Multiple school science literacies

Exploring the role of text during integrated inquiry-based science and literacy instruction

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Thesis abstract

The main aim of this thesis is to explore how literacy is embedded in six primary school science classrooms during integrated inquiry-based science and literacy instruction. This is investigated by analyzing classroom video data from six primary school science classrooms, along with interview data with students (n=33) and textual artifacts from the six classrooms. The classroom video study was conducted through a larger research and development project, *The Budding Science and Literacy* project, in which six primary school science teachers were recruited from an in-service professional development course on inquiry-based science and literacy. The six teachers were then video-recorded, along with their students, as they taught a sequence of lessons, where they were to explicitly integrate disciplinary literacy practices with inquiry-based science, as a part of the professional development course.

The first article included in this thesis (Article I) is an overview video study of the Budding Science and Literacy project, which explores the variation and patterns of integrated inquiry-based science and literacy instruction by mapping the occurrence and co-occurrence of multiple learning modalities (reading; writing; talking; doing) and main inquiry phases (preparation; data; discussion; communication) in the six classrooms. The results show that the teachers spent comparably more time on preparation and data than on the consolidating phases of discussion and communication. Reading and writing were also more prominent in these phases of inquiry.

Article II investigates the literacy practices that emerge among primary school students during integrated inquiry-based science and literacy instruction. This is mainly explored through video analysis of *literacy events* that occur in the video material, with student interviews and collected textual artifacts acting as additional data sources. The article reveals how multiple literacies emerged in the context of integrated science-literacy instruction. For example, elements of students’ informal literacies became valued resources in the dialogic process of inquiry, but the students also engaged in typically schooled literacy practices that helped structure their learning experiences. The article also indicates that the implemented instruction created new literacy demands that were not always clear to the students.
Article III provides an introduction to what a social view of literacy means for school science. In the first part of the article, we use sociocultural perspectives to argue that literacy in school science is best understood as social practices embedded in cultural and ideological contexts. In the second part, we rely on these perspectives to present a framework for promoting literacy in science classrooms. Finally, the article discusses how a social view of literacy can provide science educators with the theoretical perspectives to consider how literacy is actually used in contexts relevant to a transcending science subject for scientific literacy.

The final article, Article IV, is a methodological contribution that considers the use and re-use of video data from two perspectives: the primary researchers (or archivists) and the secondary analysts. It combines two research projects—The Budding Science and Literacy project (the primary researchers) and the PISA+ video study (the secondary analysts)—to make an argument for establishing more common practices when conducting classroom video studies.

The four articles address the overarching aim of the thesis from different perspectives. While the first article maps the time is spent on different learning modalities in the six classrooms and how these co-occur with science inquiry phases, Article II goes beyond “reading” and “writing” per se to investigate what texts students encounter, what they do with these texts, and how they talk about them, from a sociocultural perspective on literacy. These two articles represent the empirical studies that make up this thesis. The third article builds on the first two articles, along with other relevant studies on the role of text in school science, to discuss what a social view of literacy means for science teachers’ educational practice. The final article in this thesis, Article IV, considers some of the methodological issues related to using and re-using video data in classroom video studies. In this way, Article IV frames the empirical research reported in articles I and II, in addition to discussing how video can be used to investigate classroom practice in general.

Taken together, this thesis demonstrates how literacy is interwoven in the activities and inquiries of the six participating classrooms. By approaching literacy as a social practice, these findings illustrate how multiple school science literacies, which attend to markedly different purposes in the classroom, can emerge in an inquiry-based context in primary school science. The thesis highlights a need for supporting teachers in the discussion and communication phases of inquiry, as well as providing explicit instruction to the specialized conventions of scientific language that frame reading and writing in school science.
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EXTENDED ABSTRACT
1 Introduction

1.1 Literacy in the context of school science

The main concern of this thesis is how literacy is embedded in the context of school science. In science, written language has a constitutive and integral role in the social practices that make the construction of scientific knowledge possible (Bazerman, 1988; Knorr Cetina, 1999; Latour & Woolgar, 1986; Norris & Phillips, 2003). Without text, and the socially meaningful ways of dealing with these texts, science would simply not exist in the way we know it today. In school science, however, the ways in which we deal with text have traditionally been of little concern to most science teachers and science educators (Pearson, Moje, & Greenleaf, 2010; Wellington & Osborne, 2001). Thus, investigating how literacy is actually embedded in various school science contexts is crucial to support students in interacting with “reasonable comfort and confidence in a society that is deeply influenced and shaped by the artefacts, ideas, and values of science—rather than feeling excluded from a whole area of discourse, and, as a corollary marginalised” (Osborne, 2007, p. 177).

In this thesis, I explore the role of text in six primary school science classrooms during integrated science-literacy instruction, meaning that the teachers in these classrooms aimed to explicitly integrate disciplinary literacy practices with inquiry-based science education (cf. Cervetti, Barber, Dorph, Pearson, & Goldschmidt, 2012; Cervetti, Pearson, Bravo, & Barber, 2006; Pearson et al., 2010; Varelas & Pappas, 2006). The work that is reported here is part of and contributes to a larger research and development project, The Budding Science and Literacy project (Ødegaard, 2010), which sought to test and refine a teaching model for integrating inquiry-based science and literacy in collaboration with primary school science teachers through a professional development course. Six teachers from the professional development course, and their students, were thereby recruited to participate in a classroom video study. The focus of this thesis, then, concerns the ways in which the students in these classrooms encountered and used text, and how this was relevant to their engagement in school science inquiry.

The thesis builds on a main argument derived from sociocultural studies of literacy, namely that reading and writing can only be understood in the contexts of the particular social
practices of which they are a part (Barton, 2007; Barton & Hamilton, 1998; Gee, 2004, 2008; S. B. Heath, 1983; Jewitt, 2008; Lankshear & Knobel, 2006; Lemke, 2004; Scribner & Cole, 1981; Street, 1984, 1995; The New London Group, 1996). In this way, literacy becomes much more than a neutral set of skills that concerns the ability to read or write; rather, it involves engaging and participating in “particular ways of thinking about and doing reading and writing in cultural contexts” (Street, 2003, p. 79). Literacy can thus be described as something people do in their everyday life—a social activity involving text—that necessarily also includes values, talk, social relationships, attitudes and beliefs about these texts (Barton & Hamilton, 1998; Gee, Hull, & Lankshear, 1996). In this thesis, the context for researching literacy is framed within the school science lessons of the six primary school science teachers attending the professional development course on inquiry-based science and literacy.

Already, we are faced with a possible contradiction in the terminology used to describe the empirical setting (integrated science-literacy instruction) and the theoretical framework (sociocultural perspectives on literacy). The term “integrated science-literacy instruction” could imply that there must also be some form of science instruction in which literacy is not integrated. From a sociocultural perspective on literacy, however, literacy will always be integrated into our daily activities, whether in or out of school, although it may be embedded in different ways (Barton, 2007; Barton & Hamilton, 1998). In this thesis, the term *integrated science-literacy instruction* should thus not be taken to represent the integration of something (i.e., “literacy”), which would otherwise not “be there”, into science instruction. Rather, the term is used to represent an inquiry-based approach to science education that acknowledges the role of language and literacy in science (Cervetti et al., 2006; Pearson et al., 2010). As Osborne (2002, p. 215) clearly states:

“[L]iteracy is not an additional element but an essential constitutive practice of science whose study is as vital to science education as sails are to ships, bricks are to houses or engines to cars. Improving the quality of science education, both in terms of the experience it offers to its students and its cognitive and affective outcomes, requires the restoration of language and literacy to the central position it occupies in its practice; nothing less will suffice.”

This thesis comprises two main parts. The first part is an extended abstract, which outlines and categorizes the issues and conclusions of the second part: four individual articles that are either published or in the process of being published. The extended abstract thus presents the work of the individual pieces contained within this thesis as a whole. The extended abstract is
structured to first provide a contextualization for the thesis through a presentation of the Norwegian educational system and the larger research project of which this thesis is a part. The present work is then situated in the context of relevant research on the role of text in school science classroom, before the theoretical perspectives guiding the research are presented. In chapter 4, methodological approaches and concerns are introduced and addressed. This leads into a summary of the four individual articles that make up this thesis along with the extended abstract. In chapter 6, the findings and implications of these four articles are discussed in light of the preceding chapters.

1.2 Context of the study

1.2.1 The educational system in Norway

The empirical data on which this thesis is based were gathered from six primary school science classrooms in the greater Oslo area of Norway, with teachers attending a professional development course on science inquiry and literacy. To fully grasp the institutional context in which these classroom practices took shape, it is necessary to first consider some of the main characteristics of the Norwegian school system, as well as the governing national science curriculum.

In Norway, all children have a legal right to 13 years of education and usually start school at the age of six. The first ten years—primary school (grades 1-7) and lower secondary school (grades 8-10)—are compulsory and free of cost. While upper secondary school (grades 11-13) is voluntary and free of choice, all young people in Norway are entitled to upper secondary education and there is an explicit priority to increase the attendance and completion rate in upper secondary school (Ministry of Education and Research, 2009). Furthermore, it is largely the municipal authorities that finance Norwegian schools, although 185 private primary and lower secondary schools were approved for the school year 2012/2013 (equivalent to nearly 3 percent of primary and lower secondary school students) (Norwegian Directorate for Education and Training, 2013).

Schools are governed by a centralized national curriculum that is proposed by expert groups of teachers, teacher educators, and various institutions, and approved by parliament. The current national curriculum was implemented in 2006, following the Knowledge Promotion
Reform—a comprehensive national curriculum reform for primary, lower secondary and upper secondary education and training (Ministry of Education and Research, 2006). One of the central changes in the Knowledge Promotion Reform, which is of special importance to this thesis, was an increased focus on five basic skills in all subjects: reading, writing, arithmetic, oral skills, and digital skills. These basic skills were based on the OECD framework Developing Selected Competencies (DeSeCo) and considered as fundamental across subjects (Knain, 2005a). Hence, teachers are now to integrate and work with these skills in each subject, on the premise of the particular subject they teach. Because the focus on basic skills emphasizes that learning cannot be separated from language and other semiotic resources, Berge (2005, p. 4) has labeled the Knowledge Promotion Reform a “literacy reform”.

However, recent evaluations of the Knowledge Promotion Reform indicate that the intention behind basic skills has not been properly communicated to teachers and that the implementation of basic skills has not led to notable changes at the classroom level (Møller, Prøitz, & Aasen, 2009; Ottesen & Møller, 2010). In primary school, it is reading that has received the most attention, but often in relation to language arts lessons (Hertzberg, 2010). Based on these reports, The Ministry of Education and Research decided to revise the subject curricula of five subjects, among them science, to clarify what basic skills implies in each of these five subjects (Ministry of Education and Research, 2010a). The revisions made in the national science curriculum will be explored further in the next section. This section will also give an introduction to science as a school subject in Norway and the national science curriculum as it is stated in the Knowledge Promotion Reform.

1.2.2 Science as a school subject in Norway

Throughout grade 11, school science in Norway appears as an integrated and holistic school subject that comprises areas within the disciplines of biology, physics, chemistry, geosciences, and technology, along with a focus on the process dimension of science. Students are then able to choose specialized science subjects in grades 12 and 13. In primary school—the empirical setting of this thesis—328 teaching hours are allocated to science teaching over the course of these first seven years of compulsory schooling (Ministry of Education and Research, 2006). On average, school science thus constitutes approximately 47 teaching hours per grade level (per year) in primary school. In this regard, it should be noted
that the number of teaching hours in science at primary school levels in Norway is markedly lower than the international average, according to TIMSS (Trends in International Mathematics and Science Study) 2007 data (Grønmo & Onstad, 2009).

Following the Knowledge Promotion Reform in 2006, two central changes have been prevalent in the national science curriculum. First, the previously mentioned introduction of basic skills in and across all subjects requires reading, writing, arithmetic, oral and digital competences to be integrated in science teaching and learning at all grade levels. Second, a new main subject area on the processes and nature of science —*

The Budding Scientist*— was introduced to the science curriculum (Ministry of Education and Research, 2006). Isnes (2005) states that the decision to implement *The Budding Scientist* as a main subject area of its own was to place further emphasis on the process dimension of science, due to low scores on international comparative studies. For example, PISA (The Programme for International Student Assessment) 2006 data showed that Norwegian students scored below their Nordic counterparts on measures of knowledge *about* science, as opposed to measures on knowledge *of* science (Kjærnsli, Lie, Olsen, & Roe, 2007). Combined, the introduction of basic skills and *The Budding Scientist* as a main subject area to the national science curricula can be said to emphasize both disciplinary literacy and inquiry-based science as prominent foci in Norwegian science classrooms.

Still, there is reason to believe that inquiry-based approaches to science teaching and learning are not prevalent in Norwegian schools (e.g. Kjærnsli et al., 2007; Sikko, Lyngved, & Pepin, 2012; Ødegaard & Arnesen, 2010). In the PISA+ video study, which was conducted the year before the Knowledge Promotion Reform was implemented, “very little inquiry science where students used practical experiments as a basis to actively talk science” was found (Ødegaard & Arnesen, 2010, p. 16). In the PISA 2006 survey, which focused specifically on science, Norwegian students reported that practical work occurred above the international average; science inquiry, on the other hand, was consistently low across the Nordic countries (Kjærnsli et al., 2007). Moreover, in a recent survey among Norwegian science teachers, mainly from lower secondary levels, Sikko and colleagues (2012) reported that the teachers surveyed wanted to implement more inquiry-based approaches than they already did, but that they needed more, and more relevant, professional development courses to do so. Their findings reinforce the impression of the TIMSS 2007 survey, which showed that Norwegian teachers at 4th and 8th grade levels have less formal education and specialization in science
than what is common internationally (Grønmo & Onstad, 2009). Accordingly, professional development of science (and mathematics) teachers has become a main priority for the Norwegian Ministry of Education and Research (2010b) over the last few years.

As stated in the previous section, the national science curriculum was one of five subject curricula that was revised and implemented in autumn, 2013. Even though these revisions were implemented after the Budding Science and Literacy data material was collected, they provide important information on the current trends and directions for science education in Norway and helps situate the research presented in a national context.

In the revision process, basic skills and the main subject area The Budding Scientist were given particular attention (Mork, 2013). The science curriculum has, for example, been criticized for not properly emphasizing reading in science or addressing the lack of tradition for reading instruction in school science in Norway (Kolstø, 2009). Thus, in the revised curriculum, each basic skill is now presented with fuller and more detailed descriptions of what they imply for school science, as well as several competence goals having been added or reformulated in the main subject areas—especially within The Budding Scientist. Furthermore, it is now explicitly stated that The Budding Scientist should be integrated into the other main subject areas, which was also the original purpose (Ministry of Education and Research, 2013). Mork (2013) thus argues that the revised curriculum places more emphasis on how scientific knowledge is constructed than the former. Furthermore, the implementation of the Knowledge Promotion Reform and the revision of the national science curriculum illustrate that the Norwegian context is similar to other current international science education efforts and perspectives—many of which centers on scientific literacy, science inquiry and the nature of science (e.g. Abd–El–Khalick et al., 2004; National Research Council, 2012; Rocard et al., 2007).

Clearly, literacy and inquiry science have both become focal points of science teaching and learning in Norway through the Knowledge Promotion Reform, although research following the implementation of the reform has indicated a gap between the curriculum intentions and classroom practice. One of the initiatives to help address the integration of inquiry science and literacy in Norwegian primary school classrooms has been the Budding Science and Literacy project, which this thesis is a part of.
1.2.3 The Budding Science and Literacy research project

The Budding Science and Literacy project is a research and development project that was established to support teachers in integrating inquiry-based science and literacy in primary school classrooms, as a result of the new demands of the national science curriculum (Ødegaard, 2010). The main aim of the project was to study how an integrated science-literacy approach could help improve science teaching and learning in primary school. Central to the Budding Science and Literacy project was a teaching model for integrating science and literacy through inquiry (see Figure 1). The teaching model builds on an integrated approach to science and literacy that originated with the Seeds of Science/Roots of Reading1 program (Cervetti et al., 2006) at Lawrence Hall of Science, UC Berkeley, and was to be tested and refined in cooperation with teachers’ unique competence from the classroom. This was done through an in-service professional development course—generating 10 ECTS-credits—which teachers attended on a monthly basis for two semesters. The course ran twice: in 2009/2010 and in 2010/2011. As a part of the professional development course, the teachers were to teach a sequence of science lessons, in accordance with the Budding Science and Literacy teaching model, with their students. To do so, they were also given access to instructional material, detailed teacher guides, and translated reading materials from the Seeds of Science/Roots of Reading program (Cervetti et al., 2006) that they could use and adapt in their teaching.

Six teachers were then recruited from the second professional development course to participate in the Budding Science and Literacy video study. This involved being videotaped as they taught the science lessons they were supposed to teach towards the end of the professional development course. It also included being interviewed by the research group, as well as having the research group conducting interviews with students. After the final lesson, the research group also collected textual artifacts from the classrooms. In the work presented here, I draw mainly on classroom video recordings, student interviews and textual artifacts from this data material (the empirical setting will be further explored in chapter 4). The Budding Science and Literacy project thus frames the situational context of the data used in this thesis.

1 http://www.scienceandliteracy.org/
1.3 Overarching aim of the thesis

The overarching aim of this thesis is to explore the literacies of school science in the context of integrated science-literacy instruction in primary school. This topic is mainly addressed through articles I, II, and III of the four that constitute this thesis. The three articles address distinct research questions or aims that, as a whole, inform the overarching aim of the thesis. In addition, I consider central methodological issues when collecting and working with a large body of video recordings and supplementary data sources, like the Budding Science and Literacy data material, which is addressed through article IV in this thesis.

1.4 Presentation of research articles and their contribution to the overarching aim

Article I

\textsuperscript{2} The three co-authors are listed in alphabetical order.
Article I is a video study of the variation and patterns of integrated inquiry-based science and literacy instruction at the classroom level. The article is written by the entire Budding Science and Literacy research group and presents an overview of the video data from the six participating classrooms. Video recordings were coded for multiple learning modalities (reading, writing, doing, talking) and phases of science inquiry (preparation, data, discussion, communication), and analyzed for occurrence and co-occurrence. The analysis suggests that the participating teachers spent much time in the preparation and data phases of inquiry, and comparably less time in the discussion and communication phases of inquiry. The learning modalities were also more evenly distributed in the preparation and data phases than in the discussion and communication phases. Thus, we discuss the importance of supporting teachers in these two consolidating phases of inquiry.

