

# Assessment Discourses in Mathematics Class- rooms: A Multimodal Social Semiotic Study



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Lisa Björklund Boistrup

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Cover illustration: Teacher-student communication in a mathematics classroom, by Anders Enmark from video frame by Lisa Björklund Boistrup

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To David, Moa and Jim



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# Preface

Working on this thesis has been a substantial part of my life for the last five years, and now I am at the end of this process. I recall a moment three years ago when I was walking home from a seminar with PhD students, researchers and supervisors. On my walk, the song “With a Little Help from my Friends” by the Beatles came into my head. That was not a coincidence, since I had received help from my academic friends during the seminar. I had expressed my feelings about the research process, wondering whether this was the right thing for me to do and whether I would be able to handle it. The feedback from the seminar turned this “blue” mood into an understanding that it is also part of the creative process of writing a thesis to have these kinds of moments. I left the seminar with a more positive feeling than when I arrived. This story reflects the main theme of this preface, which is to express gratitude to people who have been important in this writing process. First, the five teachers who together with their students participated in this study: Without you, it would not have been possible to complete this study; all our meetings were inspiring and fruitful. I also received support from many people I have met, both in my professional and personal life, such as colleagues at the Department of Mathematics and Science Education and other departments of Stockholm University, people in (mathematics) education both in Sweden and abroad, and relatives and friends in my personal life. Your questions were stimulating and encouraging, especially since many of you saw positive potential for mathematics education in the aims of my study. One part of the PhD studies is to take courses and I learned a lot from teachers and other students during these courses.

My name is on the front page of this thesis, and I take full responsibility for everything written. Still, as I mentioned, this is not simply the accumulation of one person’s efforts. There are a number of people who read (parts of) the thesis during the process, and I regard you all as my critical friends. My supervisors are three of these friends. Astrid Pettersson, you stood by me and I could count on you during the whole process. You always read my texts thoroughly and gave feedback within the focus I requested and needed at that time. Moreover, you took the time to also discuss the process of being a PhD student, and your insights in this process helped me a great deal. Stefan Selander, I enjoyed our meetings. They were intense, productive, inspiring and challenging. You found notions in my texts that were essential for me to develop. My third supervisor was Torbjörn Tambour; I appreciate our

discussions about the nature of mathematics and your reading of my texts with a focus on details from which my writing benefitted. Most important for all three supervisors, I always left our meetings with an urge to work harder.

I have also had the privilege to have doctoral students beside me in the process. Eva Norén is one of these, and it is hard to find words to describe the support you gave me. We followed each other's progress, and I could talk to you about every aspect of my work. In the final months, we read each other's texts in detail, and you gave me insightful and supportive feedback. Elisabeth Persson has played a similar role. From the beginning, you seemed to know more about my potential accomplishments than I did myself. Your feedback from reading my preliminary research plan five years ago harmonises to a great extent with the thesis I have now written. Similarly, our discussion about the final structure of the thesis was crucial. This meant a lot to me, as did all the discussions between those two points in time.

In the two seminar groups for PhD students and researchers at Stockholm University that I have been a part of, I have friends whose critical readings meant a great deal to my writing. I have already mentioned Eva N and Elisabeth above, and also Astrid, Staffan and Torbjörn. The group "Didaktik Design" is led by Staffan Selander. Participating in this group has been a fruitful basis for developing my theoretical and methodological standpoints in this thesis. Eva Insulander, I learned a lot from you reading my texts and from our discussions about theories. I enjoyed all our talks about various parts of the PhD process. Other people that I have had extensive and/or frequent contact with, including discussions and readings, are: Anna Åkerfeldt, Susanne Kjällander, Lisa Öhman, Fredrik Lindstrand, Bengt Bergman and Gabriella Höstfält. Likewise, a seminar group for mathematics education, led by Astrid Pettersson, has similarly provided me with a solid foundation for my process. Anna Palmer, you always read my texts with particular energy. You put effort into recognising notions in the texts that I should keep and build upon, and you also gave me constructive feed forward, especially on theoretical matters. In this group, I have also had extensive and/or frequent contact with Anna Pansell, Kicki Skog, Kerstin Pettersson, Sanna Wettergren, Jöran Petersson and Samuel Sollerman. What unites us is an interest in mathematics education. I enjoyed our discussions and appreciate your readings of my texts. I also found it stimulating to see how we adopt different theoretical perspectives in our research. The impact on my process from both these groups is so valuable.

A third group that I was a part of prior to and during my doctoral studies is PRIM-gruppen, a research group on assessment of knowledge and competence. I have learnt a lot from our work on assessment over the years, and this provided me with a basis for designing the research project in this study. The time I could devote to the group's projects was limited once I started my doctoral studies. You showed great understanding about this while remaining interested in and positive about my PhD project. I have worked a lot at

home, and every time I came to work I experienced a warm, welcoming atmosphere. Katarina Kjellström and Gunilla Olofsson, you read and discussed some preliminary analytical concepts, which was an essential step in the analysis. Maria Nordlund, you read my manuscript at the end and found errors and issues I would never have found on my own. Anders Enmark, you helped me with pictures and other practical matters. I am grateful to you all.

Guri Nortvedt and Elisabeth Persson, you spent days closely examining my analyses. Those days were inspiring and, together with your involvement with my preliminary findings, they had great value for my work and my confidence.

At my 50 % seminar, Anna-Lena Kempe and Viveca Lindberg read my work and at my 90 % seminar Eva Jablonka and Per-Olof Wickman did the same. Your readings were detailed and thorough and had a vital impact on my subsequent course of action.

I am grateful to my department, which provided funding for a final language check (as well as for the PhD position). Susan Long, you performed a language check with accuracy, coherence and a linguistic sensitivity, which I appreciate considerably. Audrey Cooke, you volunteered to give my writings an extra reading. You then provided alternative wordings that gave me opportunities to choose the ones that suited my intentions the best. You also wanted to discuss language as well as content and I learned a lot from these discussions and I am very grateful to you. I also thank Gull-Britt Larsson for some additional tips regarding format issues.

To my parents, siblings and close friends and your spouses, I would like to express gratitude for your positive attitude toward my PhD studies and for never making me feel guilty when the project consumed me. Likewise, I am grateful to my extended family for putting up with me despite my focus being very much on the thesis, especially during this last year. My family in Blekinge (Erika and Andreas and families), you took care of me when I had my lonely weeks writing in the country house and were interested in my work throughout the process. My children, Moa and David (and girlfriend), I am happy about the friendship I enjoy with you. We have shared work experiences, studies and life over the last few years, which helped my writing process in many ways. You have expressed how proud you are of me; it warms my heart and is also mutual. Jim, I could not wish for a more fitting husband. You have endured my PhD work, taking a positive, constructive attitude while at the same time reminding me about other, more important, aspects of life. Your support, including in practical matters at home as well as reading parts of the thesis, is priceless. I promise you and myself that there will be more days to come of shared adventure, like scuba diving, in future.

Saxemara/Sundbyberg September 2010



# 1 Assessment in the Mathematics Classroom: Setting the Scene

This is a study of one of several features that influence students' active agency<sup>1</sup> and learning<sup>2</sup> in the mathematics classroom – classroom assessment. This introduction considers, in part, the notion of classroom assessment as a research interest. As will be described, I view classroom assessment as a broad concept that encompasses explicit as well as implicit assessments acts.

## 1.1 To be Curious

Throughout my years as a mathematics teacher, classroom assessment issues have been an area of interest. In different ways, I have tried, not always successfully, to develop the assessment practice in mathematics of me and my students. In doing so, I have become increasingly curious about the variety of assessment practices in the mathematics classroom. For several years, I have been involved in the development of national tests and diagnostic materials.<sup>3</sup> I have also taught in mathematics education for pre-service teacher training, and have reflected on the stories that students, relatives and friends have recounted about their experiences teaching and learning mathematics in school. Something that struck me in these stories was seeing how assessment acts in mathematics influenced how people view themselves in relation to mathematics, especially in terms of agency and learning. This, as well as my own background as a teacher, teacher educator and “test developer”, has influenced my research interest.

The work on this thesis has been characterised by curiosity. I was curious from the start of this study and eagerly wanted to learn about classroom assessment from the teachers and students in the classrooms I visited. The work has been an interplay between my research interest, theoretical considerations and methodological choices.

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<sup>1</sup> The term agency will be described in the chapter on theoretical considerations in Section 3.2.7. Briefly, agency is understood to be people's capacity to make choices and to impose those choices on the world.

<sup>2</sup> How the term learning is understood in this thesis is defined in 3.2.8.

<sup>3</sup> In PRIM-gruppen [PRIM group] (PRIM-gruppen, 2010a). The research group develops assessment materials including national assessment materials in mathematics on behalf of the Swedish National Agency of Education (Skolverket, 2010a).

