged in?	Representing clause by another clause (projection), metadiscourse,
WHO is taking part; what is the nature of the participants and their status and roles?	Negotiation (modality), irony
HOW is language organised into discourse?	Referent chains, presupposition

In addition, the category WHY is an interpretation of an episode into text type and social purpose as genre.

To illustrate our methodological approach, consider the utterance:

I don't think that 'trolley buses are so healthy anyway'.

This sentence consists of two clauses. One is a projecting clause, 'I don't think that'. This is a 'think' clause representing the ideas of the projected clause 'trolley buses are so healthy anyway'. Thus the semantic focus is on the projected clause, and the projecting clause is basically putting it in a speech bubble, making it someone's voice, 'I'. There is also a rather complex play of negotiation by modality. The clause is grammatical metaphor for modality; 'think' places the projected clause on the scale of probability. This is also done by, 'so' and 'anyway'. By these intertextual realisations, multiple voices are present. One is immediately present 'I'; others are opened for different degrees of necessity and truth. Actually, the modality and negating 'do not think', and 'anyway' is an implicit call; this we will return to in the analysis section.

In a sense, any act of meaning is an exchange between previous experiences and the use of the words in situations and our perception of the addressee. We find this perspective in Bakhtin's notion of trialouge (Bakhtin, 1986), but also in Dewey's principle of continuity (Dewey, 1997). In our study, we delimit ourselves to explicit intertextuality, but it will follow from our description below that a clear distinction between implicit and explicit intertextuality cannot always be made.

The data materials collected, relevant to the study in this article, were the video and field notes from observations of students' group work during four weeks, interviews (during and after the project period), and the wiki pages, including the editing history and discussion notes. Groups of students were selected pragmatically. Data were collected for all groups in one class in cycle 1, and data were collected for 6 out of 12 groups in two classes in cycle 2. Although the students varied in academic ability, many students were well immersed in the practices of 'doing schooling' and 'doing science' (Schleppegrell, 2001). There were very few disciplinary problems.

In the discussion notes and the goals of the project, different ways of dealing with complexity caught our attention through early review of the data from cycle 2, compared to cycle 1, and the groups selected were typical of each cycle in this respect, based on preliminary analysis. From the full set of interaction data (nearly 4 h of video recording in cycle 1 and 4 h video and 3 h audio recording in cycle 2), events were selected for further analysis (Derry et al., 2010). The two groups presented in this article were the focus of the data collection, because they were talkative and well-motivated students. Interaction data analysed consisted in 1 h 40 m of video recording for the group selected in cycle 1 and 1 h 30 m video recording and 14 m audio recording for the group in cycle 2. Next, we developed an analytical framework for examining different ways of handling complexity, as outlined previously.

Computer-assisted qualitative data analysis software, Atlas.ti was used during the analysis. Atlas assisted in data analysis by providing tools for memo writing and coding across different documents (text, audio, and video) and comparisons across student groups. Codes for critical issues according to the project goals were initially developed to serve the needs of the school project group, but were later refined and extended for this article by analysing linguistic features in the what, who, how, and why, focusing on multiple voices. That is, each event was analysed first in the ideational metafunction, then in the interpersonal metafunction, and, finally, in the textual. Detailed analysis at the clause level was interpreted at the discourse level (purpose) and reflected on in memos at the clause and discourse levels of analysis. Through an abductive process and discussions between the authors, a refined, shared understanding of what was going on during these episodes was developed.

Students' prior competencies are not controlled for, but the teachers did not consider the participating students unusual in important ways. According to the science teacher, there were greater variations in interests and abilities between the two classes participating in the second cycle than between students participating in each cycle. We emphasise that the overall textual practices are strikingly different between the students participating in cycle 1 and the students participating in cycle 2. Thus, the differences between the discourses identified in this article are likely owing to differences in project framing and not due to the students selected in a particular cycle. Our analysis strengthens this assumption by showing how students' texts can be related to specific aspects of the intertextual resources available in the two cycles.

6.3 Results

Episode 1

The data for the selected episode in cycle 1 consists of a Wikipedia page on which two female students found information on trolley buses, video recording of their talk about this page, and the wiki text that the students produced.

What: The teachers wanted to provide a thematic direction for students' work, but also provide freedom for the students to go in a direction of their own choice and to start an inquiry into issues that were important and interesting to them. These concerns were addressed by creating a start page in the wiki, with paragraphs, each describing a broad issue

consistent with primarily the natural science curriculum (six issues), but also with issues from the social science curriculum (two issues). This group's starting page was linked to the given issue: 'the consumer in relation to climate'. This theme opens up a potential for complexity, comprising contested claims, dilemmas, uncertainties, and ethical concerns. Each section contained a link to an empty wiki page – the start of the students' further inquiries. There were no support materials for how to structure a network of wiki pages or a given wiki page in the assignment.

Who: In the session selected for analysis, two girls are sitting in front of a PC monitor. In other data recordings, G2 takes a leading role in the group; the other two students in the group trust her opinion. (A third group member was not present at the time.) They look at resources on the Internet to use on a wiki page they are creating on trolley buses as environmentally friendly transportation.

How: The exchange of questions and answers in the oral mode evolves from something G1 reads on the Internet, and G2 gives a response, typically an evaluation and/or follow-up. In this session, G2 repeatedly closes possibilities to further inquiries, as illustrated.[1]

01: G1 I don‟t think that 'trolley buses are so healthy anyway.
02: G2 Why not?
03: G1 Because it makes… pollution because of the electricity cables, …and it must be 'very expensive as it is controlled by electricity
04: G2 Yes, but it doesn‟t matter… how !expensive it is, that is not what is…. we are supposed to find out how to 'pollute 'less, they have to pollute less than ordinary gasoline buses.
05: G1 No, but they don‟t have 'gas, but those 'cables pollutes.
06: G2 I don‟t think they pollute 'as much
07: G1 ((QUITELY)) No

Multiple voices are introduced by intertextuality as *projection* ('I don't think that. . . .') and as *negotiation* (modality) ('so' . . . 'anyway') in the first utterance as already shown (line 01): 'I don't think that 'trolley buses are so healthy anyway'. By 'don't think' and 'anyway', this sentence becomes intertextually connected to their wiki page (shown in Figure 1). This initiative from G1 invites multiple perspectives and voices. G2 responds to this invitation to further develop the theme. However, the students encounter a complex issue, and unsettledness apparently occurs, as different notions of 'pollution' seem to be at stake. G1 seems to consider pollution in broader terms than G2 (in line 05). G1 says, 'No, but they don't have gas, but those cables pollute'. What happens in the following exchanges is that complexity becomes reduced as a difference in quality (in terms of pollution) into a difference in quantity. G2 refers (in line 04) to what 'matters' and what they 'are supposed to find out',

[1] Dialogues are transcribed with a system from Du Bois et al. (1983). However, intonation units are not separated in lines. Continuing speech flow from one person is written down continuously.

suggesting that G1 is off task. What the task is could also be questioned, but it is not. The claim in the first line, when offered, provided openings for considering social and economic issues in the discussion. Thus, a possible complexity is not followed up on. The wiki page produced by the students at the end of the project that they were working on in the event is shown in Figure 1.

Den første trolleybussen som kom til Norge kom til Drammen i 1909. Det tok en stund før bussene kom til Oslo, Stavanger og Bargen de kom henholdsvis i 1940, og 1947. Trolleybussene hadde en stor nedgang i 1960- årene da flere og flere familier fikk egne biler.

En trolleybuss er en buss som er drevet av elektrisitet.
Den gir ikke fra seg avgasser og den er stillegående. Den forurensningen man kan se, fra en trolley buss er kjøreledningene.
Trolleybusser bruker likestrøm og kan kjøre i opp til 80 km i timen.

Kilde tekst:
Wikipedia, http://no.wikipedia.org/wiki/Trolleybuss
Kilde bilde:
Rutebilhistorisk senter, http://www.rhf.no/galleri.htm

Figure 1. The wiki page created by the students that discusses trolley buses and pollution.

The caption and text translated:

> The first trolley bus that came to Norway came to Drammen in 1909. It took a while before the buses came to Oslo, Stavanger, and Bergen, where they came in 1940 and 1947, respectively. Trolley buses had a big decline in the 1960s, when even more families got their own cars.
>
> A trolley bus is driven by electricity.
> It does not emit exhaust gases, and it moves silently. The pollution that you can see from a trolley bus is the catenaries.
> Trolley buses uses direct current and can drive as fast as 80 km per hour.

What: On the wiki start page, the students offer introductory sentences with links. The following sentence is linked to the Wikipedia 'trolley bus' page (the underlined word is the source link):

> Another alternative to buses driven by gasoline or diesel is Trolley buses. They are more environmentally friendly, as they are driven by electricity.

The second sentence can be interpreted as the claim taken up by G1 in line 01: 'I don't think that trolley buses are so healthy anyway'. Further, in 05 and 06, the different notions of pollution are presented as emission and visual pollution, which is likely what spurred the discussion shown previously.

Who: The participants in this dialogue are the girls in the group, and a likely audience for their written work is peer students, teachers, and the university researcher. In the interpersonal meaning, there is little trace of the authors, as would be expected in an exposition. There is no trace of modality (grades of truth and necessity).

How: It is clear that 'trolley bus' is the main participant in the theme developed through the text. The participant is developed from one clause to the next, thus building the global cohesion and meaning of the text: 'The first trolley buses . . . the buses . . . they. . . .' The image included shows trolley buses in Bergen in 1973 (information from the source link), thus showing a particular trolley bus, an example of the general information in the text. This text is evidence of the students' interpretation of the important information to include from their source. It is an example of exposition (Werlich, 1983), offering some key constituents of the participant 'trolley bus', the main participant developed through the students' text. Compared to the Wikipedia source drawn on in the group discussions, the texts are selected sentences cut from the source and pasted into the editor, and only slightly transformed. What the students omitted was most notably the uses of trolley buses in different parts of the world and comparisons with trams.

Why: The students omitted the social world *around* the trolley bus. The groups' text was about trolley buses, as such, and not choices, dilemmas, and the socioeconomic structures that would make or not make trolley buses a viable choice. The claim made about their environmental friendliness, contested in the students' talk, is not made explicit in the written text.

Thus, these students simplified, through their choices, the challenge intended by the teachers and in the project goals (multiple voices and writing in deliberative genres). There were only a few transformations from a single source; the students made the exposition (Werlich, 1983) about trolley buses consistent with a factual reproduction genre. The intended complexity was left unresolved in talk, and it was not visible at all in the presented text.

Interventions

The teachers and researchers concluded that the students relied on familiar fact-reproduction practices with the copy-and-paste techniques. The teachers and researchers also concluded that this happened because the students were insufficiently scaffolded in the first cycle. This conclusion is plausible, as a tendency to resort to factual reproduction in SSI has been identified by other researchers (Furberg & Ludvigsen, 2008), and scaffolding is important to inquiry-based approaches (Hmelo-Silver, Duncan, & Chinn, 2007). The project group concluded that there was a need to be more explicit about the purpose and to support students explicitly. Students were provided textual resources intended to stimulate them to find, select, combine, and evaluate relevant opinions and factual knowledge. The students were asked to

create a log page, a statement of a problem to be inquired into, a planning page, and a 'results' page. This way, students could be expected to separate the process and product and make the process visible through their writing. The report that the students should write from their project was guided by a description of the subheadings, assessment criteria, and what it meant to be high or low achieving on each criterion. In addition, it was requested that each project in the next cycle included an empirical investigation to provide students with authentic data. The interpretation of these data should relate to other available sources of knowledge. In sum, these changes made the intertextual challenge more explicit and offered resources intended to help the students construe and handle complexity

Episode 2

An example of a dialogue pattern in the second cycle that is qualitatively different from anything recorded in the first cycle follows. These few patterns of dialogue show new features of critical importance, when compared to those in cycle 1. In this cycle, the students were expected to formulate a problem intended to guide them through their inquiry. The problem formulated by the students was What is required to make hunting unethical? As in the previous episode, this formulation opens up a complex issue comprising conflicting claims, dilemmas, and ethical concerns. There are more examples of these features in data from other groups in the two classes participating in cycle 2.

The four girls sit at a square table in a classroom. Other groups are also present in the room. The teacher is supervising the different groups. The teacher visits each group once during the 1-hour session and reminds them about using the assessment criteria (just before the following excerpt). G1 sits in front of a PC. All four girls actively engage in discourse. G2 is partly hidden behind G1, as seen from the video recorder, and sometimes it is difficult to see whether G1 or G2 are talking.

01: G1 ((READS FROM SCREEN)) <SIT Animals should 'not suffer unnecessarily…and even though there is a saying that rules exsist to be broken= SIT>, … e=h that does not apply to ((GIGGELS))
02: G1: Doesn't that apply in --
03: G4: I think that it became sort of… disconnected
04: G1: [I think we should put something, like funny, in]
05: G4: Something a bit ironic ((LOOKING INTO CAMERA))
06: G1 ((PRETENDING TO WRITE ON THE KEYBOARD, OVERLY SERIOUS))
07: G2 But article and report and such, that isn't really--
08: G1 Sure, sure, sure. Articles can be funny, and ironic and so on
09: G2 Can they?
10: G4 Isn't that essay
11: G3 …isn't that essay
12: G1 Think that it may be a little in it, can't it ?
13: G3 ((MUMBLING WHILE EATING APPLE))
14: G1 Or it may be just like ((PRETENDING TO WRITE ON THE KEYBOARD, OVERLY SERIOUS))
15: G1 (4.0) < SIT Animals should not suffer unnecessarily=SIT>
16: G4 Because that is wrong ((IMATATIVE VOICE))
17: G1 And that no more animals than necessary are to be shot
18: G2 Are there more than necessary there?
19: G1 But we have said that
20: G2 Have we?
21: G1 We are not going to include any rules now, now we are only going to give an 'introduction ((MOVE HER HANDS AWAY FROM HER AND UP)) to what can happen if you don't follow the rules
22: G2 Yes
23: G4 We should include such things…when are we going to include the ethical stuff, then?
24: G1 When it comes
25: G4 But that's it- the ethical stuff doesn't mean that hunting is !all !wrong. A lot of people have different opinions about it
26: G2 [animals should not suffer unnecessarily] ((REEDING FROM THE SCREEN))
27: G4 I don't believe ((SHAKING HER HEAD)) that hunting is completly wrong. I believe that it is worse to let animals die from starvation
28: G3 Okey, on the ethical correctness thing we need to include --
29: G4 If it is done properly--
30: G3 What PK said, the foxhunt in E=ngland, the thing about klappjakt ((HUNTING BY CLAPPING HANDS)) ((PK IS A HUNTER INTERVIEWED BY THE GROUP))
31: G4 That is wrong
Those two ((G3 or G4))
32 32: G3: Yes, that is wrong
33: G4 (4.0) We need to clarify what klappjakt is, if it is something one does not know

34: G2 [animals should not suffer unnecessarily]
35: G2 Violate this law is, no to violate this law, subject to punishment, is subject to punishment
36: G2 [uh-hm]
37: G1 ((LOOKING AT G2)) It is not only that the law violates ((INAUDIBLE)) what is subject to punishment
38: G2 No, but it is then…
39: G4 If one violates--
40: G1 Violation of the law
41: G4 40: G4: If one violates the law, you can go to…you can loose the hunting …. (1.0) ((G1 TYPES ON PC)) loose
42: G3 Hunter
43: G4 Have lost his
44: G3 Hunting certificate
45: G4 The hunting certificate for x years, or, is.. the sentence may be very strict
46: G1 Believe that's what he said, [or] the sentence may be very strict
47: G2 That is good
48: G4 < SIT the sentence, the sentence is strict SIT> ((DICTATING))
49: G1 48: G1: No, that is not for sure, it may, it depends on what
50: G1 The sentence may be strict ((TYPING))

What: The three main thematic patterns identified in the transcript are meanings of animal suffering, rules and regulations, and punishment. There is also a short passage (lines 7–12) in which what genre norms would apply to their text is in question. Here, they seem to draw on shared experiences with important genres in the native language (Norwegian) school subject not addressed explicitly. Other voices are made present with simple fact-stating clauses. The clause 'animals should not suffer unnecessarily', which is stated repeatedly during this session (lines 01, 15, and 26), can be found in many public documents regulating to hunting, some of which are listed on the groups' log page.

Thematic meanings are introduced as multiple voices, including their own ideas, by projections: 'I think that. . . .', 'I think we should', etc. In line 30, the projected clause is what the hunter PK had said: 'What PK said, the foxhunt in England, [. . .]'. Line 01 has an unspecific reference: 'there is a saying that . . .' The marked boundary of the projection is softened by projecting it as not only a 'saying' but projecting it as an existential clause, 'there is . . .'.

Who: Students take on different roles in the group work. G1 writes the text that will become their final document, and thus is the primary agent in transforming meanings in the oral discussions into the demands of written text (lines 08 and 21). G4 is concerned about the 'ethical stuff', as in line 23: 'when are we going to include the ethical stuff, then?' She repeatedly calls for attention to this concern in the session. G3 brings their interview data into the conversations, as in line 30. G2 does not enter the conversation often, but her contributions are important in regulating the flow of the exchanges. She poses questions and comments on what the students are writing, as in lines 18, 20, 35, and 47.

In addition to this role of differentiation, students bring multiple voices to the discourse through intertextual connections. Projection is one resource already discussed for opening up for multiple voices. The other is modality; for instance, 'we should include' (line 23) and 'the ethical stuff doesn't mean' in line 25. This opens up a space for different degrees of necessity and truth, and thus for other opinions. In line 12, 'Think that it may be a little in it, can't it?' includes projection of a clause softened by the modality 'may', which invites another voice, a response.

How: Since the text is oral, we can see rapid changes in the theme and who is talking. There is fluctuation and flow. There are periods of engaged speech flow when participants sustain focus on a specific theme, and there are periods of sustained flow with rapidly changing perspectives, as in lines 27–35. Participants sometimes also stop talking for a little while, as in lines 32–33. We see that the mode of oral talk is sufficiently incoherent to allow students to bring in multiple perspectives and voices.

Written text, however, offers stasis and structure. In these group negotiations, the student G1, who is writing text on the PC, represents the structural demands (see lines 48–50). G1 is particularly important by transforming their discourses in the oral mode into written text; the oral talk is already the transformation of multiple voices. The way that the students open up for multiple contextual resources and multiple voices provides space and opportunity in the students' discourse, and the need for coherence and structure in the product narrowed it. This rhythm of closing and opening discourse forms is important in inquiry-based student work (van der Valk & de Jong, 2009).

In the excerpt from cycle 2, we infer that the students needed to consider several semiotic and contextual resources, and, in doing so, they construed complexity. To sum up, the following multiple voices were identified:

1. *The demands of cohesion in written text in the assessment criteria.* The sentence 'Animals should not suffer unnecessarily' in lines 1, 15, 26, and 34 seems to be the thematic focus. G4 remarks in line 3 that there is some problem with cohesion, but does not specify why. In line 23, the issue of cohesion reappears, but now it is specified as when to include 'ethical stuff'.
2. *The genres at hand* (purpose). In lines 4–12, they discuss whether there is room for irony and funny remarks in their text, which is related to what kind of text they are writing, an article or an essay.
3. *Personal beliefs* are at the forefront in lines 23–32.
4. *Data* from interviews are touched on in lines 30 and 46.
5. *Implicit intertextuality* in the shape of laws regulating hunting is touched on in line 33 and onwards.

Why: The purpose of the students' activity in this episode is connected to their resulting text (see the excerpt below) and the social norms of argumentation. Various voices engaged students in transformation of content and composition problems. The ideational meanings are significantly more complex in this second episode than in the previous dialogue example

(trolley buses). The complexity also made it necessary for the students to explore purpose (genre). There are tensions between genres (and what is allowed in them – an essay or an article), personal beliefs, authentic data (interview with hunter), and content knowledge (laws regulating hunting). The students needed to create meaning and coherence across these domains, genres, and modes. We see that some intertextual connections are related to school constraints and resources (assessment criteria and genre norms), and others are authentic to the problem at hand (interviews with hunters and laws regulating hunting).

The text produced as the final product is a result of the students' negotiations and choices. In this text, the students draw on the same resources of language discussed for the oral talk by setting up degrees of necessity and degrees of truth. The written text is, however, more clearly staged as argumentation. Their purpose is to explore an issue in which different positions are possible, but in which they actively seek an answer. In this endeavour, their text shows evidence of visible authors acting in the world and thus a much stronger sense of agency than in the trolley bus example. To illustrate, the following section is found in the middle of the students' final product:

> *'Hunting is only for fun'*
>
> This claim has been discussed a lot in this project period. From the start, we were generally against hunting, and we considered this claim partially true. However, as we learnt more about why hunters hunt, we ended up viewing this claim differently. A good reason that we hadn't thought about it is that one experiences nature and animal life in the forest, as we wrote above. One thing that makes hunting important is that the population needs to be regulated. Without hunting, there would be too many animals, and there would not be enough food or space for everybody. Therefore, we conclude that hunting in a way is for fun as it is a hobby, but it is also necessary for the population and for the survival of as many animals as possible.

In this passage, the field is structured by a *claim* offered as a projection by the first sentence, and the students provide reasons (starting with 'A good reason . . .') for their *conclusion* ('Therefore, we conclude . . .'). In the tenor, in several modality markers, the students take a stance towards the degree of necessity or truth ('partially true', 'good reason', 'in a way', and 'necessary'). They engage in metadiscourse (we ended up viewing; we considered this). Equally important, they have shown that they have evaluated the evidence for the claim and considered the claim from different perspectives.

6.4 Conclusions and implications

In this article we have investigated complexity as construed in students' discourses, guided by our main research question, How do students construe complexity in SSI?

Our contributions to the research literature are twofold. First, we offer an analytical framework for analysis of low and high complexity as situated and construed in unfolding discourse. Second, in an exploratory analysis, we show how students' constructs low and high complexity in unfolding discourse. Thirdly, we show tentatively how students' construal of

complexity relate to contextual frames. In order to answer our main question, we asked three subquestions.

6.4.1 What language resources are important for analysing complexity in students dialogues associated with SSI?

We staged our analysis according to Halliday's metafunction of language. Analysis of unfolding discourse in the situation is complemented by taking into account genre. We identified specific interrelations between context and language (what) and those taking part (who), as well as the role of language in discourse (how) and its purpose (why). Our analysis focuses on resources for intertextuality in this framework.