Article II

Article II investigates the literacy practices that emerge among primary school students during integrated science-literacy instruction. This is mainly explored through video analysis of literacy events that occur in the video material, with student interviews and collected textual artifacts acting as additional data sources. The article reveals how multiple literacies emerged in the context of integrated science-literacy instruction, where elements of students’ informal literacies became valued resources in the dialogic process of inquiry. Accordingly, we discuss the formal and informal elements of students’ literacy practices and identify some of the challenges that these students faced in their encounters with science text in this setting.

Article III

Article III provides an introduction to what a social view of literacy means for school science. From this view, we outline a framework to promote disciplinary literacy practices in science
classrooms. In the framework, four main themes from research on the role of text in school science and science are elaborated on to consider the ways in which text can be used as an integrated part of science teaching and learning: 1) science texts are written for particular purposes and audiences, 2) school science literacy builds on students’ informal literacy practices, 3) science reading and writing activities differ in their “authenticity”, and 4) school science literacy is embedded in explicit instruction. Finally, we claim that this view of literacy provides science educators with the theoretical perspectives to consider how literacy is actually used in contexts relevant to a transcending science subject.

**Article IV**


Article IV is a methodological contribution that considers the use and re-use of video data from two perspectives: the primary researchers (or archivists) and the secondary analysts. It combines two research projects—The Budding Science and Literacy project (the primary researchers) and the PISA+ video study (the secondary analysts)—to make an argument for establishing more common practices when conducting classroom video studies. A main characteristic of video data is that they have the potential to capture complex social phenomena that are open to a number of analytical and theoretical perspectives. Yet, video data have rarely been discussed in the debate on re-using qualitative data, where key challenges concern the methodological issue of context and ethical issues related to anonymity and confidentiality. As classroom video studies often amass large amounts of data material, it is of interest to the educational sciences in general to explore how these data can best be utilized to provide insights into classroom practices.

The four articles that constitute this thesis address the overarching aim from different perspectives, with their own distinct aims or research questions. Articles I and II are empirical studies of the six participating classrooms in the Budding Science and Literacy video study. Article I investigates the patterns and variation of activities in the data material by

³ The two authors are co-authors and are listed in alphabetical order.
categorizing the interaction in the classroom according to multiple learning modalities and phases of science inquiry. In the wider scope of this thesis, Article I provides an overview of the entire video data corpus and reveals quantified patterns of classroom activity therein. While Article I gives information on how much time is spent on different modalities in the six classrooms and how these co-occur with science inquiry phases, Article II goes beyond “reading” and “writing” *per se* to investigate what texts students encounter, what they do with these texts, and how they talk about these texts, and what they do with them, from a sociocultural perspective on literacy. The article focuses on students’ literacy practices as they are manifested in observable literacy events in the six classrooms and from interview data. This way, the article provides an empirical grounding for discussing how multiple literacies can be embedded in the context of primary school science. The findings and theoretical background from Article II are then expanded and elaborated on in Article III to present a framework for teachers to promote literacy in school science. The final article in this thesis, Article IV, considers some of the methodological issues related to using and re-using video data in classroom video studies. In this way, Article IV frames the empirical research reported in articles I and II, in addition to discussing how video can be used to investigate classroom practice in general.
2 Review of relevant research

As this thesis explores how literacy is embedded in the specific context of integrated science-literacy instruction at primary school levels, I will in this chapter review key studies that inform the present study with regards to I) the role of text in school science, and II) integrated science-literacy instruction. The research literature in the extended abstract is grouped under these two themes to first provide a background of how text is traditionally embedded in a school science context, with an emphasis on studies from primary school levels, and second, to review and situate the present study in the context of integrated science and literacy instruction.

2.1 The role of text in school science

In most science classrooms, the science textbook is, and has long been, the dominant text; it is often the only textual source of information available to students and it dictates how teachers plan and conduct instruction (Driscoll, Moallem, Dick, & Kirby, 1994; Goldman & Bisanz, 2002; Hodgson, Rønning, & Tomlinson, 2012; Nelson, 2006; Yore, 1991; Yore, Bisanz, & Hand, 2003). Recent numbers from the TIMSS 2011 survey, for example, showed that 83% of Norwegian fourth-grade science teachers and 92% of Norwegian eight-grade science teachers reported to use the textbook as the basis for their instruction (international averages were respectively 70% and 74%) (Martin, Mullis, Foy, & Stanco, 2012, pp. 402-405). Science textbooks, however, have been heavily criticized for focusing too much on consensual and well-established science, lacking argumentation, and presenting an individualistic image of science where individual scientists discover “truth” through experiment (Bauer, 1994; Knain, 2001; Penney, Norris, Phillips, & Clark, 2003). In addition, science texts also present students with specialized linguistic and multimodal demands that are difficult for those who are not familiar with scientific language and representation (Fang, 2006; Kress, Jewitt, Ogborn, & Tsatsarelis, 2001). While these demands indicate that science reading and writing requires specific attention, they are often left unattended in the classroom (Wellington & Osborne, 2001). Despite the dominant role of the textbook in science classrooms—and the obvious challenges associated with their structure and content—what matters most to the present study is rather how the textbook and other available texts are actually used by science teachers and students at the classroom level.
Driscoll and colleagues (1994), for example, investigated the natural use of the textbook in a middle school science classroom over the course of three weeks. In their study, the participating teacher used the textbook as the foundation for her instruction, and primarily to facilitate scientific vocabulary learning and study skills. Moreover, the teacher viewed the textbook as a resource for herself, as well as for her students. The students, on the other hand, largely used the textbook when prompted by the teacher. For the most part, the students’ use of the textbook was directed towards answering specific questions in the text or questions raised by the teacher, or for looking up vocabulary words. In problem-solving activities and during experiments, however, the textbook was neither referred to by the teacher nor used by the students. Thus, the textbook was mainly used in this classroom to support factual learning, which, according to Driscoll et al. (1994, p. 96), “was also assessed by the accompanying unit test”.

In a similar study of literacy events in an eight-grade Finnish-Swedish chemistry classroom (Danielsson, 2010), the textbook was clearly a prominent text, but only in the sense that it was kept on the desk in front of the students throughout the observed lessons. Most of the time, it was simply kept open to show the periodic table. Instead, the students were given homework assignments in the textbook, and the final test built solely on information from the textbook. Because of this, Danielsson (2010) argues that the textbook was not a very important text in the classroom situation. There was, however, a wide range of texts present in the lessons (e.g., teacher notes on the blackboard, labels on chemical containers, texts on the classroom walls), but longer running text was neither read nor written in class. The students took notes during the lessons, but these were rarely other notes than mere copies of the teacher’s notes on the blackboard. Danielsson (2010, p. 22) concluded that there was “an unutilized potential for working with the enculturation of the students into the written discourse of natural (school) science” in this particular classroom.

Another common text in science classroom is the experimental lab report based on practical work. For example, af Geijerstam (2006) found that lab report writing was a dominant practice in her study of school science writing in grades 5 and 8 in Swedish schools. However, there were few opportunities for the students to discuss the content, purpose and receiver of these texts in class. The students rarely sought a receiver for their texts, and the teacher was normally the only one reading the students’ reports. Similarly, Knain (2005b)
compared two Norwegian secondary school students’ writing of lab reports in science. He found that even though specific purposes for writing lab reports in science were presented as important to the students (e.g., replication of a study), they were not operationalized in practice.

Furthermore, the ways in which text is used in school science appear to be far removed from many students’ everyday use of language and literacy. For example, in a seminal ethnographic study, Shirley Brice Heath (1983) explored how people in three rural communities in North Carolina used language in their daily lives, particularly in home and school contexts. In her study, the first two communities—a pre-dominantly white working class community (Roadville) and a pre-dominantly black working class community (Trackton)—were contrasted with the town’s mainstream population (Maintown) in relation to the language practices valued in institutions like school or the workplace. Heath (1983) found that only the middle class residents of Maintown used language in ways that were congruent with school, while students from Roadville and Trackton—whose language use were distinctly different from those promoted in the science classroom and the school setting in general—became unsuccessful at school.

The work of Moje and colleagues (2004; 2001) has focused specifically on how different “funds of knowledge” frame students’ disciplinary literacy learning in seventh- and eighth-grade public school science classrooms. In an ethnographic study of the various funds that shape the texts of 30 young people in the community they studied, Moje et al. (2004) found that the students relied on popular cultural texts (e.g., movies, news media, talk shows) at least as much as they used their own experiences with the natural phenomena to frame their understandings of the related science concepts. For example, when reading a school text about a scientific experiment (growing square watermelons), one of the students reported that this was also the topic of an episode of The Simpsons. The authors argued that these popular culture texts were important funds of knowledge for learning because they enabled the students to engage with each other and with the science in the school text. However, the students did not generally volunteer their home experiences in the classroom, as they appeared to not consider these sources as valid types of knowledge in the classroom.

The above studies fit well with an increasing body of research indicating that school science is frequently experienced as the transmission of decontextualized scientific knowledge from
expert sources, like the teacher or the textbook (Lyons, 2006; Osborne & Dillon, 2008). In this mode of science teaching, students’ reading and writing activities are often reduced to copying information from the blackboard or the textbook, and answering textbook questions (Lindahl, 2003; Osborne & Collins, 2001). This is worrying because it contributes to students regarding science as a body of knowledge to be transmitted and memorized, thereby neglecting central aspects of what it means to become scientifically literate. A possible explanation is offered by Knain (2001, p. 322), whose study of Norwegian 8th grade science textbooks found that “textbooks create (and are part of) a discourse which focus on the end products of science”. Unfortunately, as indicated by Lyons’ (2006) review, these are patterns that appear to be consistent across national boundaries.

It appears, then, that the transmissive mode of science teaching and learning is particularly relevant for understanding how reading and writing is traditionally embedded in the context of school science. Goldman and Bisanz (2002, p. 40) similarly argue that the role (and nature) of science textbooks in school science leaves students with “few processing options other than trying to memorize ‘important information’, often defined by what will be tested”. Along the same lines, Yore, Bisanz and Hand (2003, p. 713) summarize how writing has traditionally been conceived of in science classrooms in their comprehensive review of research on literacy in science education:

Traditional writing tasks in science have centered on such activities as keeping accurate records, completing laboratory reports, and demonstrating an understanding of concepts for assessment purposes. These writing tasks do not explicitly place strong emphasis on students moving beyond the duplication of knowledge.

2.2 Integrated science-literacy instruction

Over the last couple of decades, science and literacy educators interested in the authentic ways in which scientists read and write have sought to develop pedagogical approaches that explicitly integrate science and literacy through inquiry (Cervetti et al., 2006; Gaskins et al., 1994; Glynn & Muth, 1994; Hand et al., 2003; Moje, 2008; Palincsar & Magnusson, 2001; Pearson et al., 2010; Yore et al., 2004). This initiative acknowledges that “science is a process of inquiry conducted through the use of language” (Yore et al., 2004, p. 348) by embedding disciplinary literacy practices in school science inquiry. As Cervetti and Pearson (2012, p.
claim, the common thread in studies of integrated science-literacy instruction has been to engage students in “reading meaningful texts for meaningful purposes in knowledge-building contexts”.

Several empirical studies now suggest that integrated approaches can improve student outcomes on science and literacy measures (e.g., Cervetti et al., 2012; Fang & Wei, 2010; Greenleaf et al., 2011; Guthrie et al., 2004; Purcell-Gates, Duke, & Martineau, 2007; Vitale & Romance, 2012). In a systematic review on quasi-experimental studies of integrated science-literacy instruction, Bradbury (2014, p. 483) noted that the reviewed studies “indicated positive outcomes for student achievement in both science and reading, as well as for affective factors”. For example, in Romance and Vitale’s (Romance & Vitale, 1992; Vitale & Romance, 2012) In-Depth Expanded Applications of Science (IDEAS) model of integration, traditional language arts instruction was replaced with joint science-reading instruction in grades 1 to 5. Central to the IDEAS model was a focus on core science concept instruction that involved firsthand experiences, reading comprehension, use of science process skills, and journal writing. In a recent summary of their multi-year research, Vitale and Romance (2012) documented increased effects on both science and reading measures. IDEAS students have also been shown to display more positive attitudes towards and self-confidence in science and reading (Romance & Vitale, 2001).

Some of the quasi-experimental studies on science-literacy integration are particularly interesting because they compare integrated inquiry science and literacy instruction with inquiry-based approaches that did not focus specifically on reading and writing. Fang and Wei (2010), for example, assigned ten 6th grade science classes into two groups: inquiry-based science plus reading and inquiry-based only. Their results showed that students in the first group outperformed students in the second group on measures of both science text reading and scientific knowledge. More specifically, Fang and Wei (2010, p. 270) argued that “discussion helped consolidate the students’ understanding of text and enhanced their learning of text information […] [while] the teaching of reading strategies also enabled students to better comprehend and learn from science texts, therefore effectively increasing their content knowledge about science”. Similarly, Girod and Twyman (2009) compared two inquiry-based curricula: one integrated and one inquiry-based only. In this study, the integrated approach showed favourable effects over the inquiry-based only approach on students’ identity as
science learners, knowledge about nature of science, and conceptual understanding. Both curricula, however, showed positive effects on interest and attitudes towards science.

While quasi-experimental studies provide valuable evidence that integrated science-literacy instruction supports student learning in science, it is mostly qualitative, classroom-based studies that frame the present study. A key study in this sense is Magnusson and Palincsar’s (2001) GiSML project (Guided Inquiry supporting Multiple Literacies), where a group of elementary school teachers collaborate with the researchers through a professional development course. In GiSML, two forms of investigations were combined to support teachers’ and students’ participation in science inquiry: firsthand investigations (hands-on) and secondhand investigation (consulting text to learn from others’ interpretations). Classroom observations and focus group interviews with the teachers regarding secondhand investigations revealed that the teachers’ main concern was that students would submit to the authority of the text, and not rely on their own firsthand experiences (Palincsar & Magnusson, 1997). This led the researchers to design “the scientist’s notebook” genre, which models how a scientist interprets data with a critical stance. When the participating students were subsequently compared with a test group that was taught with a considerate, non-refutational, expository text, results showed that the group with the notebook text was favored (Palincsar & Magnusson, 2001). Relying on their classroom observations, the authors claimed that the use of the notebook text provided opportunities for the students to actively engage in their own interpretations along with the scientist’s, while the traditional text did not afford the same constructive process.

Varelas, Pappas and colleagues (Pappas, Varelas, Barry, & Rife, 2003; Varelas & Pappas, 2006; Varelas, Pappas, & Rife, 2004) studied urban classrooms where teachers enacted integrated science-literacy instruction. In these classrooms, students engaged in hands-on activities, dialogically oriented read-alouds, the making of class artifacts and individual texts, drama experiences, and home projects that were later shared in class to inform their inquiries. The range of classroom activities was designed to provide the students with multimodal opportunities to theorize about the natural world and construct empirical evidence through collecting, analyzing, and interpreting data. In one study, Varelas and Pappas (2006) investigated the intertextual links that students in two classrooms made during read-alouds of seven related science texts. Their analysis showed that the number of connections the students made between personal experiences, written texts, discussions, and hands-on experiences
increased over this sequence of read-alouds. In these read-alouds, the students were able to use and build on their own language and experiences, in a manner that resembled scientific reasoning, to theorize about their firsthand experiences.

In the Norwegian *ElevForsk* project (Students as Researchers in Science Education), Knain and Kolstø (2011) aimed to develop new practices to support the integration of inquiry-based science and literacy—in line with the newly implemented competence objectives of the Norwegian curriculum (see Section 1.2.2). In this action research project, researchers and teachers at lower and upper secondary school levels collaborated over several years in different inquiry-based projects. A central finding in the project was the importance of creating different support structures to advance and focus students’ inquiries, which teachers had to adapt to the different aims and phases of students’ investigations (Knain, Bjønness, & Kolstø, 2011). For example, they identify learning goals, time limits, visible end products, research meetings, templates, and available information sources as possible support structures. In one particular study, Mestad and Kolstø (2014) worked with five teachers to enhance student learning from practical activities. Their analyses showed that the teachers emphasized theoretical knowledge and language to enable the students to make the correct interpretations, but, in fact, hindered the students in articulating their developing understanding. In line with Varelas and Pappas (2006), Mestad and Kolstø (2014) highlight the importance of creating *third spaces*, where students work with their own authentic language during practical activities on their way towards more scientific language.

The work of Howes, Lim and Campos (2009) on three elementary school teachers’ efforts to integrate literacy and science sheds light on how different models of integration occur. In their study, they described the ways in which these teachers linked science and literacy; even though the teachers in the study held similar views about the nature of inquiry, comparative analysis showed that the role of literacy in their teaching differed. In some cases, integrating science and literacy resulted in privileging literacy learning over science learning, which were not equally supportive of students’ engagement in science inquiry. Based on these findings, the researchers indicated that there was a need for further research “to understand more clearly what challenges teachers’ encounter in employing science–literacy integration and how we can support teachers to practice such integration successfully in their inquiry science teaching” (Howes et al., 2009, p. 214).
In sum, the evidence base for integrated science-literacy instruction is indeed promising, with an increasing number of studies documenting positive effects of explicit integration of disciplinary literacy practices into school science inquiry. Seeing that this particular line of research is still young, it is necessary to gain a better understanding of what works—and how—when literacy is positioned “to support rather than supplant the acquisition of knowledge and inquiry in science” (Pearson et al., 2010, p. 461).

2.3 Summary

From this review chapter, it becomes clear that the role of text in school science is often characterized by a dominant (but unutilized) use of the science textbook, coupled with reading/writing activities that appear to be embedded in a transmissive mode of science teaching. Typical practices include copying information and answering textbook questions. In contrast, integrated science-literacy instruction uses inquiry as its guiding principle in an attempt to provide meaningful contexts for reading, writing and engaging with science. While the evidence base in-favor of integrated approaches is growing, there are comparably few in-depth studies of science-literacy instruction at the classroom level. Hence, the present study aims to provide an image of how literacy is actually used in this context and mainly from the students’ perspectives. Hopefully, this might provide information to science educators on how to promote literacy practices in school science that are meaningful to students and the long-term goal of scientific literacy.
3 Theoretical framework

In this chapter, I present the theoretical perspectives that inform this thesis. First, I will discuss what a sociocultural perspective means for researching literacy in a school science context. Second, the notion of scientific literacy is explained, which is instrumental to understand the general aims of formal education in science. Third, I will elaborate on the idea of inquiry-based science education; a central term in the empirical context of this thesis that often takes on a wide variety of meanings.

