CHAPTER 8

Video studies in classroom research

Hidden dimensions of teaching and learning

Cecilia Kilhamn, Elisabeth Rystedt, Rimma Nyman & Britt Holmberg

A contribution to classroom research

The increased use of video to record classroom activities has made the classroom available for research across time and space, making it possible to revisit a classroom many times and view it from different perspectives. As a result, comparative studies of a qualitative nature and in-depth analyses of authentic classroom practices highlighting classroom interaction can now be added to the field of didactic research. The aim of this essay is to illustrate and discuss the use of classroom videos to enhance mathematics education research. Drawing on research conducted as part of an international video study about algebra teaching, three different types of studies will be briefly described in this essay to illustrate a range of approaches that can be used to analyse the same video data. Together, these studies address different aspects of the didactic situation involving the three corners of the didactical triangle: the teacher, the pupil, and the mathematical content (Brousseau 1997).

This essay builds on classroom videos from the VIDEOMAT project,[1] where researchers from four countries recorded and shared video

data showing introductory algebra lessons with pupils aged 12–13 (see Kilhamn & Röj-Lindberg 2013 for a more detailed description of the project design). Taking a socio-cultural approach, the first phase of the project seeks to analyse between and within countries concerning algebra teaching and learning, for example identifying and comparing instructional strategies, classroom interaction, and pupil reasoning. Five consecutive introductory algebra lessons were video recorded in four or five classes in each of the countries: Finland, Norway, Sweden, and the US (California). The videos were coded, partly transcribed, translated and shared. Initially the videos were treated as data and analysed in search of hidden aspects of algebra teaching that might be worth pursuing in a more in-depth analysis. In a second phase, the classroom videos were used to prompt teachers to discuss their own and other's practices in focus groups, in order to investigate how teachers could make use of classroom videos to enhance their own practice.

The design of VIDEOMAT builds on a tradition of large-scale comparative video research in mathematics education, starting with TIMSS video studies in 1995 and 1999 (Stigler et al 2000) and followed by the Learner's Perspective Study in 2000 (Clarke et al. 2006). These studies collected video recordings of mathematics classrooms from different countries with the aim of finding country-specific patterns of mathematics teaching that could potentially be related to pupil learning. In contrast, VIDEOMAT treats the comparative aspects as a means of collecting a wider range of examples of teaching the same topic in order to find commonalities and particularities that will reveal hidden dimensions (see Table 8.1). It is an assumption of the project that many aspects of a classroom practice stay hidden because they are taken for granted, and will emerge only if they are contrasted with a practice where they do not occur. In classrooms where the same overarching content goals are addressed, explicit comparisons may help illuminate aspects which otherwise can be hard to detect. The seeking of similarities and differences across culturally distinct settings is an analytical, bottom-up process, which reveals details that would not be noticed without comparison. Taking on board the criticism directed at large-scale international video comparisons for their assumption of the existence of an international

	TIMSS video studies 1995, 1999	LPS Learner's Perspective Study 2000	VIDEOMAT 2011–2014
School year	Year 8	Year 8	Year 6–7
Number of countries	7 countries	12 countries	4 countries
Number of lessons	≈100 lessons, one from each classroom	≈360 lessons, 10 consecutive lessons from each classroom	≈90 lessons, 5 consecutive lessons from each classroom
Content	Wide range of mathematical topics	Wide range of mathematical topics	Introductory algebra: introducing variables
Aim	Finding distinct patterns of mathematics teaching and lesson structure.	Investigating consistency and variation of lesson structure in mathematics teaching.*	Finding tacit and unknown dimensions of algebra teaching.

Table 8.1. Overview of three international video studies in mathematics education.

* More countries joined in later, expanding the initial aim of the LPS project so that it can today be expressed more in terms of "a network of researchers with common interests in classroom studies in an international context" (Niss, Emanuelsson & Nyström, 2013, p. 984)

curriculum, the question of what is the same and what is different is part of every analysis. The analytical aim of the VIDEOMAT project as a whole is to reveal embedded features of an enacted curriculum that might pass undetected without a comparison. By sharing video data across countries, each group of researchers can view their own data against the background of data from classrooms with different socio-cultural settings where similar content is dealt with. This essay illustrates how, in a large body of classroom activities incorporating social and cultural differences between countries and classrooms, patterns and intriguing phenomena can emerge, revealing new dimensions of algebra teaching.

The data corpus consists of video recordings of five consecutive introductory algebra lessons in seventeen classrooms (Table 8.1). A mathematics classroom is here defined as the space where a specific group of pupils (a class) have a mathematics lesson of 40–60 minutes, taught by a specific teacher. Three cameras were used to capture (*i*) the teacher, (*ii*) the whole-class activities, and (*iii*) one pair or group of pupils chosen by the teacher to be representative of the class. The

first four lessons in each classroom were teacher-planned according to the local curriculum and the fifth lesson was researcher-designed to include some elements of common activity in all classrooms involved. The topic of introductory algebra was chosen as the common content, because of the accumulated evidence of the problematic transition from arithmetic to algebra and the conclusion that such problems relate more to the failure of educators to offer suitable conditions for mathematics learning than to pupils' cognitive limitations (Cai & Knuth 2011; Kaput et al. 2008). The teachers who participated in this project were recruited from among teachers who were inclined to seek opportunities for professional development as mathematics teachers.