Multiple voices are important in Sadler et al.'s (2007) SSR competencies because they open a space for negotiation and inquiry into issues that have no clear-cut or ready-made answer. Further, multiple voices can be considered as being realised in language use by intertextuality. This implies that an important aspect of SSR can be analysed in students' ongoing discourses, in acts of meaning, in interplay between resources of language and situational context.

6.4.2 How are these resources realised in discourses differing in degree of complexity?

In this article we analysed two episodes where complexity was handled quite differently. We saw in the first episode that the intended complexity evaporated in students' discourses leading to exposition construing trolley buses as technological artefacts. Social purpose, content, and social roles came together as a factual display in the learning situation. In an exposition, the question can be addressed with few voices intertextually; in principle, one authoritative source is enough.

In the first episode, the intended complexity was reduced to technical knowledge about trolley buses. This can be interpreted as an example of a *substitution*, in Kahneman's terminology, in which a complex question becomes transformed into a simpler one. In this case, the question, 'Is a trolley bus environmental friendly?' is transformed into 'What is a trolley bus?' As an exposition, it is confined as a technical question, and a single authoritative source is sufficient for answering it.

In school science, the copy-and-paste routine is a configuration of textual, contextual resources and participant roles that are well known and important. However, copy-and-paste is insufficient in handling complex issues. In the first episode, factual reproduction reduced complexity to a familiar textual practice that excluded the social, ethical, and indecisive nature of the problem. It is possible that insufficient scaffolding made students rely on familiar goals, genres, and learning strategies. The teachers' unfamiliarity with novel teaching strategies and insufficient support structure may have transformed their teaching practice into familiar and manageable terrain (Tan & Pedretti, 2010).

There are several factors that regulate group behaviour in unfolding discourses. In the first episode, we saw how the dominant role of the lead girl (G2) closed the opening for multiple perspectives, doubt, and further inquiry offered by her peer. In previous research, (Sampson & Clark, 2011) interactions in group work are shown to depend on specifics of the group

interaction, such as the number of challenges and critiques, work strategies, the nature of the task, and the targeted group outcome. In this exploratory study, we have not controlled for these factors, as our point is rather to show how complexity may be construed in unfolding discourse in relation to a multitude of interrelated contextual factors.

However, we do suggest that the two examples are representative for significant differences between discourses in the two cycles. There are reasons to believe that the significant differences between the discourses in the first and second cycles are related to differences in the project framework. In the second cycle, including an empirical investigation, the complexity that became exigent by inquiry approaches (the request for a log page, a statement of issue to inquire into, a planning page, assessment criteria, and a framework for the report) likely made the products and processes more visible. These instructional strategies, offering students an ill-structured task and at the same time providing tools for handling it, may have become driving forces adding transparency and access.

Intertextual complexity could then be maintained and managed. Our analysis shows how complexity seems to sustain, and is sustained by, discursive practices, opening up for multiple resources and voices. Explicit scaffolding is important not only to provide students with discursive tools but also to counter prior learning experiences and their associated social purposes that may conflate a complex into a noncomplex (even if technically difficult) task. Following Kahneman, one could say that these scaffolding resources were necessary to make the inquiry problem accessible and manageable by the efforts of System 2 thinking.

6.4.3 How can learning situations be designed to sustain high-complexity discourses?

In the second episode, the explicit instructional support structures in cycle 2 were important to counter the drift towards lower complexity and fact-reproducing genres. Earlier work has shown how students' work becomes contextualised in 'doing school' practices, where factual reproduction makes science teaching and learning manageable (Furberg & Ludvigsen, 2008). Indeed, the interdisciplinary approach to environmental SSI investigated in this article challenges the fact-oriented teaching tradition prevailing in school science (Borg, Gericke, Höglund, & Bergman, 2012). Note that one of the differences between the cycle 1 and cycle 2 episodes is that scientific knowledge and the exposition text type were pertinent in cycle 1, whereas scientific knowledge became off-centred in cycle 2. This reduced the technical difficulty, but it opened the way for participants to approach complexity in a way that is authentic to environmental problems. Perhaps this off-centring is necessary for creating an authentic but manageable complexity.

There is nothing inherently wrong with the heuristic of making a complex question manageable by simplifying it; indeed, scientists' modelling practices aim at transforming a complex problem into a manageable one. However, if the transformation is not made explicit and critically evaluated, one risks missing the essential aspect of the complexity, and thus may end up providing an answer or a solution to a problem that is missing essential aspects. Different understandings of problems may have different stakeholders and they may serve some groups' interests but marginalise other groups. A crossover between SSI, problem

solving, and inquiry-based teaching strategies is fruitful (McVaugh, 2010). An intertextual representation of multiple voices seems to be a necessary aspect to establish and sustain such practices.

Low and high complexity

These two episodes are examples of very different literacy practices resulting from the same ambition in learning goals and similar challenges offered to students. Thus, complexity is situated in the sense that it is not something inherent in the challenge offered; complexity is construed by the interplay between ideas and their shared representation by students' discourse roles and resources in language for making them present. Transforming a complex challenge into a simpler familiar one is a common heuristic, and our analysis of the trolley bus example illustrates this heuristic and how it was negotiated in a particular literacy event. In the hunting episode, the complexity was supported by the instructional design. The students had to transform across texts and contexts.

In Table 1 we propose characteristics of the low- and high-complexity practices in the two episodes and we describe them in terms of the analytical categories used in the analysis.

Table 2

	Low complexity	**High complexity**
WHY	Knowing 'what is' Represent qualified, correct, and factual information	Decision making, action Consider relevant opinions and factual knowledge in a societal context
WHAT	Factual knowledge, puzzle solving	Contested claims, uncertainty Ethical concerns and different interests
WHO	Students who need to master science as a body of knowledge	Students who need to deal with integrated social and scientific issues in context
HOW	Factual genres (objective) Copy-and-paste is possible	Deliberative genres and multiple voices Transformation is necessary

Further research should identify how to sustain different aspects of complexity. Complexity could have been increased even more in the second episode, if, for instance, the students had interviewed more than one hunter. Complexity may be reduced in many ways. For example, complexity may be reduced by redefining the domains of knowledge involved (removing the ethical or political dimension, for instance), by reducing the number of sources considered or the range of solutions discussed, or by ignoring uncertainty. Finding the right level of complexity (authentic, but manageable) is largely a question of finding a balance between scaffolding and allowing for multiple voices, and further research is needed to identify this balance in teaching practices for developing SSI.

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7 **A2:** Characteristics and functions of sixteen-year-old students' collaborative deliberation when working with socioscientific inquiry assignments

Abstract

In these student dialogues, deliberative aspects of argumentation in SSI inquiry are documented as different from strictly scientific argumentation. I suggest that deliberative argumentation is a complex alternation between reasoning patterns that relate to different activity ¬layers. This understanding of deliberative argumentation emerged when analyzing student dialogues, developing the categories theme (theoria), inquiry (praxis) and inscribing (poeisis). Analyses are presented to account for this emerging understanding. The analyses utilize social functional linguistics (SFL), pragmatic conversation analysis, and rhetorical approaches to argumentation. What characterizes the students' oral deliberation is an alternation between certain foci. Roberts's (2011) use the terms theoria, praxis, and techne to characterize similar reasoning patterns in his Vision 1 and 2 of scientific literacy. I suggest that in civic deliberation all patterns of reasoning are necessary to handle SSI, whereas in strictly scientific argumentation, theoria is dominant. Such distinctions should also be considered when analyzing and developing instructional strategies.

Keywords:
Deliberation - argumentation analysis - conversation - rhetoric - socioscientific inquiry - scientific literacy - civic education

7.1 Introduction

Argumentation in science classrooms may be modeled on the practices of science proper, e.g., in experimental work and inquiry learning. Consequently, argumentation will be on matters of truth, or at least on matters of probability, and not on less clear-cut matters of opinion or priorities of action. According to the OECD Programme for International Student Assessment (PISA), one of the crucial competencies of scientific literacy is "Interpret data and evidence scientifically: analyse and evaluate data, claims and arguments in a variety of representations and appropriate scientific conclusions." (2013). From this perspective, skills in argumentation are crucial to scientific literacy competencies. Such evidence-based truth-seeking argumentation is a pertinent feature of the nature of science (NOS) (Chin and Osborne 2010; Driver, Newton, and Osborne 2000; Jiménez-Aleixandre and Erduran 2008; Osborne 2010).

On the other hand, in argumentation and deliberation on socioscientific issues (SSI), neither science knowledge alone, nor empirical evidence, nor other criteria for deciding what is true or false, necessarily provides sufficient grounds for sorting out the question at hand. SSI involves societal, ethical, and political perspectives (Kolstø 2001; Sadler 2010; Zeidlerand

Sadler 2008). The goals of argumentation in SSI often address conflicts of interest, controversies, and choices of action, and SSI may concern local or everyday issues in addition to global ones, as well as societal or personal causes of action regarding "wicked problems" (Murgatroyd 2010). Wicked problems, according to Murgatroyd (2010), are often characterized either by the lack of a clear problem statement, or the fact that they have no final answer and no single explanation. Trying to solve them requires actions that result in a change of the problem itself.

Thus, inquiry and deliberation in SSI imply inclusion of incompatible perspectives. In classroom-based studies on argumentation in science education, there has been an interest first and foremost in evaluation of the quality of students' scientific argumentation, and lately an emerging interest in the design of learning environments (Erduran & Jiménez-Aleixandre 2012). The present study, however, investigates deliberative aspects of student argumentation in particular, with empirical data from an SSI inquiry learning activity involving 16-year-old students. The aim of this study is to gain knowledge of students' deliberation in the classroom context. The aim is neither to critically evaluate their deliberation, or the outcome thereof, nor is it to evaluate their science competence specifically,

These students provide arguments; but how did they develop them? For the purpose of this study, deliberative argumentation is broadly understood as the way students express themselves, deliberate, and make choices of action during group activities. Shifting concerns and how students' foci alternated in initiatives and responses are described. The interplay of utterances concerning decisions on the content, the collaboration, and the composition of written text is discussed. Deliberation is more widely understood than the commonly accepted understanding of scientific argumentation in the science education research community. The reasoning and argumentation found in the data are understood in light of rhetorical theory on deliberative argumentation.

Erduran and Jiménez-Aleixandre note that a commonly accepted definition of argumentation in science education is "the evaluation of knowledge claims in the light of available evidence" (Erduran and Jiménez-Aleixandre 2012: 254). However, to include deliberative aspects of SSI that may be warranted differently, this definition may need to be expanded to include elements that also address issues of action in line with Kock's account of deliberative argumentation (Kock 2007).

Kock, a scholar in rhetoric, builds on Aristotle's Rhetoric, in which a central concept is the *enthymeme* (a syllogism where one of the premises or the conclusion is taken for granted and left implicit). Using the notion of *legitimate dissensus* to distinguish rhetorical argumentation and deliberation from dialectical (including scientific) argumentation, Kock (2007) emphasizes that deliberative argumentation aims at the persuasion of a majority from different positions. In deliberation, legitimate disagreement is more common than seeking absolute truth or reaching consensus. Deliberation concerns issues of choices of action (Kock 2007, 2009). Deliberative aspects of argumentation that focus on opposing positions and different perspectives are particularly relevant to SSI and action in the societal and political domains.

Deliberation involves matters that are viewed as good or bad and that are viewed differently among people; it requires reasoning about matters that are not easily weighed on the same scale (Kock 2007). In SSI-learning activities, deliberation is needed to handle a diverse range of discourses as well as many alternative priorities for action. Therefore, the deliberative aspects of student argumentation in SSI-learning activities should be particularly interesting to identify.

The present study seeks to identify elements of student deliberation and to contribute to the field of research regarding challenges of analysis of students' oral argumentation. The study will provide concepts and perspectives for oral argumentation analysis. The study is based on student conversation during inquiry into a socioscientific issue in the Norwegian 'ElevForsk' project. However, the findings will have potential significance for many similar student groups. In light of the perspectives on argumentation outlined above, the main research question guiding this study is:

What are the characteristics and functions of students' deliberation during inquiry into a socioscientific issue? Two subordinate research questions then become: What kinds of perspectives and approaches are prevalent during group activity and for what purposes? How are decisions reached during the developing SSI project work, in dialogic events, across events, and across lessons?

In the following, some initial considerations on analysis of the empirical material are presented. The section on Theoretical perspective describes the relation of the empirical work to theory on argumentation and deliberation -- concerning, in particular, presuppositions underlying argumentation -- drawing lines from Aristotelian logic and rhetoric as well as from modern linguistic and rhetorical work. In the section on Method, the analytical tools are described. The empirical field work and data are presented in the section on Design and data collection. In order to identify characteristics and functions of the students' conversation, in-depth analyses of excerpts of students' dialogues on three levels of meaning are presented in the Results. Finally, characteristics and functions of these students' deliberations are summarized, concluding with a macro structure of students' deliberations.

7.1.1 The present study

The study presented here is an analysis of empirical data drawn from student group activity. The student activity took place during an interdisciplinary student project addressing *sustainable development*. Over six weeks, a group of five 16-year-old students pursued a collaborative inquiry into their chosen topic, "The Rainforest." Their teachers graded their final report as well above average. These are the report's concluding lines:

> Today the cutting down [of the forest] is not controlled and much of the rainforest is disappearing. It is as if a 100 meter wide chainsaw at a speed of 100 km an hour cuts directly through the rainforest [. . .]

> [1]What we should not forget, is that there are two sides to this issue. The people who are living in these parts of South-America also need to have a job to go to. Therefore it is important to find a balance. Today the countries earn a lot from the rainforest. Therefore they have to try to find other sources of income for their country to replace the jobs.

This study's intention is to identify what happened in the students' processes of collaborative reasoning and deliberation relative to the purpose of their activity over the course of six weeks (which was to produce a written report). This analysis focuses on the oral deliberation. During exploration of the data, it became apparent that theory on argumentation and analytical frameworks (as usually referred to in research in science classrooms) were difficult to apply. For instance, Toulmin's argumentation pattern (TAP) (Toulmin 2003) could not account for the data as well as expected. The students' rational deliberations across several activity-layers in SSI inquiry activities and their collaboration on developing and writing arguments for their report during six weeks were more complex than expected; map and terrain was a mismatch. Consequently, due to the mismatch between intention and practice, theoretical and analytical approaches had to become quite tentative and pluralistic to try to capture what was happening. As a result, multiple approaches have been utilized. How the students actually develop their reasoning and arguments and how they warrant them over time may not be reducible to a neat TAP analysis.

7.1.2 Theoretical perspectives

Problems with applying TAP may be due in part to this study's interest in capturing the development of student deliberation across lessons, i.e., capturing macro structures, rather than sentence-by-sentence micro-structures. Problems with TAP noted by other authors are also referred to in the following. Because of the problems with TAP encountered in this study, analytical perspectives were searched for, from outside the research on science education community. However, the concept of *warrant* from TAP regards the implicit premises of practical and informal argumentation. Hence, in this section,Toulmin's warrant is discussed and compared to concepts from conversation analysis and rhetoric on the shared contextual communicative space (Bazerman 2013) that is more or less taken for granted by interlocutors during oral conversation. A brief historical overview in order to position the study's relation to rhetoric and dialectic is followed by a presentation of the connection of this study to scientific literacy issues.

As mentioned, other authors have also discussed problems with TAP. Andrews (2010) notes difficulties in utilizing TAP to generate arguments. Difficulties may also relate to the methodological shortcomings noted by Erduran (2008). Science educators have had difficulties applying Toulmin's model to classroom talk. Erduran argues that methodological challenges remain and that aspects of argumentation are understudied. This gap concerns structures and processes that mediate argumentation in school science: sociological, political,

[1]The students encourage their classmates to volunteer and to support organizational work.

and psychological aspects of the learning environment. In a recent study, Erduran and Jimènez-Aleixandre (2012) hold that there is still a need to explore students' and teachers' perceptions of argumentation in science. They also hold that studies on argumentation in science education could contribute more to argumentation studies in general, and vice versa. Stewart (2009) states that discourse analysis of argumentation in SSI calls for the development of analytical tools to capture handling of controversies and emphasizes SSI's position at the intersection of the personal, public, and technical (scientific) spheres.

Toulmin refers to Aristotle and discusses questions about logic and how logic is applied in practice. The Aristotelian fully explicit syllogism is his starting point. Kock (as mentioned in the introduction) and Toulmin both address the implicit premises and presuppositions underlying argumentation that are important in this study. In this study, the underlying interplay of positions and purposes, which is part of the *gross structure* (Toulmin 2003: 87), or macro structure, is focused on. Adding perspectives from conversation analysis (Svennevig 1999a) provides concepts and basic tools for the reading and analysis of student dialogues. The purpose and criteria of relevance for conversations during an activity are often taken for granted and shared by participants to the degree that they share experiences that constitute a *common ground* (Clark & Shaefer 1989) for their conversations. Common ground consists of mutual knowledge, beliefs, assumptions, and awareness. Students' and teachers' talk and argumentation convey their personal experiences and the different discourses in which they participate. Their ways of thinking, working, and talking, as individuals or individuals identifying with a group, reflect their different attitudes, values, and interests. Their talk also conveys their knowledge and skills. According to the pragmatic tradition, conversation is purposive and cooperative and meaning is created as a joint goal-directed activity. Thus, negotiations on common ground is a starting point and framing conditions for warranting arguments.

The overall oral progression of deliberation results in this case in the students' final written report. The analysis of a macro structure across events and lessons depends on a sentence-by-sentence development, a development of phases, each consisting of units of the argument (claim, data, warrants, backings, rebuttals, qualifiers, according to TAP). However, not all the units are necessarily explicitly uttered in a text sequence on the micro level, or uttered at all. Toulmin's key term *warrant* ("rules, principles, interference-licenses") (2003:91) links the micro level of the single utterances to the macro structure. Warrants relate to what Toulmin refers to as field-dependency and enable interlocutors to provide different lines of reasoning according to their positioning and different interests and engagement in a task.

In his work on rhetorical *topoi*, it is worth noting that Gabrielsen (2008) relates Toulmin's concept of warrant to cognitive facets of such topoi. Gabrielsen describes how choices of topoi, such as the use of analogies and examples, support inventive reasoning and argumentation. Topoi are thinking patterns that are shared by a group. Gabrielsen's rhetorical perspectives on the warrant are interesting, since identification of topoi could help to identify warrants more explicit.

The fact that different settings and purposes require different warrants is developed by Walton into a theory of different types of dialogues (1989) and argumentation schemes (Walton, Reed and Macagno 2008). The notion of argumentation schemes bears a relationship to Aristotelian rhetoric and the classical theories of topics of invention.

The following historical overview is given in order to position argumentation in science education and the developing understanding of argumentation in this study on a continuum from formal logic and argumentation as an analytical system, to a pragmatic focus more on substantial social and situational grounds. The line of rhetorical philosophical perspectives is drawn to connect the analysis of student conversation to a broader interpretational frame of rhetorical functions and purposes.

Aristotle was the first to write systematically about the art of persuasion in his work Rhetoric. He described human reasoning and invented the first concepts that later became fundamental to the science of logic. Aristotle's syllogism and philosophy and the idealism of Plato and later Kant sought a universal system of argumentation. Besides argumentation as pure formal logic, theory on argumentation has also developed on a wide range of fields as theories labeled informal logic and, more generally, studies in reasoning. The area of rhetoric, however, slowly faded from the seventeenth century till it's revival in the twentieth century. The philosophy of positivism and dialectical argumentation were a better match for the modern empiricist truth-seeking enterprises dating back to the sixteenth century. Recently, argumentation theory was influenced by pragmatism and the linguistic turn. At the same time, the linguistic turn opened up several modern theories of language and discourse, not all of them acknowledging their ancestors in the old art of rhetoric. Rhetorical aspects of language uses concerns first and foremost how language uses relate to the audience at hand and the persuasive purpose. Rhetorical argumentation then becomes a deliberative situated reciprocal process, and a tool for rational decision-making, even when there is not one definite answer.

Scientific and deliberative aspects of argumentation in SSI are thus linked to long lasting philosophical considerations in the field of argumentation in general. Considerations on truth-seeking argumentation and on the other hand argumentation as conflict management may be viewed as the undertow of the long-standing issue in the field of argumentation: the relation between dialectical philosophical aspects and rhetorical aspects of argumentation. In the resent research tradition of pragma-dialectic the relation between rhetoric and dialectic is discussed under the term strategic maneuvering (van Eemeren 2013). The main aim of pragma-dialectic is to achieve consensual, conflict resolution by way of critical discussion. Strategic maneuvering thus becomes subordinate to ideal syllogistic rationality. However, for example, Mendelson's (2001) turn to Quintilian's rhetorical curriculum and students' training in *controversia*, through the exercises of *progymnasmata*. This approach may support this article's suggestion to use tracking of alternating foci as tools for identifying driving forces for student deliberation. *Controversia* emphasizes the exchange among interlocutors of opposing positions. Along these lines, Blair (2012) discusses the interrelations between logic, dialectics, and rhetoric. TAP, Waltons's argumentation schemes and pragma-dialectic strategic maneuvering are models of informal argumentation. The purpose of this study is to

describe empirical material and the characteristics of deliberation during ongoing conversation. Application of a model require reconstruction since moves are not necessarily explicitly uttered.

For the purposes of this article, dialectical philosophical aspects are viewed as particularly important in inquiry and discovery, and also as characteristic of technical (scientific) argumentation, whereas rhetorical philosophical aspects are viewed as important in negotiation and deliberation, and as characteristic of personal and public argumentation. Using Walton's types of dialogues (2011), argumentation in school science usually focuses on inquiry or discovery dialogues; however, argumentation in SSI may focus on negotiation and deliberation dialogues. The scientific and deliberative aspects of argumentation mentioned here may seem partly opposed to each other and partly reciprocal, thus paralleling the goals of Vision 1 and Vision 2 of scientific literacy (Roberts 2011).

This study is connected to the focus on scientific literacy in research on argumentation in science education. Argumentation is a central feature of scientific literacy (Osborne 2010). According to Nussbaum, Sinatra and Owens (2012:17), and in line with Stewart, as mentioned earlier, students should be presented with "the two faces of scientific argumentation." Nussbaum et al.'s distinction is further consistent with Roberts's discussion and elaboration on Vision 1 and Vision 2 of scientific literacy. Vision 1 attempts to enculturate students into the science community, whereas Vision 2 attempts to develop their capacities to use and evaluate scientific knowledge in technological problem-solving, as well as in personal and public decision-making (Roberts 2007, 2011). According to Roberts, Vision 2 implies the interplay between three different patterns of reasoning: theoretical, technological, and practical (2011). Based on Roberts's account of Vision 2, in this study, deliberative argumentation on issues of action is suggested as an alternation between patterns of reasoning relative to different activity-layers. Roberts views the three patterns of reasoning in light of the Aristotelian meta terms *theoria*, *praxis*, and *techne*, that is, the activities to *understand*, to *make decisions*, and *to craft*.