3.1 Sociocultural perspectives for researching literacy in a school science context

In order to explore the overarching aim of this thesis, this study relies on a main argument derived from sociocultural studies of literacy. Namely, that literacy is best understood as a situated social practice involving text (Barton, 2007). Because this study aims to investigate literacy in a science education setting, it is also necessary to consider how a sociocultural perspective informs our understanding of science education. A sociocultural perspective of science education, where language is regarded as the main mediational means on both the social and the individual plane (Leach & Scott, 2003), is thus central to all of the articles that this thesis comprises.

First of all, taking a sociocultural approach builds on the assumption that all human action is situated in social, cultural, historical and institutional settings (Wertsch, 1991). Hence, science education can be seen as the enculturation of students into the particular ways of knowing and doing that has been developed within the culture of science (Gee, 2005; Leach & Scott, 2003; Lemke, 2001; Mortimer & Scott, 2003; Wertsch, 1991). This includes the distinctive ways of talking and thinking about the world, but also the ways in which reading, writing, acting, and interacting occur within the scientific community. Similarly, other social groups have their own specific practices in which oral and written language, activities, values, and beliefs are tightly interwoven (Gee, 2004). Bakhtin (1981) considers how these specialized ways with language are used for specific purposes in different parts of society in terms of social languages. Gee (2004) builds on Bakhtin’s notion when he refers to the social language of science (and the social language of school science) as an academic variety of
specialist language, which can be distinguished from vernacular language; the language we normally use in everyday situations. This latter variety of language is also referred to as “spontaneous” (Vygotsky, 1987) or “everyday” language (Leach & Scott, 2003). Science learning can thus be said to “occur against a backdrop of everyday/spontaneous ways of talking and thinking about phenomena” (Scott, Mortimer, & Ametller, 2011, p. 6), where several discourses and social languages (both oral and written) are present. However, the language of science differs from our everyday ways with language in both its linguistic demands and its cultural conventions of use, which, for many students, makes learning the language of science the greatest obstacle in science learning (Wellington & Osborne, 2001).

When researching literacy from a sociocultural perspective, the idea of social languages is particularly helpful, because it frames our ways with written language in the social practices of specific social groups or communities—such as school science. Thus, from a sociocultural perspective, learning to read a certain text in a certain way (in this case, texts with scientific information) requires “having access to, and ample experience in, social settings where texts of that type are read in those ways” (Gee, 2008, p. 48). It is exactly these kinds of experiences with literacy and the social settings in which literacy is embedded that are explored in this thesis.

Taking a sociocultural approach to literacy, however, is by no means restricted to the context of formal schooling. In fact, sociocultural studies of literacy, often referred to as the “New Literacy Studies” (NLS), signalled an attempt to understand literacy as a social practice across local contexts by documenting how people use literacy in their everyday lives (e.g., Barton & Hamilton, 1998). According to Jewitt (2008), NLS has in this way been central in the theorization of literacy as historically, socially, and culturally situated.

In contrast to the sociocultural view, literacy has traditionally been regarded as a universal skill or skill-set situated in the individual: i.e., “the ability to read” and “the ability to write” (Barton, 2007). In science education, Norris and Phillips (2003) claim that “a simple view of reading” has been prevalent in much of the literature and reform efforts focused on scientific literacy. In this view, being able to read simply involves the combination of decoding and comprehension (Gough & Tunmer, 1986). When it comes to science education, then, reading

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4 Scientific literacy is often referred to as what the general public ought to know about science, and will be further discussed in the next section.
and writing is positioned only in a functional relationship to science. They become little more than tools to “get to” the actual science, instead of a constitutive practice of the scientific enterprise. One of the prominent NLS scholars, Brian Street (1984), refers to the simple view of reading as an “autonomous model” of literacy, because it relies on the idea that literacy in itself—autonomously—will have specific cognitive effects regardless of the context in which these “skills” are applied. Autonomous models of literacy thus ignore how factors such as prior knowledge and cultural conventions greatly influence our understanding of a text (Norris & Phillips, 1994; Samuelstuen & Bråten, 2005).

A social view of literacy, on the other hand, shifts the focus from a set of individual skills or competences to a view of literacy as something you do—a social practice involving text (Barton, 2007). Street (1984) refers to this as an “ideological model” of literacy, because it acknowledges that literacy is always embedded in different cultural and ideological contexts. In this view, literacy involves engaging and participating in “particular ways of thinking about and doing reading and writing in cultural contexts” (Street, 2003, p. 79), which must necessarily also involve our values, power relations, talk, social relationships, attitudes, and beliefs regarding text (Gee et al., 1996). It follows that literacy is not just one thing; rather, there are multiple literacies just as there are social languages and social contexts of which literacy is a part. Take, for example, a group of local fishermen debating the latest news briefs about potential oil drilling in Lofoten, or teenagers playing a video game on their iPhones during recess. Both the fishermen and the teenagers take part in local and situated literacies, adhering to the specific conventions and ways with written language that are socially and culturally valued within those particular social groups and contexts (Barton & Hamilton, 1998).

However, as Street (2003, p. 78) points out, researchers “would find it problematic to simply use the term ‘literacy’ as their unit or object of study”, because it is hard to separate literacies from their ideological roots. NLS scholars have therefore developed two instrumental terms for researching literacy from a sociocultural perspective: literacy event and literacy practice (Barton & Hamilton, 1998; S. B. Heath, 1983; Street, 1984). These two concepts constitute the two basic units of analysis within NLS, because literacy practices are “observable in events which are mediated by written text” (Barton & Hamilton, 2000, p. 9). According to Barton (2007, p. 35), literacy events comprise “all sorts of occasions in everyday life where the written word has a role”—in other words, they are empirically observable events in which
text is used, read, written or talked about in some way or another. Literacy practices, on the other hand, are regarded as the general cultural ways of utilizing literacy, which people draw on in a literacy event. Thus, literacy practices can only be inferred from literacy events, because they also include unobservable factors, like values, power relationships, and attitudes. In Article II, literacy events in the classrooms are identified from video data and used to discuss the emerging literacy practices of the six primary school classrooms in the study.

Another central aspect of literacy, in this view, is the influence that certain socially powerful institutions have on how literacy is perceived by the general public (Barton, 2007). School, in particular, construct and shape literacies that are often more influential and valued than literacies related to out-of-school contexts. This creates a distinction between literacies that are dominant, formal or sponsored and literacies that are vernacular, informal or of personal choice (Barton & Hamilton, 1998; Gee, 2004; Street, 1993). In a school setting, this distinction can help us consider how certain literacies are regulated by others (mostly the teacher), and which literacies are student-initiated. However, when researching literacy in a school context, Maybin (2007) cautions against a strict dichotomy, because it easily conflates home literacy with vernacular literacy when this is not always the case. Maybin (2007) demonstrates that the school domain is actually far more heterogeneous than those who equate home and vernacular literacy often suggest. In turn, this might develop an unfortunate opposition between school and home. In Article II, we distinguish between formal and informal elements of school science literacy to highlight how students draw on vernacular or informal literacy practices in a formal school science setting. These aspects of literacy as social practice are then further employed in Article III to articulate what a social view of literacy means for educational practice in school science.

### 3.2 Scientific literacy—the aim of science education

Not to be confused with the literacies of school science, scientific literacy is a central term in this thesis and for science education in general. The term is often used to refer to what “the general public ought to know about science” (Durant, 1993, p. 129), and by many considered as the desired outcome of science education (DeBoer, 2000; Sjøberg, 2009). According to Roberts (1983, 2007a, 2007b), scientific literacy was first introduced as an educational slogan by US science educators (e.g., Fitzpatrick, 1960; Hurd, 1958) around the time of the Soviet
Sputnik launch. This had mainly to do with concerns about recruitment into science and the public’s understanding about science in the era of the Space Race. At the time, scientific literacy was primarily used to refer to a science education for the general public, and not students who were “potential scientists” (Klopfer, 1969). Following this first period of use, however, the term itself became subject to a “deluge of definitions” (Roberts, 2007a, p. 11) regarding what it means to be scientifically literate, which has also rendered the concept to be regarded as “diffuse, ill-defined, and difficult to measure” (Laugksch, 2000, p. 90). Here, I will rely on two main distinctions regarding scientific literacy. The first distinguishes between Vision I and Vision II, the second between the fundamental and the derived sense of scientific literacy.

In his comprehensive review of the literature on scientific literacy, Roberts (2007b) proposes that scientific literacy is best conceptualized as two overarching visions, rather than chasing consensus about one specific definition. These two visions are then taken to represent two extremes on a continuum. Whereas Vision I looks inward at science, concentrating on the promotion of scientific concepts and processes from the perspective of a professional scientist, Vision II focuses on a citizen’s understanding and use of science outside the traditional boundaries of science. In Vision I, it is thus presumed that scientific knowledge can be automatically applied and transferred to other settings in which that knowledge is needed. The presumption that science, in itself, has direct applicability to everyday life has however been shown to find little empirical support (Layton, Jenkins, Macgill, & Davey, 1993). This leads us to Vision II, which takes a more context-sensitive approach to scientific literacy, paying attention to the different situations and social contexts in which science plays a part. In these situations, personal decision-making is necessarily also influenced by factors outside of science, such as social, political, ethical and aesthetic ones. Wickman, Liberg and Östmann (2012) note that the inclusion of this normative dimension of human lives is a central difference between Vision I and Vision II. In Vision I, they argue, the normative is seen as irrational or possible to rationalize through science. The inclusion of values in the

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5 Sputnik 1 was launched by the Soviet Union on October 4, 1957, and became the first artificial Earth satellite.
6 The Space Race denotes the period from 1955 to 1970, which marked the Cold War rivalry of the US and the Soviet Union (USSR) for spaceflight capability. This period also gave way to an increased interest in science education, in order to increase the scientific literacy of the general public (Roberts, 1983). As Paul Hurd (1958, p. 52) wrote: “What have satellites, rockets and missiles contributed to American education? They have created an awareness of the importance of science and technology to social progress and economic security. The public realizes more clearly than heretofore that it is through the program of schools that science will be advanced and the ideals of the free world perpetuated”.
science curriculum is one example of the inherent tension between the two visions, which is also described by Roberts (2007a, p. 11):

Everyone agrees that students can’t become scientifically literate without knowing some science, and everyone agrees that the concept needs to include some other types of understanding about science. The differences in definition have to do with just what, how much, for whom, and in what sort of conceptual balance.

From a Vision II perspective, Wickman and colleagues (2012) further claim that science education needs to transcend not only the academic subject it aims to teach, but also the idiosyncratic backgrounds and experiences of students as citizens in a democratic society if science education is to prepare them for making informed decisions in their daily lives. Because of this study’s focus on literacy as a situated social practice, the context-sensitive approach to scientific literacy of Vision II is drawn upon to discuss how literacy in school science aligns with other contexts where scientific information is used and produced for various purposes (e.g., professional science or daily life).

Another perspective on scientific literacy that is central to this thesis, considers the role of literacy in scientific literacy. Although scientific literacy has become a heavily discussed term, the role of literacy, in its literal meaning, has traditionally not been the subject of these discussions. Rather, scientific literacy has usually been described in the tradition of cultural literacy (Trefil, 1995)—literacy in the form of thorough knowledgeability in and about science (2007b). In a much-cited article, however, Norris and Phillips (2003) theoretically positions literacy, in its literal meaning, as the fundamental sense of scientific literacy, while being knowledgeable, learned and educated in science refers to the derived sense of scientific literacy. The authors make an important clarification when they state that the two senses “can be separated in thought, but even here the separation quickly becomes strained with anomalies that urge us to merge the two senses into a complete whole” (p. 236). The central idea in this perspective is that because science is in part constituted by texts and our social ways of dealing with these texts, having access to and becoming critical consumers of scientific information is fundamental to scientific literacy. Indeed, when confronted with controversial socio-scientific issues in our daily lives, it is necessary to focus on the relevance of different sources (e.g., news media, scientific reports, personal accounts) and the trustworthiness of the knowledge claims therein (Kolstø, 2001). Accordingly, taking the fundamental sense of
scientific literacy seriously means that science education should enable students to “live and act with reasonable comfort and confidence in a society that is deeply influenced and shaped by the artefacts, ideas, and values of science—rather than feeling excluded from a whole area of discourse, and, as a corollary marginalised” (Osborne, 2007, p. 177). The articulation of a “fundamental sense” of scientific literacy has also influenced to a promising line of work on how literacy, in its literal meaning, contributes to our understanding of what a science education for scientific literacy might look like (e.g., Hand et al., 2003; Pearson et al., 2010), which also includes the present thesis.

3.3 Inquiry-based science and scientific practices

Inquiry-based science education is used as a guiding principle for science education worldwide (Abd–El–Khalick et al., 2004; Ministry of Education and Research, 2006; National Research Council, 1996, 2012; Rocard et al., 2007). It is also at the heart of the science-literacy integration model applied in the Budding Science and Literacy project (see Figure 1, p. 11), which makes it instrumental to clarify how the term is used in this thesis. First, it should be mentioned that the idea that science education should, to some degree, reflect the practices of professional scientists is not new. Rather, inquiry has a “decades-long and persistent history as the central word used to characterize good science teaching and learning” (R. D. Anderson, 2002, p. 1). It can be traced back to John Dewey (1910), who, in his address to the American Association for the Advancement of Science (AAAS) in 1909, argued that school science had too long concerned itself with science as a fixed body of knowledge, when the power of science lay in its processes and methods of thinking.

Despite its long history, and the prevalence of inquiry-based approaches to science education in reform efforts and policy documents, it is difficult to find an agreed-upon definition of what it means to “do” inquiry-based science in the classroom (Crawford, 2014). Thus, inquiry is often confused with hands-on activities, discovery learning, and problem-based learning (Hmelo-Silver, Duncan, & Chinn, 2007). Other times, inquiry-based science is associated with the use of “The Scientific Method” in the classroom, which distorts the complexity of scientific practice (Windschitl, 2004). Sociological studies of scientific practice have clearly shown that there is no one scientific method, and that the sciences have distinctly different “machineries” for constructing and validating knowledge (e.g., Knorr Cetina, 1999). Bell and
colleagues (2010) provide some insights into what inquiry-based science entails in their comparison of main inquiry processes in different inquiry models: Orienting and asking questions; hypothesis generation; planning; investigation; analysis and interpretation; model (exploration and creation); conclusion and evaluation; communication, and prediction. However, the authors emphasize that these categories do not represent a fixed order, but should be considered as processes students may go through in the order needed and returned to if necessary. The framework for the latest American science education standards (National Research Council, 2012), however, chose to emphasize scientific practices—instead of the term inquiry-based science—because of the many different interpretations associated with the term. This was done to minimize the tendency within inquiry-based approaches to reduce scientific inquiry to a single set of procedures, which often “overemphasizes experimental investigation at the expense of other practices, such as modeling, critique, and communication” (National Research Council, 2012, p. 43).

What is particularly interesting to this thesis is the lack of attention traditionally given to literacy in various conceptualizations of inquiry-based science. Whereas written language and inscriptions are embedded in the social practices and culture of science (Bazerman, 1988; Latour & Woolgar, 1986), texts have often been deemphasized in many inquiry-based science classrooms to avoid reading about science instead of “doing” science (Pearson et al., 2010). Andersson (1999, p. 973) describes the lack of attention to literacy in many inquiry-based approaches:

> We have rightly been critical of science classes where students learn facts from textbooks and worksheets. These classroom practices bear little relationship to the activities of scientists. In response, though, science educators have sometimes treated reading and writing as, at best, necessary evils, concentrating on hands-on experience as the essential core of scientific practice.

However, because science is constituted by both material and literate practices (Hacking, 1983; Halliday, 1998), there is a need to emphasize the role of literacy in inquiry-based science as well. As Pearson et al. (2010, p. 460) argue, “[s]cience literacy instruction should engage children and youth in making sense of scientific texts as one form of scientific inquiry”. This idea is at the core of the initiative to explicitly integrate science and literacy through inquiry that is described in section 2.3, and in the Budding Science and Literacy
teaching model (Figure 1). In this thesis, the perspectives on inquiry-based science that are outlined here have also contributed to the development of the coding scheme applied in Article I (see also Appendix III).

3.4 Operational definitions

I will in this section summarize and provide operational definitions of some of the key terms employed in this thesis: inquiry, literacy event, literacy practice, and, text.

3.4.1 Inquiry-based science education

In this thesis, the term inquiry is used to refer to a set of interrelated practices by which scientists and students pose questions about the natural world and investigate phenomena (Crawford, 2007), many of which are mediated through written text (Goldman & Bisanz, 2002). In the classroom, this involves supporting students in “using critical thinking skills, that includes asking questions, designing and carrying out investigations, interpreting data as evidence, creating arguments, building models, and communicating findings, in the pursuit of deepening their understanding by using logic and evidence about the natural world” (Crawford, 2014, p. 514). Inquiry is central to describe the empirical context (integrated science-literacy instruction), but also to the development of the coding scheme developed in Article I on different inquiry phases (preparation, data, discussion, and communication). In this regard, it is important to emphasize that these phases do not represent a fixed order through which inquiry is “accomplished”. Rather, they represent four overarching phases of inquiry that comprise observable practices that students in the participating classrooms rely on in their school science inquiries.

3.4.2 Literacy event

Literacy events are the main unit of analysis in Article II, in which literacy events in the participating classrooms were identified, coded, and inductively analyzed. In Article II, we chose to operationalize literacy events as the observable episodes in which the social interaction revolved around written text (Barton & Hamilton, 1998). By emphasizing that the social interaction should revolve around text, we were able to include when the teachers and students talked about text or used other means of communication to include text in their interaction (e.g., a teacher pointing to a note on a concept wall). In our data material, this was
possible to identify because we relied on video and audio data from multiple cameras in the six classrooms in the study. More specifically, we defined the start of a coded literacy event as the occasion when a text was first referenced, verbally or non-verbally, and the end-time as the end of the last connected utterance that made reference to the same text.

### 3.4.3 Literacy practice

A sociocultural perspective on literacy implies that literacy is best understood as a social practice situated in specific cultural and ideological contexts (e.g., Barton, 2007; Gee, 2008). Literacy practice is here used to refer to the general cultural ways of utilizing literacy; it is what we *do* with text in everyday situations (Barton & Hamilton, 2000). Hence, literacy practices can only be inferred from patterned literacy events, because they also include unobservable factors like social relationships, values, attitudes, and beliefs regarding text in those situations.

