Chapter 1
Introduction: Studying Interaction and Instructional Patterns in Classrooms

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Classrooms are complex places, and the best teachers are successful because they are thoughtful opportunists who create instructional practices to meet situational demands.
(Duffy and Hoffman 1999)

This book explores teaching and learning in lower secondary classrooms in the three PISA domains: science, mathematics, and reading. Based on extensive video documentation from science, math and reading classrooms, we discuss and explore how offered and experienced teaching and learning opportunities in these three subject areas contribute to student learning.

How to improve teaching and instruction has become a key priority in many countries in the last decade, and recent reviews (McKenzie et al. 2005; Seidel and Shavelson 2007; Timperley and Alton Lee 2008; Hattie 2009; Hanushek and Woessmann 2011) indicate that teaching practices do make a difference to students' learning, and are more important than other factors including students' socioeconomic background, class size, classroom climate, and teachers' formal training and experience. Up to now, research in the field has been slow due to competing theoretical and methodological paradigms, and there is a need to go behind the general achievement patterns and open the black box of teaching and learning practices in secondary schooling. Video documentation has proven especially powerful in the investigation of teaching and learning (Hiebert et al. 2002; Clarke et al. 2006; Seidel and Prenzel 2006; Klette 2009) as it enables more precise, complete, and subtle analyses of teaching/learning processes. Video supports both qualitative and quantitative analyses of teaching/learning processes and thus could serve as common ground that integrates competing camps within the educational sciences. In the field of classroom studies, these could be, on the one hand, large scale studies of teaching effectiveness and, on the other, in-depth micro-genetic studies of specific learning. Fischer and Neumann (2012, p. 115) claim that video

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K. Klette et al. (eds.), *Teaching and Learning in Lower Secondary Schools in the Era of PISA and TIMSS*, Professional Learning and Development in Schools and Higher Education 12, DOI 10.1007/978-3-319-17302-3_1

documentation is especially powerful when investigating teaching and learning 'as it captures students' and teachers' behaviors in the classrooms in one package'. This book is an attempt to start such a discussion on a European basis, using video documentation from Norwegian secondary classrooms as a point of departure.

Norway, and the Nordic countries, as a test bed for discussing contemporary challenges in teaching and learning in secondary schooling are particularly interesting due to their long tradition of national curricula, and unitary and non-streamed structure. In addition, ideas of educational progressivism and student-centered instruction, such as individualized teaching, adapted teaching, and inquiry-based teaching methods, have for a long time been actively promoted within Norwegian educational policies.

In this introductory chapter I will briefly present video documentation as a promising tool for investigating classroom learning, and give an overview of research on instructional quality relevant to the present study. I start out by summarizing research on instructional quality. This summary will serve as an analytical framework and theoretical backdrop for the analyses performed in the following chapters. Then I will discuss video documentation as a tool for understanding classroom learning and elaborate on the types of video design and strategies for data collection and processing that have been essential for the present study. Towards the end of the chapter, I will summarize the goal of this book and present an overview of its sections and individual chapters.

1.1 Research on Instructional Qualities

Research on instruction has revealed complex and significant relations between instructional variables such as teaching quality, cognitive challenge, student engagement, and teacher feedback. Analyses of classroom practices must therefore be sensitive to a range of interactions around instruction, including: the nature of the tasks; the focus of instruction; the features of classroom discourse; the types of accommodations provided; the quality of feedback; support structures, etc.