The suggested understanding of deliberative argumentation emerged through the analysis of the student dialogues resulting in the empirical categories *theme* (theoria), *inquiry* (praxis), and *inscribing* (poiesis[2]), each of which represents a different activity-layer. Examples of analysis are presented in the Results section of this article in order to explain this emerging understanding. These analyses of student dialogues thus attempt to capture the warrants of students' language and deliberation during an SSI learning activity. The empirical categories may provide insight into implicit warrants of deliberations.

Andrews emphasize the crucial role of argumentation in the learning process and knowledge development: "To understand the event itself -- the moving spirit and fire of learning as it

[2]Roberts (2011) uses the term *techne* – which is in actual fact the virtue, while *poiesis* is action which will correspond to *inscribing.*

happens, and knowledge as it is created -- requires a willingness to enter the fire, to get to the centre of intellectual inquiry. There is where argument operates" (2010:219). Students need to understand scientific argumentation in inquiry. However, they also need to understand deliberative, practical argumentation and how it differs from purely scientific argumentation.

These theoretical considerations were presented in order to link this study to theory on argumentation and informal logic, as well as to deliberative and civic argumentation and in order to give an account of the relation of this study to the studies on argumentation and scientific literacy in the science education community. In the next section, the analytical tools used to identify students' deliberation are presented along with the design, data collection, and context of the study.

7.2 Method

7.2.1 Analytical tools

The analytical approach of this study was chosen specifically to identify argumentation that addresses action and related purposes, and to track deliberative aspects of student argumentation. Analytical tools are needed that can capture the language uses and students' reasoning as well as the background of contextual and situational presuppositions.

The unit of analysis is student uses of language in initiatives and responses during inquiry into a socioscientific issue, related to situational purposes of the classroom context. The student discussions during inquiry are regarded as literacy *events*, literacy practices, and social activities (Barton 2007). According to Barton, a literacy event involves "all sorts of occasions in everyday life where the written word has a role" (2007:35). From the start, the audio recording of group activity focused particularly on capturing events (Derry et al. 2010) with referential content related to *conflicts of interest* and *uncertainties* and different phases of main *inquiry processes* (Bell et al. 2009). This concerns the requirements for the assignment given. For the purposes of this article, an event consists of a dialogue sequence with this kind of content: with a minimum of three utterances belonging to the same chain of initiatives and responses. A chain is indexed and labeled according to a shared referential content. A strong initiative (Svennevig 2009) starts an event. The event ends either when the responses lack relevant referential connections to the initial initiative or when the dialogue comes to an end.

To track the functions and purposes of language use in dialogues, Macken-Horarik (2002) offers the categories of *what*, *who*, and *how*, building on Halliday's systemic functional linguistics (SFL) (Halliday 2004; Halliday and Hasan 1985; Halliday and Martin 1993). Perspectives from conversation analysis and pragmatic linguistics (Svennevig 1999a, 2009) are used to describe initiatives and responses on the referential level (*what* is taking place, what the participants are engaged in) and the interpersonal level (*who* is taking part, the nature of the participants as well as their status and roles). Conversation analysis is characterized by an empirical and inductive focus on the procedures people use in creating social order (Svennevig 1999a). The analysis should identify this order as it emerges in the situation through participants' initiatives and responses.

In oral activity, participants induce interruptions and shifts, and the *dynamic speech flow* may change or stop due to participants' moves. Participants take turns. Change in the dynamic speech flow allows participants to change focus: they may stop talking, or try to find a way to continue. This allows for shifts in perspective. Concerning the identification of the *how* level of student reasoning and deliberation (what role language plays, what the participants expect language to do for them in the situation), I follow Andrews's characterization of argumentation as a matter of composition of discourse: "the putting together of elements to communicate something to someone or a group of people" (2010: 29). Participants' initiatives and responses relate to situational purposes. Participants' choices of lines of reasoning in initiatives and responses depend on the legitimate sources of opportunities for interpretation among interlocutors in the progressing dialogue; it becomes a matter of the rhetorical situation, of *kairos* (Silva Rhetoricae 2007).

Why -- the level of *genre as standardized social purpose* (Miller 1994) -- is included in order to identify the purposes of reasoning and deliberation during an *event* and *across events and lessons*. Justification of an argument relates to its purpose and kairos, the rhetorical situation, "the contextually situated call to persuade, whether it is oral or written" (Ramage et al. 2009: 209). In the analysis, *focus* corresponds closely to the situational purpose of the group activity at any time (*why*). For the students involved in this project, the overall activity is connected to the requirements for the assignment given. As a result, presuppositions and premises legitimating and warranting their deliberation and choices also relate to this context and situation. However, neither "doing school" (Schleppegrell 2001) nor "doing science" as presuppositions for school assignments are necessarily uttered explicitly, in oral or written texts, as they are evident to the participants.

7.2.2 Design and data collection

Fieldwork and data collection took place at a combined vocational and general track school. The fieldwork was conducted within the Norwegian ElevForsk project (Knain and Kolstø, 2011).[3] A traditional school setting framed the project. In ElevForsk, a student project was conducted each year. The fourth cycle of the student project (which provided the data for this article) lasted six weeks and took place in four to five 45-minute lessons per week. This study of student group activity is qualitative, and its design resembles that of a case study (Yin 1994) intended to develop a theoretical understanding through what Yin calls analytical generalization of the complexity of practices. However, the conclusions cannot be exhaustive since the data are neither extensive nor complete.

Two classes participated in the student project. Due to school planning and logistical constraints regarding the simultaneous recording of data from multiple classrooms, only one class was available for video and audio recording of activity in student groups. Nevertheless, this close inquiry into student talk and reasoning during group activity can expand and lend

[3]For more about ElevForsk – Students in School Science as Researchers: http://studentresearch.umb-sll.wikispaces.net/home.

greater nuance to the analysis of argumentation in this kind of data. The data on students' SSI inquiry over the course of six weeks provided material for exploring patterns of reasoning across events and lessons. Hence, deliberation across activity-layers in line with patterns of reasoning as suggested by Roberts in his Vision 1 and 2 of scientific literacy could be explored (Roberts 2011).

My role as a researcher and the purpose of research in the ElevForsk project were clearly presented to the students in an introductory session. I was part of the researcher-teacher planning group and participated as an observer during 11 lessons, walking between groups and available for support when needed. The students' need for support was usually communicated to their teachers, and the presence of a researcher most likely did not significantly interfere with the dialogues during group work.

The students were given the following assignment:

> Do you associate science with factual knowledge -- solid knowledge that no one doubts? While at the same time you see in the newspapers every day that scientists, politicians, and other engaged people are discussing environmental issues. A lot of the knowledge presented concerning these issues is uncertain, and we do not quite know what to do, or how to do what we ought to! These questions should concern you! In this project you will work on finding answers to questions that you pose yourselves, and that relate to conflicts of interest. You are going to work like scientists. You are going to conduct an empirical investigation.

The assignment given relates to sustainable development (SD) as a main science curriculum area in upper secondary school in Norway. Simonneaux and Simonneaux (2012) introduce *acuteness* to the sustainable development perspective on science education through the notion of *questions socialement vive* (socially acute questions (SAQ) in English). For the purpose and context of this study, the term SD expresses an extended understanding of environmental concerns, addressing the urge to take action (Simonneaux and Simonneaux 2012). This interrelation between science and societal concerns challenges the role of school science as presenting generalized truth. The role of science becomes displaced in SSI by the need to make decisions within a limited time frame. Moreover, students' own values are challenged (Kolstø 2001; Zeidler and Sadler 2008).

One goal of the ElevForsk project was to explore teaching and learning approaches that could be used to meet the challenges from the acuteness and call for action from the science-society interface of SSI. Argumentation, text production, and critical thinking were emphasized in order to enhance students' inquiry practices (Johansen 2013). The students chose a broad topic of inquiry and were asked to articulate an issue related to the topic. They designed and conducted an investigation of that issue. The science teacher and the Norwegian language teacher were available during group activity. Finally, a group report was submitted on a wiki

platform.[4] During group work, the students were logged on to a wiki space where the groups designed their own web pages for their projects. The student group discussed in this article involved three boys and two girls. They made a questionnaire and collected data from peers at their school. From the beginning, this group was particularly focused on data collection due to their choice of topic: the rainforest. Their topic was considered especially interesting since SD and SSI were given particular emphasis in the overall ElevForsk project.

Audio recordings of the group activity from 11 lessons were partly logged and partly transcribed during fieldwork. Field notes describe the context of the group activity. Additional background data include collected video data for three of these lessons, the web sites that students used during the activity, log pages in wiki, the final report in wiki, and teachers' final assessments of the submitted report.

Three lessons were chosen for the purposes of this article. They were chosen because they were rich in data, had extended dialogues, and all five students participated in the activity. The lessons also covered different phases of the main inquiry processes (Bell et al. 2009), including discussions in which students oriented themselves in relation to their topic and discussions in which they designed their own investigation. Student discussions during analysis of collected data were unfortunately not recorded due to school planning logistics. Two lessons were also video recorded. The videos were mainly used to support transcriptions from audio recordings.

Computer-assisted, qualitative data analysis software, Atlas.ti, was used during the first phase of the analysis. Atlas.ti assisted in data analysis by providing tools for exploring student talk through coding and memo writing. Coding was conducted on audio files for *flow* and *interruptions* on all 11 lessons. These initial questions were asked: Where are the flow episodes? What happens during flow? Where do interruptions occur? What kind of interruptions are they? What happens before, during, and after an interruption? Who participates and how? Through this exploration, relevant events were identified, indexed, and labeled according to referential content.

First, sequences with dynamic speech *flow* were coded during a lesson *when the talk was sustained and engaged participants focused on a theme for some time (a minimum of one minute).*Secondly, *interruption* was coded when there was a *shift of theme or perspective, or an occurrence interrupted the dialogue, or the talk came to an end*. Sequences of the group activity in which shifts and interruptions occurred in the dialogues and sequences in which the speech flow was engaged were fully transcribed during coding of audio files. During transcription, preliminary assertions emerged and research questions were refined.

Further coding and categories were developed through abduction (Erickson 2012). In the second phase, interpretation and exploration of the dialogues were supported by a protocol.

[4] The wiki platform: http://interessekonflikter.umb-sll.wikispaces.net/.

The protocol was used to sequence the dialogue into relevant events, to support the process of emerging coding, to support the hermeneutical process (in which the activity was described and explored), and to document the developing analysis. In the protocol, transcripts and memos from Atlas.ti , as well as reflections from field notes, were entered.

The move from description of utterances with linguistic tools to identification of student reasoning and deliberation involves an interpretive leap from studying the signifier to saying something about the signified (Barth 2002), and it is driven by a hermeneutic reading process. Other categories and approaches could have been used that might highlight other patterns that would lead to different interpretations. Furthermore, analysis of students' argumentation patterns -- based on, for instance, TAP,Walton's argumentation schemes or pragma-dialectic models of strategic maneuvering -- would to a greater extent be comparable to other studies. However, application of such models would add too much reconstructed material to the data. This study aims at reading and labeling as well as exploring and considering the more "messy" empirical data and shedding light on aspects of student argumentation in a way that contributes nuance to and expands argumentation analysis. The integrity of these empirical data would soon be disturbed by such additions, with the risk of making the analysis invalid.

7.3 Results

The analysis is based on the interplay of three aspects: *what* the students deliberate on regarding conflicts of interest and uncertainty related to their chosen topic; *who*, identified as initiatives and responses on the interpersonal level; and *how* and *why,* identifying characteristics and functions of deliberation across events and lessons.

In the examples from dialogues presented below, a dominant level is foregrounded in the presentation of the data in each dialogue sequence.

In order to represent variation in the data, the dialogue excerpts presented are from the first two lessons of the project and from one lesson that took place four weeks later. In the first two lessons, the students were trying to understand the science involved in their topic and were concerned with formulating a question on their topic (the rainforest). Four weeks later, they designed a questionnaire that was to be conducted at school among peers from other classes.

7.3.1 "The lungs of the Earth"

In this section, we will take an in-depth look at the *what* level in a sequence from the first lesson and in a sequence from the lesson that took place one month later. In the first lesson, the students sat in six groups in the classroom. Altogether, 29 students participated in the activity. Earlier that same morning, an introduction to the student project and the requirements for the assignment were presented. At this point, the students had already been working for about an hour in their groups. The students were extracting information from web sites as part of their inquiry. While talking, they were also writing on their own wiki pages.

Starting up their project, the students stumbled upon the metaphor "the rainforest is the lungs of the earth".Two web sites give seemingly contradictory information. Although both sites

make an appeal for active involvement to save the rainforest, regnskogen.no emphasizes that CO_2 emission results from deforestation and links this to climate change, whereas heiverden.no takes a life-sustaining perspective, emphasizing that the rainforest is a provider of oxygen. Boy 2 and Boy 3 used the texts from two web sites word for word to argue pro and con. They deliberated on an important question: what may be legitimately included as statements of fact?

Table 1[5]

1	B2:	((READING OUT LOUD FROM regnskogfondet.no)):< Is the rainforest the lungs of the Earth? No, this is a myth. The rainforest has no great impact on the production of oxygen> ((CONTINUES READING)) […] <Big reservoirs of carbon are stored in the vegetation> ((CONTINUES READING)) [...)]<Global climate emissions are due to destruction of the rainforest >((CONTINUES READING)) […]
2	B1:	But it is not until they come with those damn machines—
3	B2:	That is when it becomes—
4	B1:	That is when it becomes climate emission
5	B2:	But the rainforest does not produce as much oxygen as we thought...because it uses a lot of oxygen, and so eh—
6	G1:	But Marcus found out that uh…what was the name of that thing?
7	B3:	Two seconds..the rainforest..that..reason for preserving the rain forest is that it transforms carbon dioxide, that is to say.. carbon dioxide into clean air
8	B2:	That is because it
9	G1:	[that is —]
10	B1:	It makes it, right. So when those machines come, then it is released..and that is the drawback, then..so that is what Mari can write down
11	B2:	But eh…the rainforest does not produce that much oxygen..neither
12	B3:	((READING)) <The rainforest is a requirement for almost everything that is living on the earth>
13	B2:	But here it says..here it says..<Is the rainforest the lungs of the earth? No, this is a myth. The rainforest has…has no great impact> ((HE CONTINUES READING))[…]<However, the rainforest is important to provide good and healthy conditions for life on the earth >
14	G2:	Should I write that down?

During the coding of *flow* in the first phase of the analysis, sequences with extended dialogues were identified. The excerpt in table 1 (above) is the beginning of a sequence that lasted for

[5] Dialogues are transcribed with a system from Du Bois et al. (1983) as in Svennevig (2009). However, intonation units are not separated in lines. Continuing speech flow from one person is written down continuously.

about four minutes. The coding of *interruptions* revealed that the dynamics of the speech flow were regulated to a great extent by interruptions, particularly interruptions identified as *shift of theme or perspective* -- or to be more precise -- shift of *focus* or *perspective*. Lines 2 and 5 contain examples of shifts between societal and scientific perspectives. In lines 6, 10, and 14, there are examples of shifts of focus. In line 5, Boy 2 focuses on content. In line 6, Girl 1 shifts the focus to inquiry. In lines 10 and 14, there are shifts from focus on explanation of content to focus on writing. The students' deliberation seems to be construed during initiatives and responses, driven by the dynamics of the alternating foci and perspectives.

The persuasive features of the text read out seem to be of importance when the students consider the different perspectives, deciding what counts and what to include. The controversy is not initially expressed as students' opposing opinions. The scientific perspective is framed by Boy 2 in line 1, reading out for instance "*production of oxygen*," "*reservoirs of carbon*," and "*global climate change*," phrases that represent central scientific concepts. Boy 1 responds emotionally in line 2, by characterizing "*those damn machines.*" In line 7, Boy 3 seems to connect the two approaches: "*it transforms carbon dioxide, that is to say..carbon dioxide into clean air*," representing the emotional approach by adding the value "*clean*." The metaphor "the lungs of the earth," creates an urgency connected to the importance of oxygen to "*almost everything that is living on the earth.*" Controversy is conveyed through the language uses and the rhetorical and topical organization of the text (Gabrielsen 2008). The students inquired into the different perspectives and warranted their claims by the authority of the texts they were reading out to each other. Using Kock's term, legitimate dissensus is provided through the authority of the texts. In this respect, the students' collaborative reasoning is deliberation.

In the lesson that took place one month later, the students were discussing the design of a questionnaire that they were going to conduct among their peers from other classes at school. The students had been talking for a while about what kind of knowledge they might expect their peers to have beforehand. They planned to ask questions about people's attitudes toward deforestation.

In the dialogue excerpt below in table 2, Boy 2 has taken the lead and is formulating questions for the questionnaire. The group's talk is engaged -- and then an episode occurs. Boy 1's initiative and shift of focus in line 7 is directly interrupted by Boy 2 in line 8. It seems as if disagreement is not allowed by the leading boy.

Table 2

1	B2:	And then What do you think is most important..eh ((TYPING)) to preserve the rain forest ..or..that..eh= the people who are living there may use it as a resource? ((TYPING))…I think that was an incredibly good question
2	B1:	((yawning)) Yeah...Can you repeat it?
3	G2:	Shall I write that down?
4	B2:	What do you think is most—

5		Yes
	G1:	
6	B2:	What do you think is most important that the rain forest is preserved or that= people living there may use it as a resource
7	B1:	Well, they are not necessarily living there, they can be people from other countries who are coming to—
8	B2:	[!Yes, but the people around] there then ((SPEAKING LOUDLY))
9	B1:	Yes, around there, Okay then
10	G1:	((LAUGHING A BIT))
11	B3:	Sjabba-dabba-ru
12	B2:	Eh=
13	B3:	skjirbarrab-sku-rap-rap ((B1: also making some funny noises))
14	G2:	<that the people who..are living there..use it.. as ((TYPING))
15	G1:	[what if someone] ((QUIETLY))
16	B2:	as a resource
17	G2:	<resource> ((TYPING WHILE TALKING))
18	B2:	What happens now?...Complete (3.0)
19	G2:	What was the first question that we should have?
20	G1:	Eh=Do you think it is okay to burn the forest..eh or something like that ((B3 MAKING NOISES))
21	G2:	Is it cut or cot ?((in Norwegian: hogget eller hugget))
22	B2:	Hogd (4.0) Huggi ((this and the next line in Norwegian, as spoken))
23	B3:	Huggi-ha-gi! Skobber-ra-ra-skirrebippp-bipp-skirrebapp (10.0) ((TYPING))

In this excerpt, some details of the alternating of foci and perspectives should be noted. They disagree on relevance. Boy 2's concern (line 1) is the design of the survey and the writing of survey questions. His focus is on inscribing, and specifically on adjusting the language of the group's questions to their peers' supposed level of knowledge about deforestation. His sense of self-satisfaction is probably due to his self-assessment of his effort. Boy 1 shifts the focus to the complexity of the question and challenges Boy 2 to consider the presence of conflicting interests with regard to the use of the rainforest's resources, stating that the interests of the indigenous people and business interests may conflict (line 7): "*Well, they are not necessarily living there, they can be people from other countries who are coming to—*." This initiative from Boy 1, presenting a different perspective, could have been developed further in relation to the question formulated by Boy 2 in line 1. However, there seems to be a disagreement between Boy 1 and Boy 2 regarding how to understand and explain what the conflict of interest is about, and regarding what it is relevant to focus on at the moment. On one hand, Boy 2's perspective could probably involve a nature-culture controversy. On the other hand, his focus is first and foremost on formulating the question. Boy 1 is indicating a social or eco-

social controversy as the core conflict of interest. However, his focus is not the writing of the question. His focus is thematic. The disagreement seems to be on the level of premises or, in Toulmin's terms, on the level of warrant. This episode is followed by about five minutes of less engaged activity with some off-task, practical, and technical talk as well as some typing. The funny noises (lines 11, 13 and 23) are probably sort of an attempt to de-fuse the potential aggravation.

In their final report, they presented reasons for reducing the report's complexity, because of a need to "*focus on our topic*." They wrote: "*We had to get rid of some of the topics that we wanted to include, for instance the indigenous people.*" This is an example of how deliberation regarding how to proceed in the activity prevailed over further elaboration of the content. It is worth noting, though, that this part of their report hits on a core socioscientific issue of their topic. This part of their inquiry may specifically require developed skills in critical reading and inquiry procedures, including skills in argumentation. Guidance on debating and opportunities to practice debating on "wicked" questions may have been lacking. At this point, they struggled to meet the requirement of the assignment -- to discuss conflicts of interest and uncertainties -- and they were running out of time. It may be timely to ask: should these difficulties in discussing conflicts of interest be assessed as a deficiency in the students' capacities and capabilities for argumentation? In the next section, deliberative capacities and capabilities on issues of action relative to Roberts (2011) suggestion of three different patterns of reasoning are further explored.

7.3.2 Initiatives and responses

In this section, the students' initiatives and responses are presented. The excerpt in table 3 (below) is drawn from the first lesson. In the analysis, the *who* level is emphasized. The students were discussing how to pursue further inquiries and how to write up the report.

On the whole, their talk during this lesson uses fairly everyday language. However, the students' deliberation is framed by the fact that this is a science lesson, which conveys some inherent constraints and directions regarding what constitutes legitimate language use during the activity. We may infer that the classroom context functions as a common ground and a presupposition warranting their reasoning and deliberation.

Table 3

1	B3:	This is a kind of a very proper help-the-world site, sort of
2	B1:	But here it says regnskogen.no
3	B2:	But then we have to—
4	B1:	Oy !so ((LAUGHING))
5	B2:	We should ask the teacher..what he has got to say about it
6	G1:	Okay, but the teacher said
7	B2:	But then, for sure we must include that it is..that it is—
8	B3:	It even says here the lungs, the earth, the lungs of the earth
9	B2:	Ehe
10	G1:	But the teacher said that it would be smart to include, like..that we ought to like eh argue pros and cons ((DIFFICULT TO HEAR))..that we must try to include that, sort of
11	B1:	Yes, yes
12	B2:	Yes, we must find out what is right
13	B1:	Why should we cut down, and why should we not cut down?..'Yes
14	B2:	Yes, but we can make a new question. Is—
15	G1:	Yes
16	B2:	Is the rain forest the lungs of the earth or not?
17	B1:	But that is a little bit eh=
18	G1:	This we should ((DIFFICULT TO HEAR))
19	B1:	Yes, yes

It is worth noting how these students use discourse markers to chain utterances. Discourse markers call on other options or for adherence. The way these students use the discourse marker "but" (lines 2, 3, 6, 7, 10, 14, and 17) confirms Svennevig's (1999b) account of the different uses of "but" in written texts and oral conversations. In particular, these students use "but" to direct the other participants' attention. The discourse marker is not considered a strong sign of controversy. However, it directs attention to a new perspective or focus to be taken into the collaborative deliberation. In table 1 (presented earlier, above), it is noteworthy that in lines 1-6, all the responses to Boy 2's reading started with *"but,"* as did Boy 2's own comments in lines 3 and 5. The discourse markers chain together the elements of the deliberation. As described by Mendelson (2001), the development of deliberation in *controversia* is a tacking back and forth among opposing positions, rather than an elaboration of one's own claim.