### 3.4.5 Text

Texts serve as an entry point for identifying literacy events and conceptualizing literacy in this thesis. However, in today’s digital media age, the notion of “text” is becoming more fluid, and it is harder to distinguish between texts (Barton & Lee, 2013). In addition, science is not communicated or represented through language alone, but in a combination of semiotic modes (including figures, images, video, mathematical formulae, inscriptions from various devices, and gestures) (Lemke, 1998). A helpful definition of text is in this regard is “any instance of communication in any mode in any combination of modes” (Kress, 2003, p. 48). However, in order to empirically categorize literacy events, I have—in line with many NLS researchers—found it necessary to limit literacy events to observable occasions where written text has a role, whether that text is read, written, talked about, or used any other way in the classroom. This implies that I have not focused on oral texts (e.g., oral recounts of a lived experience, Varelas & Pappas, 2006), but included a wide range of texts, digital and in print, where the written word is used in combination with other modes (e.g., figures, mathematical formulae, diagrams, digital quizzes, or television).
4 Methods

In this chapter, I provide an overview of the research design and discuss methodological issues related to the data material and analyses. The chapter serves as a supplement to the methodological sections provided in Article I and II, and builds on some of the arguments presented in article IV. As this thesis is a part of a larger research project, which creates both opportunities and challenges for a PhD project, I will also address my role as a researcher in a larger research project throughout this chapter.

4.1 Using video to research classroom practices

Video recordings stand at the centre of the data sources drawn upon in this thesis and in the Budding Science and Literacy research project at large. Additionally, when exploring literacy from a sociocultural perspective, the contexts in which literacy is embedded cannot be separated from the reading and writing that goes on (Barton, 2007). This implies that literacy needs to be studied *in context*, where actual practices are occurring. While literacy studies often rely on traditional ethnographic approaches, video observations have become an increasingly rewarding and adaptive strategy for gathering data in complex learning environments, including school literacies (Blikstad-Balas & Sørvik, 2014; Derry et al., 2010; Erickson, 2006; Klette, 2009). As Heath, Hindmarsh, and Luff (2010, p. 5) state, it is now common within studies of situated action and interaction to see video as an analytic resource “to explore, discover and explicate the practices and reasoning, the cultures and competencies, the social organisation on which people rely to accomplish their ordinary, daily activities”.

The main advantage with video is that it can provide a continuous record of the social interaction that arises in a natural habitat (Erickson, 2006)—in our case, the science classroom—which can then be subjected to a number of analytical approaches and perspectives after having been recorded *in situ* (Derry et al., 2010). The rapid advances in recording technology have also contributed to making video recordings a more flexible methodological design in educational research, as well as a less intrusive mediator between researchers and research participants (Klette, 2009). For example, whereas a common debate in the field of video research has long centered on the differences between using a fixed
camera or a moving, handheld camera (cf., Bateson & Mead, 1976), classroom studies such as the present one now employ multiple cameras from multiple angles. This way, one camera can be devoted to filming the whole classroom, while other cameras (and their fields of vision) are more dependent on the theoretical perspectives and aims of the study (Tiberghien & Sensevy, 2012). Nevertheless, it is important to mention that videos, by themselves, are artifacts or documents of a certain situation or event (Erickson, 2006; Schnettler & Raab, 2008). They have been recorded for particular purposes and in particular contexts, in addition to being a product of the recording activity itself, thereby representing chosen aspects such as camera angle or focus (Knoblauch, Schnettler, & Raab, 2006). According to Erickson (2006), it is important to keep this in mind when analyzing video data, as they in no way give unmediated access to “reality”, and should be treated accordingly.

In the present study, video was used to “capture” the interactional context of six primary school science classes where the teachers relied on a teaching model for integrating inquiry-based science and literacy. This particular PhD-project was a part of the larger research and development project Budding Science and Literacy, which has guided the research design by having to conform to the overall aim of the Budding Science and Literacy project, but also the aims of the individual researchers involved. However, as argued in Article IV, the Budding Science and literacy research project has from the start attempted to facilitate for future re-use of the data by collecting videos with different fields of visions (i.e., to capture the “whole” of the classrooms), as well as artifacts, interview data, and contextual data from the classrooms and participants. This has also benefitted the individual researchers in the research group, like myself, by providing a larger set of varied data to draw upon than what would be possible otherwise.

4.2 Participants and professional development course

In the Budding Science and Literacy project, primary school teachers were invited to take part in an in-service professional development course (equivalent to 10 ECTS credit points) that took an integrated approach to inquiry-based science and literacy. The course ran in two cohorts: the first in 2009/2010 and the second in 2010/2011. For the video study, six teachers from the latter course were asked to participate in a video study halfway through the professional development course. Thus, when referring to the professional development
course from this point, it will concern the second cohort, from which the participating teachers were recruited. The premise of their participation in the study was that they would be video recorded when they—as part of the professional development course—taught a sequence of science lessons in accordance with the Budding Science and Literacy teaching model (Figure 1, section 1.2.3). In the following, in-depth information about the situational context that informs the data corpus is provided, particularly regarding the professional development course and its participants.

The in-service professional development course was spread out over two semesters, with three-hour sessions on a monthly basis. I attended all of the monthly sessions for the professional development course, but did not have any formal obligations related to the course. For the most part, attending teachers had signed up for the course along with a colleague from their school. This had been recommended in order to have teachers cooperate locally at their own schools. The monthly sessions were normally divided in two parts: first, a talk on a given subject related to inquiry or literacy was given by academics within the field, and second, a practical investigation guided by the researchers and followed by a discussion.

In the practical activities, attending teachers took on the role of students, while researchers modeled teachers. These activities were often, but not exclusively, derived from teaching materials from the Seeds of Science/Roots of Reading program (Cervetti et al., 2006). In the first semester of the professional development course, the teachers tried out a single lesson from the Seeds/Roots material with their students. In the second semester, they implemented a sequence of science lessons, in accordance with the Budding Science and Literacy teaching model, with their students. In this phase, the teachers could draw on or adapt teaching material from Seeds/Roots if they wished to do so. Their experiences with taking an integrated science-literacy approach to their science teaching were then the subject of their exam papers, which they could write collaboratively. They also documented and presented their experiences to the other attending teachers on the final course session.

The six teachers that were asked to participate were selected on the basis of their educational background, school locations, the grade levels they taught, and their years of teaching experience. This was done to provide a varied sample of teachers and students. The six teachers, along with most of the attending teachers in the professional development course, were generalist teachers with little formal science education. This means that they did not have specialization in science, but that their science background mainly consisted of science
courses from their teacher education programs. After the six teachers were approached to participate in the video study, the principals from each school were approached, before students at the school were asked to participate on the basis of parental consent. The students ranged from grade 1 (6 year-olds) to grade 5 (10 year-olds). The participating schools were located in both rural and suburban areas of the greater Oslo area, but, in an international perspective, the students still come across as a relatively homogeneous group (cf. Kjærnsli & Lie, 2002). Table 1 summarizes information on the six participating teachers.

Table 1. Information about the participating teachers in the Budding Science and Literacy video study.

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Grade</th>
<th>Years of teaching experience</th>
<th>ECTS credits in Science</th>
<th>Number of students in class</th>
<th>School location*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anna</td>
<td>5</td>
<td>0-5</td>
<td>16-30</td>
<td>14</td>
<td>S</td>
</tr>
<tr>
<td>Betsy</td>
<td>1</td>
<td>11-15</td>
<td>16-30</td>
<td>18</td>
<td>R</td>
</tr>
<tr>
<td>Birgit</td>
<td>4</td>
<td>11-15</td>
<td>16-30</td>
<td>24</td>
<td>R</td>
</tr>
<tr>
<td>Cecilia</td>
<td>3</td>
<td>20+</td>
<td>16-30</td>
<td>19</td>
<td>S</td>
</tr>
<tr>
<td>Ellinor</td>
<td>3</td>
<td>11-15</td>
<td>31-60</td>
<td>16</td>
<td>R</td>
</tr>
<tr>
<td>Emma</td>
<td>3</td>
<td>20+</td>
<td>16-30</td>
<td>21</td>
<td>R</td>
</tr>
</tbody>
</table>

*S=Suburban, R=Rural

Both the professional development course and the six participating teachers relied in some ways on ideas and teaching materials from the Seeds of Science/Roots of Reading program developed at Lawrence Hall of Science, UC Berkeley (Cervetti et al., 2006). Thus, the main ideas behind Seeds/Roots require some clarification. According to Gina Cervetti and P. David Pearson (2012, p. 580), founding developer and co-director of the Seeds of Science/Roots of Reading program, the Seeds/Roots model of science-literacy integration pertain to two central questions: “How can reading, writing, and language be used as tools to enhance the acquisition of science knowledge and inquiry processes?” and “How do reading, writing, and language benefit from being put to service in pursuit of the goals of inquiry based science?” From these two questions, then, Seeds/Roots evolved into an integrated curriculum program for primary school, consisting of curricular units of 20 to 40 sessions developed in accordance with national and state science and literacy standards in the US, and subsequently field-tested in classrooms. Each unit is specially designed to address specific topics and key science
concepts, and includes detailed teacher guides, student books, investigation notebooks, equipment kits, and a summative assessment booklet.\textsuperscript{7}

Furthermore, Cervetti and colleagues (Cervetti et al., 2006) refer to five main principles that have guided the integrated model on which these units are based. First, \textit{texts can support scientific inquiry}, which acknowledges that scientists “learn about and come to understand the natural world through text as well as firsthand experience” (p. 227). Second, \textit{comprehension strategies are inquiry strategies}. This principle relies on the recognition that science and literacy share many of the same meaning making strategies—for investigating natural phenomena and understanding a text, respectively. Third, \textit{words are concepts}. The third principle focuses on conceptual learning; in the form that learning science involves developing rich conceptual networks of words and ideas (over mere word learning).\textsuperscript{8} Fourth, \textit{science is discourse}. This principle relies on an understanding of science as a social context in which a specialized language is used to communicate: the social language of science (Gee, 2005). And fifth, \textit{literacy is visual literacy}. The final principle relates to how scientific ideas are represented though a wide range of visual elements that goes beyond words on the printed page. For example, science texts employ pictures, videos, animations, figures, graphs, and equations to present and provide multiple representations of scientific information (Kress et al., 2001; Lemke, 1998).

For the present study, the Budding Science and Literacy teaching model (Figure 1) and the Seeds/Roots teaching material serves as the two central points of reference for framing the interventions in the six classrooms. All of the six participating teachers chose to use material from the Seeds/Roots units, but there were individual variations in how closely they followed the teacher guides. This is evident in Article I, where a supplementary analysis comparing the teacher guides to the observed teaching was performed. This analysis indicated that the teachers followed the main activities from the teacher guides, but different teacher emphasized different aspects. Some of the teachers also added their own activities.

\textsuperscript{7} \url{http://www.scienceandliteracy.org/about/whatisit/components}
\textsuperscript{8} The work of fellow Budding Science and Literacy PhD student, Berit Haug, has focused specifically on how teaching for conceptual understanding occurs in an integrated inquiry-based science and literacy setting (Haug, 2014).
4.3 Data sources

4.3.1 Acquisition of data material

The data material for the Budding Science and Literacy video study was acquired in autumn, 2010, and spring, 2011. Prior to main data collection period, the Budding Science and Literacy video study design was piloted in a similar setting, at a near-by school in Oslo. In this section, I will mainly focus on how video and audio data, semi-structured group interview data with students, and textual artifacts were generated in the Budding Science and Literacy project, since these are the data sources that are drawn upon in the work presented here. In the larger research project, however, we also collected survey data on the teachers that attended the professional development course; pre- and post-interview data with the six participating teachers; video and audio recordings of teacher presentations at the professional development course; written exam papers from the professional development course; and, reflection notes from the professional development course. However, classroom studies, like the Budding Science and Literacy project, often generate large corpora of data material and a central step in the analytical process is therefore to restrict and select data sources fitting to the particular research questions (Derry et al., 2010). In the Budding Science and Literacy project, we engaged in a comprehensive data collection to fit the overarching goals of the project, as well as those of the individual researchers. Wanting to focus on students’ interactions with text as teachers implemented integrated science-literacy instruction, it was the classroom-based data sources that has been the main interest in this PhD project; namely, video and audio from the classrooms, the textual artifacts that were present or produced in the classrooms, and getting the students’ own perspectives on the observed lessons.

4.3.2 Video and audio observations

The six classrooms in the study were video-recorded with a four-camera set-up, as the teachers implemented an integrated science and literacy lesson sequence, to capture the interactional context of the classroom by relying on cameras from multiple perspectives. The camera set-up included a fixed whole-class camera to capture the events of the entire classroom, located in the front of the classroom and focusing on the students; a teacher camera located in the back of the classroom, operated by a research assistant, which followed the teacher’s movements; and, two head-mounted cameras on a student in each of two focus groups in the classroom. In Figure 2, it is possible to see how the four cameras capture the four perspectives at a given moment in one of the classrooms. Additional sound recorders
were also used in each classroom to record focus group discussions in case of camera malfunction. In this way, the particular video design and positioning of cameras employed in The Budding Science and Literacy study builds on prior classroom video studies, such as the PISA+ video study (Klette, 2009; Klette et al., 2008; Ødegaard & Arnesen, 2010). The connection between these two classroom video studies is further explored in Article IV.

![Figure 2. Snapshots from the four cameras illustrate how the Budding Science and Literacy camera set-up captures multiple perspectives at a given moment in one of the classrooms in the study.](image)

The inclusion of head-mounted cameras distinguishes the Budding Science and Literacy design from the PISA+ study, but similar cameras have been used in recent studies to explore geoscience fieldwork and outdoor learning (Remmen & Frøyland, 2013; Stolpe & Björklund, 2012) and students’ use of laptops during teacher instruction (Blikstad-Balas, 2012). We used high-definition cameras from GoPro\(^9\), which were mounted on the students’ heads with a headband during the observed lesson. By using these head-mounted cameras, we were able to obtain a record of that student’s perspective in the classroom (see Figures 2 and 3 for screenshot examples from these cameras), along with the interaction that student had with the other students in her/his sitting group and with the class in general. This means that it is possible to observe how two students in each class actually read and wrote, but also how they talked about texts with the other students in the focus groups. For example, in Figure 3, we see how one student produces a figure of a small ball-sorting system that he and the other students in his sitting group had made in the previous lesson. He starts out by drawing the system, before he makes labels with the form and function of the different parts in the system. From these snapshots, it is possible to see that the head-mounted cameras enables us to

\(^9\) http://www.gopro.com
consider what kind of writing the students is actually doing, not only what they are told by their teacher to do.

The selection of student focus groups was made in cooperation with the teachers to procure focus groups that were representative of the class. One student in each group was then asked to wear a head-mounted camera, which was also decided on with the assistance of the teacher to make sure that the student wearing the head-mounted camera was comfortable doing so. The seating arrangements in each classroom varied somewhat, from students sitting in pairs facing the blackboard (e.g., Betsy’s and Anna’s classrooms) to groups facing each other (e.g., Birgit’s and Ellinor’s classroom), which influenced the number of students in the focus group. In most of the classrooms, students were eager to wear the head-mounted cameras, which resulted in a decision to allow the students within the focus group to take turns wearing the head-mounted camera from lesson to lesson if needed. Most importantly, the interaction within the group would be recorded regardless.
The Budding Science and Literacy research group, along with two research assistants, recorded all of the video observations. I was present for almost all of the lessons being recorded, taking time-indexed field notes during the observations. By time-logging our field notes, we could easily correlate our initial observations in the field with the time codes of the video recordings in the beginning stages of analysis or mark particularly interesting events. Being present in the field and taking field notes were also important structures before interviewing the focus group students after their final lesson. We recorded for the duration the lesson sequence that the teachers implemented with their students in each classroom, but the teachers were not given any instructions on the length of these sequences (rather, they were told to include reading, writing, doing and talking activities in the lessons). The amount of recorded material thus differs between the classrooms. In total, approximately 33 hours (per camera) were recorded of the six teachers and their students. After each observed lesson, the research group archived the video recordings on a secure server, along with essential metadata, such as school code, date, time, and camera source. In Article I, the video data corpus is used to answer the research question, whereas 30 hours of video data are analyzed in Article II. In that study, two lessons of 83 and 85 minutes were removed from the total number of video recordings to provide a more homogeneous sample, because they differed in science topic from the rest of the video-recorded lessons in two of the classrooms.

Table 2. Distribution of interviewed students and time of video recordings for each classroom in the Budding Science and Literacy study. The distribution of video recordings analyzed in Article II is also listed.

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Grade</th>
<th>Interviewed students from group</th>
<th>Total time of video recordings (in minutes)</th>
<th>Time of video recordings analyzed in article II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anna</td>
<td>5</td>
<td>5</td>
<td>343</td>
<td>260</td>
</tr>
<tr>
<td>Betsy</td>
<td>1</td>
<td>4</td>
<td>165</td>
<td>165</td>
</tr>
<tr>
<td>Birgit</td>
<td>4</td>
<td>8</td>
<td>426</td>
<td>426</td>
</tr>
<tr>
<td>Cecilia</td>
<td>3</td>
<td>4</td>
<td>540</td>
<td>455</td>
</tr>
<tr>
<td>Ellinor</td>
<td>3</td>
<td>8</td>
<td>224</td>
<td>224</td>
</tr>
<tr>
<td>Emma</td>
<td>3</td>
<td>4</td>
<td>269</td>
<td>269</td>
</tr>
<tr>
<td>Total</td>
<td>33</td>
<td>1967</td>
<td>1799</td>
<td></td>
</tr>
</tbody>
</table>
4.3.3 Semi-structured focus group interviews

Following the observed lesson sequences, 33 of the students in the participating classrooms were interviewed on the basis of being included in the classroom focus group (i.e., students wearing the head-mounted cameras or being in the same sitting group as the students wearing the head-mounted camera). The interviews were conducted as semi-structured focus group interviews, which combines a predetermined set of questions with the flexibility to explore themes that the interviewees bring up (Kvale & Brinkmann, 2009). The overall distribution of interviewed students across the six classrooms is presented in Table 2. In this thesis, the interview data are drawn on in Article II, where the main purpose was to gain access to the students’ own thoughts and ideas about their experiences with literacy and science in the context of integrated science-literacy instruction. Due to the young age of the participating students—from six year-olds to eleven year-olds—particular attention was given to creating a safe and informal environment for the students. For example, the students were interviewed in groups, they were asked age-appropriate questions, the interviews took place in the classroom or adjoining rooms after the lesson, and the students were encouraged to bring their lunch boxes if it was close to lunch time. However, focus groups interviews are also suitable for exploratory studies, like this one, because the collective interaction may elicit more spontaneous and expressive views than in individual interviews (Kvale & Brinkmann, 2009).