As indicated, prior research has pointed to multiple dimensions for characterizing classroom interaction, such as the intellectual challenge of tasks assigned to students (Newmann et al. 1998), the quality of instructional conversation (Cobb et al. 2000; Sfard 2000; Cazden 2001; Mortimer and Scott 2003; Seidel et al. 2005; Fischer and Neumann 2012), including teachers' uptake and elaboration of student ideas (O'Connor and Michaels 1993; Nystrand 1997; Sfard et al. 1998), and representations of content (Leinhardt 2004). Studies have further shown that effective teachers are better at allocating more time for academic instruction (Denham and Lieberman 1980; Doyle 1986; Campbell 2004; Roth et al. 2006), as well as at keeping students focused on their tasks. Studies also show that students' motivation and engagement are linked to their achievement, particularly for students in lower secondary education (Guthrie and Wigfield 2000; Roe and Taube 2012). Effective teachers may have more efficient routines for transitioning between activities (Wang et al. 1993; Lipowski et al. 2009) and better classroom management, leading to more time dedicated to instruction (Stigler and Hiebert 1999; Wayne and Youngs 2003; Seidel and Shavelson 2007).

In summary, the four dimensions, *instructional clarity* (clear goals, explicit instruction, content-focused instruction); *cognitive activation* (quality of the task, cognitive challenge, content coverage); *discourse features* (student engagement, quality of teacher–-student interaction); and *supportive climate* (creating an environment of respect and rapport) have proven critical for high-quality instruction. Below, I will elaborate on these dimensions in more depth.

1.1.1 Instructional Clarity

Instructional clarity refers to the degree to which the teacher formulates clear goals for the activity, makes linkages to other related activities, and displays a set of tools for developing metacognitive awareness among the students, such as taking stock, summarizing and reviewing, or 'going over the do now' (Lemke 1990, p. 91). Instructional clarity also covers the degree of explicit instruction, teachers' modeling examples, guided instruction and/or teachers' worked-through examples (Clark and Mayer 2003). In his legacy paper on classroom teaching and learning (entitled *The Cultural Myths and Realities in Classroom Teaching and Learning: A Personal Journey*), Graham Nuthall (2005) claims that students often need three to four *explicit* exposures to the learning material – usually over several days – before any learning can take place. Hattie (2009) uses the term 'visible learning' to frame his argument after researching and synthesizing over 800 meta-analyses on the effectiveness of different teaching strategies. Visible learning, following Hattie, entails teaching strategies such as clear goals, mastery learning, worked examples, use of meta-cognitive strategies, and teachers' skillful use of feedback and assessment strategies. The extent to which these findings contradict basic assumptions of student-centered teaching approaches is debatable. However, the latter have dominated the common understanding of classrooms when these have been transformed into learning communities (Driver et al. 1994; Bransford et al. 2000), and thereby foreground learning rather than teaching. This type of vocabulary often includes an emphasis on student engagement, discovery learning and inquiry-based methods, individualized teaching, and students' independent work.

From the Nordic countries, Emanuelsson and Sahlstrom (2008) and Carlgren et al. (2006) report how student-centered teaching strategies have been foregrounded and privileged over the last few years, with little explicit instruction and teacher modeling as a consequence. Klette (2007) and Dalland and Klette (2012/2014) analyze teachers' instructional practices during students' independent work (individualized teaching in Norwegian terms) in Norwegian secondary classrooms and show how this goes hand in hand with the lack of instructional clarity on the requirements for expected standards of academic performance. From the UK, Alexander (2000, p. 407) discusses how individualized teaching has become the 'invisible teaching method', but at the same time, he argues, the knowledge base about individual teaching as a teaching and learning strategy is limited.

1.1.2 Cognitive Challenge

A second feature of high-quality instruction refers to cognitive challenge, that is the intellectual challenge of tasks assigned to students, the cognitive quality of the discussion involved, and the content coverage included. Teachers' capacity to 'press for accuracy and build on prior knowledge', and 'press for reasoning' are instructional activities and procedures that connect with high-quality thinking. 'Revoicing and recapturing' ("So what I'm hearing you say is . . . ") or 'marking' ("Jenny said something really interesting – we need to think about that") will also be a part of the teachers' instructional toolkit to ensure high cognitive challenge. Rigorous thinking is also scaffolded by the teachers' deliberate use of questioning and discussion techniques and, by their high expectations for students' performance in explicating their understanding and inferential structure. There is a limited knowledge base about how individual guidance supports students' rigorous thinking in a productive way. Last but not least, providing sufficient, and thus adequate, time to grapple with the demanding aspects of the task and for expanded thinking and reasoning is critical in order to engage the students with challenging thinking.