The title of the thesis represents a culmination of this journey of curiosity. Clearly, it is a classroom study in the discipline of mathematics education, which is reflected by the term “mathematics classrooms”. The term “assessment discourses” signifies my research interest (assessment) as well as my view of the classrooms visited as part of a broader institutional context (discourses). As will be shown further below, I use the term discourse according to Foucault (e.g. 1993). In the analytical process, including the construal of assessment discourses, I have also relied on “social semiotics” (Hodge & Kress, 1988; Van Leeuwen, 2005), which is the key term of the subheading. The notion of communication as being multimodal is integral to the analyses, which is clear from the first term of the subheading. I have analysed communication between teacher and student from three perspectives: (1) the assessment acts themselves, (2) the focuses of the assessment acts in the mathematics classroom, and (3) the roles of semiotic resources (semiotic resources include symbols, gestures, speech and the like) in the assessment acts. The discourses are construed based on the outcomes of the three analyses and in terms of affordances<sup>4</sup> for students’ active agency and learning in the mathematics classroom. I also address the presence of institutional traces. As for a theory for learning, I draw on a design-theoretical perspective, which is a perspective closely related to multimodal social semiotics and institutional theories (e.g. Selander & Kress, 2010).

## 1.2 Assessment in Mathematics Classrooms

In this study, classroom assessment is regarded as a concept with broad boundaries. In figure 1, a broad construct of classroom assessment is illustrated. Sometimes it is obvious that the interaction between teacher and student involves assessment. One example of explicit assessment is when a student in primary school achieves excellent results on a test in mathematics for the first time. The teacher looks at her, smiles, and tells her of her achievement on the test. The student looks at the teacher and at the test results shown as figures on the paper. The student realises, through the written assessment, that her performance on the test was good. Sometimes the assessment is more implicit. One example of this is when a student asks the teacher where a certain “rule” in mathematics comes from. The teacher communicates by way of speech, gestures and the like that this particular student does not have to bother about this, and that s/he just has to follow the rule. When other students ask the same question, the teacher engages in a mathematics discussion about the historical development of that rule. Through this implicit assessment, the first student in the example gets to

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<sup>4</sup> Affordance is here understood as a quality of an object, or an environment, that allows an individual to perform an action.

know that the teacher does not consider her/him knowledgeable enough for this kind of discussion. My assumption is that there are explicit and implicit assessment acts going on in mathematics classrooms, which contribute, or not, to students' active agency as well as to students' learning in mathematics education.

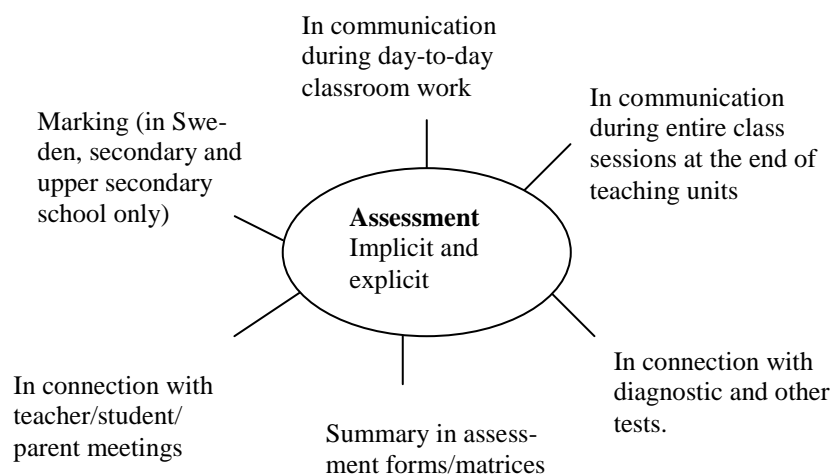


Figure 1. Assessment: A concept with broad boundaries. Some aspects of classroom assessment (adapted from Björklund Boistrup & Lindberg, 2007, poster).

As shown in figure 1, there are many instances in the mathematics classroom where assessment acts can be considered to occur. Examples of what can be part of classroom assessment are diagnostic tests that teachers use as information to plan teaching, documentation such as portfolios, and acts in communication between teacher and student during day-to-day work.

As mentioned, this study is a classroom study. I have visited five mathematics classrooms in grade four (the students are about 10 years old). In the analysis and outcomes chapters, several instances of communication between teachers and student(s) where I have identified explicit and implicit assessment acts will be considered. I wanted to provide one illustrative example to refer to throughout the thesis. However, I did not want to bring in excerpts from the study for this purpose, since the analyses relating to one classroom would then dominate analyses relating to the other four. Moreover, I viewed it as beneficial to use an example where it was possible to provide pictures showing classroom work. My solution was to choose a fictional story about Pippi Longstocking going to school as an illustration of the analytical process in this study. The first picture shows Pippi at home while Tommy and Annika head for school.



Picture not available in this version.

Picture 1. Illustration from *Pippi Goes to School* (Lindgren, 1998, p. 8, illustration by M. Chesworth<sup>5</sup>).

Of course Tommy and Annika went to school. Each morning at eight o'clock they trotted off, hand in hand, swinging their schoolbags.

At that time Pippi was usually grooming her horse or dressing Mr. Nilsson in his little suit. Or else she was taking her morning exercises, which meant turning forty-three somersaults in a row.

Tommy and Annika always looked longingly toward Villa Villekulla as they started off to school. They would much rather have gone to play with Pippi. If only Pippi had been going to school too; that would have been something else (Lindgren, 1998, p. 9, translation by F. Lamborn).

The story continues, as many readers already know, with Pippi deciding to go to school. The first subject she encounters at school is mathematics. Nevertheless, we can see in the picture and read from the text that there is already a good deal of mathematics in her life, such as the clock on the wall and the forty-three somersaults. The question, with respect to this study, is how assessment discourses take place in communication between Pippi and the teacher during mathematics teaching and learning practices. It should be noted that I do not aim to perform a literary analysis *per se*. What I do aim to do is illustrate the use of my analytical framework to analyse the data. One question relating to this thesis is how assessment acts in discursive practices

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<sup>5</sup> The pictures from the book *Pippi Goes to School* (Lindgren, 1998) are used with permission from the artist, Michael Chesworth.

take place in classroom communication in the day-to-day work of five Swedish mathematics classrooms and how they influence affordances for students' active agency and learning in the mathematics classroom. The story of Pippi was written many years ago but still serves the purpose of illustrating the operationalisation of the analytical framework.

### 1.3 Unit of Analysis and Limits of the Data

The unit of analysis in this thesis is “assessment acts related to feedback in discursive practices considered to occur in institutionally situated teacher-student communication in mathematics classrooms in grade four”. As a consequence, all data come from this communication. This was also one way to limit the data, and limiting the data was something I regarded as a prerequisite for finishing the study within the scope of a PhD project. In order to address institutional frames not explicitly present in the data, I describe some institutional circumstances in Chapter 2 as well as in the final Discussion. A second way to constrict the data is to concentrate the analyses on assessment acts occurring in the communication between teacher and students (described further in Section 4.5). There are other instances of communication in the classrooms where assessment occurs, such as between students. These are clearly worth analysing, but they are not within the scope of this study. A third way to limit the data is to analyse only assessment acts that can be connected to feedback – drawing on Hattie and Timperley (2007) – between teacher and student. In the next chapter, I describe the definitions of classroom assessment and feedback used in this thesis. Before doing so, I articulate the purpose and research questions of the study.

### 1.4 Purpose and Research Questions

The purpose of this study is to analyse and understand explicit and implicit assessment acts in discursive practices in mathematics classroom communication in terms of affordances for students' active agency and learning. In order to create a basis for a construal of discourses, I have analysed the communication between teacher and student(s) with regard to assessment acts, assessment focuses in the mathematics classroom, and roles of semiotic resources. I have also analysed institutional traces and connected them to the construed discourses. The research questions are as follows:

1. How do assessment acts related to feedback take place in teacher-student communication in mathematics classrooms and what affordances can be connected to students' active agency?
2. What are the focuses of the assessment acts in the mathematics classroom and what affordances can be connected to students' learning?
3. What roles do different semiotic resources play in the assessment acts and what affordances can be connected to students' active agency and learning?
4. What discourses of classroom assessment in mathematics can be construed based on the findings from the previous three questions? Furthermore, what institutional traces can be identified in relation to the construed discourses and what affordances can be connected to students' active agency and learning?

The above questions, as along with the purpose of this study, have been developed and adapted throughout the course of the research process. Nevertheless, the original aim and questions have similarities with those above, although the theories chosen have influenced this final version. The first three questions are related to three social semiotic meta-functions (Halliday, 2004; Van Leeuwen, 2005), and this relationship will be elaborated on in Theoretical Considerations. The fourth research question is connected to a Foucauldian concept of discourse, which will also be developed in Theoretical Considerations.

## 2 Definitions, Previous Research and the Swedish Context

The aim of this chapter is to provide both a background to this study and a foundation for how research on classroom assessment in mathematics can incorporate pertinent aspects regarding the discipline of mathematics education. I have relied mainly on references related to compulsory school, addressing classroom assessment in general as well as mathematics in particular. Moreover, I present an overview of research that has served as inspiration for this study. The background also gives an account of institutional circumstances in which classroom work in mathematics and classroom assessments in Sweden are carried out. In the first section, I define classroom assessment as it is operationalised in this thesis.

Given the substantial amount of literature in relevant research areas, the section on previous research has been organised to provide the reader with the option of choosing between two versions, enabling the footnotes to either be skipped or read. One version emphasises major themes, and attention need not be paid to the footnotes. The other version is longer and includes information in footnotes about some of the references.