Interview guides for the semi-structured focus group interviews (Appendix II) were developed and designed to reflect the broad objectives of the Budding Science and Literacy project as a whole, as well as the individual foci of the researchers. Being particularly interested in the students’ perspectives, I had a central role in designing the interview guides. I also acted as interviewer in most of the student interviews. The main priority in the interviews was to allow the students to speak freely about their experiences in the observed lessons. Hence, we structured the interviews around certain artifacts (i.e., texts and practical equipment) from the observed lessons and initiated the interview with introductory questions around these artifacts. According to Kvale and Brinkmann (2009), introductory questions (e.g., “Can you tell us about what you did in class today?”) may yield rich descriptions of what the subjects themselves experienced and in their own words. The interview guides then provided additional probing questions to further pursue specific themes or direct questions to introduce new topics later in the interviews if required. The interviews were video and audio recorded, and subsequently transcribed.
4.3.4 Textual artifacts

Students and teachers in any classroom use and produce a number of texts during a regular school lesson that are central to understand how literacy is embedded in the teaching and learning of science in that classroom. For the researcher, these physical objects (e.g., a drawing in a student’s notebook, a textbook, a concept map on the blackboard, or a poster on the classroom wall) can become textual artifacts from a certain situation or context (Borko, Stecher, Alonzo, Moncure, & McClam, 2005). With help from the teachers, the research group collected these textual artifacts after the observed lessons. In some cases, however, textual artifacts were not easy to collect. For example, Anna used a digital quiz on the interactive whiteboard in her classroom, and students in Ellinor’s classroom tested different types of glue on inscribed paper sheets. In these situations, the multiple camera set-ups provided us with video recordings that documented these and similar texts. The textual artifacts were only drawn upon in Article II, but mainly as a supplement to the video data or as a stimulant in the semi-structured interviews. While a textual artefact, on its own, give little information about how that text was actually used, it provided us with the opportunity for closer inspection of the texts that were present and used in the video recordings. Some examples of textual artifacts are presented below (Figure 4).

![Figure 4. Examples of student texts either collected or captured by video.](image-url)
4.4 Data analysis

The empirical work presented in this thesis draws primarily on video data, which are central to Article I and Article II, in addition to interview data and textual artifacts, which are drawn upon in Article II. In what follows, I describe the analytic process that was applied to the data sources in the two articles. The textual artifacts were mainly used to provide additional information on particular literacy events in Article II and will not be further discussed in isolation from the particular literacy events in which they were used.

The analytic approach of video coding was central to both of the empirical articles. According to Derry et al. (2010), analyzing video by coding is rooted in disciplined observation, a core feature of scientific methodology, and developed and used by social scientists to “document, analyze and report human behavior observed in natural contexts” (p. 20). More specifically, coding involves a transformation of people’s actions, utterances and gestures into a formal code, which corresponds to a specific reference (Tiberghien & Sensevy, 2012). Thus, coding schemes were developed to answer the particular research questions of the two articles. These are briefly described below. For the actual coding, InterAct\(^\text{10}\) coding software was used to code the videos directly, without having to transcribe speech into written form. This process is illustrated in Figure 5, where a segment from one of the classrooms in the study has been coded with the coding scheme from Article II (Table 4). InterAct also allowed for multiple videos to be juxtaposed (e.g., video from a head-mounted student camera and from the teacher camera), which was helpful for in-depth analysis of particular events. I will first go more into detail about the video analyses of Article I and Article II, before ending this section with a description of the analysis applied to the interview data in Article II.

\(^\text{10}\) http://www.mangold-international.com/software/interact/what-is-interact.html
In Article I, the entire Budding Science and Literacy research group aimed to investigate the challenges encountered and the support needed when teachers implement integrated science-literacy instruction. This was addressed through mapping time spent on different learning modalities (reading; writing; talking; doing) throughout four different phases of inquiry (preparation; data; discussion; communication) with systematic video coding. All of the four researchers in the Budding Science and Literacy project took part in the development of the coding schemes and in the data analysis. First, a coding scheme for inquiry was developed based on extensive review of the literature on inquiry-based science (e.g., Barber, 2009; Bell et al., 2010; Bybee et al., 2006; Knain & Kolstø, 2011), and from iteratively reviewing and operationalizing these codes in conjunction with the video material. We distinguished between two levels of analysis by having specific codes for central inquiry processes constituting the four overarching inquiry phases. Table 3 gives provides an introduction to these codes (see also Appendix III). Second, codes for different learning modalities were developed to correspond with the multimodal activities that are emphasized in the Seeds/Roots materials (reading, writing, talking, doing), and included codes for instructional organization (whole-class, group, pair, individual). The latter codes were inspired by the
PISA+ video study (Klette, 2009; Ødegaard & Klette, 2012). Finally, we also included a code to indicate when the teaching explicitly focused on concepts that were accentuated in the Seeds/Roots teaching material.

Table 3. Coding scheme for video analysis in Article I based on Ødegaard, Mork, Haug, & Sørvik (2012). See also Appendix III for the entire coding manual developed by Ødegaard et al. (2012).

<table>
<thead>
<tr>
<th>Category</th>
<th>Subcategories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inquiry</td>
<td>Preparation: Background knowledge/ wondering/ researchable questions/ prediction/ hypothesis/ planning</td>
</tr>
<tr>
<td></td>
<td>Data: Collection/ registration/ analysis</td>
</tr>
<tr>
<td></td>
<td>Discussion: Discussing interpretations/ inferences/ implications/ connecting theory and practice</td>
</tr>
<tr>
<td></td>
<td>Communication: Orally/ in writing/ assessing their work</td>
</tr>
<tr>
<td>Multiple learning</td>
<td>Oral activities: Whole-class/group/pair/individual</td>
</tr>
<tr>
<td>modalities</td>
<td>Writing activities: Whole-class/group/pair/individual</td>
</tr>
<tr>
<td></td>
<td>Reading activities: Whole-class/group/pair/individual</td>
</tr>
<tr>
<td>Key concepts</td>
<td>Practical activities: Whole-class/group/pair/individual</td>
</tr>
<tr>
<td></td>
<td>Focus on key concepts: Whole-class/group/pair/individual</td>
</tr>
</tbody>
</table>

These codes were then applied to the video material to investigate the occurrence and co-occurrence of inquiry and learning modalities in the six classrooms in the study. To begin with, the four researchers worked in pairs to code two randomly assigned lessons and agree upon when the codes should be applied. The researchers then coded the rest of the material individually. However, to determine inter-rater reliability, about 20% of the material was double-coded by two individual researchers. The topic of inter-rater reliability will be addressed more closely in Section 4.5.2.

In Article II, the aim was to identify literacy events in the material and explore the emerging literacy practices that students engage in during integrated science-literacy instruction. Thus, literacy events acted as the main unit of analysis in this study. Here, the data analysis was performed by myself and in three main steps. First, a coding scheme was inductively developed from the video material (Table 4) and used to identify literacy events by logging the onset and offset times of each event in which the social interaction revolved around a particular text. This way, it was the text that the participants made reference to that characterized the categories for coded literacy events. Another possibility could have been to
categorize literacy events according to the nature of the interaction around the text, instead of the type of text that was the object of interaction. In this data material, however, it worked well to categorize the coded literacy events in this way because the teachers and students often focused on a particular text at a particular time. In other school situations where students often interact with multiple texts at the same time (e.g., in upper secondary schools where students have access to computers during whole-class instruction (Blikstad-Balas, 2012), a strict *analytical* demarcation between literacy events like the one applied here might become more problematic. In this case, the coding approach served to provide detailed information on how different types of texts were used in the six classrooms, as well as important information on the typicality and atypicality of certain literacy events in the participating classrooms.

Table 4. *Coding scheme for the main coding category Text. These codes were applied to the video material to identify literacy events in Article II.*

<table>
<thead>
<tr>
<th>Subcategory</th>
<th>Description of subcategory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fictional narratives</td>
<td>Narrative text that does not aim to communicate scientific information (e.g., story books or fictional films)</td>
</tr>
<tr>
<td>Hybrid informational</td>
<td>Atypical informational text that incorporates elements from different genres (e.g., narrative, poetry etc.) to communicate scientific information</td>
</tr>
<tr>
<td>text</td>
<td></td>
</tr>
<tr>
<td>Informational text</td>
<td>Typical informational text, such as traditional science textbook texts and authentic science texts</td>
</tr>
<tr>
<td>Internet</td>
<td>Text that is accessed online in the classroom</td>
</tr>
<tr>
<td>Orienting text</td>
<td>Concept walls, learning goals on blackboard, work plans, written instructions etc.</td>
</tr>
<tr>
<td>Graphs, figures and</td>
<td>Explicit focus on visual representations of scientific information</td>
</tr>
<tr>
<td>models</td>
<td></td>
</tr>
<tr>
<td>Student writing</td>
<td>Texts produced by the students. This subcategory also includes texts co-produced by teacher and students (e.g., if the teacher constructs a text on the blackboard in co-operation with the students)</td>
</tr>
<tr>
<td>Other</td>
<td>Texts not included in the previous subcategories (e.g., digital quizzes)</td>
</tr>
</tbody>
</table>

Second, the coded literacy events were analyzed through *analytic induction*, which involves the iterative process of “reviewing evidence with an assertion in mind, revising the assertion in light of the evidence, and then reviewing the evidence again” in search of emerging patterns and themes across the data material (Erickson, 2012, p. 1460). We began by drawing on sociocultural perspectives on literacy to consider the contexts that were relevant to the students’ interaction with text. This led us to differentiate between literacy events that were typically “schooled” and literacy events that relied on both formal and informal elements in the students’ inquiry engagement, which were categorized into tentative categories for emerging literacy practices. In the third step of the analysis, we analyzed interview data to uncover some of the feelings, attitudes, values, and social relationships from the students’
own experiences in the observed lessons. This analysis is accounted for in more detail at the end of this section to discuss the video analyses in the two empirical studies.

In both of the empirical studies, systematic video coding allowed for quantification to be employed in qualitative research. According to Erickson (2012, p. 1462), it is apparent that:

[...] the [qualitative] researcher must pay careful attention to frequency of occurrence, especially to relative frequency, in comparing different kinds of phenomena across different comparison groups. It is necessary to count things and to make decisions carefully about what things to count and in which sets.

The coding approaches applied in the two articles rely on systematic results for two particular purposes. In Article I, systematic coding and quantification were used to illuminate the occurrence and co-occurrence of multiple learning modalities and inquiry phases. This was not done to generalize from the findings, but to reveal patterns of classroom activity in the data that are not easily observed (Ødegaard & Arnesen, 2010). In Article II, systematic coding allowed for close attention to be paid to specific literacy events as part of larger patterns in the classrooms. In turn, this enabled us to distinguish between the typical and the atypical (Erickson, 2012) when analyzing and describing those events. While systematic video coding inevitably reduces complex social situations into seemingly clear-cut categories, in-depth analysis helps add nuance to the results (Snell, 2011). This is achieved with an illustrative example of the video analysis in Article I (from Birgit’s classroom), and with the combination of systematic coding of events and analytic induction of those events in Article II. Snell (2011, p. 257) argues that the two methods of analysis are, in fact, complementary: “micro-ethnographic analysis adds nuanced interpretation and prevents systematic results from being used in a reductionist manner; and systematic quantitative analysis build rigour into the selection process, warding off claims of researcher basis in ‘cherry-picking’ video clips”.

Lastly, in article II, interview data were analyzed to get the students’ own perspectives on the observed science lessons and science in general. Thus, the transcribed student group interviews were subjected to meaning condensation, which, according to Kvale and Brinkmann (2009), entails compressing the interviewees’ statements into briefer statements that retain the main sense of what is said. Following Kvale and Brinkmann’s approach, I started out by reviewing the video recorded interviews and reading through the entire
transcripts to get a sense of the whole. I then determined natural “meaning units” as expressed by the students and restated these units into simpler themes, such as *Working like a scientist involves doing experiments* or *I used my imagination when I wrote the text*. These themes were subsequently aligned with the study’s focus on how the students’ viewed and used literacy in school science, and tied together into descriptive statements. In article II, the interviews served to provide insights into the students’ experiences regarding text and social practices in the observed lessons. In this regard, it was central to explore what the students themselves thought about what they did in the observed lessons. Meaning condensation was in this way a valuable analytical tool to maintain the students’ everyday use of language and ways of talking about their experiences in the classroom (Kvale & Brinkmann, 2009).

4.5 On the quality and credibility of the research

In all research, it is necessary to discuss the quality and credibility of the work. Here, I discuss the present study’s validity, reliability, and generalizability.

4.5.1 Validity

The concept of validity in qualitative research has been treated to a vast array of related terms (e.g., credibility, authenticity, trustworthiness etc.), but there is little doubt that qualitative researchers need to demonstrate that their study is credible (Creswell & Miller, 2000). More specifically, the validity of a qualitative study concerns “whether or not the inferences that the researcher makes are supported by the data, and sensible in relation to earlier research” (Peräkylä, 2011, p. 365). Creswell (2007) uses the term to emphasize a process, rather than a strict verification, where different strategies are chosen and applied to add to the accuracy of a study’s findings. This includes scrutiny and presentation of the choices made regarding collecting, processing, and analyzing the data. In turn, these validation strategies should be made clear to the reader.

In this thesis, *prolonged engagement* in the field has been a central strategy to form an accurate impression of the social action in the six participating classrooms. In addition to the hours of actual video recording in the classrooms, I and other researchers in the project group visited participating teachers and students prior to the video observation to observe and build trust in the classrooms. I was also present at the professional development course meetings as
an observer. In Article IV, it is further explored how the Budding Science and Literacy project has aimed to facilitate for future re-use of the data corpus from the start. This means that we have attempted to generate a rich data corpus, which goes beyond the individual researchers’ research interests or need, paying specific attention to document contextual information and other relevant data from the field.

Triangulation has been another central strategy to improve the validity of the study. The process of triangulation involves using multiple data sources, theories, and methods while searching for convergence in a study (Creswell & Miller, 2000). As described in the previous sections, observational data, interview data, and textual artifacts have been combined in this thesis to explore literacy in the six classrooms. However, the reason for using data collected through multiple methods is not for validity concerns alone; they are also closely intertwined with the object of study (i.e., school science literacies) and the theoretical perspectives (i.e., literacy as social practice). In a social view of literacy, feelings, attitudes, values, and social relationships are central to people’s literacy practices, but not necessarily readily observable in a literacy event. This implies that it is important to gain insights into the participants’ experiences of the classroom activities, in addition to the video-recorded events.

Peer debriefing has also been used continually in the research process to challenge and check methods and interpretations (Creswell & Miller, 2000). Video recordings have been central in this regard, because they can be viewed multiple times by multiple researchers and allows for inferences to be debated among several researchers or for a researcher’s interpretations to be checked against the specific events (Derry et al., 2010).

When researching sites chosen on an a priori theoretical basis—in this case, an integrated science-literacy intervention—a possible threat to validity is that the researcher is overly committed and influenced by that perspective (Schofield, 2002). In the two empirical studies included in this thesis, however, the aim was not to prove or falsify such an approach, but to investigate what was actually happening in the six classrooms when the participating teachers implemented integrated science-literacy instruction. Validity problems of this sort can then be somewhat mitigated by approaching the data as openly as possible (Schofield, 2002). In the work presented here, it has been important to explore both the opportunities and the challenges that arose in the participating classrooms to best support teachers and students in
reading and writing science texts in meaningful contexts. Accordingly, openness towards the data has been a premise for the project from the start.

Another threat to validity in a classroom video study concerns how the participants react to the presence of video cameras in the classroom—an issue often referred to as reactivity (C. Heath et al., 2010; Knoblauch et al., 2006; Lomax & Casey, 1998). It is a serious methodological issue to consider for researchers exploring social action in the context in which that action occurs, because the situations to be studied can be modified by the camera to greater or lesser extent (Knoblauch, Tuma, & Schnettler, 2014). However, Heath, Hindmarsh and Luff (2010, p. 49) argue that reactivity is often minimized as the research participants get used to the camera with time:

Throughout our studies of a diverse range of settings and activities we found that within a short time, the camera is ‘made at home’. It rarely receives notice or attention and there is little empirical evidence that it has transformed the ways in which participants accomplish actions.

While we initially were anxious to see how such young children adjusted to wearing head-mounted cameras, when asked informally after class or in the interviews, most replied that they had forgotten they were wearing the camera in class. This was particularly evident in one of the third-grade classrooms, where a student with a head-mounted camera simply got up, asked her teacher to go to the bathroom, and walked out of the classroom with the camera still on her head—leaving the researcher closest to the door in a sudden rush to catch up with the student and turn the camera off (which was accomplished). It was also the case in the other classrooms that the cameras soon became a regular aspect of the school science lessons we observed. In line with Heath et al. (2010), reactivity is accordingly not regarded as a major threat to the validity of the present study.

4.5.2 Reliability

Reliability is used here to refer to “the degree of consistency with which instances are assigned to the same category by different observers or by the same observer on different occasions (Hammersley, 1992, p. 67). In other words, the reliability of a study concerns whether or not a study is replicable—if other researchers could perform the same study with the same results (Silverman, 2011). However, actual replications of qualitative studies are often hard to achieve in practice, because they involve unique settings that change over time.
(Seale, 1999). Rather, to satisfy reliability criteria in qualitative research, Moisander and Valtonen (2006) propose that the research and analytic process must be made transparent, as well as the researcher being theoretically transparent (being explicit about the theoretical stance that influences your interpretation of data). Here, theoretical transparency is addressed through the theoretical perspectives presented in chapter 3.

The reliability of a qualitative study can however be enhanced when working with video recordings, because they make it possible to “capture” social interaction in the context in which it occurs. Peräkylä (2004) thus claims that video recordings have an “intrinsic strength” when it comes to reliability. In contrast to traditional ethnographic approaches, which are often based on the accuracy of a researcher’s field notes, video has the opportunity to provide highly detailed representations of the social interaction it is intended to document. Being part of a larger research project also enabled the researchers in the Budding Science and Literacy group to take part in joint viewings, coding workshops, and debates concerning code descriptions and particular events in our data material, thereby enhancing the reliability of our analyses. Moreover, in Article I, the members of the research group jointly developed the coding schemes and all four researchers took part in coding the video data corpus. Determining inter-rater reliability is then a common procedure to assess reliability, which was used to evaluate the coding procedures in Article I. In Article II, the first author carried out the entire video analysis, but the second author coded a sub-set of the video material to test the reliability of the coding scheme that was applied. In both cases, inter-rater reliability was deemed satisfactory with Kappa values of respectively 0.75-0.80 for the coding procedures used in Article I (among the four authors) and 0.81 for the coding procedures in Article II (cf. Banerjee, Capozzoli, McSweeney, & Sinha, 1999). In instances where there were discrepancies, these were subsequently solved collaboratively.