Analyses of group work in Norwegian language arts classrooms (see Klette and Ødegaard, Chap. 2) suggest, for example, that the tasks involved were adequately designed and demanding, and so also was the grouping. However, the timeline for solving the task was too generous, and thus served as a hindrance for engaging the students in high-quality thinking. Basically the students were given 20 min to perform a specific task (text-based conversation); however, several of the groups accomplished the assignments within the first 6 min and used the rest of the allotted time for non-academic activities. When the teacher passed by, they argued for yet another 15 min to accomplish the task. Thus, only 6 out of the total 35 min (20 + 15 min) were used for targeted intellectual work.

The TIMSS video science study (Roth et al. 2006; 2009) reveals huge differences in cognitive challenge when comparing lower secondary science classrooms in the US, Australia, Japan, the Netherlands, and the Czech Republic. While students in Czech classrooms, for example, were systematically exposed to challenging talking and learning content through public conversations and targeted classroom work, US students performed a lot of different activities in class – but with low linkages and coherence between the different activities. The US teachers did not typically use these various activities to support the development of content ideas in ways that were coherent and challenging for students (Roth 2009). Using video recordings from mathematics classrooms in Germany and Switzerland, Klieme et al. (2009) demonstrate how high cognitive activation is related to achievement scores in mathematics. The same relationship increased significantly when the supportive climate was taken into account as well (Lipowski et al. 2009). Seidel and Shavelson (2007) found that domain-specific features of instruction and cognitive challenge had the largest effect size when analyzing the effects of teaching on student learning.

1.1.3 Discourse Features

The quality of classroom discourse has long been acknowledged as crucial for students' classroom learning (Alexander 2006; Cazden 2001; Dysthe 1995; Lemke 1990; Mortimer and Scott 2003; Nystrand 1997; Sfard 2000). Discourse features cover elements such as the quality of the instructional conversation in class and teacher–student interaction, as well as the level of student participation and student engagement during class. It conveys teachers' sensitivity to students' ideas and reflections and teachers' uptake and elaboration of those same ideas. Discourse features also covers teachers' capacity to keep everyone together so that they can follow complex thinking (like "What did she just say?" "Can you repeat what Juan said in your own words?") as well as getting students to relate ideas to one another (like "Who wants to add on to what Anna just said?" or "Who agrees and who disagrees with what Anna just said?").

Opportunities for student discussion will also be included in dialogue features in class, that is, teachers provide opportunities for elaborate conversations for at least 4–5 min about a topic between the teacher and students, and among the students.

Analyses of discourse features in lower secondary classrooms in Norway and Sweden suggest a high degree of student participation and student engagement (Emanuelsson and Sahlström 2008; Ødegaard and Klette 2012). However, how these interactional patterns contribute to students' reasoning and achievement scores needs further probing. From analyses of Norwegian lower secondary classrooms, Ødegaard and Klette (2012) report a high degree of student initiatives in science classrooms. To a large extent, these initiatives concern practical and procedural questions, and show poor linkage to making relationships between key concepts and ideas, or exploring high-quality questions. From Swedish mathematics classrooms, Emanuelson and Sahlström (2008, p. 205) discuss the challenge between teachers' control versus students' involvement as 'the price of participation', pointing to the dilemma between, on one hand, teachers' content control and, on the other hand, students' participation. Juswik et al. (2008) discuss dialogic features in language arts classrooms and accentuate how seemingly monologic instruction can optimize the dialogic potential of classroom discourse by opening the floor to student ideas and responding to competing voices. Mortimer and Scott (2003) use the distinctions between authoritative and dialogic, and interactive and non-interactive, to explore communicative approaches in science classrooms in the UK. They argue that any effective teaching lesson should include both dialogic and authoritative discourse, achieved in both interactive and non-interactive ways.