### 2.1 Defining Classroom Assessment

A central construct in the literature on classroom assessment is formative assessment (see Cizek, 2010, or Brookhart, 2007, for an account of the historical development of the construct). One example is Black and Wiliam's (1998) seminal work, in which formative assessment is defined as "encompassing all those activities undertaken by teachers, and/or by their students, which provide information to be used as feedback to modify the teaching and learning activities in which they are engaged" (p. 7f; see also Black & Wiliam, 2009). Torrance and Pryor (1998; see also Morgan, 2000; Tunstall & Gipps, 1996; Lindberg, 2005b) challenge the common notion in the literature that formative assessment is always seen as a "good thing":

Our own position is that formative assessment is an ‘inevitable thing’, *i.e. all assessment practices will have an impact on pupil learning*, but whether or not it is a ‘good thing’, and if it is, how this is actually accomplished in practice, is an empirical question. (Torrance & Pryor, 1998, p. 10, italics in original)

This idea of formative assessment as something inherently good is still found in the literature today (one recent example being Cizek, 2010). Morgan (2000) instead addresses how “the day-to-day judgements of teachers about individual pupils inevitably affect future interactions, judgements, and hence opportunities” (p. 225). This view, proposed by Torrance and Pryor (1998) as well as Morgan (2000), is in line with the interest of this thesis since the findings are connected to affordances for students’ active agency and learning in the mathematics classroom.

An additional construct found in research on assessment is summative assessment (e.g. Newton 2007; Pettersson, 2010a). Summative assessments are often connected with tests on a local or national level, but summarised assessments of students’ performances in relation to stated goals are also included here. These kinds of assessments can also serve formative functions (Newton, 2007). Newton challenges the term formative assessment, arguing that formative is more a purpose than a kind of assessment (see also e.g. Black, Harrison, Lee, Marshall, & Wiliam, 2003; Brookhart, 2007; Wiliam, 2010). Using this definition of formative assessment, it is possible to discuss formative aspects embedded in summative assessments found in mathematics classrooms.

In defining classroom assessment in this thesis, I draw on the considerations mentioned above. Like Black and Wiliam (1998), I include a broad range of possible acts in the mathematics classrooms as part of assessment (see also e.g. Watson, 2000). Drawing as well on Torrance and Pryor’s (1998) and Morgan’s (2000) emphasis on formative assessment as being inevitable, I contend that, in every situation in mathematics classrooms, there are acts taking place that can be analysed in terms of classroom assessment. In this study, I address those assessment acts in mathematics classrooms that can be connected to feedback. In this instance, I am inspired by the definition of feedback as expressed by Hattie (2009): “information provided by an agent (e.g. teacher, peer, book, parent, or one’s own experience) about aspects of one’s performance or understanding” (Hattie, 2009, p. 174; see also Hattie & Timperley, 2007; Askew & Lodge, 2000).

In this thesis, classroom assessment is regarded as the lens through which I view institutionally situated teacher-student communication in the classroom. This is in order to capture acts associated with feedback that hold more or less affordances for students’ active agency and learning in mathematics classrooms. Feedback is defined here as information provided by an agent (for example, the teacher or the student) through various semiotic re-

sources about aspects of the student's performance or about the teaching in relation to the students' meaning making. This definition incorporates feedback presented in connection with summative assessments.

A few caveats are necessary. Firstly, I do not claim that it is possible to view all communicative acts between teacher and student during classroom work solely as assessment acts. Research investigating classroom communication in conjunction with other converging interests includes de Abreau (2000<sup>6</sup>) and Moschkovich (2004<sup>7</sup>). In this thesis, the research interest is classroom assessment, and therefore I perform the analyses by looking at communication acts in mathematics classrooms as part of classroom assessment. The second caveat, drawing on Hattie and Timperley (2007) and Kulhavy (1977; see also Askew & Lodge, 2000; Shute, 2008), is that feedback, in contrast to what is maintained in a behaviourist argument, is seen as a complex interaction that cannot necessarily be deemed a reinforcer because feedback can be accepted, modified, or rejected by an agent.

## 2.2 Previous Research on Classroom Assessment

Filer (2000) divides research on assessment into two genres<sup>8</sup>: a technical and a sociological genre of assessment. In the technical genre there is an interest in the means whereby given "ends" (marks, for example) can be achieved as objective as possible. In the sociological genre, there is an interest in how assessment fulfils political and social functions in societies. This includes studies on classroom contexts of assessment. This study belongs to this sociological genre, and this affects the selection of research presented in the overview.

The notion of classroom assessment as a construct with broad boundaries, as assumed in this thesis, is quite widespread in the literature (described in Björklund Boistrup, 2009). There is a substantial body of research showing that assessment is one activity among others that has a strong interaction with learning and teaching. In mathematics education, classroom assessment has been investigated from several perspectives, for example, by Niss (1993), Clarke (1997) and Schoenfeld (2007a). However, there does not seem to be great interest in these matters in mathematics education research today, at least not in some of the research journals in the field. In my

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<sup>6</sup> de Abreau's (2000) interest lies in bridging the macro cultural context of the students (like in their everyday lives) and the micro cultural context of the mathematics classroom.

<sup>7</sup> In Moschkovich (2004), the research is on the interaction between tutor and students. There are acts of feedback addressed but no emphasis on assessment issues as such.

<sup>8</sup> Filer (2000) uses the term discourse, but I use genre here in order not to confuse it with how the concept of discourse is used in this study.

literature search, very few articles with an articulated focus on teacher- and/or student-initiated assessment in mathematics classrooms were identified (Björklund Boistrup, in press<sup>9</sup>).

### 2.2.1 Frameworks of Classroom Feedback

There are several frameworks of formative assessment summarised in the research literature (e.g. Wiliam, Lee, Harrison, & Black, 2004; Black & Wiliam, 2009; Cizek, 2010).

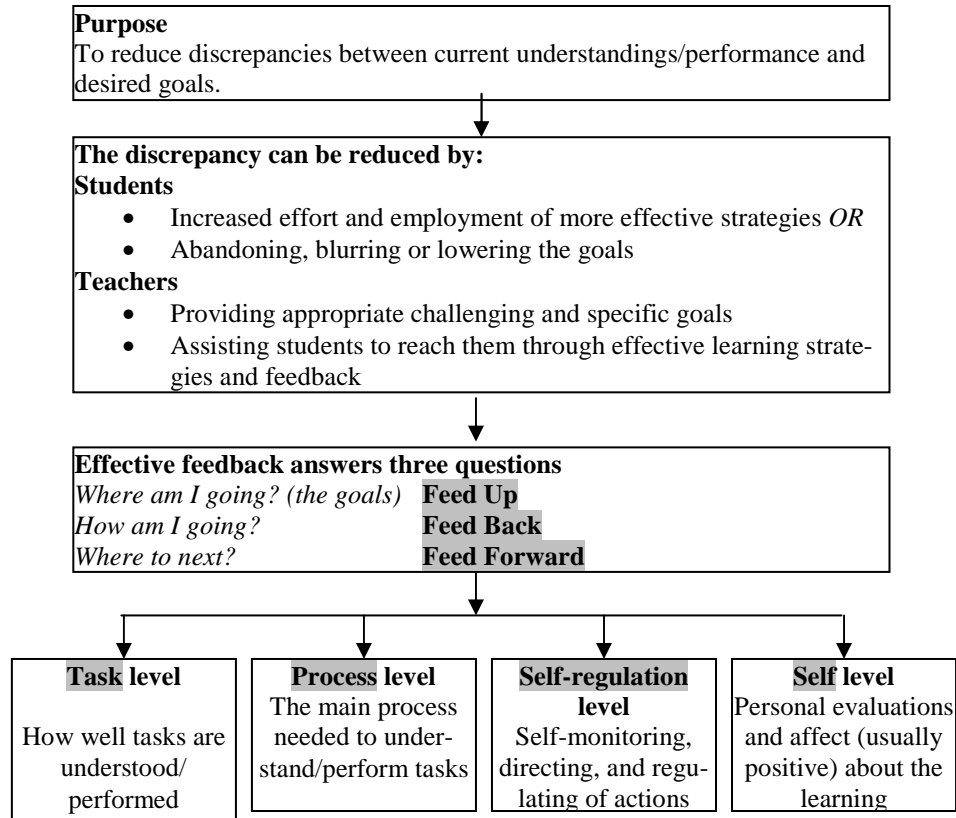


Figure 2. A model of feedback to enhance learning (Hattie & Timperley, 2007, p. 87). Words marked in grey are part of the analytical framework of this study.

<sup>9</sup> A review of the literature is presented in Björklund Boistrup (in press). In a search of *Educational Studies in Mathematics Education* (ESM) and *The International Journal on Mathematics Education* (ZDM), there were a total of ten articles from 2000 and later that met the following criteria: “An explicit focus (can be one of several) on one or several aspects of teacher- and/or student-initiated classroom assessment and with a relation to compulsory school”. It is easy to conclude that classroom assessment is not addressed to a great extent in the two journals. On average, one article with this focus is published in each journal about once every two years. In a cursory literature search, similar results are found for the journals *Journal for Research in Mathematics Education* and *Nordic Studies in Mathematics*.

Since the assessment acts analysed in this thesis are those that can be related to feedback, I give a detailed account of structures that model feedback. Hattie and Timperley (2007) present a model on feedback that is the outcome of a review of studies on how students' achievements are affected by various kinds of feedback (figure 2). In Hattie and Timperley's model, the interest lies mainly in feedback as a "consequence" of performance, where the aim is to reduce the discrepancies between current performances and goals. As indicated, Hattie and Timperley consider three feedback questions (see also Black & Wiliam, 2009; Wiliam, 2010), summarised as feed up, feed back and feed forward. In their model, these feedback questions occur in four levels: task, process, self-regulation and/or self.