The following sections will present three examples of studies emanating from the same set of classroom video data, but answering different types of research questions. First, we describe how we produced an overview of the data using a coding system developed within the project, as an example of knowledge gained from a macro-level comparative analysis. Second, we give an example of a micro-level study where only one section of one classroom video has been analysed in depth, chosen from the larger set of videos because it emerged as an explicit example of an interesting phenomenon. The third example is an analysis of data from the second phase of the project, where the original video data was used as a starting point for teachers' discussions about instructional practices. At the end of the essay, we return to a more general discussion of the contribution of video studies to comparative analysis and the development of instruction.

Macro-level comparative analyses of video data

When a large amount of video data is collected, it is necessary to create an overview of the data to help single out lessons and phenomena for in-depth analyses. In this project, the overview was also used to compare instructional strategies and classroom interaction across classrooms. To this end, a coding system of mutually exclusive coverage codes was developed, describing features of the classroom that are of relevance in a socio-cultural research tradition (Säljö

2000). Each of the four teacher-planned lessons in every classroom was described in a lesson log and coded with respect to types of activity and interaction in the classroom. Activities were coded as mathematical or non-mathematical, and as either whole-class teaching or pupil work (Jacobs et al. 2003), and from this initial analysis more specific codes emerged. Since the mathematical content of the project is an introduction to algebra, and specifically an introduction to variables, we decided to specify in the codes when new concepts or procedures were introduced (I) in a whole-class setting, as opposed to when the same setting was used to follow up (F) on work already done and concepts previously met. We also saw that it was not always the teacher who conducted the whole-class activity, and so we coded these activities as led by either the teacher (T), a student (S),[2] or collaboratively by teacher and student (TS). Pupil work was coded in accordance with the main type of interaction going on (individual or group work). As a last subcategory, the student group (SG) codes also indicated what kind of notation or documentation was requested from the pupils: individual (I), shared by the group (G), or none (N). Each activity that lasted at least 30 seconds was thus assigned a code describing the main activity in the classroom (Fig. 8.1).

The coding system helped us identify and quantify the use of lesson time for different types of activities and interactions. Comparisons revealed a large variation in lesson structure across classrooms, both within and between the four countries. Although no general conclusions can be drawn at a national level, the variation sheds light on issues that are taken for granted or avoided in some classrooms, and highlights aspects of the lesson structure that varied, which generated questions for further analysis.

When comparing across the whole data set, it was possible to pick out lessons that seemed similar but differed in some aspect. One such comparison is between the two classrooms, Finland S4 (School 4) and California S2T2 (School 2, Teacher 2) (Fig 8.2). In both of these classrooms, approximately one-third of the time in the four teacher-planned lessons was spent on pupil work (SI+SG) and almost two-thirds on whole-class instruction (IT+FT). The percentage of