The tacking back and forth between different positions and purposes provide the dynamics of the initiatives and responses in the speech flow. Referring to the ethos of the site inquired into, in line 1: "*This is a kind of a very proper help-the-world site, sort of*," Boy 3's concern seems to be the trustworthiness of the sources, a thematic concern. In line 5, Boy 2 reinforces this concern and suggests asking the teacher for guidance. In line 10, Girl 1 takes a new

strong initiative (Svennevig 2009). She shifts the focus to inscribing: "*But the teacher said that it would be smart to include, like…that we ought to like eh argue pros and cons…*," getting an affirmative response from Boy 1, in line 11: *"yes, yes."* This in turn provides an opening for Boy 2's next initiative. He shifts focus to the need for more information. Boy 2 can now clarify his concern regarding what issues they need to inquire into further: "*Yes, we must find out what is right.*" Due to Girl 1's shift of focus, the exchange of initiatives and responses continues and provides an opening for new perspectives. It is worth noting that the use of affirmative discourse markers ("ok," "ehe," "yes") also helps to sustain the exchange of initiatives and responses.

The students alternate between different main concerns and they engage in several chains of reasoning simultaneously. Regarding referential content, this dialogue sequence consists of two events: lines 1-9 are labeled *Two web sites that contradict each other*, and lines 10-19 are labeled *Developing the issue/conflicts of interest*. The labeling indicates that within each event, the initiatives and responses belong to the same chain of referential connections. The strong initiative in line 10 starts a new chain. Another example of alternations between chains of referential connections may be illustrated by the dialogue sequence in table 1, presented earlier, which started at 3:50 into the lesson, comprising two event types. Lines 1-6 are labeled *Deforestation results in CO_2 emission*, and lines 6-12 are labeled *Two web sites that contradict each other*. During the lesson, the conversation tacks back and forth between different event types.

Figure 1[6]

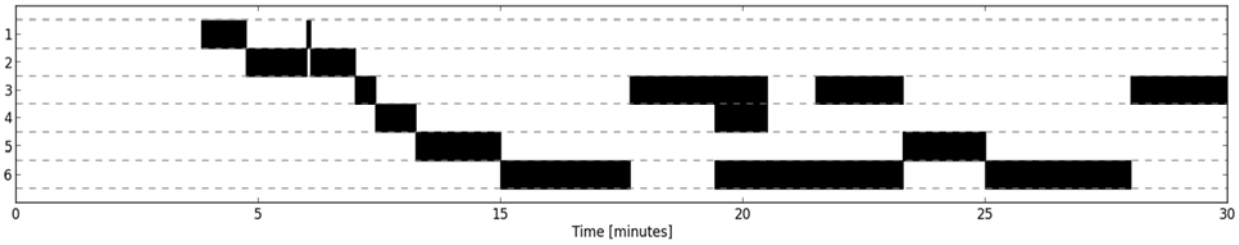

Fig. 1 presents an overview of event types identified in the first lesson: 1. Deforestation results in CO_2 emission, 2. Two web sites that contradict each other, 3. Developing the issue/conflicts of interest, 4. Find out/investigation, 5. Technical info/practical info/socializing/low activity and 6. Disposition and structuring of the text. The indexing is connected to the order of occurrence. Before 3:50, the activity was low, and events are not labeled. About seven minutes of practical information from the teacher and some technical talk (event type 5) between 8:15 and 15:00 are left out.

[6] The artwork was created with the programming language "Python."

In this first lesson, the labeling of events reflects to some degree different phases of the main inquiry processes, comprising the following types: Developing the issue, Deforestation results in CO_2 emission, Find out/investigation, and Disposition and structuring of the text. The figure illustrates how event types reoccur several times. Main inquiry processes are identified by Bell et al. (2009): orienting and asking questions, hypothesis generation, planning, investigation, analysis and interpretation, model exploration and creation, conclusion and evaluation, communication, and prediction. Notably, in almost all of the main inquiry processes, the first steps of some considerations seem to have been taken during this first lesson. The alternation between diverging perspectives and different foci may be a way to allow for the inquiry to emerge and be elaborated upon.

7.3.3 Deliberation on the how and why levels across events and lessons

This section will discuss how the three suggested activity layers emerged as analytical categories through the analysis. Not only in the first lesson, but throughout the material drawn from this group, initiatives and responses were often characterized by several shifts between considerations about: (1) *theme*, or understanding scientific content or information collected from another source, (2) *inquiry process*, or pursuing further investigations, and (3) *inscribing*, or writing up the different parts of the assignment and expressing concerns about the structure of the text. Deliberation and negotiation regarding which of these strands to attend to went on continuously during all the lessons. Such deliberation resulted in action choices, progress through the project, and finally in the group's submission of their report. Three foci, strands or threads were weaving the students' collaborative deliberation during the student project as illustrated in figure 2.

Figure 2[7]

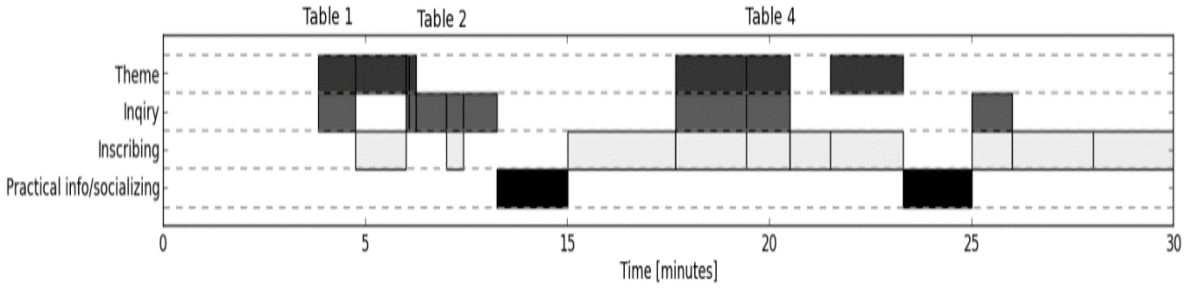

Fig. 2 presents the foci in analysis labeled *theme*, *inquiry*, and *inscribing*. (*Practical info/socializing* is not labeled according to foci, and corresponds to issue 5 in figure 1). Prpbably due to the students' use of the wiki tool while talking, inscribing is quite dominant. In the beginning and towards the end of the lesson, foci on theme and inquiry alternate. In the middle of the lesson, all three foci operate simultaneously. An example of this occurs in the dialogue sequence presented in table 4 (below), as indicated in the figure. Sequencing of events is indicated by vertical lines. Tables 1 and 2 are also identified in the figure. (Table 3 is drawn from another lesson.)

[7] The artwork was created with the programming language "Python."

The figure illustrates the macro structure of the students' deliberation through alternating foci, resulting in progression and development of referential content during inquiry. The empirical categories, *theme*, *inquiry* and i*nscribing* provide insight into implicit warrants. Deliberation on choices of action was warranted in the task at hand -- to complete the assignment given. Different strands were predominant in different situations, and each was related to a particular concern or purpose, thus leading the group toward the completion of the report. In table 2, (above) for example, Boy 2's concern in line 1 and 6 was *inscribing*, trying to formulate a question for the questionnaire. In line 7, Boy 1 shifts the focus to *theme*. In line 14, Boy 2 shifts back to *inscribing*. In table 3 (above) in the dialogue between Boy 2 and Boy 3 in lines 1-9, the focus is *inquiry*; they are concerned about the trustworthiness of the sites. In line 10, Girl 1 shifts the focus to *inscribing*, mentioning that they are required to include arguments from different perspectives. The rest of the sequence is a tacking back and forth between these foci.

In the next dialogue sequence, the dynamics of the alternating foci are illustrated. An elaboration is presented on how these foci operate on the micro level, sentence-by-sentence.

The excerpt below, from the first lesson, starts a sequence of flow lasting about four and a half minutes. The group, particularly Boy 2 and Girl 1, have been copying-and-pasting from the web site regnskogfondet.no. They used questions from this site to devise the group's own list of topic questions. The other three students seemed to be working on their own, or engaging with pals in off-task talk. However, in this event, they all participated in the deliberation, when Girl 1 took the initiative by posing a question about how to write up their material regarding pro and con statements.

Table 4

Line	Student	Theme	Inquiry	Inscribing
1	G1:			Eh..And then maybe we should have a question like: Why are some people pro and=... con? Sort of because it is—
2	B3:	How could anybody be pro? I don't understand that		
3	B2:	Because many make their living from that livelihood to cut down rainforest		..buteh..we are 'against it
4	G1:			May we decide?... In the introduction?
5	B2:	..but we are, well...it seems the most right thing to do is to save the rainforest	..most people probably think so, so we should try to=	Yes, or we should be somewhat on the outside, then
6	G2:		But we sort of have to find a—	
7	B2:			But we should be like a 'newspaper, then.. I think
8	G1:		Yes	
9	B2:			Should be eh.. 'objective or 'subjective. I don't know which is which

This sequence of flow is initiated by Boy 3's critical question in line 2: "*How could anybody be pro? I don't understand that.*" His concern, expressed while trying to formulate their main question, is about understanding why there could be two sides to this problem. In this way, the unsettledness regarding the trustworthiness of web sites reoccurs from another angle. Boy 2's response provides a pro argument: "*Because many make their living from that livelihood to cut down rainforest... but eh…we are against it.*" The question "*May we decide?*" posed by Girl 1 shortly afterward in line 4 is thematically linked to Boy 3's question. However, instead of responding by giving an answer to his question, her focus shifts back to *inscribing*, to whether having an opinion will satisfy the requirements for the assignment. Girl 1's question is a relevant response, taking the context into consideration: the purpose of the overall activity is to handle conflicts of interest, but the primary goal may be to complete their assignment.

Although it is tacit, the most important contextual common ground on which to seek warrant for their arguments is perhaps that they are at school. Against this background, the shifts drive deliberation on what to do next. Boy 2's next answer concerns what kind of genre might be appropriate according to the requirements of the assignment: "*…But we should be like a newspaper, then.. I think.*" In this particular event, how to handle a controversy reoccurred on a meta level, on the level of composition. The focus is *inscribing*, as genre and social purpose (Miller 1994). Through these considerations on composition as well as on content, the controversy is further clarified and construed. This kind of multilayered dynamic alternating between foci, and the way the foci reoccur, is characteristic of the students' deliberation across events in one lesson and across different lessons. The way in which shifts of foci are warranted relates to relevance, audience, and assessment.

7.3.4 Collaborative construction of an argument

An example from the second lesson shows how the students collaborated in the construction of arguments (table 5). The teacher walked between the desks and guided student groups during the activity. He emphasized the science involved: the role of carbon dioxide and oxygen in photosynthesis, and the rainforest as an ecosystem. The teacher also reminded the students to consider what deforestation means to the indigenous people. About five minutes later, the following event occurs:

Table 5

1	B2:	Then I can write=… should we then write on one of the questions: What does this have to say for the indigenous people?...Or, no, we have got that, yes: What does it have to say for the people living there?
2	G2	[But then I can cut out those questions] It uses just as much as it produces…because it has no great net production of oxygen …That will be right then (3.0)
3	B2:	But what we know now, is that.. eh…if the rain forest is there and no one does anything to it, then it balances at zero
4	B1:	Hmmm
5	G2:	That is okay then, sort of
6	B2:	Yes, but if anybody does anything to it, then it releases—
7	B1:	Much more
8	B2:	Then the forest itself kind of becomes a—
9	B1:	That we should include that there are quite a lot of animals
10	B2:	[CO_2 source?]
11	B1:	And animals and things that produce CO_2..which balances it at zero.. We also have to say why it balances at zero, not just that it balances at zero
12	B2:	And if
13	G2:	But I did say that, because what I wrote—
14	B2:	[And if it should disappear]..then it would..the whole= area would dry up and become a desert, and then it would become.. would have resulted in great=.. environmental changes..
15	B3:	Huh? That would not be any good at all
16	B2:	No, that would have been
17	B1:	Eh=
18	B2:	Almost environmental changes to the whole of the earth so to say

Boy 1 and Boy 2 collaborate on devising a scientific explanation. The dialogue also includes traces of controversies (Simonneaux and Simonneaux 2012) and "wicked" problems (Murgatroyd 2010). For example, Boy 2 says: "*What does this have to say for the indigenous people?...Or, no, we have got that, yes: What does it have to say for the people living there?*" In lines 6-10, Boy 2 and Boy 1 are building on each other's utterances by alternating the foci between explaining and inscribing. Toward the end, Boy 3, who is listening to their conversation, assesses the consequences: "*huh? That would not be any good at all*" (line 15). And Boy 2 may provide a conclusion in line 18, putting into words a possible consequence: "*Almost environmental changes to the whole of the earth so to say*." This development of the argument is due to their collaboration and the interplay between foci on *theme* and *inscribing*, the effort to understand the science involved, and the effort of structuring their text.

In this collaboration between Boy 1 and 2, the meaning is in the shared utterances, not necessarily in the utterances of any single participant. A chain of utterances may contain the potential for both agreement and disagreement. A participant may, through his or her choice of words and expressions, invite the next participant to give the utterance meaning by building on it with expansion, repetition, or greater precision. Vague forms of expressing conflict and disagreement seem to sustain a discussion. Vagueness and unsettledness are expressed, for instance, when an utterance is not completed. Moreover, unsettledness often reappears several times across events. In this way, assertions and justifications may be subject to further clarification, and may be developed on recurrent occasions.

7.4 Discussion and Conclusions

The main research question attempted to identify *characteristics and functions* of these students' deliberation through exploring what kind of *perspectives and approaches* were prevalent and for what *purposes*, and furthermore, *how decisions were reached in events, across events, and across lessons*.

Even though the group's final report was tidy and assessed as above average by the teachers, data from the dialogues did not show straightforward explicit explanation and argumentation. Rather, oral argumentation in this group activity was characterized by a kind of multilayered and collective puzzle-solving driven by students' rational deliberation across several activity-layers. Using a TAP analysis (Toulmin 2003) on this kind of data would require extensive reconstruction and speculation on implicit premises across lessons. Thus, TAP was unable to account for the "messy" data that constituted the students' inquiry process and progress in developing arguments over six weeks. As mentioned in the section on method (see the last paragraph) reconstruction would disturb the data. As an afterthought, it is worth considering that the design of a student project and of the data collection that can capture more of students' written work and writing practices might better fit the tools of TAP or for instance Waltons schemes, the pragmatialectical strategic maneuvering model, or reveal more of the rhetorical functions On the other hand, the students' written argumentation would be foregrounded to a greater extent. However, the interest of this study was the exact opposite: to look into students' oral deliberation. The consequence of the design was the identification of

significant differences between the ongoing deliberations in the oral dialogues during the inquiry activity and the written arguments and justifications that were presented in their final written product, in other words a gap between process and product. Ideally, further studies should include in depth analysis of both written and of oral argumentation, keenly considering the rhetorical kairos.

Tracking these students' different foci during group activity revealed characteristics and functions of their reasoning and deliberation on a macro level connected to situational purpose (*why*) based on a common ground of the overall science classroom activity. Furthermore, analysis of initiatives and responses revealed perspectives and approaches and especially deliberative aspects addressing issues of action.

The categories *what*, *who,* and *how*, building on SFL, were used to explore the dynamics of flow and interruptions in the audio-recorded and transcribed dialogues from six weeks of group activity.

On the *what* level, the students discussed (to a certain extent) scientific explanations regarding the content of their chosen issue. They struggled with the part of the assignment that concerned conflicts of interest. Sequences of argumentation involving explicit knowledge from the ethical, political, or economic domains were scarce, probably due to a need for more scaffolding and guidance on the relevance of arguments and adequate sources.

On the *who* level, the most prominent characteristic of the students' deliberation was the tacking back and forth between opposing positions (Mendelson 2001:278). Alternating perspectives and foci also provided the students with topical resources (Gabrielsen, 2008). On the *how* and *why* levels, changes of perspective or shifts of foci in initiatives and responses were legitimated by the overall purpose of the activity. Knowledge from school science, from public debates, and from personal and everyday sources was evident in their talk and deliberations. The students included different perspectives through intertextuality, giving voice to authoritative sources by reading to each other as well as referring to their teacher. They copied-and-pasted , and transformed material (spoken as well as written) from different authoritative sources. They relied extensively on authorities. The classroom conventions prevailed throughout. The difficulties these students encountered in handling conflicts of interest could have resulted in an assessment of their argumentation skills as deficient in relation to norms of dialectics or standards of scientific argumentation. However, the macro structure of their procedural strategy of shifting perspectives and foci proved to be a deliberative capacity that enabled them to make progress in their collaborative effort to complete the requirements for the assignment and write up a final report.

The students' deliberations, with shifting foci went on continuously during all the lessons, resulting in action choices and progress through the project. Three foci or strands of reasoning were identified in their activity: *theme*, or understanding the content, *inquiry*, or prudent deliberation on actions to be taken, and *inscribing*, or producing a neatly written report. The interplay of the three strands of reasoning links initiatives and responses, and was characteristic of the macro structure of student deliberation during the 11 lessons. In engaged

sequences, there was often interplay between all three foci. The foci arose according to the purpose of the activity, and the purpose provided a script regarding what is relevant as an argument and what is important (and unimportant) as a focus during group activity. The foci framed the situated common ground and provided criteria of relevance for deliberation.

Issues involving ethical, political, and societal considerations are complex and challenging, and SSI often involve frontier science as well as an acute focus on societal decision-making. Simonneaux and Simonneaux (2012) address this acuteness as controversies that emerge due to the urgent need to take action within a limited time frame. Time is limited because there is an imbalance between human utilization of nature and nature's capacity to renew. This perspective was actually taken up by the students in their final conclusion. The difference between a traditional science education approach and an SSI approach has similarities to the difference between dialectical philosophical approaches to argumentation and rhetorical philosophical approaches (see the section on Theoretical perspectives. Kock and Villadsen (2012) state that in a modern democracy, rhetoric and deliberation provide necessary procedural tools for practicing citizenship.

Unsettledness often seemed to sustain deliberation. Kock's (2007) notion of *legitimate dissensus* describes deliberative and rhetorical argumentation. The recurrence of unsettledness may sometimes be due to dialectical consensus seeking aspects of argumentation, and sometimes to seeking distinction or differentiation among legitimate alternatives.

Roberts's (2011) discussion about goals in the two visions of scientific literacy draws on Aristotle's distinction between three aspects of human activity: *theoria*, *praxis*, and *poiesis* that parallel the three foci identified in the analysis of this study: theme, inquiry and inscribing -- or phrased more generally: *to understand the content, to collaborate on decisions on how to continue, and to craft and compose* a written or oral end product. Roberts identifies two goals for science education: Vision 1 and Vision 2 (2007). The aims of SSI are similar to Vision 2, which is aimed at developing students' capacities to use and evaluate scientific knowledge in technological problem-solving as well as in personal and public decision-making. Roberts links Vision 2 to an interplay between three different patterns of reasoning: theoretical (*Theoria*), practical (*praxis*), and technological (*techne*). As a consequence of the analysis of student dialogues presented, it is suggested that the understanding of student argumentation in SSI inquiry should be nuanced and broadened, particularly concerning how students warrant their arguments alternating between foci on *the content, the collaboration* and *the composition*.

The conventions of the science classroom provide a topical landscape or the common ground for legitimate language uses (*how*) and alternation between patterns of reasoning according to the rationality of the overall purpose (*why*). The importance of the regulatory and instructional effect embedded in the referential (*what*) and interpersonal (*who*) levels of the situated science classroom context is also thoroughly supported by Johansen (2013), who discusses the rhetorical framing of the science classroom.

The contribution of this study to the field of research on argumentation and SSI education is related to the methodological challenges of analysis of students' oral argumentation. In order to better understand the collaborative deliberation in the students' oral speech flow, the deliberation is described as an interplay of activity-layers or patterns of reasoning. The Aristotelian meta terms of theoria, praxis, and poiesis may be used to further explore oral deliberative argumentation. The study provides perspectives and conceptualization on the macro structure of students' oral argumentation. These insights should be taken into consideration in order to nuance and further develop analytical tools, for instance TAP, for analyzing student conversation and argumentation. Further studies could explore if the meta terms can help teachers develop instructional strategies for training students' deliberative skills. Erduran (2008) also noted that aspects of argumentation are understudied. In research on argumentation in science education, she identified a gap concerning structures and processes, sociological, political, and psychological aspects of the learning environment. Further studies are needed where the identified characteristics and functions of the macro structure can guide development of analysis as well as teaching approaches and learning environments.

Argumentation in SSI, to a great extent, concerns deliberation on choices, rather than a demonstration of how to arrive at scientific answers. Opportunities to practice deliberative argumentation in inquiry along different patterns of reasoning can provide occasions for developing general skills in deliberative argumentation as well as in scientific argumentation. That is, students need to practice forms of argumentation related to procedures and choices as well as those related to the explanation of content knowledge. An awareness of the distinction between deliberative and dialectical aspects of student argumentation should be taken into consideration in the analysis of student argumentation, as well as in designing learning environments and teaching approaches for SSI.