1.1.4 Supportive Climate

Supportive climate refers to the capacity to create an environment of respect and rapport in the classroom, and includes factors such as a supportive teacher–student relationships and positive and constructive teacher feedback. ‘Supportive climate’ refers to how responsive the teacher is to emotional and academic needs, such as providing comfort and encouragement. Supportive climate also includes the extent to which the classroom activities are structured in an orderly way (e.g., classroom management) and the degree to which children’s autonomous behaviors are exhibited. Procedures for supervision and monitoring of student progress might further be a part of a supportive climate. Klieme et al. (2009) add to this list a positive approach to student errors and an ability to support them when they face misconceptions.

However, research findings on the relationships between aspects of classroom climate and student learning are mixed (Brophy 2000, 2004), partly due to differing operationalization of the constructs ‘climate’ and ‘teacher–student relationship’ (Klieme et al. 2009), and partly due to the degree to which classroom management procedures are included in the construct. Seidel and Shavelson (2007) claim that both supportive climate and classroom management should be treated as ‘distal factors’ when trying to understand classroom learning, as they have little *direct* effect on student performance. They have at best an indirect effect on student interest and motivation for learning, the authors argue.

Taken together, these four dimensions (*instructional clarity; cognitive activation; discourse features; and supportive climate)* will serve as lenses when analyzing offered and experienced learning opportunities in Norwegian secondary classrooms. Individually – and together – they provide us with relevant information for understanding the complexities of classroom learning. For such an endeavor, rich data sets that enable us to combine analyses of instructional clarity and content coverage with analyses of teacher–student interaction and dialogue features are required. Video design has a unique position in this respect, as it makes it possible to freeze and scrutinize situations of teaching and learning processes and support multiple analytical ventures when investigating classroom learning. The following section describes the type of video design and data sources underlying this book’s chapters.

1.2 Videos as Lenses for Exploring Classrooms

As already indicated, recent developments in video technology and video documentation have made videos the preferred study design when investigating classroom teaching and learning, and researchers around the world increasingly agree that the advantages of collecting videos of teaching practices can be significant.

In the US, Hiebert and Stiegler (2004) searched for a path that could lead from teachers' classrooms to a shared, reliable knowledge base for teaching, and they argue that video technologies provide an especially useful medium for storing, sharing, and examining knowledge in teaching. They claim that video meets the requirements for how a knowledge base for teaching should look:

- it must be public,
- it must be represented in a form that enables it to be accumulated and shared with other members of the profession, and
- it must be continually verified and improved.

In Australia, Clarke et al. (2006) argue that video documentation supports multifaceted analyses of a commonly held database of teaching, undertaken from different educational and theoretical positions, and "… provide(s) a much richer portrayal of classroom practice than would be possible from any single analysis" (2006, p. 6).

In Europe, Janik et al. (2009) and Klette (2009) demonstrate how video data facilitate fine-grained analyses and re-analyses of patterns and segments of classroom practice, thus making coding procedures and coding more explicit and transparent. At the same time, video data support further analyses, as researchers can always move between the data selected for analyses and the originally collected video data. As such, the researcher can take one step back, Janik et al. (2009) argue, and return to the original video tapes, "…thus avoiding the reduction caused by coding" (p. 13).

Thus, the merits of video documentation are obvious and can be summarized as follows:

– Reveals practices more clearly
– Deepens educators' understanding of teaching
– Enables the study of complex processes
– Stimulates discussion about choices within each instructional practice and context
– Enables coding from multiple perspectives
– Facilitates integration of qualitative and quantitative information
– Stores data in a form that allows new analyses at a later time
– Facilitates communication of results

In summary, video studies have proven to be a valuable tool to investigate instruction on a large scale, as well as on the level of individual teachers. Video analysis allows for identification of context- and subject-specific patterns of instruction, so-called 'cultural scripts' (Stigler and Hiebert 1999, p. 9), and/or discourse features and interaction patterns. It also enables identification of cause–effect relationships in different teaching–learning scenarios, and allows for in-depth analyses of instructional processes.