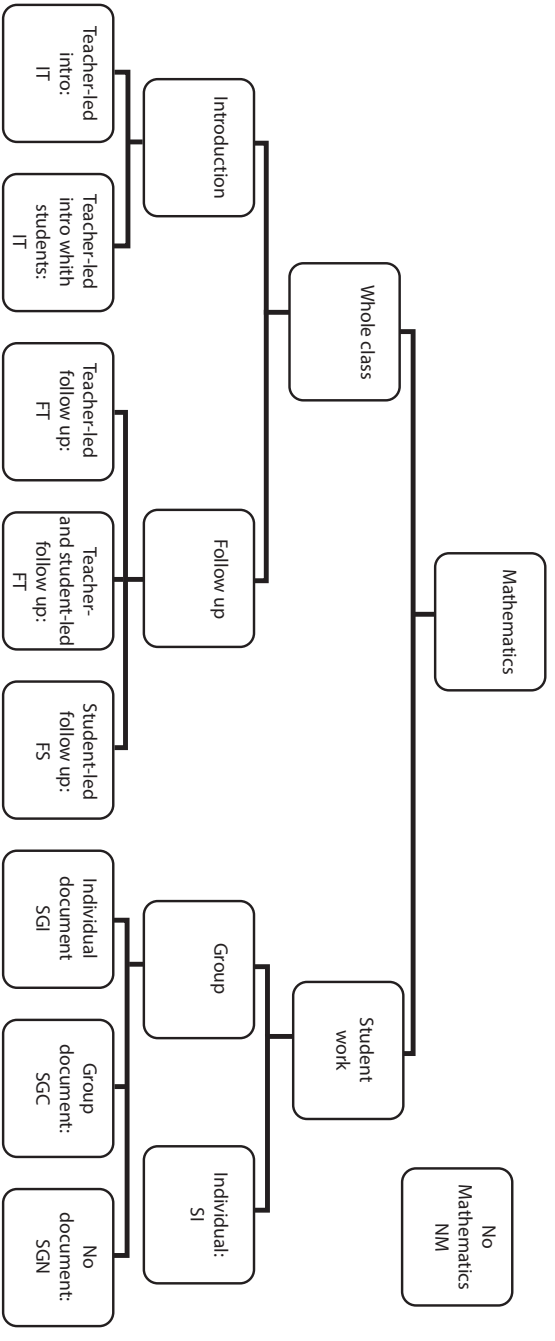

Figure 8.1. Overview of three international video studies in mathematics education.

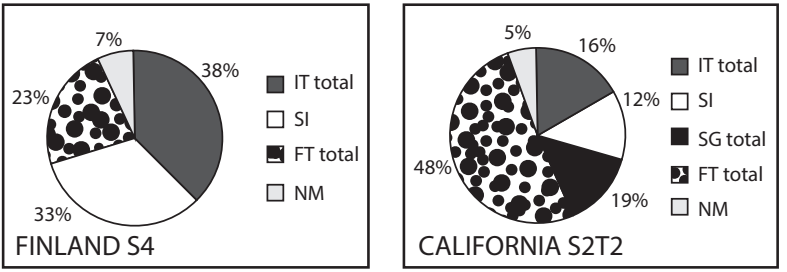

Figure 8.2. Distribution of lesson time in two different classrooms: Finland S4 and California S2T2.

time spent on non-mathematical activities in both classrooms was roughly the same (5–7 per cent). Despite these similarities, the codes reveal two very different teaching approaches. In Finland S4, there was no group work at all, whereas in California S2T2, pupil work was more often in groups than individual. In Finland S4, two-thirds of the whole-class instruction was spent introducing new concepts or giving instructions, and only one-third on follow-up activities, compared to California S2T2, where three-quarters of the whole-class activities—in fact almost half the lesson time—was used on follow-up activities. Despite the similar distribution of lesson time on the level of whole-class instruction versus pupil work, and the similarity of the content matter, it is very likely that the learning opportunities and the enacted learning goals were quite different, building more on pupils' own work and reasoning in the Californian classroom than in the Finnish one. The results of this kind of analysis generate questions concerning, for example, the extent to which each of the approaches offers pupils opportunities to develop reasoning skills, make conjectures and generalisations, revise ideas, listen, and communicate. In short, the quantitative analysis helped us to identify lessons where a more detailed observation and qualitative analysis could reveal new insights. The initial comparison thus supplied contrasting examples for a more fine-grained analysis.

Although algebraic reasoning without the use of written symbols constitutes the core of what is called early algebra (Cai & Knuth 2011), developing fluency in written representations is ultimately an essential part of algebra. Early algebra builds on contexts of

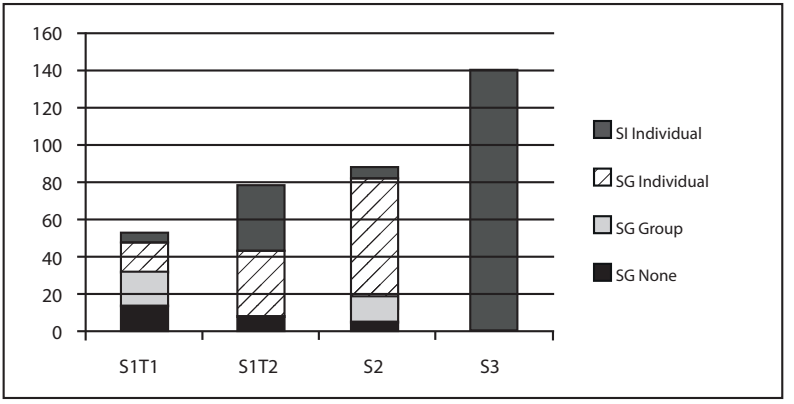

Figure 8.3. Lesson time in minutes spent on student work, differentiating between types of documentation (Kilhamn & Hillman, 2014).

problems, interweaves existing topics from early mathematics, and gradually introduces and extends pupils' own representations into formal representations such as symbolic notation (Carraher et al. 2008). The focus on the introduction of variables was a way for the project to direct its research interest towards the point in the learning trajectory where formal symbolic notation is one of the learning goals. For that reason, a coding of pupil documentation was introduced to indicate when and how pupils were given an opportunity to use algebraic notation. Four Swedish classrooms were compared in terms of how much time out of the total of four lessons (each lesson being 40–60 minutes) was spent on pupil work where some kind of written documentation was produced (Kilhamn & Hillman 2014). It is clear that the practices of writing in the algebra classrooms were all distinctly different (Fig. 8.3). In Classroom S1T1 for example, only twelve minutes out of four lessons involved activities where pupils were asked to write something, whereas in Classroom S3 pupils worked with individual written exercises for 140 minutes. The question is in what way these differences constrain or afford the learning of symbolic algebra. Again, we see how the results highlight an aspect that *may* influence pupil learning, hence generating research questions needing a more detailed, theory-driven analysis. Our second example describes

such an in-depth analysis of an episode that was chosen from the larger set of lessons with the help of the overview and the possibility of accessing a sequence of lessons.