Another structure in the literature on feedback is a typology proposed by Tunstall and Gipps (1996), whereby four types of feedback are construed, called types A, B, C and D; see figure 3. The upper part is labelled positive feedback for types A and B, and then turns into achievement feedback for types C and D. The lower part is labelled negative feedback for types A and B and is then transformed into improvement feedback for types C and D.

Type A	Type B	Type C	Type D
<b>Rewarding</b>	<b>Approving</b>	Specifying attainment	Constructing achievement
Rewards	Positive personal expression	Specific acknowledgment of attainment	Mutual articulation of achievement
	Warm expression of feeling	Use of criteria in relation to work/behaviour; teacher models	Additional use of emerging criteria; child role in presentation
	General praise	More specific praise	Praise integral to description
	Positive non-verbal feedback		
<b>Punishing</b>	<b>Disapproving</b>	Specifying improvement	Constructing the way forward
Punishments	Negative personal expression	Correction of errors	Mutual critical appraisal
	Reprimands; negative generalisations	More practice given; training in self-checking	Provision of strategies
	Negative non-verbal feedback		

Figure 3. Typology of teacher feedback. (Tunstall & Gipps, 1996). Words in grey are added to the analytical framework of this study.

The typology put forward by Tunstall and Gipps (figure 3) presents a comprehensive view of feedback that goes from teacher to student. They note that these four types are to be seen as part of a construed model and that the different types are placed on a continuum. Similar assessment acts are presented in Hargreaves, McCallum, and Gipps (2000), where they address the following strategies:

*Evaluating feedback strategies*

- giving rewards and punishments,
- expressing approval and disapproval

*Descriptive feedback strategies*

- telling children when they are right or wrong,
- describing why an answer is correct,
- telling children what they have and have not achieved,
- specifying or implying a better way of doing something and
- getting children to suggest ways they can improve.

(Hargreaves et al., 2000, p. 23)

What is clear in the quote from Hargreaves et al. (2000) is the division between evaluative feedback strategies and descriptive feedback strategies. Similarly, Torrance and Pryor (1998) refer to communication as becoming more “conversational” rather than being “scholastic”.

The structures presented in this section serve as a basis for the analytical framework of the thesis. They will be adapted to incorporate the theoretical considerations.

## 2.2.2 Students’ Involvement in Classroom Assessment

In this study, the relation between classroom assessment and affordances for students’ active agency in the mathematics classroom is addressed in broad terms as I give an account of research on students’ involvement in classroom assessment. Torrance and Pryor (1998) contend that there is disagreement in research over whether formative assessment is mainly teacher-controlled or whether the student can also be invited to take part as an active subject (see also Brookhart, 2007).<sup>10</sup> In this regard, the authors emphasise the importance of students being an active part of classroom assessment. A similar view is offered, for example, by Ljung and Pettersson (1990<sup>11</sup>) and Stiggins (2008<sup>12</sup>).

<sup>10</sup> An example of a research and development project where assessment in mathematics classrooms clearly is controlled by the teacher is described by Romberg (2004).

<sup>11</sup> Ljung and Pettersson (1990) suggest student responsibility for reflecting on their own knowing before, during, and after a teaching unit.

<sup>12</sup> Stiggins’ (2009) main concern is with the students’ involvement in the assessment. He argues that the most important decisions are made by the students. Furthermore, he believes in the great potential value of classroom assessment that is realised when we open up the process and welcome students as full partners in their learning.

Black and Wiliam (2009; see also Wiliam 2010) stress that anyone can be an agent in the assessment, such as the student or peers, although many decisions will be made by the teacher.

A common theme in the literature in terms of student involvement in classroom assessment is students' self and peer assessment. Brookhart, Andolina, Zuza, and Furman (2004) present findings from an action research project in mathematics classrooms. Their study suggests that students' self-assessment, when students really are involved in the process, can add reflection and meta-cognition to rote memory lessons, such as learning the multiplication tables. In some of the research literature, there are ways proposed for how to "create" mathematics classrooms in which students are involved in the assessment via self-assessment (see e.g. Lee, 2006<sup>13</sup>; Boaler, 2009<sup>14</sup>; Wiliam et al., 2004<sup>15</sup>). In the present study, students' self-assessment in the mathematics classroom (see Hattie & Timperley, 2007; Andrade, 2010) is expanded on and included in the findings.

A second theme in the literature is connected with assessment acts where the teacher and/or students act in a way that facilitates feedback taking place; a theme that is part of this thesis. A central notion here is the questions posed by the teacher. One textual aspect emphasised is the openness of the question (e.g. Gipps, 2001<sup>16</sup>; Shepard, 2000). When a question (for example, a task) is open in the sense that there are many correct answers to the question and/or there are many ways of solving the task, the student is invited to take part in the assessment and also demonstrate a variety of mathematics knowing (see also Lee, 2006). Harlen (2007) emphasises open questions that invite students to express their own ideas.

A third theme in the literature regarding students' involvement in classroom assessment, is students' potential to affect the teaching. When this is addressed in literature, it is mainly through emphasising teachers' active use of their assessment of students' performances as feedback for their own

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<sup>13</sup> Lee (2006) presents an improvement matrix as a way for pupils to think about their work in mathematics. The matrix incorporates aspects of communication, systematic working, use of algebra, and use of graphs and diagrams.

<sup>14</sup> Boaler (2009) describes aspects that are important for children's learning mathematics, with assessment being one part. She then primarily promotes 'assessment for learning' with reference to, for example, Black and Wiliam (1998). She includes the importance of the students' knowing *what* needs to be learnt, *how* they are doing, and *how* to improve; feedback is an important element here. She also addresses the need for teachers to view the students' learning as feedback for their teaching.

<sup>15</sup> In Wiliam et al. (2004), a study exploring different classroom activities and their impact on students' achievements is carried out. Many of the activities are connected to students' self-assessment.

<sup>16</sup> Gipps (2001) emphasises open questions in open communication between teacher and student that is oriented towards understanding and respecting each other's perspectives.

teaching (see e.g. Harlen, 2007; Hattie, 2009; Boaler, 2009; and Li, 2000<sup>17</sup>). Here, the students' involvement is indirect. It is the teacher who is the active agent in capturing and reflecting on students' performances for her/his future teaching. In this study, I give an account of assessment acts like those mentioned here, as well as expanding the ways students can be actively involved in classroom assessment in relation to their teachers' teaching.

Mellin-Olsen (1993) considers a specific power relationship when he asks where the student is as a subject in the assessment of mathematics (see also Anderson, 1993<sup>18</sup>; Cotton, 2004<sup>19</sup>). He attests that the student is often treated as an object, as "the one who is assessed". In this study, I refer to arguments presented by Mellin-Olsen.

### 2.2.3 Classroom Assessment and its Relation to Learning

This section considers the relation between classroom assessment and affordances for students' learning of mathematics. It is argued that what is assessed and how the assessment is carried out influence students' learning. In the study by Black and Wiliam (1998) mentioned earlier, they analysed numerous (250) studies, all examining formative assessment. Based on these studies, they argue for the importance of students getting feedback on what qualities their performances demonstrate and also on what they should focus their learning on in the future. The studies referred to by Black and Wiliam indicate a strong association between formative assessment and students' achievements. Similar findings are shown by Hattie and Timperley (2007).

Pettersson (2005) has constructed a model to illustrate what consequences assessment can have for the individual student (figure 4). Pettersson (2005) contends that an assessment that supports and stimulates learning is one where the knowledge demonstrated by a student is analysed and assessed in such a way that the student progresses in his/her learning and feels self-confidence in his/her own ability (I can, want to, dare to). This is in contrast to an assessment that leads to a judgement and perhaps condemnation (I cannot, do not want to, dare not). To achieve this, students need to get feedback on what qualities their performance demonstrates and also on what they should focus their learning on in the future. Motivation is one aspect; moreover, there are research findings that indicate that, in most cases, students' motivation increases when the focus of the feedback is on what is positive,

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<sup>17</sup> Li (2000) conducts a review of the development of assessment practices in China from a historical perspective. Li discusses teachers assessing each student's knowing, giving feedback to students, and relying on knowing demonstrated by students as feedback for their teaching.

<sup>18</sup> Anderson (1993) emphasises students as active agents in classroom assessment. She writes that as active assessors, students exercise a more autonomous role and demonstrate greater decision-making in their learning.

<sup>19</sup> Some information on Cotton (2004) is presented in 2.6.1.

that is, on the student's demonstrated knowing (Black & Wiliam, 1998; Hattie & Timperley, 2007).

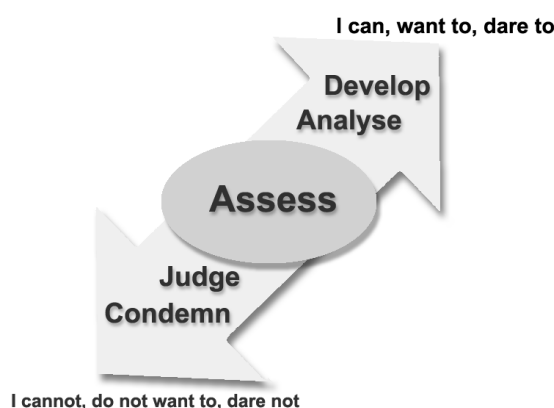


Figure 4. The consequences of assessment (Pettersson, 2005, English version from Pettersson & Björklund Boistrup, 2010, p. 374).