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8 **A3:** Framing student dialogue and argumentation: Content knowledge development and procedural knowing in SSI inquiry group work

Abstract

We discuss the negotiation of the situated common ground *in classroom conversations. Decision making on socioscientific issues (SSI) includes norms of diverse funds of knowledge and interests. Arguments and justification may include warrants that cannot necessarily be weighed on the same scale. We discuss Roberts' Visions 1 and 2 of scientific literacy as framing the common ground of classroom discussions. Two teacher–student dialogue sequences with 11th grade students from the Norwegian research project ElevForsk exemplify the negotiation of the situated common ground and the students' deliberation. Our analysis examines what goes on in the thematic content, as well as at the interpersonal level of language use. Further, we suggest that different framings may complement each other and provide a space for the students' emerging scientific conceptual development as well as for deliberation as a form of emerging procedural knowing.*

Key words: Science topic: socioscientific issues; Didactic approach: argumentation; Age/group: 11 th grade students; Methodology: classroom discourse analysis

8.1 Introduction

In order to address the development of instructional strategies for group discussions in socioscientific issues (SSI) inquiry, this article discusses the situated common ground for warranting arguments in SSI inquiry. The *common ground* provides the language resources for justification in a particular situation on the relevant topic. In this article, the situated common ground refers to presuppositions, the shared knowledge, and meaning constructed, construed, and negotiated, depending equally on the speaker and the audience as well as a shared understanding of the default address of communication, i.e., the "mutual knowledge, mutual beliefs, mutual assumptions, and mutual awareness" (Svennevig, 1999, p. 55). A common ground is construed by the participants' framing. A frame—a mutually recognized space of interaction—gives a particular social characterization or shape to a situation and attune the audience to the appropriate context (Goffman, 1974; Bazerman, 2013).

Such framing is important to instructional strategies in terms of which aspects of argumentation are foregrounded. Of particular concern is the students' development of content knowledge and the development of the students' collaborative procedural knowing. Procedural *knowing* is used here to emphasize communal capabilities for proper action and procedure, as distinguished from *knowledge* seen as capabilities possessed independently by individuals. Accordingly, we discuss two complementary frames for SSI dialogues.

The rhetorical term *topoi* (Gabrielsen, 2008) refers to "common places," or "topics of invention." The invention concerns finding something to say, thematically, but also in general terms, as for instance, cause and effect, analogies, and comparisons. Science-specific issues provide special topoi on content and participant roles, whereas SSI includes diverse discourses and multiple voices, thus providing content and participant roles providing more general topoi from the public debate. Common ground concerns not only knowledge but also social norms on how teacher and students negotiate meaning. The framing of teacher−student dialogues is a matter of both content and participation.

Basically, what counts as "being scientific" in the classroom is regulated by norms (Knain, 2005). However, SSI inquiry cannot be relegated to the familiar sets of genres or norms that have provided security for generations of science teachers. When teaching science products and procedures, there is a relatively stable set of genres to rely on, for instance the textbook, initiative-response-evaluation (IRE) questioning routine (Mehan, 1979), or the laboratory report. These genres provide a stable common ground, deriving from the culture of academic science reinterpreted and adapted to the school institution. However, SSI is not tied to specific social institutions in any similar manner, but is drawn from rich public discourses. The increasing focus of educational goals on SSI and student participation in classroom debates about controversial issues regards concerns on uncertainties linked to frontier science, as well as to handling diverging values and conflicts of interests (Kolstø, 2001; Sadler, Barab, & Scott, 2007; Walker & Zeidler, 2007; Christensen, 2009). This means that the common ground is less likely to be tacitly shared and instead becomes open for negotiation and contestation. Therefore, the framing of dialogue and argumentation in an SSI inquiry should provide room for the development of students' capacities for choice and action and argumentation as a means of procedural knowing.

The teacher's instructional strategies may address the teaching of scientific argumentation (Osborne, 2010). Based on Piaget's thinking, this aspect of argumentation has been prevalent in studies on science education. The importance of dialogue and argumentation in order to promote conceptual learning and to develop students' understanding of argumentation as a critical feature of the nature of science (NOS) has been comprehensively examined (Driver, Asoko, Leach, Mortimer, & Scott, 1994; Driver, Newton, & Osborne, 2000; Duchl & Osborne, 2002; Jimenéz-Alexandre & Erduran, 2008; Mortimer & Scott, 2003; Scott, Mortimer, & Aguiar, 2006).

However, SSI raises questions concerning human behavior, well-being, economics, and social norms. SSI inquiry emphasizes the need for effective decision making and problem solving within a limited amount of time (Simonneaux & Simonneaux, 2012). In this respect, the primary purpose of argumentation is to deliberate on alternatives, rather than to provide empirical justification of knowledge claims (Byhring, in press).

Our aim is to highlight both the differences and similarities between the different ways of framing dialogue and argumentation in SSI at the classroom interactional level. Our research

question is: *How can SSI inquiry dialogues make space for both content knowledge development and the capacity and capability for deliberation and decision making?*

When focusing on science content knowledge learning, argumentation concerns the warranting and justifying of knowledge claims. The classroom conversation is then based on a relatively firmly framed situated common ground. The appropriate ways of what to say and how to do things are familiar to both the teacher and students. In contrast, the second framing may include out-of-school discourses addressing ethical, societal, and economic concerns in the situated common ground, which implies that what should count has to be negotiated to a greater extent. The knowledge claims in SSI cannot necessarily be weighed on the same scale. Rather than agreement and consensus, disagreement and legitimate dissensus may be the norm of deliberative argumentation (Kock, 2007).

In the following we first review several studies focusing on different aspects of inquiry and SSI in order to place our study within the science education discourse. We examine how our perspectives on student argumentation relate to Roberts' Visions 1 and 2 of scientific literacy. Further, the relation between the common ground and warranting of arguments is accounted for. Secondly, we present some further theoretical perspectives that may guide the development of teaching approaches aiming at creating a space for the development of both conceptual knowledge and deliberation skills. The two sequences were selected for further analysis to illustrate two different framings of the common ground. It is suggested that the different ways of framing are complementary. SSI inquiry provides a context for situating science content as well as processes.

8.2 Theoretical Perspectives

8.2.1 SSI and the two visions of scientific literacy

The acquisition of generalized canonical knowledge, scientific facts, and scientific ways of justification is necessary in SSI inquiry, but it is not sufficient (Kolstø, 2001, 2006; Ryder, 2001; Sadler et al., 2007; Zeidler & Sadler, 2008). Chang Rundgren and Rundgren's (2010) SEE-SEP model is a holistic approach to interdisciplinary SSI content knowledge. They include values and personal experiences as important aspects to stimulate decision making and student skills in argumentation. Østergaard (2012) discusses teacher questioning in Inquiry Based Science Education (IBSE) to stimulate students' qualified guessing in order to help them focus their investigations. Alternating between different instructional strategies may be necessary during the different phases of inquiry. Nussbaum, Sinatra, and Owens (2012) identify argumentation in science classrooms as addressing content as well as social dimensions of scientific work and collaborative inquiry. Their approach to argumentation focuses on dialectical argumentation and students' collaborative construction and critique. They note that students should engage with the "two faces of scientific argumentation": the content and the social angle. According to Borg, Gericke, Höglund, and Bergman (2012), the teaching approaches to SSI and education for sustainable development should include the presentation of different opinions. Overall, instructional strategies that provide pluralistic

perspectives to promote dialogue and argumentation are needed in inquiry learning and not least in SSI inquiry.

In distinguishing between science teaching based on Visions 1 and 2 of scientific literacy, Roberts (2007; 2011) emphasizes that Vision 1 provides reasoning patterns based on the practices of science proper, and Vision 2 provides reasoning patterns relevant to science-in-society issues. Vision 1 is rooted in the discipline of science itself and focuses on theoretical reasoning. Vision 2 is rooted in the perspective that science plays a role in human affairs. Roberts relates Vision 2 to the interplay between three different patterns of reasoning: theoretical (theoria), technological (techne), and practical (praxis). The three patterns of reasoning are based on Aristotle's account of the three domains of human purpose, respectively: to understand, to craft, and to make decisions. Roberts perceives all three patterns of reasoning as necessary to be scientifically literate. Vision 1 aims at enculturating students into the science community, whereas Vision 2 aims at developing students' capacities to use and evaluate scientific knowledge, technological problem solving, and personal and public decision-making skills. According to Vision 1, science learners are introduced to science concepts, theories, and models of conventional science, and scientific argumentation is included as part of this process. School science texts, as authoritative sources (Yeo & Tan, 2009), use the topical resources and language of science. Scientific genres convey the epistemological truths of the discipline as well as the ways in which these truths are usually elaborated upon, but also how they are legitimately challenged and questioned (Knain & Flyum, 2003). In Vision 2, socioscientific knowledge claims appear in diverse shapes and discourses, and an implication of dealing with SSI is the need to be able to handle diverse norms (Kolstø, 2001). We will discuss Visions 1 and 2 as framing the common ground of classroom discussions.

8.2.2 Common ground and warrants

Common ground is dependent on context and situated negotiation on language use in conversations, expert panels, politics, and public debates, as well as in science classrooms, thus governed by culturally informed contextual constraints (Clyne, Norrby, & Warren, 2009). The notion of a common ground, to some extent, is the representational parallel to the experiences that Andrée and Lager-Nyqvist (2012) define as *funds of knowledge.* Funds of knowledge conceptualize the processes of drawing on experiences, skills, and knowledge from different domains, subject matter domains, and out-of-school knowledge domains. Andrée and Lager-Nyqvist (2012) advocate that teaching approaches should build on students' experiences and funds of knowledge and raise issues of procedure such as construct validity, fair testing, and research ethics. In this way, a common ground can be negotiated and shared. The common ground of classroom discourse thus provides the situated legitimate resources for warranting arguments. In a science inquiry lesson, scientific inquiry procedures and NOS would be an expected common ground for justifying arguments. However, in SSI, an urge for action also provides a common ground for arguments and deliberation (Simonneaux & Simonneaux, 2012; Kock, 2007).

The situated common ground is a resource for the rational support of arguments. Toulmin (2003) addresses the philosophical choices hidden behind the general premises of argumentation in formal logic. He focuses on the relation between statements of fact and statements of assertion in practical argumentation. Toulmin emphasizes that knowledge claims convey values, theories, and interests, though often as implicit *warrants* ("rules, principles, interference-licenses") (Toulmin, 2003, p. 91). The warrants concern relevance and support the connection between the data and the claim. The preferred warrants are contextual, domain specific, and dependent on the field or group producing the argumentation. Further, the justification of a claim, and thus the soundness and strength of an argument, is retrospective. Justification and evidence are required to support a claim only when it is questioned. The criteria for what counts as justification differ from one field or community to another. The common ground for providing topical resources in complex fields may need to be negotiated (Gabrielsen, 2008).

These negotiations may entail different undertakings in Visions 1 and 2 (Roberts, 2011). For instance, the issue of the rainforest addresses scientific and technological knowledge, but also economy and ethics. Forestry affects the living conditions of local people. Also, the biodiversity of the rainforests may concern students' everyday life, on health (medical product development) and personal welfare, thus rousing commercial interests, environmental interests, and interests of local and indigenous people.

During negotiation of the common ground students can draw on various norms. Language uses and appropriate topoi (Gabrielsen, 2008) convey those norms in standardized ways of using language in recurrent situations (Miller, 1994). Hence, identifying genres is an important part of designing SSI teaching. It is important that the situated common ground is open for multiple discourses and perspectives. This calls for deliberative argumentation. In the following we present theoretical perspectives aiming at creating a space for warranting argumentation within the frames of Visions 1 and 2.

8.2.3 Making space

To a great extent, the framing of the classroom situation depends on the teacher's interventions and the discourse patterns that are established by the teacher. Mortimer and Scott (2003) suggest framing of inquiry dialogues as shifts between *interactive* and *non-interactive* moves as well as between *authoritative* and *dialogic* communicative approaches. An alternation between teacher-directed authoritative approaches and dialogic approaches (with multiple voices) creates tension between different explanations and perspectives, providing opportunities for learning. Authoritative approaches aim at developing the science perspective, whereas dialogic approaches aim at giving space and opportunities to use and explore ideas (Scott et al., 2006). By staging and leading the students through the *scientific story* (Leach & Scott, 2003), the teacher aims at achieving a common understanding and consensus on the concepts and explanation of phenomena.

Wallace (2004) presented a model for developing scientific literacy in the genres of science. In Wallace's model, exchanges between discipline-based subject matter and students' interests

create tensions that are important for students' learning. Successful learning implies that the students use scientific language and genres of science to communicate about science events (Wallace, 2004). Wallace's framework for developing scientific literacy consists of the following factors: (1) *authenticity*—a dynamic interplay between subject matter, situated authenticity, and student authenticity, whereby students must appropriate scientific language into their own forms of communication; (2) *multiple discourses*—students need to be exposed to multiple discourses and learn to negotiate between them; and (3) *Third space*—students must be willing to accept the opportunity to enter a discourse with hybrid language along a continuum between everyday and scientific languages. Different authenticities and multiple discourses create opportunities for transforming semiotic resources into new meanings in a *space*, where meanings are negotiated, co-constructed, and transformed in light of new experiences. In making a distinction between cultural and personal authenticities, Murphy, Lunn, and Jones (2006) emphasize that the students' negotiation is driven by their sense of personal authenticity, which is the extent to which students find learning experiences personally meaningful and relevant. *Multiple discourses* (texts and genres) may call for various authenticities in the situated common ground, so that in the third space the participants can negotiate and engage in the dialogue as authentic in terms of their familiarity with the discourse and genre as well as their background knowledge and participant roles. A space for negotiations on the situated common ground can be realized through dialogic communication, not by authoritative communication (Scott et al., 2006).

The theoretical understanding of a problem develops with activity. After all, theoretical knowing is not necessarily universal and decontextualized, but perpetually interchanging with people and technology. Knowing is dynamic and flexible, and dynamic situations in which people construct understanding through social interaction and practical action may be accounted for as *emergent problem spaces* (Greeno, 1998). This is a relational theory of meaning, which is based on conversation analysis research (Clarke & Wilkes-Gibbs, 1986; Schegloff, 1991). Constructing the referential meanings of terms is a basic part of the interpretive process and a collaborative achievement by the participants in conversations. The concept of emergent problem spaces draws on theories of social and collaborative knowing in communities of practice as accounted for in theories of situated learning (Brown, Collins, & Duguid, 1989; Greeno, 1998; Hennessy, 1993; Lave & Wenger, 1991).

In the following, we will investigate two selected teacher–student dialogue sequences in order to illustrate how a space for negotiation of the common ground is created by the teacher's situated framing. We will discuss the framing of SSI inquiry dialogues addressing Roberts' Visions 1 and 2 of scientific literacy. We emphasize that these examples are selected for analytical purposes; we do not make claims on the typicality of these interactions.

8.3 Method

8.3.1 Participants

The dialogue excerpts presented are with 11th grade general track students from the Norwegian action research project ElevForsk ("Students as Researchers in Science

Education" [StudentResearch]). A traditional school setting framed an open inquiry student project. Teachers and researchers developed instructional strategies to support the implementation of the competence objectives outlined in the Norwegian curriculum (Knain & Kolstø, 2011). The ElevForsk project aimed at providing students with opportunities for exposure to diverse authenticities and multiple discourses. In the context of ElevForsk, inquiry learning refers to the ways of working and thinking that cultivate competencies, such as posing questions and developing answers that are supported by different kinds of evidence. Such evidence may involve data collected by the students themselves, data collected by others, and authoritative texts (Knain & Kolstø, 2011b). The students were required to choose a topic and an issue to inquire into on the main curriculum area of *sustainable development* and to include *conflicts of interest*. Finally, the students submitted a group report on a wiki platform (ElevForsk, 2011).

The episodes presented are led by the same science teacher. Two different groups of students participated. In the first episode, the students worked on formulating a question related to an issue. During the activity, the students sat in groups in the classroom, and the teacher walked between the desks, guiding the groups. The second episode occurred during a student–student group meeting led by the teacher. They discussed the design of a questionnaire to be conducted in the local community.

The group participating in the first episode was particularly focused on data collection from the start due to their choice of topic, the rainforest. Their topic was considered particularly interesting since sustainable development and SSI were given particular emphasis in the overall ElevForsk project. The group participating in the second episode was chosen by the teacher to collaborate with the first group in teacher-guided group meetings. The teacher assembled these groups due to the relevance between issues. The first group chose global climate issues and the second group chose local attitudes toward and effects of CO_2 emission control.

8.3.2 Data collection

Video and audio recordings as well as field notes from classroom observations, audio-recorded interviews with teachers and students, and students' written work on a wiki-space were collected over four years in the ElevForsk project. The two sequences presented are from the fourth year. For analysis of student–student group discussions (Byhring, in press), lesson were chosen on the basis that they were rich in data and had extended dialogues. The student project spanned six weeks and took place in four to five forty-five-minute lessons per week. The two episodes presented here were particularly selected for analysis of teacher–student dialogues. The presentation of the sequences serves to illustrate our discussion of the situated common ground. The episodes were chosen retrospectively from different phases of the inquiry process (Bell et al., 2009).

8.3.3 Analysis

Our research question calls for analysis and interpretation that connect the individual and the collaborative aspects and that enables us to look at what goes on in the thematic content as well as at the interpersonal level of language use. Our analysis of these episodes is structured

according to the analytical categories offered in a framework by Mortimer and Scott: content, communicative approach, patterns of discourse, and teacher interventions (2003, p. 25). We operationalize the categories for our analytical purpose by selected concepts on text and meaning making from Halliday's systemic functional linguistics (Halliday, 2013). Hence, we connect Mortimer and Scott's categories with a theory on text that opens for detailed analysis. First, we use *referent chains* to trace thematic patterns in the excerpts. Referent chains are strings of words through stretches of text that are "about the same." Referent chains are analyzed by combining two resources in Halliday's theory for establishing cohesion: *reference* and *lexical cohesion* (Halliday, 2013, pp. 605–606). By analyzing referent chains, we trace aspects of both *content* and *patterns of discourse*. By considering in addition how meaning is developed between utterances, we are able to address the *teacher interventions*. From this analysis, we reach conclusions on the *communicative approach* (Mortimer & Scott, 2003; Scott et al., 2006).

Part of the meaning is explicit in language, but inevitably, there are presuppositions that are made, drawing on what is taken to be familiar and shared contextually, that is, the common ground. Our analysis aims at understanding the implicit warrants of argumentation and deliberation by interpreting contextual aspects presupposed in the exchanges among interlocutors, in terms of the categories offered by Mortimer and Scott.

In accordance with our research question, an objective is to identify traces of the situated common ground and the framing that allows for emerging conceptual meaning making and warranting of argumentation, deliberation, and decision making. Our interest is in how the teacher may make space for argumentation addressing both Visions 1 and 2 of scientific literacy.

8.4 Two Examples – The Situated Common Ground of the SSI Inquiry

In the first episode, the students read about the rainforest and considered divergent information from two websites. The students asked the teacher for advice. The episode is drawn from a 45-minute lesson and the episode lasted for about one minute. The lesson is chosen from a total of 8 hours and 12 minutes of audio-recorded material from their group work.

There are three important referent chains: Chain 1 is related to the two internet pages. Chain 2 is related to aspects of the rainforest. These two chains were initiated by the students. Chain 3 is started by the teacher in line 07. There are thus three thematic patterns.

[1]Episode 1

Dialogue and referent chains		Chain 1	Chain 2	Chain 3
01 B_1	We have a question for you. We have been reading on two different pages. There it says . . eh . . on one page, it says that the rainforest is the lungs of the earth, that is, that it produces more oxygen than carbon dioxide. And then it says on another page that it does not, that is, that this is just a myth. So, we are really confused	two different pages – page – it – another page	rainforest – lungs of the earth – more oxygen than carbon dioxide – it – this	
02 B_2	And both pages were really like "reliable" ((HE SAYS 'RELIABLE' IN ENGLISH))	– both pages –		
03 B_1	Like Regnskog.no or Regnskogfondet.no, and sort of like . . much like	regnskog.no – regnskog-fondet.no		
04 B_2	What should you believe in?			
05 B_	Yeah			
06 B_3	Rainforest-		rainforest	
07 Teacher	What have you learnt about ecosystems? It is a limited area in nature that to a great extent manages itself			Eco-systems
08 B_1	. . . mmm . . . but that is also relevant to _			
09 Teacher	So, that means the animals and the bacteria in the woods up here		woods	animals – bacteria
10 B_1	Yes			
11 Teacher	They have a metabolism, just like people, don't they?			Metabolism
12 B_1	Yes			
13 Teacher	And give off CO_2			CO_2
14 B_1	Mmm			
15 B_2	So all the animals in _			
16 Teacher	It increases then, the concentration of CO_2 increases, and then all the green plants take this up and bind it again		green plants	
17 B_1	Yes			
18 Teacher	In photosynthesis			Photo-synthesis

[1] Short breaks are marked . . Somewhat longer breaks . . . ; interruption of words: *interru-;* interruption of speech: *interruption of speech* _ . Overlapping speech: [simultaneously] when more than two people talk at the same time [[simultaneously]]. Comments: ((IN DOUBLE PARENTHESES)). Dialogues are transcribed with a system from Du Bois et al. (1983) as in Svennevig (2009). However, intonation units are not separated in lines. Continuing speech flow from one person is written down continuously.

The *content* regards the students' inquiry into different websites. The students refer to claims of knowledge made by the websites. However, the teacher first and foremost directed their focus to the science involved. He addressed scientific concepts and directed them to the relation between metabolism and photosynthesis (line 11, followed up in lines 16 and 18). The teacher shifted the focus from the students' problem with an inquiry into which website to trust, to explaining and presenting them to a scientific argument (lines 7, 9, 11, 13, 16, and 18). Looking closer at the referent chains, chain 1 relates to online resources, while the other two relate to subject matter concepts. Chain 2, on the rainforest as the lungs of the earth, runs parallel to the website pattern. They run from the start initiated by the statement in line 01: "*We have a question for you*", through line 04: "*What should you believe in*." The third chain is initiated by the teacher in line 07: "*What have you learnt about ecosystems?*", starting with ecosystems and ending with photosynthesis.

The shift in thematic pattern in line 07 divides the episode into two main parts. Other evidence of the shift is a change on the interpersonal level. In the first part the students are talking, in the second part the teacher takes the lead. The episode is staged as a question−answer pattern: The question is phrased in lines 01 to 04, and the teacher answers in lines 07 to 18. The teacher's main concern here seems to be scaffolding the students' conceptual understanding of the rainforest as an ecosystem. He reframed the students' question concerning which source to trust and placed the discourse on establishing the scientific ground of Vision 1.

Boy 2's question in line 04 is vital in the SSI contexts associated with Vision 2. The decisive moment for reframing the discourse is in line 07. The teacher's framing by his question to the students has two key features: it has no immediate relation to the question in line 04, and the teacher immediately started to answer it himself. His intervention was to remind the students of the key scientific idea. Utterances made by the students in this answering part were effectively ignored. What made the teacher's answer relevant to the student's question was that the referent chain about the rainforest as the lungs of the earth stretches into the ecosystems chain in line 9 (*animals*, *bacteria* and *woods*) and in line 17 (*green plants* and CO_2). Thus the teacher intervened by listening to the question and then offered a piece of explanation that he deemed important to the students in the situation.