Despite the intrinsic strength of video recordings in reliability matters, there are certain challenges to transparency that are not trivial when reporting on video-based research (Erickson, 2006). The complexities caught on tape will in most cases be lost as they are re-represented in a journal article or report, and must accordingly be represented in other ways. A possible solution could be to avail segments of video for review through electronic journals or digital platforms, but without exposing the identity of the research participants. As I will discuss in the next section, the confidentiality of the research participants has been kept by restricting access to the video material, which makes this a nonviable option. Rather, in line
with Derry and colleagues’ (2010, p. 23) recommendations, I have used “more than one
method of representation when reporting the research” to increase transparency. For example,
transcripts, still pictures, thick descriptions, and various graphics have been used in
combination with quantified measures from the video coding to provide thorough re-
representations of the video data.

4.5.3 Generalizability

According to Schofield (2002), there is broad agreement among qualitative researchers that
generalization in the form of producing universally applicable laws is not a goal for
qualitative research. Rather, generalization in qualitative research is best conceptualized as “a
matter of the ‘fit’ between the situation studied and others to which one might be interested in
applying the concepts and conclusions of that study” (Schofield, 2002, pp. 198-199). This can
be seen in relation to what Kvale and Brinkmann (2009, p. 262) refer to as analytical
generalization, which “involves a reasoned judgment about the extent to which the findings
of one study can be used as a guide to what might occur in another situation. It is based on an
analysis of the similarities and differences of the two situations”. Analytical generalization
thus differs from statistical generalization, where “an inference is made about a population
(or universe) on the basis of empirical data collected about a sample” (Yin, 1994, p. 30).

In the Budding Science and Literacy project, teachers and classrooms were purposively
chosen, as they were part of a local and specific setting that involved the professional
development course. In other words, the empirical data were not randomly sampled and,
accordingly, findings from the study can only be analytically generalized. This implies that
thick descriptions about the situation studied are crucial if such judgments about fit are to be
made (Schofield, 2002). In the extended abstract, I have systematically addressed this issue
by describing the contexts that informs the data on three central levels: the interactional level,
the situational level, and the institutional level (cf. Bishop, 2006). First, the interactional level
refers to the interactions with or conversations about text (the classroom). Second, the
situational level refers to the specific setting (the professional development course). And
third, the institutional level refers to the institutional and cultural factors influencing the data
at the time they were collected (the Norwegian school context). In Article IV, these three
levels of contexts are also applied to consider the archiving and re-contextualizing of video
data for future re-use.
A potential issue related to generalization in this thesis concerns the use of quantitative measures in a qualitative study. According to Maxwell (2010), using numbers to present results in qualitative research can lead to inferences being made (by either the researcher or the reader) about greater generality of the findings than what is actually the case. As previously stated, results from video coding are employed and represented quantitatively in Article I and Article II, but without any intention of generalizing outside the specific context of the Budding Science and Literacy study. Rather, numbers are used to explicate the contexts in which literacy occurs by allowing patterns of classroom activity to emerge from the data (Ødegaard & Klette, 2012) and provide important information on the typicality or atypicality of events in the data material (Erickson, 2012).

4.6 Ethical considerations

Research drawing on video data is confronted with significant ethical challenges that must be carefully managed—before, during and after the data collection process—perhaps more so than with other types of qualitative data.

In Norway, any research involving the recording and storing of video material (or other personally identifiable markers) are required by the Personal Data Act (2000) to be reported to and approved by the Norwegian Social Science Data Services11 prior to data collection. Being the last project member to join the Budding Science and Literacy research group, however, this process was already in progress when I started my PhD. An application was submitted on behalf of the project, where it was applied for secure storage of personally identifiable data until the end of project period (the year 2030), as well as approval of informed consent drafts, which were to be distributed to the research participants. Upon approval, we started the process of informing the six teachers, their students, the students’ parents, and the school principals, in accordance with national guidelines (National Committees for Research Ethics in Norway, 2006). This way, the research participants were informed of the research project, their rights to confidentiality, and that all personally identifiable information would be deleted by the end of the project period. In this phase of the video study, the professional development course acted as a meeting ground between researchers and the participating teachers, where the teachers could ask questions about the

11 http://www.nsd.uib.no/nsd/english/index.html
study and what they would be consenting to, while we were provided with the opportunity to explain our methodological choices. The research participants were then formally asked to participate voluntarily by signing informed consent forms (see Appendix I). In all, there was one student who did not wish to participate in the study. Special arrangements were then made for her by the researchers and her teacher to make sure she was not video-recorded (i.e., adjusting camera angles and changing seating arrangements).

When being video recorded, research participants may also be put in situations where private or sensitive information is shared and recorded inadvertently (C. Heath et al., 2010). Fortunately, our participants did not find themselves in this type of dilemma when being recorded. The participating teachers were however instructed to turn off the microphones they wore during filming to prevent these kinds of situations if they were to arise. The participating students were similarly told to inform their teacher or us if they wanted to take off the head-mounted camera. Additionally, since these were young children, between the ages of 6 and 11, we also gave specific attention to making the children feel at ease with our presence in the classroom and with the video cameras. For example, we visited most of the classrooms in the autumn of 2010 to inform them about our work, to observe the class in a regular science lesson, and in some cases, to conduct shorter video recordings as some of the teachers taught a single lesson from the Seeds/Roots curriculum material. The students were also given the chance to play a little around with and explore the head-mounted cameras together with us when we were not recording. After the data collection period, we visited the participating classrooms to thank the students for participating and to talk about the videos we had recorded in their classroom. For these meetings, we had created short videos with some footage from the recorded lessons that we showed each class, which were the cause of much excitement in the six classrooms. I also attended a parent-teacher conference at one of the schools in the study to describe the research process and give the parents an update on the work we did with the data we collected in their children’s classroom.

Furthermore, it is obvious that video recordings are more sensitive towards maintaining the research participants’ anonymity than audio recordings or transcripts. According to Derry et al. (2010, p. 36), “video data are inherently non-anonymous,” which requires that researchers protect the confidentiality of those recorded in other ways than simply removing identifying information from the data material (e.g., assigning pseudonyms instead of using the informants’ real names). For example, with a video recording, it is possible to mask or blur
the faces of the participants, but not without significantly reducing the quality of the data. One possibility for protecting the participants’ confidentiality, which has been utilized in the Budding Science and Literacy project, is to restrict the access to the data material (Derry et al., 2010).

Accordingly, all video recordings and other data sources from the classrooms have been stored to a secure server that is only accessible to the research group. Restricting access to the data in this way was the first step in protecting the participants’ anonymity. The second step involved finding an appropriate level of anonymization of data and metadata. Metadata coding schemes were developed to include codes for the participating schools, students, and teachers, as well as time, date, and the source of the data material (teacher camera, whole-class camera, head-mounted camera, audio, textual artifacts etc.). All data files were accordingly logged and tagged with these codes to make sure that the names of schools and participants were excluded. As described in Article IV, the ways in which the data were stored and access restricted is particularly relevant for this data corpus, because it has been an objective from the start of the research project to archive data and facilitate for secondary analysis of the data material. However, by restricting access to the research group, secondary researchers must become formally involved in the research project and their access to the data material approved by the Norwegian Social Science Data Service. Through the informed consent forms, the data are also bound by the conditions that were established in the data collection process, which we, the original researchers, were involved in—and secondary analysts need to abide by. Hence, facilitating for re-use of personally identifiable data material, such as video recordings, has important ethical considerations and implications for both the primary and the secondary researchers.
5 Summary of the articles

This chapter provides a summary for each of the four articles that are included in this thesis. Since the articles can be explored in their entirety in Part II of the thesis, these summaries focus on each article’s aim, its main findings, and the key arguments being presented.

5.1 Article I

Challenges and support when teaching science through an integrated inquiry and literacy approach. *International Journal of Science Education*, 36(18), 2997-3020.

This article, written by the four researchers involved in the *Budding Science and Literacy* project, reports on the variation and patterns of multiple learning modalities and science inquiry phases during integrated science-literacy instruction. The main objective of the study is to explore how the interrelationship between multiple learning modalities and science inquiry might challenge and support the teaching and learning of science. From a sociocultural approach to science education, we investigate this by analyzing video data from the six primary school science classrooms that were recruited from the professional development course.

The six teachers were video-recorded during their implementation, and video coding schemes for multiple learning modalities (reading, writing, talking, doing) and science inquiry (preparation, data, discussion, communication) were developed. The coding schemes were based on extensive review of literature on inquiry-based science education in combination with iteratively reviewing examples from the *Budding Science and Literacy* video material. We then coded 33 hours of video material and explored the frequency of occurrence, co-occurrence and sequential patterns of these codes. In addition, we coded for key concepts, which was applied when the teachers explicitly focused on central science concepts.

The findings reveal that oral activity was the most prominent of the learning modalities in all classrooms, often occurring in combination with the other modalities. Reading activities occurred as plenary and paired readings. Writing activities were mainly individual, but plenary writing also occurred, often for modeling purposes. When coded for inquiry, results indicated that the teachers spent a large amount of time in the preparation and data phases of
inquiry, but comparatively less in the discussion and communication phases. Only one of the teachers spent more time in the discussion phase than what was recommended in the teacher guides. Moreover, by combining the codes for learning modalities and science inquiry, we find that reading and writing activities were mainly included in the preparation and data phases. The focus on key science concepts was mostly in the preparation and discussion phase. These findings align with previous studies showing how school science often concerns preparing and doing, with less focus on summing up activities, debating, making inferences, and connecting theory and empirical data (e.g., Furtak & Alonzo, 2010; Newton, Driver, & Osborne, 1999; Ødegaard & Arnesen, 2010). The implications of these findings, however, are that teachers need more support to include activities that help students discuss and communicate their results and ideas. Thus, the findings also suggest that the Budding Science and Literacy teaching model—and professional development in science education—must focus particularly on the consolidating phases of inquiry.

5.2 Article II

Sørvik, Gard Ove, Blikstad-Balas, Marte & Ødegaard, Marianne (2015). "Do books like these have authors?" New roles for text and new demands on students in integrated science-literacy instruction. Science Education, 99(1), 39-69.

This article investigates students’ emerging literacy practices in the six integrated science-literacy classrooms. The study combines observational video data and interview data to examine students’ encounters with and use of text in specific literacy events, along with their views and experiences related to science and science text in this setting. By doing so, we seek to answer calls on how texts are actually used by students in an integrated science-literacy context. The approach to researching literacy in school science classrooms is based on a sociocultural view of literacy, which involves understanding literacy as embedded in the social practices of the different discourse communities of which they are a part (Barton, 2007; Gee, 2008).

First, we identify 335 literacy events through video coding of approximately 30 hours of video data from the six classrooms in the Budding Science and Literacy study. In total, the duration of these literacy events constituted 53,5 % of the total video recordings; with the students’ own writing (31,0%) and informational texts (11,9%) being the most dominant text
types that these events were structured around. The most frequently occurring category of literacy events, however, was based on orienting texts (n=132, 2.9%), such as instructions written on blackboards or whiteboards or the teacher pointing to a specific concept on the concept wall. Most of these events lasted for less than a minute and mainly acted as guidance for the students, which help explain the high frequency and the limited amount of time spent on these types of texts. Second, analytic induction (Erickson, 2012) of the coded literacy events revealed how multiple literacies emerged in the six classrooms, which attended to markedly different purposes. On the one hand, students engaged in literacy practices that were typically “schooled”, in the traditional sense, such as reading a definition from a concept wall or writing to document a task. On the other hand, students also incorporated informal elements from their everyday literacy practices as valuable resources in the dialogic process of inquiry. In the article, we refer to the former as school-science-only literacies, and the latter as science-in-school literacies. Whereas the school-science-only category, in most cases, acted as learning structures or typical classroom routines, science-in-school literacies were embedded in the students’ inquiry process, which helped situate literacy in contexts that appeared to be meaningful and engaging to the students. Third, we analyzed focus group interviews with 33 students to uncover some of the students’ own experiences and views of the integrated science-literacy instruction. Our data indicate that the implemented instruction created new literacy demands on the students that were not always clear to them. Hence, we argue that paying explicit attention to how science texts have both a sender and a receiver, and that they are written for a purpose, is of central importance to situating literacy in the context of school science.

Overall, this study indicates that purposefully embedding literacy in a science inquiry context allows students to go beyond the transmissive reading and writing activities that are common in school science. This requires that we build on students’ vernacular or everyday literacy practices, identify what “counts” as literacy in the science classroom, and provide explicit attention to the representational and communicative aspects of science and school science, of which the genres and social languages of science and school science work to fulfill.

5.3 Article III
In this article, we introduce what a social view of literacy means for science education. Traditionally, texts have been of little concern to most science teachers and educators (Hand et al., 2003; Norris & Phillips, 2003; Pearson et al., 2010; Wellington & Osborne, 2001), which is contrary to the view that students will need to become critical consumers of writing in and about science to actively participate and make informed decisions in a democratic society (Osborne, 2007). Hence, we build on sociocultural studies of literacy to show how a social view of literacy informs our understanding of literacy when the context is school science. We then draw on research related to the role of text in science education to outline what a social view of literacy implies for teachers’ educational practice. The latter section is structured according to four main propositions for promoting literacy in science classrooms in accordance with a social view of literacy.

In the first part of the article, we use sociocultural perspectives to argue that literacy in school science is best understood as social practices embedded in cultural and ideological contexts. In this view, literacy becomes something people do in their everyday life, a social activity, which necessarily also involves people’s values, talk, social relationships, attitudes and beliefs regarding text (Barton & Hamilton, 1998). Thus, a social view of literacy highlights how reading and writing are situated in particular situations at particular times for particular purposes, whether in or outside the school science classroom. Accordingly, this view of literacy can provide a suitable framework for considering how texts with scientific information function and are used across contexts that are relevant to science education. The most notable of these, we argue, include the daily lives of students and citizens, the school science classroom, and communities of practicing scientists.

In the second part, we rely on the perspectives presented in the first part to present four propositions that we suggest are key to promoting literacy in science classrooms in accordance with a social view of literacy; namely that: i) science texts are written for particular purposes and audiences, ii) school science literacy builds on students’ informal literacy practices, iii) science reading and writing activities in school differ in their “authenticity”, and iv) school science literacy is embedded in explicit instruction. These four propositions, which rely on research on the role of text in science education, are meant to
illustrate what adopting a social view of literacy implies for science teachers and science educators in practice.

Finally, we discuss how a social view of literacy provides science education with the theoretical perspectives to examine the role of literacy in a transcending science subject (cf. Wickman et al., 2012). However, seeing literacy as a social practice also implies that there will always be multiple school science literacies—the sociocultural ways in which literacy occurs in science learning environments—related to different conceptualizations of science education and scientific literacy. Accordingly, we suggest that adopting a social view of literacy does not present us with a set of pre-determined literacy practices to promote in science classrooms, but with a means to reflect on how and why scientific information is used in various societal contexts that are important to our vision of scientific literacy.

5.4 Article IV

The fourth article draws on two illustrative case studies of video-based research in the educational sciences to make an argument for establishing more common practices when conducting classroom video studies. The aim of the article is to use these two cases to document the processes of 1) collecting and archiving video data in the *Budding Science and Literacy* research project and 2) performing secondary analysis on archived video data from the *PISA+* project.

A main characteristic of video data is that they have the potential to capture complex social phenomena that are open to a number of analytical and theoretical perspectives, even by secondary researchers not originally involved in the original data collection (Derry et al., 2010). Re-using archived qualitative data, however, has been heavily debated over the decade. This debate has largely revolved around contextual and ethical issues concerning re-use, but little has been presented on actual researchers re-using archived data, or on the re-use of video data in particular. However, video data provide both new opportunities and new challenges as
opposed to other types of qualitative data. Thus, the two illustrative case studies illustrate how these issues have been addressed from the perspective of the archivists and from the perspective of the secondary analyst. We show that addressing the methodological issues of re-use is not a matter that only concerns the secondary researchers; it necessarily involves the primary researchers as well. This implies that both primary and secondary video researchers should engage in developing more standardized ways of generating and archiving video data in classroom studies if we are to move toward the long-term goal of programmatic research in the field.

Based on these two cases, we argue that establishing more common practices for designing and conducting classroom video studies—a common thread in the *Budding Science and Literacy* and *PISA+*—provides an important ground for researchers in this line of research to fully benefit from the opportunities that new media avails, which may in turn contribute to more cumulative research from the classroom. For the video research communities, this could involve establishing ethical guidelines for re-use and sharing, standardized tools and procedures for generating data, agreed-upon analytical tools, and procedures for logging and archiving video data.
6 Discussion

The overarching aim of this thesis was to explore the literacies of school science in the context of integrated science-literacy instruction. The empirical studies included in this thesis shed light on this aim from two different perspectives. The first article (Article I) maps the time spent on different learning modalities and science inquiry phases in the six participating classrooms. The second article (Article II) explores the emerging literacy practices that students engage in from a sociocultural perspective on literacy. Both studies rely mainly on video data to answer the articles’ respective research questions, but Article II also draws on interview data with students (n=33) and textual artifacts from the classrooms. The third article (Article III) builds on these and other studies to introduce what adopting a social view of literacy means for science teachers’ educational practice. The last article in this thesis (Article IV) discusses the potential re-use of classroom video data and will serve as a point of departure in section 6.6, where some future directions for research in science education and video-based classroom research will be suggested.

6.1 School science literacies in integrated science-literacy instruction

The two empirical articles included in this thesis (Articles I and II) demonstrate how literacy is interwoven in the daily activities and inquiries of the six participating classrooms. What is common across the classrooms in this study is an emphasis on the beginning phases of students’ inquiry and the presence of multiple literacies that attend to markedly different purposes in the classroom. In this section, I will elaborate on these two aspects from the empirical studies to discuss how literacy is embedded in the six classrooms in the Budding Science and Literacy study.