Micro-level analyses of video data

Using an inductive approach (Derry et al. 2010), the video corpus was initially subject to a broad search for possible connections between whole-class instruction and pupil problem-solving in algebra. Whenever a didactically interesting phenomenon emerged, it was singled out for a micro-level analysis. In the project design, the first four lessons described in the overview were followed by a fifth lesson in which all the participating pupils worked in small groups to solve three algebra tasks distributed by the researchers. This generated a body of video data on small-group problem-solving where it was possible to look for connections to the specific instructions they had been given. The case study described here is an analysis of a 26-minute-long discussion where three pupils solved a task involving an equation that was also expressed as a word problem. The case stood out as an example of a specific phenomenon: when pupils on their own initiative apply previous experiences of manipulatives as a resource in a new situation. In the video data, we could see that this class had spent three of the preceding four lessons using manipulatives to build an understanding of equation-solving on a concrete level. Fig. 8.4 shows a picture of the manipulatives in the form of boxes and beans used during those lessons. The unique instance of an episode where pupils spontaneously made explicit connections between lessons provided an opportunity to investigate the pros and cons of using manipulatives in mathematics—a didactical issue for mathematics teachers in all countries.

In line with the socio-cultural research tradition, a dialogical approach was used to analyse pupils' communication (Linell 1998). In a small-group discussion, pupils' reasoning is articulated and therefore becomes accessible for analysis (Sfard 2001). During a 26-minute-long interaction, the pupils made a total of 282 interactive turns, here termed utterances. These were transcribed

verbatim. In addition, the video data also provided an opportunity to capture, at least partly, the complexity of a small-group discussion with its manifold interactional phenomena, such as gesture, gaze, movement, and facial expression, which deepen the verbal communication and written representations and help make sense of the situation.

The analytical construct of contextualisation was applied with the aim of investigating 'how and why a certain way of reasoning takes form and what it contains in terms of mathematical potential' (Nilsson 2009, 64). The discussion was analysed in terms of how the pupils contextualised the task and how they moved between different contextualisations. The given task provided the pupils with two contexts: a 'Zedland' context and an equation context (Fig. 8.5). The manipulatives used in the preceding lessons provided a third: a boxes-and-beans context. The results of our analysis show that the pupils were quick to recontextualise the given task in terms of boxes and beans, finding a correct value for *x*. However, although they spent another 20 minutes discussing their solution, they did not arrive at an answer to the original question posed in the context of Zedland. The final solution from this group was 'there are 30 grammes in each

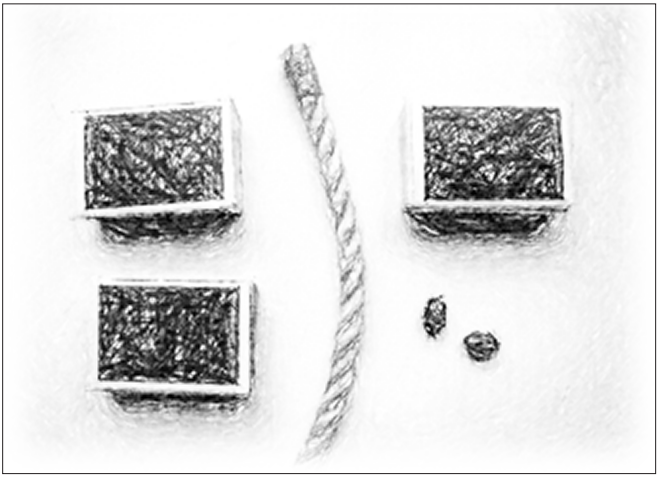

Figure 8.4. Boxes and beans displaying the equation $2x = x + 2$ where x is the unknown number of beans in each box. The string symbolises the equals sign.

In Zedland, the cost of shipping a parcel is calculated using the following equation: $y = 4x + 30$, where x is the weight in grams and y is the cost in zed dollars.
A parcel that costs 150 zed dollars to ship can be written using the following equation: $150 = 4x + 30$.
How many grammes does that parcel weigh?

Figure 8.5. Algebra task discussed in the group, adapted from the TIMSS 2007 survey (Foy & Olson, 2009).

parcel'. Their answer made sense in the boxes-and-beans context where x represents the unknown number of beans in each of the four boxes, but not in the Zedland context, where x represents the number of grammes for one specific parcel.