From the above analysis of thematic content, discourse patterns, and intervention, we infer that the communicative approach in this episode was *interactive* and *authoritative*. It was interactive since the teacher responded to a question from the students. It was also authoritative since he offered the students a piece of scientific explanation with no actual contribution from the students. The correct explanation from science prevailed. Hence, the science lesson authenticity became foregrounded as the context for providing appropriate topical resources and framed the situated common ground. The teacher framed the content as well as the participant roles. During his presentation of the science content, the teacher paused several times, but the students' short responses were just prompts for the teacher to continue his explanation. The students accepted his framing, as seen from their affirmative comments (lines 10, 12, 14, and 17).

The teacher's intervention provided topical resources by telling a scientific story (Mortimer & Scott, 2003). He modeled a scientific argument, using the appropriate school science terms. The students asked for guidance on how to inquire further into their chosen issue, so they may also have interpreted the teacher's guidance as an implicit call to critically consider their sources. In their final report, the students did not refer to the website that used the metaphor of the rainforest as *the lungs of the earth*.

To sum up, the teacher shifted the focus by offering theoretical reasoning, in line with Roberts' Vision 1. Undeniably, conceptual understanding is important in science education, and the teacher's modelling of a scientific explanation to the students has a legitimate place in SSI teaching. However, the common ground provided by the scientific exposition genre narrowed the discourse by positioning the students as receivers of knowledge rather than as inquirers into a question. In fact, Boy 2's initial question (line 04) was a call for criteria for choosing between the two websites: "*What should you believe in?*" This question has no prior answer, and a decision would require an examination of different perspectives.

The students were exposed to various out-of-school discourses and genres through their web searching and questioned the reliability of sources. Their initiative called for a space for collaboration and deliberation, but the teacher did not use the opportunity of the uncertainty that had emerged to address, for instance, genre, publisher, ideology, or adaptation to the audience. In the framing of the dialogue, the teacher excluded the societal discourse. Out-of-school contexts were transmuted into classroom tasks (Andrée & Lager-Nyqvist, 2012).

The next episode involved the students engaging in their own investigations. They planned interviews with members of the local community. In this situation, the teacher adopted a different strategy resulting in a different framing. The episode lasted for a couple of minutes, during a teacher-guided student–student group meeting about 18 minutes long.

In the following episode, we have identified four referent chains. They represent interwoven thematic patterns, which we have grouped into two pairs. Chains 1 and 2 are on the questionnaire. Chains 3 and 4 are on busses and their use of energy. Further, the term "environmentally friendly," introduced by a student in line 07, is repeated and discussed.

Episode 2

Dialogues and referent chains		Chain 1	Chain 2	Chain 3	Chain 4
01 Teacher	Interview them about some knowledge. And then I think that one could develop some questions about the future . . . Would . . you . . change your attitude to the use of. . public . . eh transport if . . or something	interview – questions –	them – you		Public . . eh transport –
02 G_A	But we did have that. If . . eh, this becomes . . eh	that			
03 B_A	Environmentally friendly				
04 G_A	Environmentally friendly; would you use the bus then?		you		the bus
05 Teacher	Yes. Environmentally friendly is a somewhat vague concept . . isn't it? Don't you agree?				
06 B_A	What do you mean? I think it is quite clear whether a bus is environmentally friendly or not				a bus
07 G_A	Then it runs on hydrogen or biogas or_			hydrogen - biogas	it
08 B_A	It may be environmentally friendly even if it runs on petrol too, if it only emits little, kind of			petrol	it – it – it
09 G_B	Yes, yes ((AGREES))				
10 B_A	But we can deepen the question a bit, and write if it had been driving on zero emission stuff, then . . sort of	question		zero emission stuff	it
11 Teacher	. . yes, and what _				
12 B_A	That does not pollute anything at all			that	
13 Teacher	Yes, and you think that the man in the street has knowledge about that [laughs a little bit]		the man in the street		
14 B_A	Yes				
15 Teacher	They must know something about emission		they	emission	

Dialogues and referent chains		Chain 1	Chain 2	Chain 3	Chain 4
16 B_B	[simultaneously] They do know the difference between emission, zero emission, and some emission		they	emission – zero emission – emission	
17 G_ B(?)	. . emission . . ((MUMBLING))				
18 B_A	I think most people know _		most people		
19 Teacher	I am not quite sure about that myself. You have just been through Energy for the Future, so your insight into this is good				
20 B_A	Yes, right				
21 G_B	But if it says zero emission, then [I?] don't understand _	it		zero emission	
22	[[they talk simultaneously and mumble]] ((INAUDIBLE))				
23 B_C	It is even written on the busses				buses
24 B_B	But they sort of know, if they are told. This bus does not emit CO_2. Then they know that there is no CO_2 emission		they – they – they	CO_2 - emission	bus
25 Teacher	Yes, it's OK				
26 B_A	Then we could change it a bit, write it a little more precisely in the last question	question			

The teacher addressed the crafting of the questionnaire. The critical turn is line 05, where he questions the term "environmentally friendly." In line 13, he challenges the students on audience awareness, and he raises doubt in line 19.

The repetition of the adjective "environmentally friendly" is important, since it sets off an inquiry into what an environmentally friendly bus is. The students grappled with the theme in two different contexts. In the first place, in the school context situation (what characterizes environmentally friendly busses according to use of energy) (line 19). In the second place, in the context of interviewing lay people, the students need to operationalize this "vague concept" (as expressed by the teacher in line 5). This concerns how the term is commonly used by lay people. The students need to interpret the responses from the interviewees.

Compared to episode 1, here, no referent chains were "owned" by the teacher. In his three significant turns (01, 05, and 19) he asked open questions and expressed doubt, on behalf of the interviewees (10) and on the students' understanding, expressed subjectively ("I") and hedged ("not quite sure") (19). This interaction pattern we label *sustaining inquiry*. From the above we label the teacher's interventions *shaping ideas* (Mortimer & Scott, 2003, p. 45). The teacher is opening and keeping open a space for sustained inquiry. It follows from the pattern of discourse and the teacher's intervention that the *communicative approach* is *interactive* and *dialogic* "in that the teacher listens to, and takes account of the students' point of view" (p. 36). The teacher's interventions stimulated the students to take critical initiatives (line 16 and 23). The teacher's intention seems to be to find a formulation that can communicate the notion of *environmentally friendly* effectively to the interviewees. In fact, the teacher did not intervene in order to clarify the scientific concepts, even if supporting the students' conceptual development could also have been an obvious approach in this situation.

The driving forces of the conversation between the teacher and the students are the authentic constraints of designing a questionnaire at the intersection of science concepts and lay knowledge. Another authentic constraint is their need for the questionnaire to provide valid and reliable data. The deliberation on which term is appropriate is supported by warranting from a situated common ground consisting of a diversity of discourses, including school science, as well as technical and layman public discourses. The referent chains may be viewed as traces of these topical resources. The teacher's dialogic approach keeps the third space open and allows for a wide range of topical resources.

The framing of this learning situation opened up for the participation of different points of view and allowed the students to voice their ideas and perspectives (Scott et al., 2006), and these included how "plain folks" (Brown et al., 1989) speak about and understand the wording *environmentally friendly*. This attempt to adapt to the audience made the students negotiate the situated common ground.

By questioning the students' choices, the teacher provided opportunities for them to exercise inventive and critical thinking skills in an *emergent problem space* (Greeno, 1998). The discussion between the teacher and the students may be viewed as a negotiation of the situated common ground. The framing here may serve the purposes of both of Robert's

Visions. However, the context of schooling (Schleppegrell, 2001) was, perhaps, in the end the dominant situated common ground. In the end, the students chose the precise scientific expression, *CO_2 emission* (lines 24 and 26).

8.5 Discussion

The dialogue sequences illustrate two different ways of framing student argumentation in an SSI inquiry: 1) the negotiation of the situated common ground is framed by science-subject conceptual knowledge and participant roles, with roles defined as someone possessing knowledge and others who do not. 2) The negotiation of the situated common ground draws on broader topical resources and a diversity of knowledge domains from the public debate. In the first episode, the students asked a question about which website to trust, opening for a complex negotiation of criteria for trusting a source, framing the conversation within the realm of Vision 2, since "trust" is a less-defined issue than the question of what is correct knowledge or not. However, the teacher transformed this into questions of understanding scientific concepts, moving the issue into the practices of learning established scientific knowledge in the realm of Vision 1 addressing theoretical patterns of reasoning. This shift in thematic pattern was not a complete break. However, it was a fundamental shift in the interpersonal aspect. He could also have supported the students in recognizing the need to address the validity of the knowledge claims made by the different websites, and he could have addressed practical and technical concerns in line with Roberts' Vision 2. However, the teacher's authoritative approach did not make space for the students to experience this need. The teacher modeled the scientific argument about the ecosystem and photosynthesis. We note that when interpreting the situation as a matter of recalling conceptual knowledge, through his authority, the teacher simultaneously closed the third space that had been potentially created by the students' initial question. The teacher could have facilitated the students' identification and negotiation of common ground by including different authenticities, e.g., science subject matters, non-governmental organization (NGO) websites, and students' personal experiences, and individual interests, for instance by taking up the term "reliable" used by one of the students. The opportunity for authentic inquiry into which website to trust was then lost, at least temporarily.

The different ways of framing complement rather than oppose each other, as both authoritative and dialogic approaches are needed in teaching. Furthermore, we should acknowledge that capturing all aspects of Vision 2, scientific and social, alternating authoritative and dialogic approaches in one and the same guiding session, may be impractical and possibly unwise. However, in the first episode (line 04), the teacher did not offer any explicit reasons for his exposition and how it related to the student's initial question or why they would need it. Therefore, the intervention resulted in a marked shift in common ground by both content and participant roles. For the teacher, the importance of establishing the scientific connections may be very obvious, but likely not for the students.

The data are not extensive enough to support inferences about the appropriateness of different frames to the different phases of the inquiry process, but it is interesting to notice that in this

early phase, the teacher chooses to frame the discussion first and foremost within the science subject discourse, while later he made efforts to open up a space for negotiation and deliberation between discourses. It is also interesting to notice the closing lines in episode 2. The teacher finally accepted the student's choice (line 25), which may be more in line with Vision 1 than with Vision 2.

Related to Vision 2, practical, technical, and theoretical reasoning patterns are not only useful but necessary for decision making and action. The teacher's questioning in the second episode challenged the students' procedural knowing and crafting skills regarding the design of a questionnaire. The teacher's strategy allowed for the participation of multiple discourses by including plain folks' talk, and students' experiences, as well as school science. The appropriate concepts emerged in context and relative to a particular situation and audience. According to Greeno (1998), the referential meanings may be characterized as relations between situations, rather than as properties of symbolic expressions (p. 9). Consequently, the meaning of the concepts that are appropriate in any particular situation becomes a relation between the situation where someone talks and the situation to which the utterance is interpreted as referring. The criteria that constitute a common ground may be part of what is negotiated in the process of meaning making. In deliberative argumentation, associated with Vision 2, the teacher needs to support the students in this process, for instance, by sorting out what are the ethical, political, or scientific aspects of the inquiry and whether the purposes of the discussion relate to content, collaboration, or crafting, for instance the design of a questionnaire or a report (Byhring, in press).

Deliberation is learned through enculturation both in school science settings and in out-of-school settings, where different funds of knowledge are developed and drawn from. Members of a culture share ways of referring to and talking about phenomena. From a science education perspective, Driver et al. (1994) call this *informal* ways. Informal ways of talking may convey other warrants than those from scientific perspectives. To gain a broader understanding of the complexity involved in SSI, students need guidance and teacher support in discussions and carefully planned teacher presentation and modeling. Further research should explore and examine teachers' alternation between strategies and identify effective approaches to the different aspects of argumentation that has been presented. Learning environments should provide students with opportunities to create a space for the complexity of concepts and issues to emerge. They should also provide students with opportunities to deliberate on procedures and to inquire into different genres, in order to stimulate skills in decision making aiming at authentic civic engagement.

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Appendixes 1-5

Appendix 1 (explains the protocol as a tool)

A protocol was designed for the analysis of the second case, in order to support hermeneutical reading and analysis of argumentation and deliberation in student dialogues. In depth analysis was conducted on transcribed data from 11 sessions from one group.

The Layout of the protocol:

Codes are inserted the first row on each page of the protocol (Numbers of codes are inserted in the columns when a code occurs)											
Information on group and the date of the lesson are given Text describing the session, with time, room, how many students, or which group. Short review of the content of the session and particularities from field notes											
Transcripts are inserted 00:00 with time incerted Interlocutor 1: Interlocutor 2: Etc.											
Interruption/continuing speech flow are coded in running transcripts. A new row starts when the speech flow is interrupted or the speech flow starts again after a silence, marked with heading											
Comments are inserted Particularities from researchers fieldnotes are entered into the protocol in running transcripts											
Transcript continues 00:00											

Codes:

A coding list was used during analyses and codes were inserted into the protocol, se example below. Codes were a mixture of predetermined asserted findings and inductive labeling, when pre-defined categories could not fit the material. The codes used in the example (Appendix 2) are the following

1: Threads: T: THEME – content; P: PROSESS – ways of thinking and working, inquiry methods (how do they work/inquire into); S: WRITING process – concerns assessment criteria and purpose, genre

2: Forms of knowledge: T: understand. Pr – use/do. Po – make (1)

6 Purpose – (genre as social norm) – Why (2)

9 Multiple voices (Emprical codes drawn from analysis of case 1 (See article 1)

S – Requirements for coherence

B – Belief – personal engagement

D – Data

I – implicit intertextuality

H – Purpose (genre)

10 A – affect; W – win; S – share; D – demonstrate; V – verify (3)

11: Questions

12: Correction: S – self-correction; I – interactional correction

13: Arg1 – scientific argumentation – concerns expressions of uncertainty and doubt

Arg2 – interdisciplinary/societal/democratic – concerns disagreement and violation, e.g. norms, values or different foci (power and interest)

N – Negotiation

15 C – claim; D – Data; W – Warrant; B – Bacing; Q – Qualifier; R – Reservation (4)

16: Warrant

17 Ma – counter argument; Mo – Contradiction; K – critical remark

19 Identified topoi? (5)

20 E – Agreement; Us – uncertainty; Ua – ambiguity/unresolved; B: Confirmation

21 T – doubt; S – violation

22: U – disagreement; K: Controversy

23: H – humor; T – funny talk and being funny

24 Contextual empirical codes (preliminary): P+ a number between 1-25.

No1: Uncertainty/doubt - 1d: on the sice of the area that disappears

No 14: off-task talk that might be of interest

No 16: the investigation

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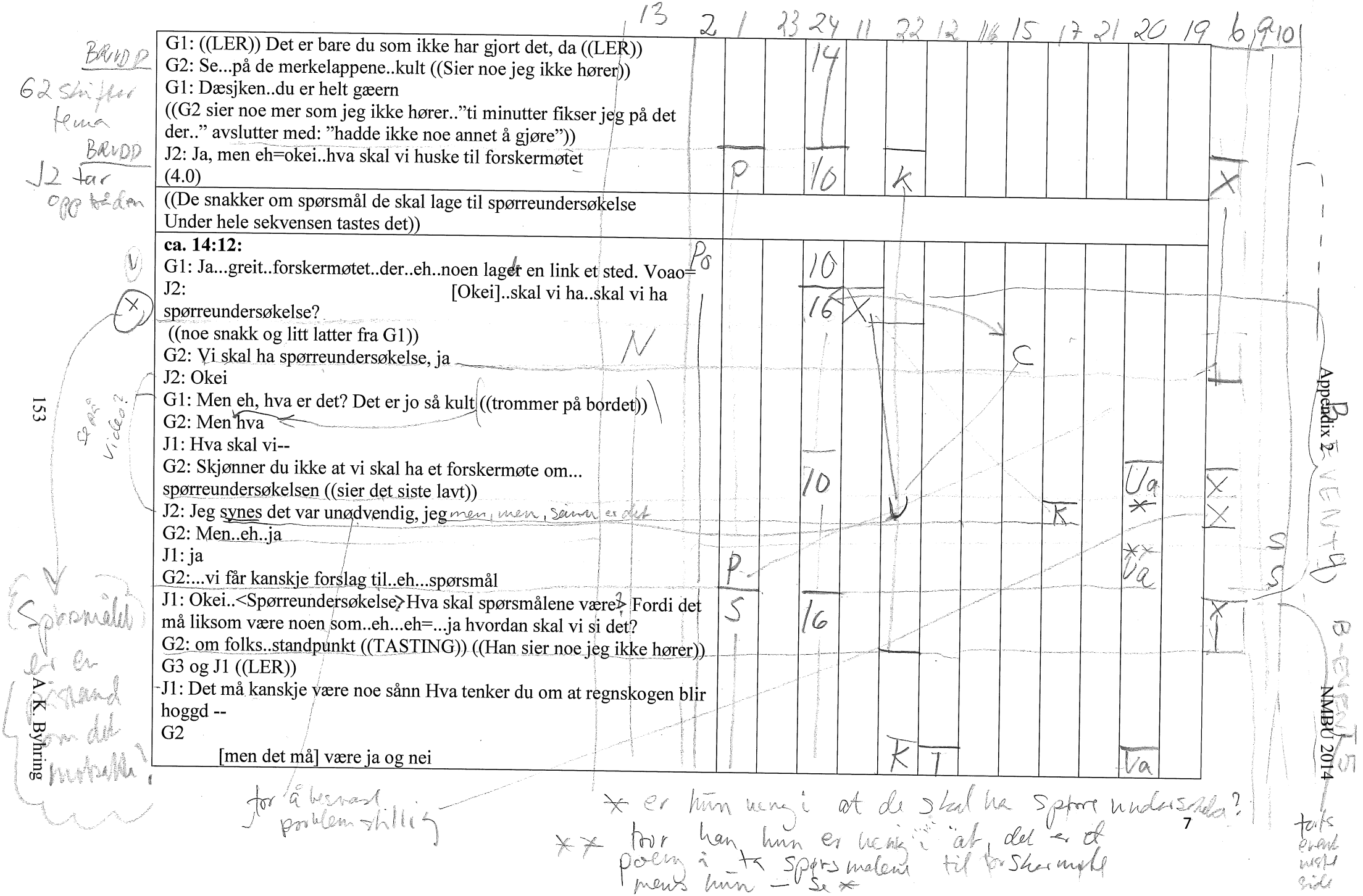
Appendix 2

– an example of the first level of the protocol

(Transcripts and analysis in Norwegian)

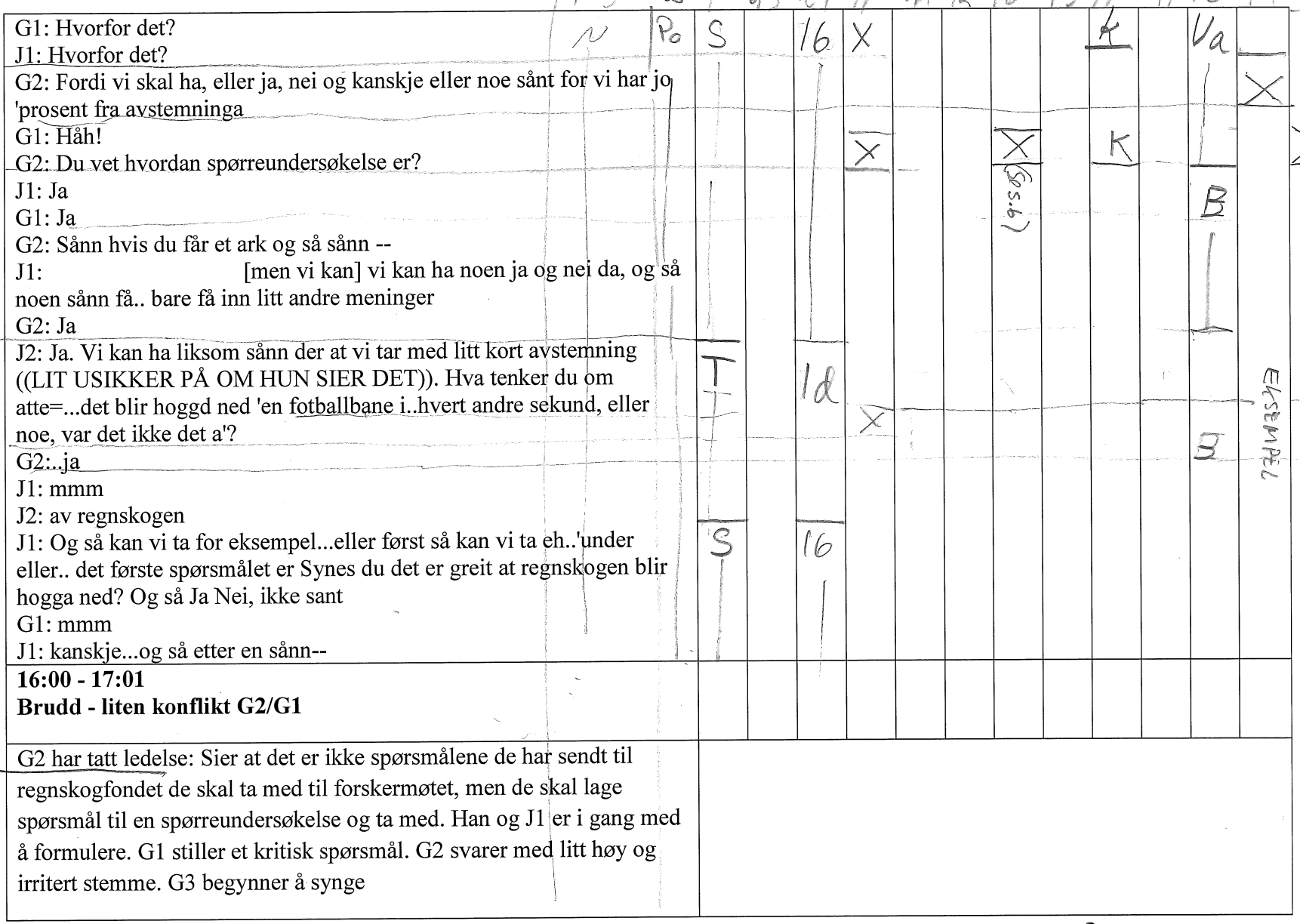
The episode in table 2 in A2 is drawn from this transcript. The episode starts at page 9 in the protocol. Translation of the episode is given in Appendix 5