According to the findings presented in the reviews, when addressing (mathematically) incorrect student performances, it is preferable to do this in terms of feed forward and then relate it to the student's future learning. Volmink (1994) stresses the importance of an assessment in mathematics that points out students' accomplishments rather than merely identifying deficiencies, while noting a struggle for social justice and equality.

Although the studies reviewed by Black and Wiliam (1998) rely on quantitative methods, the authors emphasise the importance of qualitative studies for the field of assessment. A similar conclusion was made by Hattie eleven years later (2009). In his synthesis of over 800 meta-analyses relating to students' achievement in school, one of the most powerful influences is found to be feedback. The notion of feedback considered by Hattie (2009) encompasses various meanings: effects of different types of feedback, feedback via frequent testing, teaching of test-taking skills, provision of formative information to teachers, questioning to provide teachers and students with feedback, and immediacy of feedback. Hattie (2009), like Shute (2008), calls for more research in the area – both quantitative and qualitative research – on how feedback works in the classroom and in learning processes. Clearly, this study answers this call, particularly with respect to the subject of mathematics.

#### 2.2.4 Critiques of Research on Classroom Assessment

The literature on classroom assessment includes critical discussions of research-related matters. One such discussion is presented by Dunn and Mul-

venon (2009), who address one criticism regarding the multiplicity of terms in the research on assessment. They write that a more stable and shared lexicon is needed for more productive communication, for example, among teachers, researchers, policymakers, parents and students. Addressing another criticism, Dunn and Mulvenon (2009) offer a critical analysis of Black and Wiliam's (1998) review and some recently published research reports. The authors argue that these studies contain too many statistical shortcomings to be used as a basis for advocating a specific practice of "formative assessment". The first of these criticisms is addressed in this thesis when I draw on earlier frameworks to construct the analytical framework for my study. However, I do not believe that a "shared lexicon" as proposed by Dunn and Mulvenon is possible. Depending on the theoretical perspectives used, each researcher will have to make adjustments in whatever framework is adopted. The second criticism by Dunn and Mulvenon concerns quantitative studies and, in my interpretation, their underlying positivist assumptions, but this is not relevant to this study. When I discuss the trustworthiness of this study in the Methodology chapter, I rely on alternative terms that are suitable for qualitative research and from an interpretative viewpoint.

An additional critical theme relates to the content of the assessment. Delandshere (2002) writes that a common question in classroom assessment research is "What do students know?" instead of a more central, and critical, question: "What does it mean to know?" The researcher needs to address the issue of knowledge and knowing in ways that can, for example, guide classroom assessment. In this thesis, matters of content and knowing are connected to affordances for students' learning of mathematics. I also address content matters in Section 2.4 as well as in Theoretical Considerations.

Another criticism is taken up by Sebatane (1998). In addressing how institutional frames play roles in classroom assessment in different ways, he argues that reviews like Black and Wiliam (1998) cannot be generalised to apply to every country, especially in environments of a developing country. Sebatane further considers traditions, which it is essential to include in research and which can explain teachers' resistance, for example, when it comes to inviting students into assessment processes through a practice of self-assessment. It is not just teachers who are part of various assessment traditions; this also is also true of parents and students. Shepard (2005) emphasises that educators will not be able to act on the basis of research on formative assessment if there is not a "larger cultural shift in which teachers and students jointly take up learning as a worthy endeavour" (p. 68; see also

Shepard, 2000; Smith & Gorard, 2006<sup>20</sup>). Morgan (2000) offers a critique similar to Sebatane's (1998), noting what she calls mainstream traditions of mathematics assessment research. She emphasises research that adopts a social perspective, arguing that a main concern of research from a social perspective is to understand how assessment works in mathematics classrooms and more broadly in education systems. As I see it, one consequence of this reasoning is that it is essential to view the mathematics classroom as part of an institutional context (see Section 2.6).

One area critiqued in the literature on assessment in mathematics classrooms is equity issues (Broadfoot, 1996; Gipps, 1994, 2001). This can be on a system level, where it can be argued assessment serves in the selection, certification and control of groups of students (Broadfoot, 1996). These processes are also identified in classroom work. Watson (2000) addresses equity problems in assessments in the day-to-day communication in mathematics classrooms since, according to her findings, the same student's performance would most likely be assessed differently by different teachers (see also Morgan & Watson, 2002). In Mercier, Sensevy, and Schubauer-Leoni (2000) too, there are findings indicating that the feedback students receive from the teacher in the mathematics classroom varies. In Mercier et al., teachers' assessment of students' actions are described to be affected by each student's social position. On the other hand, Watt (2005) draws on earlier research when she argues that teachers' assessments, for example, in contrast to Watson (2000), can be trusted. In this thesis, equity issues are addressed indirectly when the findings of the analysis are presented in terms of affordances for students' active agency and learning in the construed discourses.

### 2.2.5 Classroom Assessment in Relation to Theories of Learning

Murphy (1999) considers awareness with respect to theories of learning in relation to assessment (see also e.g. Gipps, 1994, 2001; Lindberg, 2005a; James, 2008; and Shepard, 2000). Murphy presents a dichotomy between two groups of theories of learning. One is interested in the individual's internal mental processing. The other sees human knowledge and interaction as inseparable from the world. Similarly, Torrance and Pryor (1998) present two models of classroom assessment where theories of learning are an integral part.<sup>21</sup> One, called the "convergent" model, based on behaviourist theo-

<sup>20</sup> In Smith and Gorard (2006), the effects of traditions are illustrated in a study where a developmental project on formative assessment in a school did not work out as planned. The students received written feedback on tests, which has proven to be powerful, instead of marks (e.g. Black & Wiliam, 1998; Black et al., 2003). The project did not work out as planned since the teachers' written feedback (for example "Well done!") was provided in such insufficient detail that the students, in fact, received less information than if they had been given marks on the tests.

<sup>21</sup> The models by Torrance and Pryor (1998) are a summary of a study they performed on classroom assessment.

ries, considers the interaction between student and curriculum from the point of view of the curriculum, judgmental evaluations, and a view of assessment as carried out by the teacher. Another, proposed by the authors, called the “divergent” model, is based on a socially oriented model of learning. The divergent model also examines the interaction between student and curriculum from the student’s view, descriptive assessments and a view of assessment as carried out jointly by the teacher and student. Of the two, the divergent model is more relevant to this study, for example, with regard to students’ agency and thus serves as inspiration for the study. There are also aspects considered in this study that are not identified in the Torrance and Pryor’s model, such as an emphasis on semiotic resources and the institutional context.

## 2.2.6 Models of Classroom Assessment Over Time

In this study, my interest in assessment acts lies not only in analysing assessment acts between teacher and students as though the acts are separate occasions. I also have an interest in viewing assessment acts and discourses along a timeline. I present two models where classroom assessment is seen over a longer period of time. These are both constructed in a Swedish context and are therefore of special interest to this study. The first model was developed by Ljung and Pettersson (1990) and depicts a proposed formative classroom assessment process (figure 5).

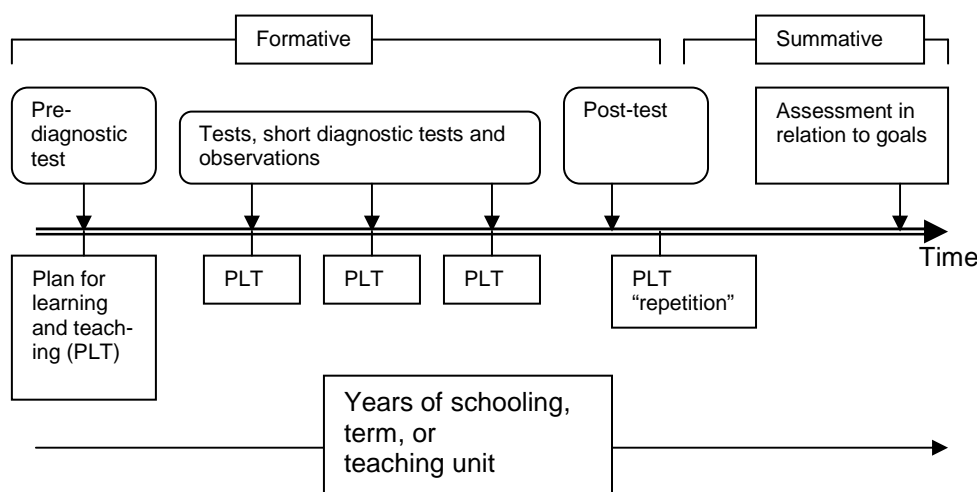


Figure 5. A model of formative classroom assessment. Translated and adapted from Ljung and Pettersson (1990, p. 13).

As indicated in the lower portion of the model (figure 5), the timeframe in this model can be several years, a term or a teaching unit. At the beginning

of the period, there are one or several pre-diagnostic tests, and during the period there are a number of short diagnostic tests and/or observations. It is expected that the results of these will be followed by adjustments in the plan for learning and teaching. At the end, there are post-tests and finally some kind of summary assessment relating to stated goals.