A general conclusion from this study was that although pupils are able to mobilise resources that are helpful in specific cases, additional problems might arise when they try to comprehend general algebraic principles. This case supports the claim made by Mason (2008) that learning about an abstract principle (in this case an equation) through the introduction of a concrete manifestation (in this case boxes and beans) requires pupils to see the general through the particular. The results highlight the importance of giving pupils opportunities to comprehend the particular position of symbolic mathematical representations when dealing with mathematical concepts. While a symbolic representation describes something general, concrete representations always describe something particular, and no particular example incorporates the rich meaning of a mathematical concept.

The aim of the study was to investigate how pupils made use of an earlier algebra activity with manipulatives as a resource when solving an equation expressed in a word problem (Rystedt et al. 2016). The interest was in understanding, as Dysthe (2003) suggests, a little bit more of what happens or does not happen, and the reasons for this. In this example, we have shown how a broad corpus of video data initiated and formed the background for a small-case in-depth analysis based on an interest in the use of manipulatives in mathematics. The example illuminates a phenomenon on the pupil-content axis of the didactical triangle, exposing a didactical

consequence, which is that teachers would do well to connect the use of manipulatives to abstract mathematical concepts if they are to provide pupils with powerful learning opportunities.

Using classroom videos to support professional development

Our final example of how video-recorded classroom activities can enhance research and support practice is an analysis of focus-group discussions (Boddy 2005) from the second phase of the project, where the original video data was used as a starting point for teachers' discussions about instructional practices. In preparation for the focus-group sessions, the eight participating Swedish teachers were handed recordings and overviews of their own lessons, along with instructions to select episodes from the films that they wanted to discuss. After three weeks of preparation, the teachers were invited to focus-group sessions at the university (Fig. 8.6). There were two focus groups (three teachers in one and five in the other), and each group met for seven one-hour sessions to discuss a range of topics. During the first three sessions, the teachers discussed the episodes they had chosen from their own lessons, and in the second round of four sessions they discussed episodes chosen by teachers in the other participating countries.

One of our research questions concerned the topic of interest and engagement (Ainley 2012) during classroom interaction about introductory algebra. The aim of the study was to gain insight into the way interest and engagement are perceived by teachers, and how they attempt to enhance pupil engagement in algebra. To direct the focus-group discussions towards interest and engagement, the teachers had been asked to select episodes where they could see that the pupils were engaged in algebra, and to think about how they as teachers engage pupils in the algebra content they were dealing with. The session commenced with an introduction of the topic by the researcher, then one of the teachers continued by showing his/her chosen episodes, which initiated a discussion about engagement

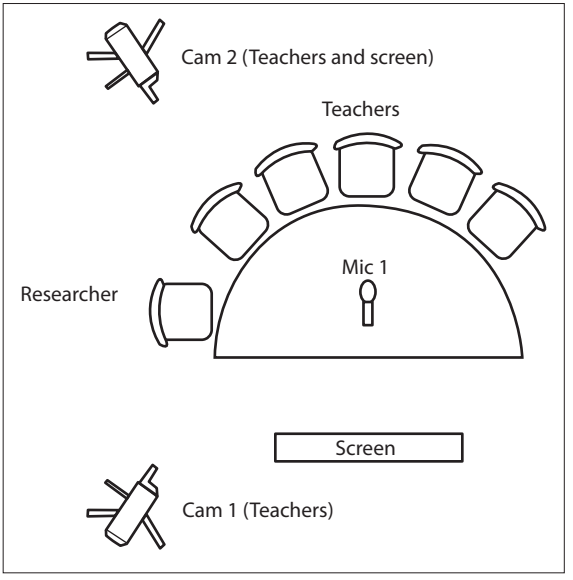

Figure 8.6. The set-up of a focus-group session. Classroom video episodes were shown on the screen (Nyman, 2015).

and how it was, or could be, enhanced. Each teacher showed his or her episode(s) in turn, explaining and discussing why each episode was chosen and in what way it visualised engagement.

The findings consist of a video portfolio of episodes chosen by teachers, along with teachers' utterances (their interactive turns) when commenting on one another's episodes. The two group discussions on the topic of interest and engagement were video-recorded and transcribed, resulting in a total of 588 utterances that were taken to represent the meaning of interest and engagement as interactively constructed by the eight teachers. Two researchers analysed the discussion in an iterative process, revisiting both the transcripts and the videos several times. In the transcripts, the researchers identified indicators of engagement corresponding to an existing model (Helme & Clarke 2001; Nyman 2015) and didactical strategies to enhance pupil engagement brought up by the eight teachers (Nyman & Kilhamn 2015). The main results indicate various ways of describing, initiating and sustaining pupil engagement on the activity

level of the didactical contract (Brousseau 1997), relating more to activities and social interaction than content—the recognition of pupils' achievements, for example, or the way individual solutions could be presented in whole-class interaction. The presented video episodes showed whole-class or group interaction about algebraic expressions, representations, the structure of equations, and patterns, but despite the moderator's attempt to direct the discussion towards content-related issues, the participants kept referring to the activities rather than the algebra content as being interesting and engaging. Although the mathematical content was at the fore in the focus-group sessions, the teachers' discussions focussed more on the social aspects of the didactic contract, thus placing the research results closer to the teacher–student axis of the didactical triangle. Based on these results, we would argue that much could be gained if teachers were to focus more on content-related issues in order to engage pupils.