G1: ((LER)) Det er bare du som ikke har gjort det, da ((LER))
G2: Se...på de merkelappene..kult ((Sier noe jeg ikke hører))
G1: Dæsjken..du er helt gæern
((G2 sier noe mer som jeg ikke hører..”ti minutter fikser jeg på det der..” avslutter med: ”hadde ikke noe annet å gjøre”))
J2: Ja, men eh=okei..hva skal vi huske til forskermøtet
(4.0)

((De snakker om spørsmål de skal lage til spørreundersøkelse
Under hele sekvensen tastes det))

ca. 14:12:
G1: Ja...greit..forskermøtet..der..eh..noen lager en link et sted. Voao=
J2: [Okei]..skal vi ha..skal vi ha spørreundersøkelse?
((noe snakk og litt latter fra G1))
G2: Vi skal ha spørreundersøkelse, ja
J2: Okei
G1: Men eh, hva er det? Det er jo så kult ((trommer på bordet))
G2: Men hva
J1: Hva skal vi--
G2: Skjønner du ikke at vi skal ha et forskermøte om... spørreundersøkelsen ((sier det siste lavt))
J2: Jeg synes det var unødvendig, jeg
G2: Men..eh..ja
J1: ja
G2:...vi får kanskje forslag til..eh...spørsmål
J1: Okei..<Spørreundersøkelse> Hva skal spørsmålene være? Fordi det må liksom være noen som..eh...eh=...ja hvordan skal vi si det?
G2: om folks..standpunkt ((TASTING)) ((Han sier noe jeg ikke hører))
G3 og J1 ((LER))
J1: Det må kanskje være noe sånn Hva tenker du om at regnskogen blir hoggd --
G2
[men det må] være ja og nei



G1: Hvorfor det? J1: Hvorfor det? G2: Fordi vi skal ha, eller ja, nei og kanskje eller noe sånt for vi har jo 'prosent fra avstemninga G1: Håh! G2: Du vet hvordan spørreundersøkelse er? J1: Ja G1: Ja G2: Sånn hvis du får et ark og så sånn -- J1: [men vi kan] vi kan ha noen ja og nei da, og så noen sånn få.. bare få inn litt andre meninger G2: Ja J2: Ja. Vi kan ha liksom sånn der at vi tar med litt kort avstemning ((LIT USIKKER PÅ OM HUN SIER DET)). Hva tenker du om atte=...det blir hoggd ned 'en fotballbane i..hvert andre sekund, eller noe, var det ikke det a'? G2:..ja J1: mmm J2: av regnskogen J1: Og så kan vi ta for eksempel...eller først så kan vi ta eh..'under eller.. det første spørsmålet er Synes du det er greit at regnskogen blir hogga ned? Og så Ja Nei, ikke sant G1: mmm J1: kanskje...og så etter en sånn--	
16:00 - 17:01 **Brudd - liten konflikt G2/G1**	
G2 har tatt ledelse: Sier at det er ikke spørsmålene de har sendt til regnskogfondet de skal ta med til forskermøtet, men de skal lage spørsmål til en spørreundersøkelse og ta med. Han og J1 er i gang med å formulere. G1 stiller et kritisk spørsmål. G2 svarer med litt høy og irritert stemme. G3 begynner å synge	

G2: Og så Hva tror du er viktigst..eh ((TASTER)) at regnskogen består..eller..at..eh= folkene som bor der bruker den som en ressurs?
((TASTING))…det synes jeg var et utrolig bra spørsmål
G1 ((gjesper)) Jah...Kan du gjenta det?
J2: Skal jeg skrive det ned?
G2: Hva synes du er vik-
J1: Ja
G2: hva synes du er viktigst at regnskogen består eller atteh folk som bor der får brukt det som en ressurs
G1: Det er ikke nødvendigvis folk som bor der da, det kan være folk fra andre land som kommer å --
G2: [!Jammen folka rundt] der da ((MED STERK STEMME)
G1: Ja, rundt der, greit da
J1: ((LER LITT))
G3: Sjabba-dabba-ru
G2: Eh=
G3: skjirbarrab-sku-rap-rap
((G1: også med noen tullelyder))
J2: <at folkene som..bor der..bruker den.. som ((taster))
J1: [tenk hvis noen] ((tror hun sier det))
G2: som ressurs
J2: <ressurs> ((taster mens hun snakker))
G2: Hva skjer nå?...Fullfør
(3.0)
J2: Hva var det første spørsmålet vi skulle ha?
J1: Eh=Synes du det er greit å brenne skogen..eh eller noe sånt
((G3 lager lyder))
J2: Er det hogget eller hugget?
G2: Hogd (4.0) huggi
63: Huggi-ha-gi! Skobber-ra-ra-skirre bippp-bipp-skirrebapp
(10.0) ((TASTING))
J2: Får håpe vi får noe... forslag til spørsmål, holdt jeg på å si, på forskermøte, da

Appendix 3 – an example of the second level of the protocol (transcripts and analysis in Norwgian)

Who is communicating to whom about what, with what purpose (why?) and how? *Rhetoric – the 'arts of discourse' – the craft and design of communication (Andrews 2010, p. 29)*	What Field and ideational metafunction	Who Participants and interpersonal metafunction	How Mode and textual metafunction Levels based on Andrews (2010)*	Why To whom with what prupose (social norm – genre)
1STC_5. 7. Mars 2011 Norsktimer 9:50 dobbelttime (Lærer 2 på kurs). Elevene sitter på et grupperom. Det finnes video. Forberedelse til forskermøte. Alle er til stede. AK (researcher) er innom. AK snakker om at de skal tenke igjennom undersøkelse når de lager spørsmål. G2 spør i starten om det er ang spørreundersøkelse. AK snakker om at rektor skal se på spørsmålene dersom noe er personlig følsomt, men bemerker at det kanskje ikke er så aktuelt for denne gruppa, men at Knut og Martin skal se igjennom undersøkelsen Gutt2 spør om de kan spørre elever på skolen AK svarer at det må gi noe mer enn læreboka eller andre kilder gir Arbeid med spørsmål.	Elevene forbereder seg til forskermøte. De lager spørsmål til spørreundersøkelse som skal legges fram for medelever på forskermøtet – og som skal godkjennes av rektor	3 gutter 2 jenter. Lærer Marcus er på kurs. Ak er innom	Det er en måned ut i prosjektet. De sitter på grupperom.	Elevene lager spørsmål rettet mot elever og forbereder presentasjon til forskermøtet - rettet mot lærer og medelever
((De snakker om spørsmål de skal lage til spørreundersøkelse Under hele sekvensen tastes det))				
Excerpt of transcript:	* How is described on three levels based on Andrews (2010) A: The level of the utterance: practices for composition of speech, referential chains B) argumentation: a process where such practices serve the purpose of handling distinction and differences C) rhetoric, genre, the art of communication, the craft and design of communication			
ca. 14:12: G1: Ja...greit..forskermøtet..der..eh..noen lagde en link et sted. Voao= J2:	Språk Hverdagslig	J2 stiller spørsmål /kritisk innvending «Okei…skal vi ha…skal vi ha spørreundersøkelse?»	Nivå A) Lite modalitetsmarkører, bare G2 til slutt: Vi får «kanskje» forslag…	Forberede forskermøte

[Okei]..skal vi ha..skal vi ha spørreundersøkelse? ((noe snakk og litt latter fra G1)) G2: Vi skal ha spørreundersøkelse, ja J2: Okei G1: Men eh, hva er det? Det er jo så kult G2: Men ((trommer på bordet)) hva J1: Hva skal vi-- G2: Skjønner du ikke at vi skal ha et forskermøte om... spørreundersøkelsen ((ser på J1 og sier det siste lavt)) J2: Jeg synes det var unødvendig, jeg…men, men sånn er det G2: Men..eh..ja J1: ja G2:...vi får kanskje forslag til..eh...spørsmål J1: Okei..<Spørreundersøkelse. Hva skal spørsmålene være> Fordi det må liksom være noen som..eh...eh=...ja hvordan skal vi si det? G2: om folks..standpunkt ((TASTING)) ((Han sier noe jeg ikke hører)) G3 og J1 ((LER)) J1: Det må kanskje være noe sånn Hva tenker du om at regnskogen blir hoggd -- G2 [men det må] være ja og nei G1: Hvorfor det? J1: Hvorfor det? G2: Fordi vi skal ha, eller ja, nei og kanskje eller noe sånt for vi har jo 'prosent fra avstemninga G1: Håh! G2: Du vet hvordan spørreundersøkelse er? J1: Ja G1: Ja	Event B.5. Språk: Hverdagslig Projeksjon Fotballbane som visualisering av nedhogging har de funnet i kildetekst Presupposisjoner	Kritisk innvendig G1 retter en kritisk innvendig mot J2: «Men eh, hva er det? Det er jo så kult» G2 stiller spørsmål om at det er forstått at forskermøtet skal være om spørreundersøkelsen J2 responderer: «Jeg synes det var unødvendig, jeg…men, men sånn er det» Initiativ/respons Spørsmål: Flere spørsmål kommer etter hverandre her. J1: «…ja hvordan skal vi si det?» Og så stiller G1 og J1 kritisk innvending «hvorfor?» til G2 som påpeker at de bør lage «ja og nei» spørsmål G2 adresserer igjen det	Ytringene er stort sett selvstendige setninger Nivå B) Motsetningen settes opp ved Ja/Nei spørsmål/svar J2: Skal vi ha spørreundersøkelse? G2: Vi skal ha spørreundersøkelse, ja Bekreftelser binder sammen de følgende replikkene Nivå C) G2 og J2 ser ut til å være uenige. G2 får støtte fra G1 og utfordringen, G2: «Skjønner du ikke…» ser ut til å avgjøre saken Referentkjede Folks standpunkt – regnskogen blir hoggd – prosent fra avstemminga - spørreundersøkelse - avstemning – hoggd ned en fotballbane – hvert andre sekund	G2 presiserer hensikten: «Skjønner du ikke at vi skal ha et forskermøte om…spørreundersøkelsen»

G2: Sånn hvis du får et ark og så sånn -- J1: [men vi kan] vi kan ha noen ja og nei da, og så noen sånn få.. bare få inn litt andre meninger G2: Ja J2: Ja. Vi kan ha liksom sånn der at vi tar med litt kort avstemning ((LITt USIKKER PÅ OM HUN SIER DET)). Hva tenker du om atte=...det blir hoggd ned 'en fotballbane i..hvert andre sekund, eller noe, var det ikke det a'? G2:..ja J1: mmm J2: av regnskogen J1: Og så kan vi ta for eksempel...eller først så kan vi ta eh..'under eller.. det første spørsmålet er Synes du det er greit at regnskogen blir hogga ned? Og så Ja Nei, ikke sant G1: mmm J1: kanskje...og så etter en sånn--	G2 går ut i fra noen forestillinger om spørreundersøkelser som han legger til grunn, men som ikke nødvendigvis deles – han får motbør og sjekker ut hva de snakker om G2: «Du vet hvordan spørreundersøkelse er?» «sånn» og «sånn der» peker mot noe inneforstått G2: «sånn hvis du får et ark og så sånn» J2: «Ja, vi kan ha liksom sånn der at vi tar med litt kort avstemning» Projeksjon: «fotballbane» som mål finnes på flere nettsider Event B.5. slutt	uavklarte G2: «Du vet hvordan spørreundersøkelse er?» Diskursmarkører J1: «Okei» (bekrefter etter at G2 gir en begrunnelse for at de skal ha med spørsmål til spørreundersøkelse til forskermøtet) G2 bringer inn nytt fokus med: «men» det må være ja og nei… G2: «for» vi har jo 'prosent…indikerer en forutsetning – ligger i presupposisjonen om hva en spørreundersøkelse er J1:» Vi kan ha noen ja og nei «da», og så noen sånn få..» peker på at det er flere muligheter Bekreftelser Hele veien Modalitet i liten/ingen grad		
16:00 - 17:01 Brudd - liten konflikt G2/G1				
G2 har tatt ledelse: Sier at det er ikke spørsmålene de har sendt til regnskogfondet de skal ta med til forskermøtet, men de skal lage				

spørsmål til en spørreundersøkelse og ta med. Han og J1 er i gang med å formulere. G1 stiller et kritisk spørsmål. G2 svarer med litt høy og irritert stemme. G3 begynner å synge				
G2: Og så Hva tror du er viktigst..eh ((TASTER)) at regnskogen består..eller..at..eh= folkene som bor der bruker den som en ressurs? ((TASTING))…det synes jeg var et utrolig bra spørsmål G1 ((gjesper)) Jah...Kan du gjenta det? J2: Skal jeg skrive det ned? G2: Hva synes du er vik- J1: Ja G2: hva synes du er viktigst at regnskogen består eller atteh folk som bor der får brukt det som en ressurs G1: Det er ikke nødvendigvis folk som bor der da, det kan være folk fra andre land som kommer å -- G2: [!Jammen folka rundt] der da ((MED STERK STEMME) G1: Ja, rundt der, greit da J1: ((LER LITT)) G3: Sjabba-dabba-ru G2: Eh= G3: skjirbarrab-sku-rap-rap ((G1: også med noen tullelyder)) J2: <at folkene som..bor der..bruker den.. som ((taster)) J1: [tenk hvis noen] ((tror hun sier det)) G2: som ressurs J2: <ressurs> ((taster mens hun snakker)) G2: Hva skjer nå?...Fullfør (3.0) J2: Hva var det første spørsmålet vi skulle ha?	C.1 EVENT: Interessekonflikten Flertydighet Hvem/hva handler G2's spørsmål om: Hvem er det «som bruker den som en ressurs»? hvem er «folkene som bor der»? Hva med urbefolkning? G1 påpeker at: «det kan være folk fra andre land som kommer å» men blir avbrutt av G2 Flere muligheter for hva som skjer her, egentlig – men det oppstår en konflikt mellom G2 og G1 Presupposisjon G2: «jammen folka rundt der da» Og G1: «Ja, rundt der, greit da» Kan peke på at de har bestemt seg for å holde seg borte fra noe av de politiske implikasjonene?	Initiativ/respons G2 dikterer spørsmål til spørreundersøkelsen G1 kommer med kritisk innvending: «det er ikke nødvendigvis folk som bor der da» G2's respons med irritasjon, og G1 som gir seg fort, kan tyde på at G2 dominerer i å definere hva som er legitimt Spørsmål J2: «Skal jeg skrive det ned?» Bekreftelser G1: jah J1: Ja G1: Ja, rundt der, greit da Uavklart Etter at G2 gir uttrykk for irritasjon, blir ikke spørsmålet om hvem «som bruker den som en ressurs», diskutert Modalitet i liten/ingen grad	Referentkjede Regnskogen folkene som bor der – ressurs – spørsmål – regnskogen – folk som bor der – en ressurs – folk som bor der – folk fra andre land som kommer – folka rundt der – tullelyder – folkene som bor der – ressurs – spørsmål – brenne skogen – hogge – forslag til spørsmål – forskermøte Nivå A) Replikkene er hele setninger Nivå B) G2: «!Jammen…» Setter opp uenigheten mellom G2 og G1 Nivå C) Uenigheten som kommer opp blir ikke videre utviklet – G3 (G1 følger opp) synger – kan være lynavledning? Ønsker å ta vare på harmoni?	De lager spørsmål til spørreundersøkelse

J1: Eh=Synes du det er greit å brenne skogen..eh eller noe sånt ((G3 lager lyder)) J2: Er det hogget eller hugget? G2: Hogd (4.0) huggi 63: Huggi-ha-gi! Skobber-ra-ra-skirre bippp-bipp-skirrebapp (10.0) ((TASTING)) J2: Får håpe vi får noe... forslag til spørsmål, holdt jeg på å si, på forskermøte, da ((G3 fortsetter å lage rytmelyder)) ((Noen småreplikker mens tekst blir skrevet inn)) J2: ((GJESPER)) Eksempler på spørsmål da? G2: Er alle trøtte? J2: mm J1: nei J2: nei da ((G3 lager litt lyder, så stille)) (17.0) G2: Du skreiv det på den wikien? ((litt snakk om å skrive inn i wikien og linker))	De har gitt uttrykk for at det blir for mye å skrive om urbefolkningen Språk Hverdagslig. Pluss at G3 begynner å synge tulleord på tema			

Appendix 4 Session 02/07 - 2011 (See A2 - figure 1 and 2)

Time	Event (Index)	Theme (theoria)	Process of Inquiry (praxis)	Writing (poeisis)
3:50	1.1. Deforestation results in CO_2 emission	Interpreting reading material	Exploring websites	
4:45	2.1.Two websites that contradict	Extracting information		Writing into their own wiki-pages
6:00	1.2. Deforestation results in CO_2 emission	Extracting information	Exploring websites	
6:05	2.2. Two websites that contradict	Discovering contradictory information	Reading to each other from websites	
6:15	2.3. Two websites that contradict		Assessing information	
7:00	3.1. Developing the issue /conflicts of interests		Seeking information	Formulating the main issue/question
7:25	4.1. Find out /investigation		Suggesting to call an expert	
8:15	Some practical information on the project			
10:15	Some technical talk and time off task/ socializing			
14:30	5.0 technical /socializing		Start up and linking of wiki-pages	
15.00	6.1. Disposition and structuring of the text			Copying questions from their main source Regnskogfondet.no
17:00	6.2. Disposition and structuring of the text			Organizing extracted material
17:40	3.2. Developing the issue /conflicts interests	Address agency and consumer behavior	Read from the web site	Organize material according to the topic list of questions
19:25	3.3. Developing the issue /conflict of interests + 6.3. Disposition and structuring of the text + 4.2. To find out / investigate	Relate personal belief to conflicting interests	Balancing different opinions Assert an opinion among «most people»	Consider writing genre related to a balanced presentation objective – subjective
20:30	6.4. Disposition and structuring of the text			The teacher supervise regarding genre
21:30	3.4. Developing the issue /conflict of interests + 6.5. Disposition and structuring of the text	The teacher addresses uncertainty, different perspectives. Focus on science knowledge and the impact of human activity on climate change		The student (G2) focus on genre and disposition
	Some minutes of technical talk/ time off task/ socializing			
25:00	6.6. Disposition and structuring of the text		Adherence to presenting arguments from both sides	Formulate (on the wiki) their attitude of a balanced presentation
26:00	6.7. Disposition and structuring of the text			Considering genre related to their topic list of questions and to writing an article
28:00	3:5. Developing the issue /conflict of interests			Addressing the assignment given, they choose a topic sentence (question)
30:00	Technical talk			
32:00 - 45:00	Writing log, some technical talk and some time off task and socializing			

Appendix 5 - Dialogues from the articles in Norwegian and English

Dialogues are transcribed following Du Bois et al. (1983) as in Svennevig (2009). However, intonation units are not separated in lines. Continuing speech flow from one person is written down continuously.

Svennevig, J. (2009): *Språklig samhandling: Innføring I kommunikasjonsteori og diskursanalyse*. Oslo: Cappelen.

Symbols used in transcripts:

…	Break
..	Short break
(4.0)	Longer breaks in seconds
=	Longer duration of a word or sound
- like: interru-	Interruption of a word
-- like: interruption of--	Interruption of speech (However, this is done differently in the articles: (A1: -- ; A2: —; A3: __)
((COMMENT))	Comments are written in uppercase letters
’	Emphasize on one word
!	Emphasize on one word with even more energy than when the word is marked with ‘
[simultaneously]	Overlapping speech is marked
[[simultaneously]]	Overlapping speech, several people talking

Article 1 - A1
Episode 1

(A1-1)	**Norwegian**	**English**
01: G1	Jeg tror ikke 'trolleybusser er så innmari sunt allikevel jeg.	I don‟t think that ‘trolley buses are so healthy anyway.
02: G2	Hvorfor ikke?	Why not?
03: G1	Fordi det lager…forurensing som følge av kjø=reledningene, …og så uansett så må det være 'kjemepdyrt da, …siden det blir styrt av elektrisitet	Because it makes… pollution because of the electricity cables, …and it must be ‘very expensive as it is controlled by electricity
04: G2	Ja, men det er ikke noe …hvor !dyrt det er, det er ikke det som er … vi skal finne ut hva som kan 'forurense 'mindre, de må jo forurense mindre enn vanlig bensinbusser.	Yes, but it doesn‟t matter… how !expensive it is, that is not what is…. we are supposed to find out how to ‘pollute ‘less, they have to pollute less than ordinary gasoline buses.
05: G1	Nei, men de har ikke ’gasser liksom, men de ’ledningene forurenser	No, but they don‟t have ‘gas, but those ‘cables pollutes.
06: G2	Jeg tror ikke de forurenser 'like mye	I don‟t think they pollute ‘as much
07: G1	((LAVT)) Nei	((QUITELY)) No

Article 1 - Episode 2

(A1-2)	**Norwegian**	**English**
01: G1	((LESER FRA SKJERMEN)) <SIT Dyr skal 'ikke lide unødvendig…og selv om det er noe som heter at regler er til for å brytes= SIT>, ... e=h, gjelder ikke dette ((FNISER))	((READS FROM SCREEN)) <SIT Animals should ‘not suffer unnecessarily…and even though there is a saying that rules exsist to be broken= SIT>, … e=h that does not apply to ((GIGGELS))
02: G1:	Gjelder ikke det i --	Doesn’t that apply in --
03: G4:	Jeg synes det blei litt sånn... ut av sammenheng	I think that it became sort of… disconnected
04: G1:	[Jeg synes vi må ha med sånn derre morsomt]	[I think we should put something, like funny, in]
05: G4:	Litt ironisk ((SER MOT KAMERAET))	Something a bit ironic ((LOOKING INTO CAMERA))
06: G1	((TULLESKRIVER)) ø-hø-hø ø-hø-hø	((PRETENDING TO WRITE ON THE KEYBOARD, OVERLY SERIOUS))
07: G2	Men artikkel og rapport og sånn, det er liksom ikke --	But article and report and such, that isn’t really--
08: G1	Jo, jo, jo. Artikler kan være morsomme de da, og ironiske og sånn	Sure, sure, sure. Articles can be funny, and ironic and so on