In Selander and Kress (2010; see also Selander, 2008a), a model for a learning design sequence is presented (figure 6). Here, the interest is in the teaching and learning as a whole and not on assessment in particular. The model is part of a design-theoretical perspective. This perspective draws, on one hand, on the active, situated representation and communication in a specific institutional environment and, on the other hand, on a multimodal theory in order to follow, analyse and understand in more detail the meaning made through different semiotic resources.

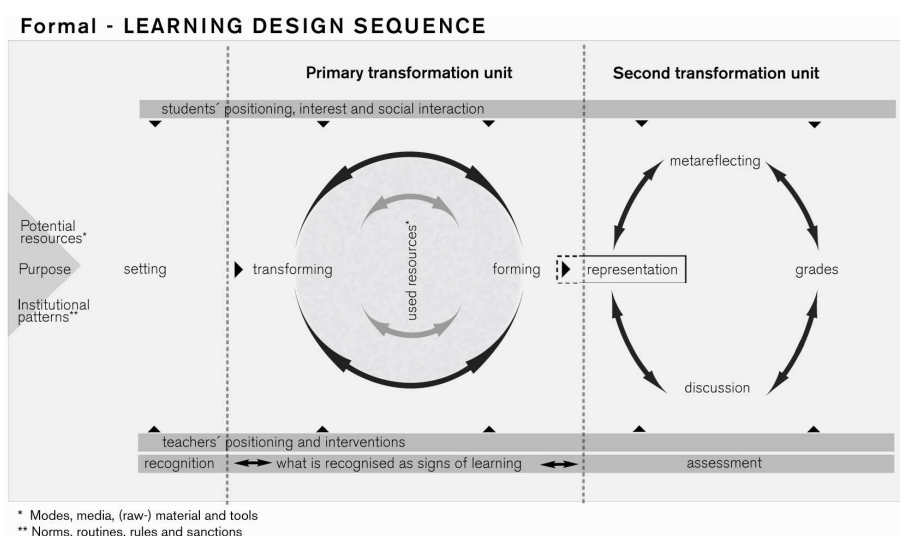


Figure 6. Formal learning design sequence (Selander & Kress, 2010, translation: Staffan Selander<sup>22</sup>).

Selander (2008a; see also Selander & Kress, 2010) describes how, according to this model, a sequence starts when the teacher introduces a new task or teaching unit and sets the conditions for the work. During the primary transformation unit, the students work on the task(s) and there are occasionally interventions by the teacher. During these interventions, assessment acts are present. Here, students' communication is recognised (or not) as signs of learning. The secondary transformation unit includes students representing their work. There is also space here for meta-reflections and discussions. Selander (2008a) proposes that if the goals, as well as expectations of the

<sup>22</sup> This picture of the model is used with the permission of Staffan Selander.

process and the product, are clearly defined and explained in the beginning, both students and teachers will have a powerful tool for reflection and assessment. At the end of the sequence, some kind of summary assessment can take place. The two models by Ljung and Pettersson (1990) and Selander and Kress (2010) serve as inspiration for parts of the analysis when I follow assessment acts and focuses in the mathematics classroom along a timeline (see Sections 5.2.6 and 6.2.7).

In Section 2.2, I described previous research conducted on classroom assessment in general and on mathematics education in particular. Many of these studies have been performed in the Anglo-Saxon world. Other countries and cultures are represented, but Sweden's presence is limited. The reason for this is simple. I have not managed to find many Swedish studies on assessment in mathematics classroom related to compulsory school. In one related project (started in 2004), teachers in communication with each other and with researchers have developed methods for bringing students in as a subject in the assessment (PRIM-gruppen, 2010b; also described in Ridderlind, 2009). The lack of Swedish research on classroom assessment is considered in an overview by Lindberg (2005b; see also Lindberg, 2005a).

## 2.3 Related Studies in Mathematics Education

The research on classroom assessment presented in Section 2.2 is performed with an explicit interest in classroom assessment, partly in mathematics classrooms. In this section, I present studies in which classroom assessment as such is not emphasised but there are still connections to the study since the research is on communication between teacher and student.

One example of teacher-student communication where it could be claimed assessment is present is scaffolding. Shepard (2005) describes phases of scaffolding and elaborates on how there is also, in fact, formative assessment going on when the teacher “uses insights about a learner’s current understanding to alter the course of instruction and thus support the development of greater competence” (p. 67; see also Shepard, 2000). She writes that from a sociocultural perspective formative assessment (like scaffolding) is a collaborative process. Below, I give an account of studies performed in Sweden.

J. Emanuelsson’s (2001) research is on both mathematics and science education, and he is interested in how teachers’ questions provide them with possibilities to see, understand, recognise, and experience students’ ways of understanding. Using phenomenography and variation theory (see Runesson, 1999), J. Emanuelsson examines what the students may focus on and deal with, as a consequence of the teacher’s questions. The findings indicate that, in mathematics, the teachers are largely open to the students’ learning when it comes to remembering facts and procedures. In another study,

Löwing (2004) describes her interest in terms of how teachers communicate with students to support their learning in mathematics. She also presents findings concerning the frames that the teachers create in the classrooms, describing how the teachers did not determine the students' pre-knowledge and expressed their goals for teaching in terms of "how to do" instead of "how to understand". Most of the teachers in Löwing's study did not use adequate language in terms of mathematics content and the students' understanding. Neither J. Emanuelsson (2001) nor Löwing (2004) claim to specifically examine assessment. Nevertheless, adopting a broad notion of classroom assessment, I find it possible to view these studies partially contributing to research on assessment and link them with some of the findings in the analysis and outcomes chapters of this study. Moreover, when I address institutional and discursive aspects, which neither Emanuelsson nor Löwing clearly does, I provide a basis for discussing and understanding findings from classroom research (on assessment in mathematics classrooms).

## 2.4 The "What" Question in Mathematics Classroom Assessment

Since this is a thesis on assessment in mathematics classrooms, it is inevitable and also desirable to address the "what" question in an overview of previous research, which is the theme of this section. This is connected to the second research question as well as to students' affordances for learning mathematics.

### 2.4.1 The Content of Classroom Mathematics

There are similarities in the research literature for describing the mathematics content to be learnt by students. Clarke (1997<sup>23</sup>), de Lange (1999<sup>24</sup>) and Niss (2003<sup>25</sup>) consider activities both in relation to "pure" mathematics activities and to contexts outside mathematics. Recently there have been Swedish frameworks presented consisting of competencies drawing on Niss

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<sup>23</sup> Clarke (1997) argues that assessment should model "the mathematical activity we value" (p. 8). In his model, the mathematics content is structured through mathematical activities such as applying mathematics in different kinds of contexts, an appropriate use of mathematical language, tool selection and the like.

<sup>24</sup> de Lange (1999) describes what is called mathematical literacy. Using this, de Lange and his colleagues follow, or coordinate with, the OECD Program for International Student Assessment (PISA). They present a non-hierarchical list of mathematical competencies: mathematical thinking, mathematical argumentation, modelling, problem posing and solving, representation, symbols and formal language, communication, and aids and tools.

<sup>25</sup> The competencies described by Niss (2003) are similar to those described by de Lange (1999).

(2003); see Skolverket (2010b<sup>26</sup>); and Lithner, E. Bergqvist, T. Bergqvist, Boesen, and Palmberg (in press<sup>27</sup>). De Lange and his colleagues describe three levels for mathematics skills (see also de Lange, 2007): (1) reproduction, procedures, concepts and definitions; (2) connections and integration for problem solving; (3) mathematisation, mathematical thinking generalisation and insight. These levels are also used in Romberg (2004). In Schoenfeld (2007b<sup>28</sup>), the applications of mathematics in contexts outside mathematics are only indirectly present.

In this study, the interest lies in how assessment acts consider a range of aspects of mathematics competence, including critical reflection. Gellert and Jablonka (2009<sup>29</sup>; see also Jablonka & Gellert, 2007) address how, through technology, mathematics is becoming more and more implicit in social interactions in many areas. Drawing on Skovsmose, they contend that mathematics “has not only become an integrated part of technological planning and decision making but also an invisible part of social structuration, encapsulated in political arguments, technologies and administrative routines” (Gellert & Jablonka, 2009, p. 22f). One can say that mathematics is a hidden part in many decisions that affect people’s lives. Gellert and Jablonka argue for an active citizenship that includes a mathematics competence where decisions based on “hidden” mathematics are more often made apparent and also criticised. Volmink (1994) addresses critical aspects in the sense of how mathematics can be a powerful tool in a critical pedagogy which includes issues like equality, anti-racism and so on (see also Mellin-Olsen, 1987).

In this study, I consider critical reflection based on Skovsmose (1990, 2005, 2006). He argues that mathematics competence<sup>30</sup> involves not only mathematics notions, but also support for a critical citizenship “implying that people not only need to see themselves as affected by political processes, but also as possible participants in such processes” (Skovsmose, 2005, p. 46). Skovsmose divides this mathematics competence into three aspects, which are first addressed in Skovsmose (1990) and expanded on here, while also drawing on Skovsmose (2005):

- Dealing with mathematics notions, mathematics knowing itself
- Applying mathematics notions in different contexts

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<sup>26</sup> Skolverket (2010b) considers upper secondary school and mathematics demonstrated in vocational programs

<sup>27</sup> Lithner et al. (in press) label their framework a research framework, which is constructed to be a tool in analysing empirical data.