The video recordings from the lessons were central to the teachers' discussion of the interactive aspects of interest and engagement in algebra. Since the teachers were given the videos early in the process, they had time to reflect and carefully choose their episodes. During the focus-group interaction, the classroom videos gave access to detail and provided a sense of authenticity and recognition in relation to the topics discussed. Ideas were shared and validated within the group. It can be concluded that with access to video data, teachers could discuss their own and one another's lessons, and reach a consensus based on and strengthened by empirical evidence of classroom practice.

Another research question for the focus-group discussions concerned what knowledge the teachers acquired when they discussed episodes of their own choosing from their own teaching. As preparation for a second focus-group session, the teachers had been asked to choose episodes showing anything they thought it relevant to discuss in relation to the teaching of introductory algebra. What kind of episodes did they choose, and what kind of knowledge was it possible to develop through the discussion? Two video-recorded sessions of 54 and 60 minutes from one focus group with three teachers were transcribed verbatim. The transcripts were analysed

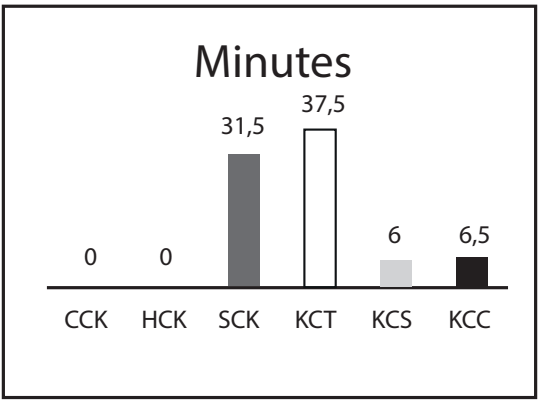

Figure 8.7. Total number of minutes of the discussion related to each MKT category.

using the framework Mathematical Knowledge for Teaching (MKT) (Ball et al. 2008). This framework, which builds on Shulman's notion of pedagogical content knowledge (1986), includes categories that describe different aspects of mathematics teachers' knowledge. It was used to characterise what the teachers discussed, not to assess their knowledge. Although a researcher moderated the session in order to support the discussion, it was the teachers who decided which episodes to watch, what questions to ask, and what to discuss about each episode. Each 30-second section of the discussion was coded in accordance with the topic discussed. If it was related to mathematical content in any way, it was coded as one of the MKT categories. Through this theoretical approach, the analytical focus was directed towards the teacher–content axis of the didactical triangle.

Our analysis and coding show that the teachers spent most of the time discussing specialised content knowledge (SCK) and knowledge of content and teaching (KCT) (Fig. 8.7). Issues related to knowledge of content and pupils (KCP) and knowledge of content and curriculum (KCC) were mentioned to a lesser extent, and the remaining two categories—common content knowledge (CCK) and horizon content knowledge (HCK)—were not raised at all. The results indicate that the classroom videos served as a useful vehicle for initiating discussions about issues related to a deep and

specialised understanding of the content, such as various ways a variable can be used in different tasks, and aspects of importance for teaching, such as various ways of presenting the content in class. We could see that the teachers reflected on their way of teaching when they discussed episodes of their own choosing from their own classrooms. In particular, they discussed things they could have done differently based on what they saw in these episodes. The opportunity to watch an episode several times while choosing and preparing, and again during the discussion, was mentioned by the teachers as being helpful for the development of their teaching. Our results strengthen the idea that teachers involved in research projects about their own teaching as *insiders* contribute to their own development in teaching, but can also contribute to research when a researcher who is an *outsider* takes part in the project (Jaworski 2004). The study shows that discussions about education using classroom videos as a tool can give teachers opportunities to develop mathematical knowledge for teaching, and could therefore be effective in teacher professional development.