(A1-2)	**Norwegian**	**English**
09: G2	Kan de?	Can they?
10: G4	Er'ke det essay, a	Isn't that essay
11: G3	Er'ke det essay da	…isn't that essay
12: G1	Tror det kan være litt i det, kan det ikke det?	Think that it may be a little in it, can't it ?
13: G3	((MUMLER MED EPLE I MUNNEN))	((MUMBLING WHILE EATING APPLE))
14: G1	Eller må det bare være sånn ((LATER SOM HUN SKRIVER PÅ TASTATURET))	Or it may be just like ((PRETENDING TO WRITE ON THE KEYBOARD, OVERLY SERIOUS))
15: G1	(4.0) <SIT Dyr skal ikke lide unødvendig= SIT>	(4.0) < SIT Animals should not suffer unnecessarily=SIT>
16: G4	For det er feil ((TILGJORT STEMME))	Because that is wrong ((IMATATIVE VOICE))
17: G1	Og så skal det ikke skytes flere dyr enn nødvendig	And that no more animals than necessary are to be shot
18: G2	Er det flere enn nødvendig der da	Are there more than necessary there?
19: G1	Men det har vi sagt	But we have said that
20: G2	Har vi?	Have we?
21: G1	Vi skal ikke ta med noen regler nå, nå skal vi bare ta en 'innføring ((GJØR EN BEVEGELSE MED HÅNDEN OPP OG FREM)) til vi sier hva som kan skje hvis du ikke følger reglene	We are not going to include any rules now, now we are only going to give an 'introduction ((MOVE HER HANDS AWAY FROM HER AND UP)) to what can happen if you don't follow the rules
22: G2	Ja	Yes
23: G4	Vi burde ha med sånn derre..når skal vi ha med det etiske greiene da?	We should include such things…when are we going to include the ethical stuff, then?
24: G1	Når det kommer	When it comes
25: G4	Men det at det- de etiske greiene betyr jo ikke at jakt er !helt !feil. Det er mange som har forskjellige meninger på det	But that's it- the ethical stuff doesn't mean that hunting is !all !wrong. A lot of people have different opinions about it
26: G2	[dyr skal ikke lide unødvendig] ((LESER SAMTIDIG FRA SKJERMEN MENS JENTE 4 FORTSETTER))	[animals should not suffer unnecessarily] ((REEDING FROM THE SCREEN))
27: G4	Jeg synes ikke ((RISTER PÅ HODET)) jakt er helt feil. Jeg synes det er verre å la dyr sulte ihjel liksom.	I don't believe ((SHAKING HER HEAD)) that hunting is completly wrong. I believe that it is worse to let animals die from starvation
28: G3	Altså med etisk riktig da må vi ha med --	Okey, on the ethical correctness thing we need to include --
29: G4	hvis det gjøres på riktig vis --	If it is done properly--

(A1-2)	Norwegian	English
30: G3	Det som PK en jeger som gruppa intervjuet] sa, det med revejakta i E=ngland, og klappjakt	What PK said, the foxhunt in E=ngland, the thing about klappjakt ((HUNTING BY CLAPPING HANDS)) ((PK IS A HUNTER INTERVIEWED BY THE GROUP))
31: G4	Det er feil De to ((G3 eller G4))	That is wrong Those two ((G3 or G4))
32	J3: det er feil, ja.	32: G3: Yes, that is wrong
33: G4	(4.0) Vi må forklare litt hva klappjakt er, hvis man ikke vet det'	(4.0) We need to clarify what klappjakt is, if it is something one does not know
34: G2	[dyr skal ikke lide unødvendig]	[animals should not suffer unnecessarily]
35: G2	Overskride denne loven er, nei å overstride denne loven, straffbart, er straffbart	Violate this law is, no to violate this law, subject to punishment, is subject to punishment
36: G2	[hm-m hm-m]	[uh-hm]
37: G1	((SER PÅ J2)) Det er ikke bare den loven overstrider ((UKLART)) som er straffbart, da.	((LOOKING AT G2)) It is not only that the law violates ((INAUDIBLE)) what is subject to punishment
38: G2	Nei, men den er jo det, den...	No, but it is then…
39: G4	Hvis man overstrider--	If one violates--
40: G1	Overstriding av loven	Violation of the law
41: G4	Hvis man overstrider loven, kan man havne..., kan man bli tatt fra ...(1.0) ((J1 SKRIVER)) tatt fra...	40: G4: If one violates the law, you can go to…you can loose the hunting …. (1.0) ((G1 TYPES ON PC)) loose
42: G3	Jeger....	Hunter
43: G4	Tatt fra	Have lost his
44: G3	Jegersertifikatet	Hunting certificate
45: G4	Jegersertifikatet for x antall år, eller er.. kan.. kan dommen være streng	The hunting certificate for x years, or, is.. the sentence may be very strict
46: G1	Tror det var det han sa [eller], dommen kan være ganske streng	Believe that's what he said, [or] the sentence may be very strict
47: G2	Det er bra	That is good
48: G4	<SIT'er dommen, 'er dommen streng SIT> ((DIKTERER))	< SIT the sentence, the sentence is strict SIT> ((DICTATING))
49: G1	Nei, det er ikke sikkert, det kan hende, det spørs jo hva	48: G1: No, that is not for sure, it may, it depends on what
50: G1	Dommen være streng ((SKRIVER PÅ TASTATUR))	The sentence may be strict ((TYPING))

Article 2 – A2

Table 1

(A2-1)	**Norwegian**	**English**
01: B2	((LESER HØYT FRA "regnskogfondet.no»)): < Er regnskogen jordas lunger? Nei dette er en myte. Regnskogen har ingen stor innvirkning på produksjonen av oksygen> ((FORTSETTER Å LESE)) (…) <Det lagres store reserver med karbon i vegetasjonen> ((FORTSETTER Å LESE)) [...] <De globale klimautslippene skyldes ødeleggelse av regnskogen>((FORTSETTER Å LESE)) […]	((READING OUT LOUD FROM regnskogfondet.no)):< Is the rainforest the lungs of the Earth? No, this is a myth. The rainforest has no great impact on the production of oxygen> ((CONTINUES READING)) […] <Big reservoirs of carbon are stored in the vegetation> ((CONTINUES READING)) [...)]<Global climate emissions are due to destruction of the rainforest >((CONTINUES READING)) […]
02: B1	Det er først når de kommer med de jævla maskinene—	But it is not until they come with those damn machines—
03: B2	Det er da det blir—	That is when it becomes—
04: B1	Det er da det blir klimautslipp	That is when it becomes climate emission
05: B2	Men regnskogen produserer ikke like mye oksygen som vi trodde.. fordi den tar mye oksygen og så eh—	But the rainforest does not produce as much oxygen as we thought...because it uses a lot of oxygen, and so eh—
06: G1	Men Marcus fant ut at eh…hva het den derre?	But Marcus found out that uh…what was the name of that thing?
07: B3	To sekunder..regnskogen..den derre..årsaken til å bevare regnskogen er at den omvandler karbondioksid, altså karbondioksid til ren luft	Two seconds..the rainforest..that..reason for preserving the rain forest is that it transforms carbon dioxide, that is to say.. carbon dioxide into clean air
08: B2	Det er derfor den	That is because it
09: G1	[det er --]	[that is —]
10: B1	Den lagrer det, ikke sant, Og når de maskinene kommer så frigjøres det..og det er det som er bakdelen, da..det kan Mari skrive, da	It makes it, right. So when those machines come, then it is released..and that is the drawback, then..so that is what Mari can write down
11: B2	Men eh…regnskogen produserer ikke så mye oksygen heller	But eh…the rainforest does not produce that much oxygen..neither
12: B3	((LESER OPP)) <Regnskogen er en forutsetning for nesten alt liv på jorden>	((READING)) <The rainforest is a requirement for almost everything that is living on the earth>

(A2-1)	Norwegian	English
13: B2	Men her står det..her står det..<Er regnskogen jordas lunger? Nei, dette er en myte. Regnskogen har…har ingen stor innvirkning> ((HAN LESER VIDERE))[…]<Derimot er regnskogen viktig for gode og sunne livsbetingelser på jorda>	But here it says..here it says..<Is the rainforest the lungs of the earth? No, this is a myth. The rainforest has…has no great impact> ((HE CONTINUES READING))[…]<However, the rainforest is important to provide good and healthy conditions for life on the earth >
14: G2	Skal jeg skrive det?	Should I write that down?

Article 2 - Table 2

(A2-2)	Norwegian	English
01: B2	Og så Hva tror du er viktigst..eh ((TASTER)) at regnskogen består..eller..at..eh= folkene som bor der bruker den som en ressurs? ((TASTING))…det synes jeg var et utrolig bra spørsmål	And then What do you think is most important..eh ((TYPING)) to preserve the rain forest ..or..that..eh= the people who are living there may use it as a resource? ((TYPING))…I think that was an incredibly good question
02: B1	((gjesper)) Jah...Kan du gjenta det?	((yawning)) Yeah...Can you repeat it?
03: G2	Skal jeg skrive det ned?	Shall I write that down?
04: B2	Hva synes du er vik-	What do you think is most—
05: G1	Ja	Yes
06: B2	Hva synes du er viktigst at regnskogen består eller atteh folk som bor der får brukt det som en ressurs	What do you think is most important that the rain forest is preserved or that= people living there may use it as a resource
07: B1	Det er ikke nødvendigvis folk som bor der da, det kan være folk fra andre land som kommer og --	Well, they are not necessarily living there, they can be people from other countries who are coming to—
08: B2	[!Jammen folka rundt] der da ((MED STERK STEMME)	[!Yes, but the people around] there then ((SPEAKING LOUDLY))
09: B1	Ja, rundt der, greit da	Yes, around there, Okay then
10: G1	((LER LITT))	((LAUGHING A BIT))
11: B3	Sjabba-dabba-ru	Sjabba-dabba-ru
12: B2	Eh=	Eh=
13: B3	Skjirbarrab-sku-rap-rap ((B1: Også med noen tullelyder))	Skjirbarrab-sku-rap-rap ((B1: also making some funny noises))

(A2-2)	Norwegian	English
14: G2	<At folkene som..bor der..bruker den.. som ((TASTER))	<that the people who..are living there..use it.. as ((TYPING))
15: G1	[tenk hvis noen]	[what if someone] ((QUIETLY))
16: B2	Som ressurs	as a resource
17: G2	<Ressurs> ((TASTER MENS HUN SNAKKER))	<resource> ((TYPING WHILE TALKING))
18: B2	Hva skjer nå?...Fullfør	What happens now?...Complete
	(3.0)	(3.0)
19: G2	Hva var det første spørsmålet vi skulle ha?	What was the first question that we should have?
20: G1	Eh=Synes du det er greit å brenne skogen..eh eller noe sånt	Eh=Do you think it is okay to burn the forest..eh or something like that
	((G3 LAGER LYDER))	((B3 MAKING NOISES))
21: G2	Er det hogget eller hugget?	Is it cut or cot ?((in Norwegian: hogget eller hugget))
22: B2	Hogd (4.0) huggi	Hogd (4.0) Huggi ((this and the next line in Norwegian, as spoken))
23: B3	Huggi-ha-gi! Skobber-ra-ra-skirre bippp-bipp-skirrebapp	Huggi-ha-gi! Skobber-ra-ra-skirrebippp-bipp-skirrebapp
	(10.0) ((TASTER))	(10.0) ((TYPING))

Article 2 - Table 3

(A2-3)	Norwegian	English
01 B3	Det står på en sånn skikkelig hjælp-verden-side, liksom	This is a kind of a very proper help-the-world site, sort of
02: B1	Hos oss står det jo regnskogen.no	But here it says regnskogen.no
03: B2	Men da må vi –	But then we have to—
04: B1	Oj !da ((LER))	Oy !so ((LAUGHING))
05: B2	Vi spør læreren om det..hva han har å si om det	We should ask the teacher..what he has got to say about it
06: G1	Ok, men læreren sa	Okay, but the teacher said
07: B2	Men da må vi sikkert ta med at det er..at det er—	But then, for sure we must include that it is..that it is—
08: B3	Her står det til og med jorden lunger, jordens lunger	It even says here the lungs, the earth, the lungs of the earth
09: B2	Ehe	Ehe

(A2-3)	Norwegian	English
10: G1	Men læreren sa at det er lurt å få med altså..at vi må liksom eh argumentere for og mot ((noe uhørlig))..at vi må prøve å få inn det liksom	But the teacher said that it would be smart to include, like..that we ought to like eh argue pros and cons ((DIFFICULT TO HEAR))..that we must try to include that, sort of
11: B1	Ja, ja	Yes, yes
12: B2	Ja, vi må finne ut hva som er riktig	Yes, we must find out what is right
13: B1	Hvorfor vi skal hogge ned, og hvorfor vi ikke skal hogge ned?..'Ja	Why should we cut down, and why should we not cut down?..'Yes
14: B2	Men vi kan jo lage et nytt spørsmål. Er-	Yes, but we can make a new question. Is—
15: G1	Ja	Yes
16: B2	Er regnskogen jordas lunger eller ikke?	Is the rain forest the lungs of the earth or not?
17: B1	Men det er litt eh=	But that is a little bit eh=
18: G1	Det får vi jo ((SIER NOE UHØRLIG))	This we should ((DIFFICULT TO HEAR))
19: B1	G1: Ja, ja	Yes, yes

Article 2 - Table 4

(A2-4)	Norwegian	English
01: G1	Eh..Og så kanskje vi må ha et sånt derre spørsmål: Hvorfor er noen for og=... mot? Liksom for det er—	Eh..And then maybe we should have a question like: Why are some people pro and=... con? Sort of because it is—
02: B3	Hvordan kan noen være for? Det skjønner jeg ikke	How could anybody be pro? I don't understand that
03: B2	Fordi det er mange som lever av den næringen å hogge ned regnskogen...men eh..vi er 'imot	Because many make their living from that livelihood to cut down rainforest..buteh..we are 'against it
04: G1	Får vi bestemme?... I begynnelsen?	May we decide?... In the introduction?
05: B2	Ja, eller vi skal vel være litt utenfor da..men vi er jo...det er vel mest riktig å bevare regnskogen, det synes vel de fleste, så vi må prøve å=	Yes, or we should be somewhat on the outside, then..but we are, well...it seems the most right thing to do is to save the rainforest ..most people probably think so, so we should try to=
06: G2	Men vi må liksom finne en-	But we sort of have to find a—
07: B2	Men vi må jo være som en 'avis, da.. tror jeg.	But we should be like a 'newspaper, then.. I think

(A2-4)	Norwegian	English
08: G1	JaA	Yes
09: B2	Å være eh..'objektive eller 'subjektive. Jeg vet ikke hva som er hva jeg	Should be eh.. 'objective or 'subjective. I don't know which is which

Article 2 - Table 5

(A2-5)	Norwegian	English
01: B2	Da kan jeg skrive=…skal vi skrive på et av spørsmålene da: Hva har det å si for urbefolkningen?...Eller, nei det har vi jo da: Hva har det å si for de menneskene som bor der?	Then I can write=… should we then write on one of the questions: What does this have to say for the indigenous people?...Or, no, we have got that, yes: What does it have to say for the people living there?
02: B3	Men da kan jeg ta bort de der spørsmålene] Den forbruker like mye som den produserer…for den har ingen stor nettoproduksjon av oksygen…Da er det riktig (3.0)	[But then I can cut out those questions] It uses just as much as it produces…because it has no great net production of oxygen …That will be right then (3.0)
03: B2	Men det vi vet nå, det er at.. eh…hvis regnskogen er der og ingen gjør noe med den, så går det i null	But what we know now, is that.. eh…if the rain forest is there and no one does anything to it, then it balances at zero
04: B1	Mmm	Hmmm
05: G2	Da er det greit liksom	That is okay then, sort of
06: B2	Ja, men hvis noen gjør noe med den, så slipper den—	Yes, but if anybody does anything to it, then it releases—
07: B1	Ut mye mer	Much more
08: B2	Så blir liksom selve skogen en—	Then the forest itself kind of becomes a—
09: B1	Det må vi få med at det er såpass mye dyr	That we should include that there are quite a lot of animals
10: B2	[CO2 kilde?]	[CO_2 source?]
11: B1	Og dyr og ting som produserer CO2..som gjør så det går i null.. Vi må også si hvorfor det går i null, ikke bare at det går i null	And animals and things that produce CO_2..which balances it at zero.. We also have to say why it balances at zero, not just that it balances at zero
12: B2	Og hvis	And if
13: G2	Men det sa jeg jo, for det at jeg skrev—	But I did say that, because what I wrote—

(A2-5)	Norwegian	English
14: B2	[Og hvis den hadde blitt borte]..så hadde det..hele= området der tørka inn og blitt en ørken, og så hadde det.. ført til store=.. miljøforandrings..	[And if it should disappear]..then it would..the whole= area would dry up and become a desert, and then it would become.. would have resulted in great=.. environmental changes..
15: B3	Hæ? Det hadde ikke blitt noe bra	Huh? That would not be any good at all
16: B2	Nei, det hadde blitt	No, that would have been
17: B1	Eh=	Eh=
18: B2	Nesten miljøforandring på hele jorda liksom	Almost environmental changes to the whole of the earth so to say

Article 3 - A3

Episode 1

(A3-1)	Norwegian	English
01: B1	Vi har et spørsmål til deg. Nå har vi lest på to forskjellige sider. Hvor det står..eh..på den ene sida står det at regnskogen er jordas lunger, da, at den produserer mer oksygen enn karbondioksid. Og så sto det på en annen side at den ikke gjør det, da, at det bare er en myte. Vi er skikkelig forvirra, da	We have a question for you. We have been reading on two different pages. There it says.. eh.. on one page, it says that the rainforest is the lungs of the earth, that is, that it produces more oxygen than carbon dioxide. And then it says on another page that it does not, that is, that this is just a myth. So, we are really confused
02: B2	Og begge sidene var skikkelig sånn der reliable, da ((HAN SIER 'RELIABLE' PÅ ENGELSK))	And both pages were really like "reliable" ((HE SAYS 'RELIABLE' IN ENGLISH))
03: B1	Sånn Regnskog.no eller Regnskogfondet.no, og liksom sånn..veldig sånn	Like Regnskog.no or Regnskogfondet.no, and sort of like.. much like
04: B2	Hva skal du tro på?	What should you believe in?
05: B	1: Ja	Yeah
06: B3	Regnskog-	Rainforest-
07: Teacher	Hva har dere lært om økosystem? Det er et avgrensa område i naturen, som stort sett klarer seg sjøl	What have you learnt about ecosystems? It is a limited area in nature that to a great extent manages itself
08: B1	…mmm…men det gjelder også _	…mmm… but that is also relevant to _

(A3-1)	Norwegian	English
09: Teacher	Så det betyr at dyra og bakteriene i skogen her oppe	So, that means the animals and the bacteria in the woods up here
10: B1	Ja	Yes
11: Teacher	De forbrenner, akkurat som mennesker, ikke sant?	They have a metabolism, just like people, don't they?
12: B1	Ja	Yes
13: Teacher	Og sender ut CO_2	And give off CO_2
14: B1	Mmm	Mmm
15: B2	Så alle dyra i _	So all the animals in _
16: Teacher	Da øker, da øker jo konsentrasjonen av CO_2, og så er det alle de grønne plantene som binder det igjen	It increases then, the concentration of CO_2 increases, and then all the green plants take this up and bind it again
17: B1	Ja	Yes
18; Teacher	I fotosyntesen	In photosynthesis

Article 3 - Episode 2 (G_ for Girl, and B_: for boy)

(A3-2)	Norwegian	English
01: Teacher	Intervjue de litt i kunnskap. Og så synes jeg også at man kan lage noe spørsmål om framtida… Vil..du..endre holdning til bruk av..kollektiv..eh..transport hvis….et eller annet	Interview them about some knowledge. And then I think that one could develop some questions about the future…Would.. you.. change your attitude to the use of.. public.. eh transport if.. or something
02: G_A	Det hadde vi jo. Hvis..eh, det blir..eh	But we did have that. If.. eh, this becomes.. eh
03: B_A	Miljøvennlig	Environmentally friendly
04: G_A	Miljøvennlig, vil du bruke buss da?	Environmentally friendly; would you use the bus then?
05: Teacher	Ja. Miljøvennlig er et litt ullent begrep..sant? Er dere ikke enig i det da?	Yes. Environmentally friendly is a somewhat vague concept.. isn't it? Don't you agree?
06: B_ A	Hva tenker du på? Jeg synes det er ganske klart om en buss er miljøvennlig eller ikke jeg da	What do you mean? I think it is quite clear whether a bus is environmentally friendly or not
07: G_ A	Da går den på hydrogen eller biogass eller_	Then it runs on hydrogen or biogas or_
08: B_ A	Den kan jo være miljøvennlig om den går på bensin også, bare den slipper ut lite, liksom	It may be environmentally friendly even if it runs on petrol too, if it only emits little, kind of
09: G_ B	Jaja ((ENIG))	Yes, yes ((AGREES))

(A3-2)	Norwegian	English
10: B_ A	Men vi kan jo utdype spørsmålet litt, og skrive hvis den hadde gått på nullutslipp stoff da..liksom	But we can deepen the question a bit, and write if it had been driving on zero emission stuff, then.. sort of
11: Teacher	..ja, og hva _	.. yes, and what _
12: B_ A	Som ikke forurenser noe	That does not pollute anything at all
13: Teacher	Ja, og det tror dere mannen i gata har greie på [ler litt]	Yes, and you think that the man in the street has knowledge about that [laughs a little bit]
14: B_ A	Ja	Yes
15: Teacher	De må kunne vite litt om utslipp	They must know something about emission
16: B_ B	[snakker oppå] De vet jo forskjellen på utslipp, null utslipp og litt utslipp	[simultaneously] They do know the difference between emission, zero emission, and some emission
17: G_B(?)	..utslipp..((MUMLER))	..emission..((MUMBLING))
18: B_A	Jeg tenker de fleste veit _	I think most people know _
19: Teacher	Jeg er ikke så sikker på det, jeg. Nå har akkurat dere vært i gjennom Energi i framtida, så dere har god innsikt i det	I am not quite sure about that myself. You have just been through Energy for the Future, so your insight into this is good
20: B_ A	Jo da	Yes, right
21: G_ B	Men hvis det står null utslipp, så skjønner ikke _	But if it says zero emission, then [I?] don't understand _
22	[[flere snakker og mumler i munnen på hverandre]] ((UTYDELIG))	[[they talk simultaneously and mumble]] ((INAUDIBLE))
23: B_ C	Det står til og med på busser det	It is even written on the buses
24: B_B	Men de vet liksom, hvis de får høre. Denne bussen slipper ikke ut noe CO_2. Så vet de at den ikke slipper ut noe CO_2	But they sort of know, if they are told. This bus does not emit CO_2. Then they know that there is no CO_2 emission
25 Teacher:	Ja, det er greit	Yes, it's OK
26: B_A	Så vi kan jo forandre litt på det, skrive litt mer presist på det siste spørsmålet	Then we could change it a bit, write it a little more precisely in the last question