In what follows, I will describe the type of data and data sources provided through the video design explored for the present study – the PISA+ Video Study.

1.2.1 Research Design and Data Sources

The PISA+ Video Study was designed to explore offered and experienced learning activities in the three PISA domains: science, mathematics, and reading (Klette 2009). Six grade nine classes (students aged 14-–15 years) at six different schools were followed for 3 weeks in the subjects science, mathematics, and language arts. 45 science lessons, 37 mathematics lessons, and 44 language arts lessons were videotaped. In addition, video recordings from 10 cross-disciplinary lessons, plus video documentation of science excursions and experiments outside the classrooms were collected.

Pairs of students were interviewed (video-stimulated interviews) immediately after the lessons in science and mathematics. Teachers were interviewed once or twice during the three week observation period. Targeted interviews focusing on the students' reading habits and reading engagement were also conducted.

In summary, PISA+ contains video recordings from 140 videotaped lessons, 57 videotaped interviews with pairs of students ($n = 113$), 42 audiotaped student interviews (reading habits and reading engagement), and 18 interviews with teachers, plus copies of student work and assignments from the observation period. Table 1.1 gives an overview of the total data material.

1.2.2 Camera Set-Up

All lessons were filmed using three surveillance cameras; one remotely controlled following the teacher, one capturing the whole class, and one focusing on a small group of students, usually two (Fig. 1.1 gives an overview of the camera set-up). The small sized surveillance cameras that were used in PISA+ made the technology less intimidating. In order to reduce observer interference (Ericksson 2006; Klette 2009), the cameras were mounted before the lessons started and discretely placed.

Table 1.1 Overview of data material included in the PISA+ study

	Type of data source	Quantity	Type of data
1	Video recordings from science (n = 49), mathematics (n = 37), and language arts (n = 44) classrooms plus cross disciplinary lessons (n = 10)	*n = 140*	Coded video data
2	Video recording of pairs of students (number of students in total n = 113)	*n = 57*	Un-coded video data
2b	Transcriptions of videotaped student interviews	*n = 57*	Written transcriptions
3	Audio recordings from student interviews (reading habits and reading engagement)	*n = 42*	Written transcripts
4	Interviews with all videotaped teachers	*n = 18*	Written transcripts
5	Copies of lesson plans, work plans, student assignments and student work		Printed copies

Fig. 1.1 PISA+ video recording layout: three perspectives

The camera following the teacher was remotely controlled, while the two others were in stable positions. By using this camera set up, it was possible to back up the video documentation with participant observers being present in the lesson; one researcher following the group of students in order to prepare the interview and the other observing the whole class. The technology used also made it possible to conduct video-initiated interviews with students ($n = 113$) immediately after the lesson. Students watched sequences from the lesson and were asked to comment on their interpretation of the events. In this way, classroom observation data were compared to the students' interpretation of the events.

1.2.3 Sample: The Composition of Classrooms

The schools and classrooms in which the data were collected were chosen with the aim of providing as wide a span as possible across cases regarding student background and school organization. PISA has shown that achievement scores vary more within schools than between schools in Norway (Kjaernsli et al. 2004; Kjaernsli and Roe 2010). This means that students from one school may represent a broad range of knowledge and literacy skills. The schools in this study represent urban and rural areas, differences in socio-economic and ethnic backgrounds. They also represent a variation in terms of organization of lessons, that is, the use of architecture and physical space, lesson plans and time schedules, or the composition of the student groups.