Discussion

In this essay, we have described the use of video to record classroom activities for both research purposes and professional development in mathematics education. The greatest advantage with video data is the possibility of returning to a classroom practice, watching a video many times in search of patterns of similarities and differences in order to identify episodes of interest for further analysis. In this way, questions closely related to practice can become the focus of research. Another advantage is the possibility of sharing classroom data among researchers and teachers. Rich classroom video data can be analysed from different perspectives to answer a wide range of research questions. To this end, it is necessary to have a large corpus of video data to start with, and good quality recordings that capture all activities in the classroom. Naturally, there may also be disadvantages with video recordings. The presence of researchers and a camera in the classroom can have an impact on pupils and teachers

(Clarke et al. 2016). However, considering the recent development of technical tools and social media where pupils and teachers frequently take pictures and videos both in and outside class, it is plausible that such impact will be less noticeable in the future. The more a group of pupils are subject to video recording, the less attention will be paid to the camera. In the VIDEOMAT project, all pupils and their parents were asked to give informed consent to participate, with an option to agree for us to use the data either for research purposes only or for research purposes and teacher education. In a few cases when consent was not given, the pupils in question were given the option of participating in class during the video-recorded lessons, but were placed outside the range of the camera. In this way they could participate, and be heard but not identified. This turned out to be a workable compromise. If some pupils had been kept out of the classroom, the recorded lesson would have lost authenticity and ethical value. Since it is difficult to anonymise video data, it is important to be sensitive as to who is given access to the original videos. Transcripts, overviews, and coded summaries are good alternatives to the actual videos when wider groups of researchers or teachers are involved.

We would like to end with some reflections from the Swedish teachers at the end of the second phase of the project. In the first round of focus-group sessions, they had watched and discussed video episodes from their own classrooms. Questions about things that were not visible in the video could be easily answered, which helped give the discussion focus and depth. In contrast, during the subsequent session when episodes were shared between groups with no teacher present who could answer questions, the discussion sometimes petered out into uncertainty, with remarks such as 'Well we don't know why the teacher did this', or unanswered questions about what happened in the previous or following lesson. When watching the episodes shared between countries, the teachers acknowledged different cultures and curricula with comments such as, 'Perhaps this is a common way of doing it in [that country]' or 'It may seem strange to us, but we don't know anything about their curriculum'. These comments suggest that we need to be very careful when

conjecturing about teaching and learning in the classroom in cultures that are unknown to us. Short video episodes need to be embedded in rich descriptions of the classroom culture and curriculum if they are to be used to argue for or against different didactical strategies. In the use of video as a tool for the development of instruction, discussing your own teaching or that of others in unknown contexts will ultimately be two very different things.

A combination of macro– and microanalysis, like the studies generated by the VIDEOMAT project, shows the wide potential of video studies. The systematic overview and macro-level analysis served mainly as a tool to generate more interesting research questions. Attention to detail as described in the microanalysis and a collaborative reflection as described in the focus-group discussions serve to generate quite different types of knowledge, which is valuable for the research community and practising teachers alike. Although in-depth analyses were made of the data each team had recorded and was best acquainted with, it was through macro-level comparisons that interesting episodes were found. A similar effect was seen in the focus-group discussions, where teachers were given the opportunity to view their own classroom in relation to other classrooms. The teachers had more to say about their own teaching than about one another's, but noticed different things about their own teaching as a result of also watching episodes from other classrooms. Comparisons made it possible to detect and scrutinise previously hidden aspects of the classroom. The examples given here shed light on some factors that have didactical consequences for teaching and learning in algebra classrooms. We have seen that the use of manipulatives requires a thorough abstract knowledge of algebra on the part of the teacher; that teachers need to become aware of the possibility of making use of the content to engage pupils in algebra; and that video analysis can be instrumental in developing teachers' mathematical knowledge.

In this essay, we have shown how video data can be used for research purposes as well as for professional development. New dimensions of teaching and learning mathematics were highlighted through quantitative comparisons as well as in-depth analysis of classroom

work and teachers' discussions. Using video to record classroom activities has enabled us, both as researchers and teachers, to enter classrooms and increase our understanding of different classroom cultures, temporally and spatially. In particular, the large-scale comparative point of entry helped us to find potentially interesting and hitherto unknown dimensions of the mathematics classroom, to pursue further using theory-driven in-depth analyses.

Notes

1 The VIDEOMAT project was funded by the Joint Committee for Nordic Research Councils for the Humanities and the Social Sciences (NOS-HS) through a grant to the Linnaeus Centre for Research on Learning, Interaction and Mediated Communication in Contemporary Society (LinCS).

2 In this coding procedure the letter (S) for student was used when referring to pupils of age 12-14 years participating in the study (Kilhamn & Röj-Lindberg, 2013).

References

Ainley, M. (2012), 'Students' interest and engagement in classroom activities', in S. L. Christenson, A. L. Reschly & C. Wylie (eds.), *Handbook of research on student engagement* (New York: Springer Science).

Ball, D. L., M. H. Thames & G. Phelps (2008), 'Content knowledge for teaching: What makes it special?' *Journal of Teacher Education*, 59/5, 389–407.

Boddy, C. (2005), 'A rose by any other name may smell as sweet but "group discussion" is not another name for a "focus group" nor should it be', *Qualitative Market Research: An International Journal*, 8/3, 248–55.

Brousseau, G. (1997), *Theory of didactical situations in mathematics* (Dortrecht: Kluwer Academic).