The first article provides an overview of the six Budding Science and Literacy classrooms. More specifically, it explores how different learning modalities (reading, writing, talking, doing) and science inquiry phases (preparation, data, discussion, communication) occur and co-occur in the six participating classrooms. For coding purposes, however, this study does not attempt to show how texts are used beyond plenary, individual or group “reading” or “writing”. In other words, the codes do not allow us to consider if the students talk about a specific text in the discussion phase or if they use a figure or a poster when they orally communicate their findings (unless they are actively reading from that poster). Rather, this
study reveals specific patterns in the students’ inquiries, which provided a starting point for identifying challenges that teachers face when implementing science-literacy instruction. This was also one of the study’s main findings; namely, that four of the six teachers considerably downplayed discussion activities in lieu of preparation and data activities (see Article I, figure 1). Reading and writing activities were also more dominant in the preparation and data phases. Thus, the teachers emphasized particular aspects of inquiry, and thereby also the particular ways in which literacy was embedded in these classrooms. For example, in Birgit’s classroom, considerably more time was spent on discussing and communicating the students’ results than in the other five classrooms (see Article I, figure 2).

Similarly, other studies have shown that inquiry-based science teaching depends on teachers’ own preferences and ideas about scientific inquiry (Windschitl, 2004), but also that the role of literacy in integrated science-literacy instruction differs, even with teachers whom hold seemingly similar views about inquiry (Howes et al., 2009). In our study, the teachers were afforded detailed teacher guides, but there were still significant differences when the teacher guides were compared with the actual implementation. Findings like these emphasize the importance of reflecting on how certain literacy practices, or social practices in general, necessarily become more strongly encouraged in the classroom than others. In the article, we point to the possibility that the teachers in our study found it particularly challenging to engage their students in the consolidating phases of inquiry (discussion and communication) or that they perceived scientific inquiry as more about scientific procedures than about developing scientific explanations.

Article II attempts to further explore the literacies of the six participating classrooms by investigating how students in this context actually *use* text. Thus, this study goes beyond codes such as “reading” and “writing”. Instead, literacy events were identified whenever the interaction in the classroom revolved around text. These events were then subjected to qualitative analysis in search of emerging patterns and themes. The inherent differences in the two coding approaches can be illustrated when the systematic coding results are compared. Even though two lessons were removed from the data material analyzed in Article II, the duration of coded literacy events from Article II exceed the results for coded reading and writing in Article I. In this way, the two articles can act complimentary to each other, because the first study explicates the interactional context in which reading and writing is embedded in these six classrooms in a different way than the second one.
In Article II, a central distinction that emerged across the six classrooms concerned literacies that were restricted or confined to the context of school science and literacies that transcended the mere context of school science. In the article, we refer to the former category as “school-science-only” and the latter category as “science-in-school”. These two categories distinguished themselves in the participating classrooms, from a sociocultural perspective on literacy, because of the markedly different contexts they related to. Whereas the school-science-only category included literacy practices that were distinctly “schooled” (like students reading a definition from a concept wall or documenting a completed task), the science-in-school category included literacy practices that incorporated students’ everyday ways with words (e.g., adding vivid colors and speech balloons to figures and diagrams or using popular culture texts as prior knowledge) in the dialogic process of school science inquiry. However, many of the “schooled” literacy events, which were based around the use of templates, instructional tasks written on blackboards and whiteboards, and concept walls, helped organize and structure the students’ activities. In their research, Knain, Bjønness and Kolstø (2011) refer to similar practices as support structures, which were important to advance and focus the students in their inquiries. In this sense, school-science-only literacies are also valuable in a school context, but they seem more likely to be meaningful to students in combination with other literacies that are relevant to contexts beyond the classroom.

Taken together, this thesis emphasizes how school science literacies are embedded in the social practices associated with school science. This is elaborated in Article III, in which we argue that a social view of literacy enables science educators to consider contexts that are particularly relevant to our vision of scientific literacy. From a social view of literacy, it also becomes apparent that the literacies of school science rarely transcend the context of school science, but are too often embedded in a transmissive pedagogy (Lyons, 2006). In this mode of science teaching, school science literacies are reduced to practices concerning copying scientific information from expert sources (e.g., Danielsson, 2010) or answering textbook questions (e.g., Driscoll et al., 1994). In contrast, the findings presented in this thesis illustrate how multiple literacies can emerge in an inquiry-based context in primary school science classrooms, which relate to contexts that are relevant and purposeful to students as participants in a school setting and in their daily lives.
6.2 Students’ informal literacies as valuable resources for inquiry

"Can’t we just get a picture? It’s so much easier.”
- John Olav, 3rd grade

Researchers that approach literacy from a sociocultural perspective tend to emphasize the differences between literacy in- and out-of-school, mainly because institutions like school have a greater influence on how literacy is generally perceived (Maybin, 2007). In Section 3.1, I described how these kinds of literacies are normally considered as dominant, formal, and academic. On the other hand, informal, everyday, and free-of-choice literacies are often less valued. However, Maybin (2007) cautions that a strict dichotomy easily conflates vernacular or informal literacies with out-of-school literacies. As I have discussed in the previous section, Article II reports a complex relationship of formal literacies and informal literacies in the participating classrooms, which further complicates such a dichotomy.

This was particularly evident in how the students relied on a number of informal or everyday literacy practices in the formal context of school science inquiry. The quote at the start of this section is a good example of how this occurred in one of the classrooms. In that particular event, John Olav suggested several times that the class should use Google Images to settle a dispute on whether or not a humming bird had four or two limbs (the students could not observe this from the video they had watched). Thus, it is John Olav who suggests using a text that is not necessarily valued in their classroom (i.e., Google Images). Eventually the teacher agreed and the class found evidence of humming birds having four limbs from observing pictures online. After this event, using Google Images as a source of data became a valued practice in this particular classroom, which was promoted by the teacher. For example, the class subsequently used Google Images to compare the tails of wolves and foxes. It is particularly interesting that it was a student who initiated the event, but that the teacher assigned value to it in the classroom by picking it up and promoting it later on. Similarly, students’ informal literacies became valuable resources as they grappled with a new topic or discussed findings and ideas in the other classrooms. For example, students in Anna’s classroom relied on movies and superheroes to make a mind-map for the concept of force, while students in Birgit’s class referenced a Donald Duck comic book to discuss the function of a turning wheel. In most of the classrooms, the students also included vivid colors, speech
balloons, and representations of themselves (“And, that’s me!”) in diagrams, figures, and posters.

Even though the presence of texts from the students’ everyday lives and popular culture represents small amounts of time in the data material—and especially in comparison to longer and more prevalent events promoted by the teacher (i.e., reading informational texts or writing a comparative text)—these literacy events were important because the students were allowed to bear on their own references and backgrounds to advance their inquiries. Moje and colleagues (2004) use Bhabha’s notion of “third space” to describe similar hybrid literacies, wherein both everyday and specialized academic language and texts are negotiated to develop new understandings. They especially highlight popular culture texts, because the students in their study relied on these texts as much as they did their own observations for making sense of scientific ideas and concepts. In a recent study, Mestad and Kolstø (2014) provide an interesting example of the importance of making connections between everyday and scientific language in the third space. In their study, the teachers started out by emphasizing theoretical knowledge and language to support the students in correctly interpreting their observations and applying theory during practical activities. According to Mestad and Kolstø (2014, p. 1065), however, “the students felt that the teacher expected them to speak the correct scientific language before they had developed the prerequisite understanding and language competence. Consequently, the students chose not to express their current understanding in their own words”. On the other hand, when the teachers explicitly informed the students that they should use their own language, the students attempted to formulate their own emerging understanding that could later be used in a classroom discussion. This body of research (see also S. B. Heath, 1983; Olander & Ingerman, 2011; Varelas & Pappas, 2006) clearly demonstrates the importance of allowing students to build on their informal or everyday ways with oral and written language when moving towards the social language of science. The findings in Article II indicate that paying attention to these aspects might help situate school science literacy in inquiry-based contexts that are meaningful to students and provide them with a sense of ownership over the own science learning experiences.
6.3 What demands do integrated science-literacy instruction place on students and teachers when it comes to literacy?

Central to this thesis is a focus on how teachers and students can be supported in doing more meaningful reading and writing activities in school science. What are the challenges? Where is there a need for more support? For many of the students in this study, data from the focus group interviews indicated that the implemented instruction was accompanied by new literacy demands that were not always clear to them. In Ellinor and Ella’s classrooms, for example, the students were asked to write a log after experimenting with various ingredients to make glue. However, the students did not appear to grasp the purpose or conventions for writing a scientific log, and much confusion arose as they started writing. In fact, most of the students started to copy what they had read in a science trade book in the first lesson. The students’ confusion’ became even clearer in the subsequent focus-group interviews, in which they mentioned the logs to our question about using their imagination in science. This is contrary to the purpose that scientific log writing usually fulfills, namely providing a factual presentation of a certain procedure:

“Yeah, when we . . . when we had to write logs. I at least used a lot of imagination.”

- Henrik, 3rd grade

A valuable concept to further discuss how the implemented instruction created different or new demands in this context is the notion of didactical contract (Brousseau, 1997). Originally developed to describe interaction in mathematics classrooms, a didactical contract refers to the often unspoken and implicit agreement between teacher and students of how particular learning situations are carried out in the classroom, where each participant has her/his expectations and obligations associated with that situation. Thus, Brousseau and Warfield (2014, p. 1) define the term, in the broad sense, as “an interpretation of the set of these expectations and obligations, be they compatible, explicit, and agreed to or not”. In light of the present study’s findings, it raises the question of what was expected behavior for teaching and learning science in these particular classrooms. As it appears to me, many of the students had expectations of more traditional science teaching, which did not require them to reflect on many of the issues concerning science texts that were raised during the implementation. Thus, in instances when the teachers did not explicitly address these aspects, a new contract would have to be negotiated implicitly between teacher and students. This could very likely be the
case with the aforementioned students’ confusion about writing scientific logs. When neither Emma nor Ellinor explicitly addressed how and why to write a scientific log to begin with, the students in these two classes had to decide what to do based on prior expectations and practices. Another example was found in Cecilia’s class, where Cecilia asked her students to discuss why the author of a science trade book had used images and captions in the book. In this case, however, the mismatch between Cecilia’s expectations and at least one of the students became clear when Eivind expressed how he had clearly not even thought about these types of text (i.e., school science texts) in terms of having an author (“Do books like these have authors?”). A possible alternative could perhaps have been to acknowledge Eivind’s question as a common misunderstanding about textbooks, talk with the class about who they think the senders and receivers of school textbooks are, and discuss what a science textbook is, thereby establishing a new and compatible expectations for talking about science texts in class.

In contrast, the use of Google Images in Cecilia’s class is an example when Cecilia explicitly addressed how they had started to use the search engine to collect data on the characteristics of several animals after John Olav initially suggested it. It could thus be said that the students and Cecilia eventually came to agree on a new didactical contract, in which using Google Images was considered a valued practice in the classroom to collect data of this kind.

As mentioned in Section 6.1, a specific challenge the teachers faced when implementing integrated science-literacy instruction was identified in Article I. The video analysis of learning modalities and inquiry phases showed that most of the teachers spent a lot of time on preparation and data, but comparably less on discussion and communication. This was also the case for reading and writing activities. In line with the study by Howes et al. (2009), findings such as these point to the fact that teacher knowledge about literacy teaching in science is key to supporting students in engaging with science texts in more authentic ways. Pearson, Moje and Greenleaf (2010, p. 462) point especially to the need to move beyond what Street (1984) calls an autonomous model of literacy, which has traditionally been prevalent in many science classrooms (Norris & Phillips, 2003):

Many science teachers hold misconceptions, or at the very least, limited conceptions, of literacy teaching and learning; they tend to think of reading and writing as basic and universal skills that are developed in elementary or middle school or down the hall in the English
department. They do not expect to teach science reading and writing to students, yet they are confronted with students who do not comprehend science texts, their specialized language, or the many ways science ideas are conveyed through print, diagrams, images, models, graphs, and tables.

Hopefully, the framework presented in Article III might provide a first step for many science teachers and educators to consider how a social view of literacy (what Street calls an ideological model) influences how we think about language and literacy in an educational context. This shift in focus seems particularly important when the evaluations of the current Norwegian national curriculum indicate that the introduction of basic skills in all subjects has not led to notable changes in the classroom (Ottesen & Møller, 2010). Similar to the review by Pearson et al. (2010), the Norwegian evaluations show that it is reading that has received the most attention of the basic skills in primary school, but largely in language arts lessons (Hertzberg, 2010). These studies add to the conclusion that literacy should be a prioritized aspect when teaching about inquiry-based science and scientific practices in science teacher education programs and in the professional development of science teachers if we are to take the demands of becoming scientifically literate in today’s society seriously.

6.4 Limitations of the present study

Before this extended abstract draws to an end, there is a need to make clear some of the limitations of the study. First, the research is based upon a small sample of six primary school science classrooms in the greater Oslo area, with teachers who attended a particular professional development course on integrated science-literacy instruction. Thus, the findings should not be generalized beyond analytical generalization (see Section 4.5.3). Rather, the studies’ findings serve to illustrate how reading and writing can function in the context of school science inquiry in primary school, and provide grounds for comparison in similar situations and contexts. Furthermore, because the thesis’s empirical findings are concerned with literacies in primary school science classrooms, many of the documented ways in which literacy was used in these classrooms was also embedded in social practices that we often associate with primary school. For example, we found mostly plenary and paired reading (Article I), few instances of Internet use or multiple information sources (Article II), and no writing of individual lab reports. At secondary school levels, however, recent studies of science classrooms have documented a wider use of learning resources and texts (both digital
and analogue) than what have traditionally been the case (Furberg, Dolonen, Engeness, & Jessen, 2014), as well as the use of multiple texts and informational sources, in combination with the textbook, when dealing with complex socio-scientific issues (Knain, Byhring, & Nordby, 2014). The lab report is also a central practice at higher grade-levels than those explored in this study (Af Geijerstam, 2006; Knain, 2005b).

In retrospect, I would also have liked to go further into detail around specific texts and specific literacy events during the focus group interviews with the students. Failing to have done so has to do with the fact that the research focus has changed over time along with repeated viewings and analyses of the video data. According to Erickson (2012), this is often a necessary step in a working qualitative analysis if we are to find out something we could not have known prior to our research process. A different solution might have been to perform video-stimulated interviews with the students wearing the head-mounted cameras, but because of the students’ young age, it was decided to prioritize group interviews, in which they would most likely be more at ease, and to perform these interviews immediately after the implemented instruction. Because the student interviews also had to reflect the objectives of the overarching research project, it would have been difficult to decide which video segments were the most relevant to use in interviews. In a smaller study, however, this would be particularly interesting in order to gain even more information about the students’ personal decisions and beliefs about science and science texts and how these relate to specific literacy events.

6.5 Future directions

With some of the limitations of the present study outlined in the previous section, we are able to turn to the implications that this study might offer for future research on school science literacy and for educational practice.

In Article IV, it is argued that more common practices for conducting classroom video studies will help contribute to more cumulative research in the field of educational research. In light of the present study, the theoretical perspectives taken imply that literacy must be studied in the context in which it occurs. Thus, classroom video studies across various school science contexts (e.g., grade-levels, local contexts, interventions etc.) will be valuable to further understand how literacy influences and is influenced by various science teaching and learning
contexts. A common practice along this line of research might center on the use of multiple video cameras, including head-mounted video cameras, and systematic coding of video data to help determine how the different contexts can be analytically compared. In turn, with the use of multiple video data sources and rigorous contextual data, other researchers might investigate the same data material with new aims and from different theoretical perspectives—if the ethical challenges associated with re-use of personally sensitive data, such as video recordings, are properly dealt with by both the primary and the secondary researchers.

Moreover, in a time when new media and Web 2.0 are constantly altering the ways in which we use language and information (Barton & Lee, 2013), it seems particularly important to explore how digital media and online environments influence school science practices. For example, people interact and share information in new ways through blogs, video sharing platforms, social media etc., you can comment and make changes to texts instead of just reading, and intertextuality, multimodality, and interactivity have become central characteristics. This line of inquiry could include research into actual uses of scientific information in society at large, as well as within the classroom, for instance with regards to how online communication and texts influence our engagement with science and complex socio-scientific issues on a daily basis. In a transcending science subject for scientific literacy (Wickman et al., 2012), this will be an important aspect to address for researchers if science education is to prepare students for making informed decisions in their own lives. In this regard, literacy studies can provide an interesting path for researching how such science-related literacies emerge across social and cultural contexts in everyday life. In turn, such studies might help science educators to further promote and acknowledge new literacy practices in the science classroom that are becoming increasingly important to students outside the classroom.

Finally, it feels appropriate to end this thesis with a focus on what the research presented here might imply for educational practice in school science, because this has been an important issue to me personally throughout the period spent working on this project. First of all, this thesis emphasizes a view of literacy as situated social practices, not as a set of universal skills that can be applied independent of the context in which they are situated (i.e., the ability to read and write), which has long been the prevalent view among science teachers and educators (Norris & Phillips, 2003; Pearson et al., 2010; see also Section 6.3). In a social view
of literacy, reading and writing cannot be seen as additional elements to inquiry-based science education (or to scientific inquiry), but must be regarded as constitutive of its practice (Gee, 2004; Osborne, 2002). Not only does this challenge how reading and writing in school science are often reduced to copying scientific information (e.g., Lyons, 2006; Osborne & Collins, 2001), it also questions why experimentation tends to be taught in isolation from the specialized ways of reading, writing, and talking science in many inquiry-based approaches to science education (National Research Council, 2012). In this sense, the findings of the empirical studies provide science teachers with illustrative examples of how literacy is interwoven in the practices of six specific inquiry-based science classrooms, and how multiple school science literacies can emerge when teachers explicitly emphasize disciplinary literacy practices during inquiry-based science instruction at primary school levels. Furthermore, the third article attempts to develop a framework for science educators and teachers to consider how science reading and writing in school can relate to relevant contexts beyond the context of formal schooling from a sociocultural perspective on literacy. Hopefully, this thesis will help shed light on how literacy is inextricably linked to the social practices of science classrooms, and provide science teachers with some tools and examples to support their students in reading and writing more and more meaningful texts in contexts that are meaningful and relevant to their science education and to their daily lives.
7 References


Bateson, Gregory, & Mead, Margaret. (1976). "For God's Sake, Margaret": Conversations with Margaret Mead and Gregory Bateson. CoEvolution Quarterly, 10(21), 32-44.


Erickson, Frederick. (2012). Qualitative research methods for science education. In B. J. Fraser, K. Tobin & C. J. McRobbie (Eds.), *Second International Handbook of Science Education* (pp. 1451-1469). Dordrecht: Springer.


Hertzberg, Frøydis. (2010). Arbeid med grunnleggende ferdigheter [Working with basic skills]. In E. Ottesen & J. Møller (Eds.), *Undervis, men i svært ulikt tempo. Et blikk inn i ti skoler etter tre år med Kunnskapsløftet*. [On the way, but at different speeds. A glimpse into ten schools after three years with the Knowledge Promotion reform.] (pp. 77-89). Oslo: NIFU STEP.