1.2.4 Analyses

As indicated, one of the strengths of video data is how it may support analyses from multiple perspectives and involve either qualitative or quantitative inferences, or a combination of the two. The analyses that run through this book display and bring to the fore the various and differentiated modes of analyses that can be performed on video data, combining analyses of surface structures, such as instructional format and grouping of students, with micro-genetic analyses of teacher–student interaction and content coverage. Klette and Ødegaard (Chap. 2) combine, for example, systematic coding of instructional practices in science classrooms with in-depth analyses of the type of interaction that took place in the same classrooms. Bergem (Chap. 10) draws on video-stimulated interviews when disentangling different student strategies during independent work in mathematics. Anmarkrud (Chap. 3) combines analyses of teachers' reading instruction with teacher interviews in order to identify how, and to what extent, the students' experienced reading instruction in language arts. Roe, on the other hand (Chap. 6), draws on audiotaped interviews with 42 students on reading engagement to shed light on the same phenomenon. As yet another angle of analysis, Bergem (Chap. 4) combines data from the PISA+ mathematics classrooms with questionnaire data from PISA for Norway when discussing teacher support and student effort and perseverance in Norwegian secondary classrooms.

To construct profiles of the instructional choreographies and teacher–student interaction and student–student interaction across classrooms, each lesson was coded on different levels and conceptual scales using the software program Videograph.[1] Analyses have been conducted on several levels, discharging instructional format, instructional focus, and type of teacher-led activities across all the videotaped classrooms. For this purpose, we developed common coding manuals (see Klette et al. 2005). Targeted analyses of discourse features and interaction patterns linked to science (Ødegaard and Arnesen 2006) and mathematics (Ødegaard et al. 2007) classrooms have also been performed.

[1]Videograph is a computer software program developed at IPN, Kiel, http://www.ipn.uni-kiel.de/aktuell/videograph/htmStart.htm.

1.3 Research Contributions and the Composition of the Book

The proposed book draws on analysis that combines expertise in video-based microgenetic classroom studies with expertise in domain-specific instruction (math, science, and reading) and psychometrics. Whilst issues related to teaching, learning, and subject content are central to pedagogical practice, associated discussions tend to be fragmented. Despite a massive growth of studies of discourse patterns and dialogues in classrooms (Edvards and Mercer 1987; Wells 1999; Mortimer and Scott 2003; Alexander 2006), we still know little about the productive interplay *between* discursive engagements, instructional practices, and students' learning in different subject areas. Foregrounding interaction analyses (i.e., mundane talk and general linguistic maneuvers) and discourse analyses have contributed to expanding our understanding of the power of turn taking and competing voices in the classroom. How these discursive patterns interact with and support learning in different subject domains is, however, still an open question. And more importantly, how issues of communication patterns are dealt with and made productive within different instructional formats is still not in sight. This book feeds into such a discussion, and makes it possible to compare and analyze how instructional formats and discursive practices are made productive for students' learning.

The book is divided into three parts plus an Introduction. The first part – Instruction Matters – discusses instructional patterns within and across science, mathematics and language arts classrooms. The analyses indicate distinct differences between the three school subjects, with specific challenges and profiles within each subject (Chaps. 2, 3, 4, 5 and 6). While language arts classrooms, for example, seem to balance a certain variety of instructional practices, math classrooms suffer from monotony and repetitious ways of working, using either plenary teaching or individual seatwork as the basic form of instructional format.

The second part – Discourse Matters – analyzes language use and discourse features in the three subject areas (Chaps. 7, 8 and 9). Our analyses suggest that communication patterns in the observed classrooms are favorable for student initiatives and utterances. However, these utterances are for the most part concerned with practical and procedural questions, whereas substantive discussions linked to the subject area at stake are infrequent. We report, for example, on high student participation when it comes to turn taking and student–teacher interaction within both science and mathematics classrooms. However, how these interaction patterns contribute to students' learning within these two subject areas is unclear, and PISA and TIMSS data report average mathematics and science scores for Norwegian students at this level.

In the third part – Engagement Matters – we discuss how different instructional formats support student engagement with regards to the subjects at stake (Chaps. 10, 11 and 12). While student autonomy and student-centered ways of working have been actively promoted by educational policies, our analyses suggest that Norwegian students might have been left with too much responsibility for their own learning, with a lack of perseverance and determination as a consequence.

From different angles and data sources (video data, interviews with students, video-stimulated interviews, PISA and TIMSS questionnaire data), analyses from math and reading classrooms question the powerful balance between teacher–student engagement and teacher support.

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