Cai, J. & E. Knuth (2011) (eds.), *Early algebraization: A global dialogue from multiple perspectives* (Berlin: Springer).

Carraher, D., A. Schliemann & J. L. Schwartz (2008), 'Early algebra is not the same as algebra early', in J. J. Kaput, D. Carraher & M. L. Blanton (eds.), *Algebra in the early grades* (London: Routledge).

Clarke, D., C. Keitel & Y. Shimizu (2006) (eds.), *Mathematics classrooms in twelve countries: The insider's perspective* (Rotterdam: Sense).

Derry, S., R. Pea, B. Barron, R. Engle, F. Erickson, R. Goldman & B. Sherin (2010), 'Conducting Video Research in the Learning Sciences: Guidance on

Selection, Analysis, Technology, and Ethics', *Journal of the Learning Sciences*, 19/1, 3–53.

Dysthe, O. (2003), 'Om sambandet mellan dialog, samspel och lärande', in O. Dysthe (ed.), *Dialog, samspel och lärande* (Lund: Studentlitteratur).

Foy, P. & J. F. Olson (2009) (eds.), *TIMSS 2007 International Database and user guide. Released items. Mathematics—Eighth Grade* (Boston: TIMSS & PIRLS International Study Center) http://timss.bc.edu/timss2007/items.html.

Helme, S. & D. Clarke (2001), 'Identifying cognitive engagement in the mathematics classroom', *Mathematics Education Research Journal*, 13/2, 133–53.

Jacobs, J., H. Garnier, R. Gallimore, H. Hollingsworth, K. B. Givvin, K. Rust et al. (2003), *TIMSS 1999 Video Study Technical Report: Volume 1: Mathematics Study, NCES (2003–12)* (US Department of Education; Washington, DC: National Center for Education Statistics).

Jaworski, B. (2004), 'Insiders and outsiders in mathematics teaching development: The design and study of classroom activity', *Research in Mathematics Education*, 6/1, 3–22.

Kaput, J. J., D. Carraher & M. L. Blanton (2008) (eds.), *Algebra in the early grades* (New York: Routledge).

Kilhamn, C. & A.-S. Röj-Lindberg (2013), 'Seeking hidden dimensions of algebra teaching through video analysis', in B. Grevholm, P. S. Hundeland, K. Juter, K. Kislenko & P.-E. Persson (eds.), *Nordic research in mathematics education, past, present and future* (Oslo: Cappelen Damm Akademisk).

Kilhamn, C. & T. Hillman (2014), 'Structural and Pedagogical Diversity in Swedish Grade Six Algebra Classrooms', in O. Helenius, A. Engström, T. Meany & P. Nilsson, E. Norén, J. Sayers, M. Österholm (eds.), *Development of Mathematics Teaching: Design, Scale, Effects: Proceedings from Madif 9, The Ninth Swedish Mathematics Education Research Seminar,* Umeå, 4–5 Feb. (Linköping: SMDF).

Linell, P. (1998), *Approaching dialogue: Talk, interaction and contexts in dialogical perspectives* (Philadelphia: John Benjamins).

Mason, J. (2008), Making use of children's powers to produce algebraic thinking', in Kaput, Carraher & Blanton (eds.), *Algebra in the early grades* (New York: Lawrence Erlbaum).

Nilsson, P. (2009), 'Operationalizing the analytical construct of contextualization', *Nordic Studies in Mathematics Education*, 14/1, 61–88.

Niss, M., J. Emanuelsson & P. Nyström (2013), 'Methods for Studying Mathematics Teaching and Learning Internationally', in M. A. Clements (ed.), *Third International Handbook of Mathematics Education* (New York: Springer)

Nyman, R. (2015), 'Indicators of student engagement: What teachers notice during introductory algebra lessons', *International Journal of Mathematics Teaching & Learning*, 15/3, 1–17.

Nyman, R & Kilhamn, C. (2015), 'Enhancing engagement in algebra: Didactical strategies implemented and discussed by teachers', *Scandinavian Journal of Educational Research*, 59/6. 623–37.

Rystedt, E., O. Helenius & C. Kilhamn (2016), 'Moving in and out of contexts in collaborative reasoning about equations', *Journal of Mathematical Behavior*, 44, 50–64.

Shulman, L.S. (1986), 'Those who understand: Knowledge growth in teaching' *Educational Researcher*, 15/2, 4–14.

Stigler, J. W., R. Gallimore & J. Hiebert (2000), 'Using video surveys to compare classrooms and teaching across cultures: Examples and lessons from the TIMSS video studies', *Educational Psychologist*, 35/2, 87–100.

Sfard, A. (2001), 'There is more to discourse than meets the ears: Looking at thinking as communication to learn more about mathematical learning', *Educational Studies in Mathematics*, 46, 13–57.

Säljö, R. (2000), *Lärande i praktiken: Ett sociokulturellt perspektiv* (Stockholm: Prisma).