Knain, Erik. (2005a). Definering og valg av kompetanser - DeSeCo [Definition and Selection of Competencies - DeSeCo]. *Norsk pedagogisk tidsskrift, 89*(01), 45-53.


Knain, Erik, & Kolstø, Stein Dankert (Eds.). (2011). *Elever som forsøker i naturfag [Students as scientists]*. Oslo: Universitetsforlaget.


Varelas, Maria, Pappas, Christine C., & Rife, Amy. (2004). Dialogic inquiry in an urban 2nd grade classroom: How intertextuality shapes and is shaped by social interactions and conceptual understandings. Establishing scientific classroom discourse communities: Multiple voices of research on teaching and learning, 139-168.


Ødegaard, MARIANNE. (2010). Forskerføtter og leserøtter—sentrale didaktiske prinsipper ["Budding Science and Literacy" – central educational principles]. In M. Ødegaard & M. Frøyland (Eds.), Utforskkende naturfag inne og ute [Inquiry-based science in and outside of the classroom] (pp. 4-12). Oslo: Norwegian Centre for Science Education.


Appendices

Appendix I: Informed consent forms for teachers and students, and letter of information for school principal

Appendix II: Interview guide for focus group interviews with students in the Budding Science and Literacy project

Appendix III: Coding scheme for the Budding Science and Literacy project
Appendix I: Informed consent forms for teachers and students, and letter of information for school principal [translated by the Budding Science and Literacy research group].
To teacher at XXXX school

Oslo, XXXX 2010

The research project «Budding science and literacy»

Budding science and literacy is a project that aims to develop a teaching program that integrates inquiry-based science and literacy and facilitates teaching and learning for Norwegian teachers and students. The research project is carried out by the Norwegian Centre for Science Education, University of Oslo, and is funded by the Norwegian Research Council. We are pleased that you have volunteered to contribute in the project.

In the project, researchers and teachers will collaborate to develop and improve science teaching and learning. This involves following you and students when planning, doing, and discussing science activities. We will video- and audiotape the lessons, and researchers will be present during instruction. Furthermore, there might be video recorded interviews with you and some of the students after the lessons. This study follows various teachers and students over time, and the data material might be used in later studies. Only researchers who are connected to the project and familiar with this agreement have access to the material. The researchers’ presence in the classroom will take place as agreed with you. We will visit the school several times throughout the school year. Scheduled time for data collection for this project is fall 2010-spring 2012.

Registration, storing and reporting of data will be according to the guidelines of the law of personal information storage. The collected information will be treated confidentially, and only by persons employed at this project. The results from this investigation will be presented in a way that makes it impossible to trace the information back to the participating students, teachers, class or school. Some video recordings may be presented at research conferences and for educational purposes, in those cases; participants will be asked for additional consent. Recordings will never be available on the Internet. The project is registered in the Data Protection Official for Research, Norwegian Social Science Data Services (NSD).

Participation is voluntarily, and it is possible to withdraw at any time without having to provide an explanation. If someone withdraws, information regarding this person will be anonymized as soon as possible. The recordings will be deleted and all information will be made anonymous by the end of the project in December 2030.

We ask for your consent to collect audio- and video recordings and to perform interviews. Agreement of participation requires that you sign this letter.

Best regards

Anders Isnes  Marianne Ødegaard  Sonja Mork
Leader  Project leader  Associate professor

☐ I give my approval to take part in the research project. I am aware that this involves being audio- and videotaped.

Date, place  Teacher’s name and signature
To students at XXXX school

Invitation to participate in the research project «Budding science and literacy»

Budding science and literacy is a project that aims to develop teaching materials in science in which practical activities is combined with reading, writing and oral competencies. The research project is carried out by the Norwegian Centre for Science Education, University of Oslo, and is funded by the Norwegian Research Council. We have invited teachers at your school to contribute and help us increase our knowledge on successful teaching and learning in science subjects.

In the project, researchers and teachers will collaborate to develop and improve science teaching and learning. This involves following teachers and students when planning, doing, and discussing science activities. We will video- and audiotape the lessons, and researchers will be present during instruction. There will also be video recorded interviews with teachers and students after the lessons. This study follows various teachers and students over time, and the data material might be used in later studies. Only researchers who are connected to the project and familiar with this agreement have access to the material. The researchers’ presence in the classroom will take place in agreement with the teacher. We will visit the school several times throughout the school year.

Registration, storing and reporting of data follow the guidelines of the law of personal information storage. The collected information will be treated confidentially, and only by persons employed at this project. The results from this investigation will be presented in a way that makes it impossible to trace the information back to the persons that participate in the research. Some video recordings may be presented at research conferences and for educational purposes, in those cases; participants will be asked for additional consent. Recordings will never be available on the Internet. The project is registered in the Data Protection Official for Research, Norwegian Social Science Data Services (NSD).

Participation is voluntarily, and it is possible to withdraw at any time without having to provide an explanation. If someone withdraws, information regarding this person will be anonymized as soon as possible. The recordings will be deleted and all information will be made anonymous by the end of the project in December 2030.

We ask for your consent to collect audio- and video recordings and to perform interviews. Agreement of participation requires that both the student and a parent/caretaker sign this letter.

Best regards

Anders Isnes             Marianne Ødegaard             Sonja Mork
Leader                   Project leader              Associate professor

☐  I give my approval to take part in the research project. I am aware that this involves being audio- and videotaped.

________________________________________________________________________

Student name and signature             Parent/caretaker signature

________________________________________________________________________
To the principal at XXXX school

The research project «Budding science and literacy»

Budding science and literacy is a project that aims to develop a teaching program that integrates inquiry-based science and literacy and facilitates teaching and learning for Norwegian teachers and students. The research project is carried out by the Norwegian Centre for Science Education, University of Oslo, and is funded by the Norwegian Research Council. We have been introduced to the specific teachers at your school through the professional development course “Integrating science and literacy” provided by the Norwegian Centre for Science Education/University of Oslo, we have been introduced We are pleased that the teachers have volunteered to contribute in the project.

The research project is part of a longitudinal study over 7 years and involves measures towards teachers and students in science education. The project is funded by the Norwegian Research Council’s «Programme for Norwegian Educational Research towards 2020».

The project can be described as an intervention study in which researchers and teachers collaborate to develop and improve science teaching and learning. We consider the professional development course as the intervention. This involves following the teacher and students when planning, doing, and discussing inquiry-based science activities. As part of this work, we will video- and audiotape the lessons, and researchers will be present during instruction. Furthermore, there might be video recorded interviews with the teacher and some of the students after the lessons.

Our presence in the classroom will take place in agreement with the teacher. It is preferable to visit the school several times throughout the school year. Scheduled time for data collection for this project is fall 2010-spring 2012.

Registration, storing and reporting of data will be according to the guidelines of the law of personal information storage. The collected information will be treated confidentially, and only by persons employed at this project. The results from this investigation will be presented in a way that makes it impossible to trace the information back to the participating students, teachers, class or school. Some video recordings may be presented at research conferences and for educational purposes, in those cases; participants will be asked for additional consent. Recordings will never be available on the Internet. The project is registered in the Data Protection Official for Research, Norwegian Social Science Data Services (NSD).

We want to emphasize that the quality of the study depends on teacher and students allowing researchers access to the classroom activities. Our intention is that the teachers, students and school will find this collaboration interesting, informative and useful for further development.

Best regards

Anders Isnes
Leader
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Internett: www.naturfagsenteret.no
Appendix II: Interview guide for focus group interviews with students in the Budding Science and Literacy project [my translation].
Interview guide for focus group interviews with students in the Budding Science and Literacy project

Introduction:
Now we’re going to talk about the science lesson(s) you have just had (provide additional information if needed). We are curious to know what you think about the lesson. There are no right or wrong answers when we talk and we will not talk to your teacher about what each of you say here.

Introductory question related to a specific artifact from the lesson:

1. This (hold up text or practical equipment) is a (name of artifact) from your science lesson. We wonder how you experienced this lesson. Could each of you tell us a bit or show us about what you did? (Provide additional information about the lesson if the students have a hard time remembering.)

Probing questions 1 (Learning):

2. What is this (hold up artifact)?
3. Why do you think that you used this in class today?
4. What did you learn from doing that?
5. Is this something you like to do?
6. When do you feel like you’re learning the most in science?
7. What does it really mean to learn?
8. Did you explore anything today?
9. How does the work you do at school resemble what scientists do?

(Provide examples or specifics related to the topic at hand if needed. The interviewer must have acquired insights into the different ways to understand the subject matter that was taught in the lessons)

Probing questions 2 (Concepts and argumentation):

10. Did you learn any new words today?
11. What words did you learn?
12. What do they mean?
13. What made you understand those words?
14. Do you think that there are many difficult words in science? (e.g., observation or conclusion).
15. Do you talk a lot in your science lessons?
16. How do you agree on something when you talk in groups?

(If the students have not mentioned specific key concepts from the lesson related to inquiry and argumentation, ask the students about them at this point)

17. We have a concept chart for that word here (i.e., a key concept from the lesson). Could you fill it out together? (Ask the students to think aloud while filling out the chart)

Probing questions 3 (Literacy):

18. We’re also curious to know what you think about the texts you read today? They are brand new in Norway, and few students have read them. (Present a copy of a Seeds/Roots trade book if the students used them.)
19. Why do you think that you read this text in class today?
20. Is there any connection between this text and the other things you did in the lesson?
21. How did you like to read these texts?
22. Are there any differences between these texts and your regular science textbook?
23. Do you read science texts in the same ways that you read other types of text? If not, what is different?

Probing questions 4 (Imagination and creativity):

24. Did you use your imagination in class today? (If no, ask about a specific episode.)
25. What did you use it for?
26. How do you use your imagination to learn science?
Appendix III: Coding scheme for the Budding Science and Literacy project
BUDDING
SCIENCE AND
LITERACY

A CLASSROOM STUDY ON INQUIRY-BASED SCIENCE AND LITERACY

Categories for video analysis of science lessons

by Marianne Ødegaard, Sonja M. Mork, Berit Haug & Gard Ove Sørvik.

Oslo, 2012.
1 Coding Scheme: Activity Type

Activity Type

- Oral activities
  - Plenary
  - Group or pair talk
  - Student presentation
  - Inner speech

- Reading activities
  - Reading aloud
  - Group reading
  - Paired reading
  - Individual reading

- Writing activities
  - Shared writing
  - Group writing
  - Individual writing
  - Drawing

- Practical activities
  - Whole-class doing
  - Group or pair doing
  - Individual doing

BUDDING SCIENCE AND LITERACY
Do it! Talk it! Read it! Write it!
### Table 1. Activity Type Coding Scheme - Budding Science and Literacy

<table>
<thead>
<tr>
<th>Oral activities</th>
<th>Description of code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plenary</td>
<td>Teacher-led whole-class talk</td>
</tr>
<tr>
<td>Group or pair talk</td>
<td>Students are asked to talk in groups or in pairs about something subject-specific.</td>
</tr>
<tr>
<td>Student presentation</td>
<td>Students present their own work.</td>
</tr>
<tr>
<td>Inner speech</td>
<td>Teacher asks students to reflect on something or think about something.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reading activities</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading aloud</td>
<td>Reading aloud in classroom by teacher or student, or choral reading.</td>
</tr>
<tr>
<td>Group reading</td>
<td>Students read in groups.</td>
</tr>
<tr>
<td>Paired reading</td>
<td>Students read in pairs, for example by reading every other line aloud to each other.</td>
</tr>
<tr>
<td>Individual reading</td>
<td>Students read silently.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Writing activities</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Shared writing</td>
<td>Teacher and students collaboratively compose a piece of writing. The code also covers modelled writing by the teacher.</td>
</tr>
<tr>
<td>Group writing</td>
<td>Students collaborate to compose a piece of writing.</td>
</tr>
<tr>
<td>Individual writing</td>
<td>Students individually compose a piece of text.</td>
</tr>
<tr>
<td>Drawing</td>
<td>Students make charts, figures, diagrams etc.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Practical activities</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole-class doing</td>
<td>Teacher and students do practical work as a part of the whole-class setting. This may involve a teacher demonstration or the teacher and students working together on a larger experiment.</td>
</tr>
<tr>
<td>Group or pair doing</td>
<td>Students do practical work in groups or in pairs.</td>
</tr>
<tr>
<td>Individual doing</td>
<td>Students do practical work individually.</td>
</tr>
</tbody>
</table>
2 Coding Scheme: Science Inquiry

Science inquiry

Preparation
- Activating background knowledge
- Wondering
- Formulating researchable questions
- Making predictions
- Making hypotheses
- Planning

Data
- Collecting data
- Registering data
- Analyzing data

Discussion
- Discussing different interpretations, views or ideas
- Making inferences
- Discussing implications
- Linking theory and empirical data

Communication
- Oral communication of results
- Written communication of results
- Evaluation

Figure 2. Overview of Science Inquiry Coding Scheme - Budding Science and Literacy
Table 2. Science Inquiry Coding Scheme - Budding Science and Literacy

<table>
<thead>
<tr>
<th>Preparation</th>
<th>Description of code</th>
<th>Teacher utterances that might initiate the code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activating background knowledge</td>
<td>Teacher-initiated activities, in which the teacher makes links to previous science lessons, everyday experiences or students’ prior knowledge, or enables the students to do so.</td>
<td>“Do you remember when we…?” “How many senses do we have?”</td>
</tr>
<tr>
<td>Wondering</td>
<td>The teacher initiates an activity to cause wonderment. For example by showing the students a cherry pitter and asking them “What do you think this is used for?”</td>
<td>“How can you separate the blue balls from the yellow balls?” “What do you think this is?”</td>
</tr>
<tr>
<td>Formulating researchable questions</td>
<td>The students (or in co-operation with teacher) formulate researchable questions.</td>
<td>“Is this something you want to find out about?” “What can we find about about animals by watching a video? Try to make your own questions.”</td>
</tr>
<tr>
<td>Making predictions</td>
<td>The students make a prediction.</td>
<td>Which of these types of glue will be the most effective?</td>
</tr>
<tr>
<td>Making hypotheses</td>
<td>The students explicitly make a hypothesis—a tentative explanation that can be tested with further investigation.</td>
<td>“Why do you think that?” “Write down why you think that this glue is the strongest.”</td>
</tr>
<tr>
<td>Planning</td>
<td>The students (or in co-operation with teacher) plan how they are going to investigate something.</td>
<td>“Make a plan for how you are going to sort the different ball sizes.”</td>
</tr>
<tr>
<td>Data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collecting data</td>
<td>The students (or in co-operation with teacher) collect data through firsthand or secondhand investigations. They make observations, do practical activities, or gather data from text.</td>
<td>“Use the picture of page 4 to make observations on how the sea turtle moves” “Begin testing out your system for sorting balls of different sizes”</td>
</tr>
<tr>
<td>Registering data</td>
<td>The students (or in co-operation with teacher) review or register data from their inquiry.</td>
<td>“What did you observe? “ “Write down your observations”</td>
</tr>
<tr>
<td>Analyzing data</td>
<td>The students (or in co-operation with teacher) work with and organize data by categorization.</td>
<td>“Which observations could you make for all the animals you observed?”</td>
</tr>
<tr>
<td><strong>Discussion</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------------</td>
<td>----------------------------------------------------------------</td>
<td>----------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Discussing different interpretations, views or ideas</strong></td>
<td>The students (or in co-operation with teacher) discuss different interpretations of the data they have collected or analyzed. The students discuss different views or exchange ideas.</td>
<td>“What is the structure of this wheel?”</td>
</tr>
<tr>
<td><strong>Making inferences</strong></td>
<td>The students (or in co-operation with teacher) make inferences based on data/evidence.</td>
<td>“What can this tell you about its function?” “What can you say about these two animals based on the observations we’ve made?”</td>
</tr>
<tr>
<td><strong>Discussing implications</strong></td>
<td>The students discuss implications of their findings, or of their different interpretations. They come up with new questions as a result of their inquiry.</td>
<td>“Would a bicycle wheel without its spokes work?” “But what if...?”</td>
</tr>
<tr>
<td><strong>Linking theory and practice</strong></td>
<td>The students link findings from their inquiry to theoretical perspectives. This may include scientific laws and theories, published research results, or information from their textbook or other informational science texts.</td>
<td>“What is the function of the tube in the system you have made?”</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Communication</strong></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Oral communication of results</strong></td>
<td>The students communicate their findings orally to other students in the class or another recipient. Results are here taken to include both process and product of the students’ inquiry.</td>
<td>“Present the system you’ve made and how you thought of making it”</td>
</tr>
<tr>
<td><strong>Written communication of results</strong></td>
<td>The students communicate their findings through text. There is a clear aim for writing and a viable reader in mind.</td>
<td>“You are now going to communicate your findings to someone who has not been working with this topic the way you have” “Make a brochure that shows...”</td>
</tr>
<tr>
<td><strong>Evaluation</strong></td>
<td>The students evaluate their investigation and results. Could anything be done in a different way? Did they face any obstacles along the way? What effort did they put into the work? In which ways did they work like scientists? Evaluation may be both oral or in writing.</td>
<td>“Was there any challenges along the way?” “Why did you choose to do this instead of that?” “How does this compare to how scientists work?”</td>
</tr>
</tbody>
</table>
3 Additional codes for NOS and key concepts

Table 3. Code description for the code Nature of Science (NOS).

<table>
<thead>
<tr>
<th>Nature of Science</th>
<th>Description of code</th>
<th>Teacher utterances that might initiate the code</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The code is used every time the teacher or the students makes reference to working like scientists or to “the” Nature of Science (NOS).</td>
<td>“How do scientists work?”</td>
</tr>
</tbody>
</table>

Table 1. Code description for the code Key Concepts.

<table>
<thead>
<tr>
<th>Key Concepts</th>
<th>Description of code</th>
<th>Teacher utterances that might initiate the code</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The code is used every time the teacher or the students explicitly talk about the meaning of a concept or about how words and concepts are used.</td>
<td>“Observation means using all of your senses”</td>
</tr>
</tbody>
</table>
This document is downloadable from
http://www.naturfagsenteret.no/buddingscience

To cite this document:

¹ Norwegian Centre for Science Education, Oslo, Norway.
² Department of Teacher Education and School Research, University of Oslo, Oslo, Norway.

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PART II
ARTICLES
Errata

p. 82: Reference for Personal Data Act (2000) added to the reference list.