<sup>28</sup> Schoenfeld (2007b) presents mathematical proficiency divided into (a) Knowledge base, (b) Strategies, (c) Metacognition, (d) Beliefs and Dispositions.

<sup>29</sup> Gellert and Jablonka (2009) use the term mathematical literacy, which is similar to the notion of mathematics competence operationalised in this thesis.

<sup>30</sup> Skovsmose uses the term *mathemacy*.

- Critically reflecting on such applications including consequences of different mathematics decisions in people's lives.

It is important to note that the three aspects should not be seen as a hierarchy. A person can, for example, demonstrate knowing with respect to the second and third aspects and not the first. Jablonka (2003) expands on this:

Consciousness of the values and perception of mathematical knowledge associated with distinct mathematical practices and their history can compensate to a large extent for a lack of detailed expert knowledge. Introducing critical discussions, as proposed here, means introducing a new discourse into school mathematics that will eventually establish a new practice of out-of-school mathematics of informed citizens (Jablonka, 2003, p. 98).

In my research, I consider it highly relevant to analyse to what extent assessment acts promote this new discourse, presented by Jablonka (2003). There is a notion of empowerment when students are given the opportunity to take part in a discourse of using, applying and critically reflecting on uses of mathematics concepts (Skovsmose, 1990, 2005). I return to Skovsmose's three aspects of mathematics competence further on in this thesis, firstly in Theoretical Considerations. There, I also elaborate on the notion of competence as a whole (Ellström, 1992; Wedege, 2001).

#### 2.4.2 Processes in Mathematics

As a background for some of the fine-grained analysis, I address two structures from the Nordic context where specific attention is drawn to processes in mathematics, and in which critical aspects are included.

Lindenskov and Wedege (2001) present a working model that has four dimensions: Media, Context, Personal Intention, and Substance. Under the heading Personal Intention, they propose the following processes: to inform (be informed), to construe, to evaluate, to understand, to be valued, to practice, to be entertained, to sharpen one's argument, and to gain information. Björklund, Pettersson, and Tambour (2002) construct an open model of contents and perspectives of mathematics (figure 7). In the model by Björklund et al. (2002), the relevant part here is the inner circle, where the authors have placed the processes logical reasoning, defining, modelling, problem solving, generalising, seeing connections, multimodal communication, and critical scrutiny. The processes present in the models by Lindenskov and Wedege (2001<sup>31</sup>) and Björklund et al. (2002) are a basis for part of the analytical framework.

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<sup>31</sup> I do not use the processes by Lindenskov and Wedege (2001) in the sense of intentions, but in the sense of processes present in the communication between teacher and student(s).

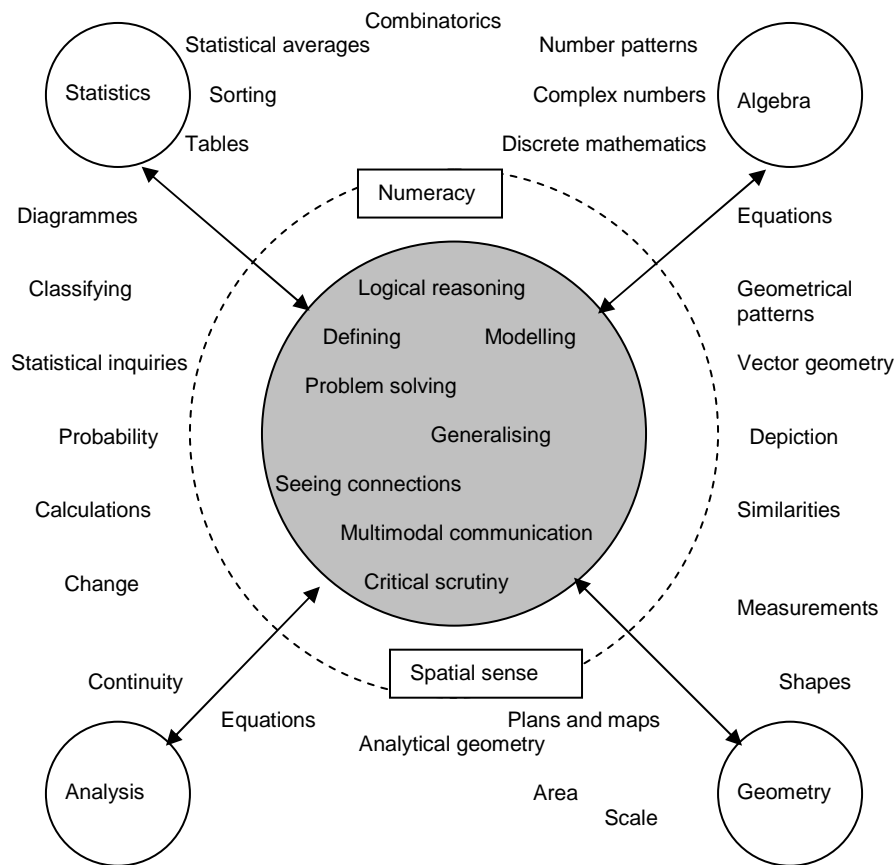


Figure 7. Overview of content and perspectives of mathematics. Translated and adapted from Björklund et al. (2002, p. 54). The processes in the grey circle are partly present in the analytical framework of this study.

## 2.5 Studies Addressing the Roles of Semiotic Resources

A main assumption in this study is that all communication, such as assessment acts in mathematics classrooms, are constituted by different communicational resources, such as speech, gestures, pictures, artefacts and the like. This also applies to communication through silence. An account of this relative to classroom assessment is given in Black et al. (2003), which examine studies showing that if the teacher waits in silence for just three seconds or more after posing a question to a student, there is an increased chance of getting an elaborated answer from the student.

There is an interest in semiotic issues in the “field” of mathematics education. One example is a special issue of *Educational Studies in Mathematics* from 2006 (Sáenz-Ludlow & Presmeg, 2006). Another is an anthology on the subject from 2008 (Radford, Schubring, & Seeger). In Sabena (2008), the interest is in the roles of gestures in mathematics classroom communication and how these differ from other resources such as language and symbols. As will be argued, in this study I have a broader interest than, for example, Sabena when I adopt a social semiotic perspective, which includes an interest directed at communication in a broad sense with a special interest in semiotic resources and their relation to each other and the social practice. Another example of a study on classroom assessment in mathematics is Moschkovich (2007<sup>32</sup>), who emphasises how communicational resources other than words can demonstrate mathematics knowing by students. I have often identified arguments in the research literature suggesting that total openness regarding available semiotic resources for students to demonstrate (mathematics) knowing is most beneficial in gaining access to a variety of students’ demonstrated knowing (see e.g. Moskal & Magone, 2000<sup>33</sup>). In this thesis, I add to this view.

Morgan (2006) gives an account of what social semiotics has to offer mathematics education research. She argues that language, from a social semiotic perspective, is conceived as socially organised; that is, it clearly takes place in a social environment and is also structured by that environment. Another contribution of social semiotics, according to Morgan, is the recognition in this theory of the variety of functions of language and other semiotic resources. She writes:

Every instance of mathematical communication is thus conceived to involve not only signification of mathematical concepts and relationships but also interpersonal meanings, attitudes and beliefs. This allows us to address a wide range of issues of interest to mathematics education and helps us to avoid dealing with cognition in isolation from other aspects of human activity (Morgan, 2006, p. 220).

As will subsequently be shown, in this thesis social semiotics serves the function of helping, as Morgan notes in the quote above, “address a wide range of issues of interest to mathematics education”. In Morgan (2006), social semiotics is used with an interest in linguistics and the construction of the nature of school mathematics activity. Other studies on mathematics

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<sup>32</sup> Moschkovich’s interest is English-learning students in mathematics classrooms.

<sup>33</sup> Moskal and Magone (2000) emphasise the importance of sensitivity to ways in which the semiotic resources used in the presentations of tasks affect students’ responses. They also argue in favour of the benefits when students are free to choose the semiotic resources they use to perform tasks since this can give insight into the students’ reasoning.

classrooms that adopt a social semiotic perspective are O'Halloran (2000<sup>34</sup>) and Meaney (2005<sup>35</sup>).

There are also studies in education research regarding various disciplines where a social semiotic perspective with a *multimodal* approach is adopted. In these studies, semiotic resources are viewed as a part of multimodal ensembles that serve communication and representation functions; see Insulander (2010<sup>36</sup>), Kress, Jewitt, Ogborn, and Tsatsarelis (2001<sup>37</sup>), Kress et al. (2005<sup>38</sup>), Lindstrand (2006<sup>39</sup>) and Öhman-Gullberg (2008<sup>40</sup>). These studies have provided inspiration for this study in operationalising multimodal aspects as well as social semiotic meta-functions (see Section 3.2).

## 2.6 The Classroom in the Institutional Context

Viewing assessment acts in mathematics classrooms as part of the institutional context is not often a main theme in the literature on assessment in (mathematics) classrooms (Björklund Boistrup, 2009; Morgan, 2000; see also Lerman, 1994ab, with respect to mathematics classroom research). Since social aspects in terms of the institutional context are a main focus of this study, I give an account below of a selection of classroom research with similar considerations and present some models that incorporate discourses.

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<sup>34</sup> In O'Halloran (2000), there is an interest in three semiotic resources/modes: mathematical symbolism, visual display and language. The author addresses the impact that the multisemiotic nature of mathematics has on classroom communication.

<sup>35</sup> Meaney (2005) looks at affordances of viewing mathematics as text. Relying on Halliday (see 2004), she analyses three different functions of a text in part of her article.

<sup>36</sup> Insulander (2010) studies visitors' engagement and meaning-making in museums adopting a design-theoretical perspective. She uses multimodal transcripts and social semiotic meta-functions.

<sup>37</sup> Kress et al. (2001) present a multimodal approach. They draw on social semiotics and focus on the science classroom.

<sup>38</sup> Kress et al. (2005) study teaching and learning in English classrooms using social semiotics with a multimodal approach. This study is on visual displays and spatial design in the English classroom and how these signs can be seen as signs of school English.

<sup>39</sup> Lindstrand (2006) describes and analyses teenagers' collective work and communication with film using social semiotics with a multimodal approach.

<sup>40</sup> Öhman-Gullberg (2008) investigates how students create and interact with visual representations as a signifying practice in school, using a design-theoretical perspective. She presents results from her analysis of students' films while also developing the gender perspective.

### 2.6.1 Classroom Studies Where Social Aspects are Addressed

Social aspects relative to assessment in mathematics education are addressed in Morgan, Tsatsaroni, and Lerman (2002<sup>41</sup>). The authors suggest that Bernstein (e.g. 1996) provides powerful tools for these issues (see also Lerman & Zevenbergen, 2004; Cotton, 2005).

In a classroom study by Persson (2009), it is apparent that the classroom is viewed as being connected with the broader institutional context. Her tool for this is institutional theory (Fleck, 1997; Douglas, 1986) in combination with a design-theoretical perspective (Rostvall & Selander, 2008; Selander, 2008a). Jewitt (2005) is another study where multimodal social semiotics is combined with a complementary theory, activity system theory (see e.g. Engeström, 2000), in order to bolster the emphasis on institutional, and hence social, aspects.

There are also a number of studies, including this one, where the work of Foucault is addressed for similar purposes (see also Valero, 2009). One example is a study by Jablonka (2006), which is interested in classroom communication with students and teachers in situations where the students are at the (white) board in front of the classroom. Jablonka compares data from Germany, Hong Kong and the United States. She discusses the findings in terms of, on one hand, aspects of classroom practice resulting from local cultural tradition and, on the other hand, those “which can be interpreted as arising from the ‘culture’ of mathematics instruction in the context of formal schooling” (p. 107). In Norén (work in progress), the interest is in students from a minority background in mathematics education. Norén construes discourses that are products of selective traditions: the public, traditional mathematics education, and language discourses in mathematics classrooms. She argues that power relations in the broader society are repeated in these discourse practices. Her findings also show that the students in the classrooms are not passive recipients but agents of their learning and empowerment. Cotton (2004) discusses discourses of assessment in mathematics education and proposes an alternative discourse where “an overriding principle might consider assessment as a dynamic force that sees student learning both as a part of the assessment and as a result of the assessment” (p. 228). As will be made clear in Theoretical Considerations, I draw on Foucault in relation to the concepts discourse, institution, power, and agency. The studies mentioned serve as inspiration for this.

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<sup>41</sup> Morgan et al. (2002) use Bernstein’s work (e.g. 1996) in bringing together macro-sociological analyses with their realisation in the classroom. In doing so, they discern the discourses of assessment within which teachers carry out activities of assessment. They construe a model for teachers’ subject positions (whether the teacher accepts or rejects the official discourse) in the education discourse and their orientation in assessment practice.

## 2.6.2 Models – With Discourses

It is apparent in the review of the literature on classroom research that a dichotomous picture is often identified in models, sometimes through the use of discourses. This is the case for research on mathematics classrooms in Sweden (e.g. Persson, 2006<sup>42</sup>) and research and/or theories on classroom assessment (e.g. Broadfoot & Pollard, 2000; Lindström, 2005; Ljung & Pettersson, 1990; Torrance & Pryor, 1998). Palmer (2005; see also Palmer, 2010) describes two discourses regarding mathematics education (figure 8). Both are construed from a report by a mathematics delegation initiated by the government (SOU 2004:97). The discourse on the left is construed from the delegation's description of common teaching practice in mathematics classrooms. The discourse on the right is construed from the kind of mathematics education considered by the delegation to be desirable.

<b>The discursive practice – textbook dependence</b>	<b>Mathematics delegation's vision of mathematics education</b>
meaningless	meaningful
boring	fun
individual work	collaboration
single-minded	variation
quiet	communication
destructive	constructive
poor	rich
narrow	broad
individual projects	collaborative projects

Figure 8. Model of discourses with concepts in a schematic sketch (Palmer, 2005<sup>43</sup>, p. 55, my translation).

Shown in the left column is a dominant discourse in mathematics education where individual work in the mathematics textbook is an essential part. In the right column is Palmer's version of the mathematics delegation's vision of mathematics education. This includes rich mathematics activities with meaningful and cooperative work in group projects. A similar dichotomous set of discourses is presented in Mellin-Olsen (1991), called task discourse and alternative discourse. In Walkerdine (1988), a discourse connected to the

<sup>42</sup> Persson (2006) describes two thought styles regarding school mathematics, drawing on Fleck (1997). One thought style is present in the thought collective that consists of school staffs and their work. In this thought style, there is an emphasis on the textbook. The other thought collective is teacher education. The thought style here is connected to steering documents with an emphasis on students' experiences, cooperation, reasoning and so on.

<sup>43</sup> Palmer (2005) construes several discourses linking pairs into dichotomies. In constructing the table, Palmer (2005) writes the words used and re-enters them in the table. She also writes the opposite word even if it is not clearly stated but is indirectly present in the text.

task discourse is construed from interaction between teacher and children – the testing discourse, where the teacher “asks the children questions to which she clearly knows the answer, and by doing so achieves the focusing on the aspect [...] which she wants the children to consider” (Walkerdine, 1988, p. 122f).

There are also, albeit not many, studies where a broader set of discourses are found, for example Morgan et al. (2006) and Askew and Lodge (2000). The theoretically construed model in Askew and Lodge consists of three feedback discourses connected to models of teaching (and views of learning) (figure 9).

<i>Model of teaching</i>	<i>Feedback discourse</i>
Receptive-transmission	<ul style="list-style-type: none"> <li>-Traditional discourse in which ‘expert’ gives information to others to help them improve</li> <li>-Primary goal to evaluate</li> <li>-Feedback is a gift</li> </ul>
Constructive	<ul style="list-style-type: none"> <li>-Expanded discourse in which ‘expert’ enables others to gain new understandings, make sense of experiences and make connections by the use of open questions and shared insight</li> <li>-Primary goal to describe and discuss</li> <li>-Feedback as a two-way process (ping pong)</li> </ul>
Co-constructive	<ul style="list-style-type: none"> <li>-Expanded discourse involving a reciprocal process of talking about learning</li> <li>-Primary goal to illuminate learning for all</li> <li>-Feedback is a dialogue, formed by loops connecting the participants</li> </ul>

Figure 9. Models of discourses of feedback (parts of Askew & Lodge, 2000, p. 4).

In the final analysis and outcomes chapter (Chapter 8), I elaborate on the discourses presented above and connect to them in construing discourses of assessment in mathematics classrooms.

## 2.7 Assessment in Mathematics in Sweden

In this section, I position classroom assessment in a Swedish context. This encompasses both the Swedish school system as such and a summary of some of the discussions that are taking place with regard to assessment.

### 2.7.1 The Swedish School System

The Swedish steering system of teaching including assessment is quite different compared with many other countries. One aspect is that there is no external examination throughout compulsory school and upper secondary school. The marks (grades) that the students get (starting from the eighth year of school) are determined by the teacher. In this respect, one can claim that there is a great trust in teachers in the Swedish system. The Swedish system is described as goal-based, with a high degree of local responsibility (Kjellström & Pettersson, 2005; see also Jönsson, 2010; Lindberg, 2005a). For example, there are no official textbooks that must be used and the decision of what teaching material to purchase is made on a local level. The responsibility for education lies mainly with the municipalities and authorities responsible for independent schools. There are a variety of “steering” documents, described in the next section. The quotation marks around the word steering indicate that these documents do not, in fact, steer teaching in full. This is described with respect to mathematics education in Sweden in a report from a mathematics delegation initiated by the government (SOU 2004:97, see also Skolverket, 2003b).

The national syllabus for mathematics that was in place during the data collection phase of this study was first issued in 1994 and revised in 2000. In the syllabus, there are goals to aim for, which are expected to be a basis for teaching. There are also goals which students should have attained, at a minimum, by the end of the fifth and ninth year of school.<sup>44</sup> As noted above, Swedish education is a goal-based system. That is, it is not stated in the syllabus how the teaching should be executed; the goals for the students’ learning are simply made clear. To support the teachers’ assessment in relation to goals to be attained (and also marking (grading) in the ninth year of school), national tests are developed in mathematics (as well as in Swedish and English) on behalf of the National Agency for Education (Kjellström & Pettersson, 2005). Materials are also developed for the purpose of providing help for the teachers’ formative assessment (Skolverket, 2001; 2003a). Pettersson (2005) describes how the Swedish national syllabus in mathematics has changed over the years. These changes have also affected what assessment is expected to focus on. Pettersson writes that the subject of mathematics and its content have expanded and become more in-depth in a comparison of syllabuses from the nineteenth century onwards.

### 2.7.2 Steering Documents in Relation to This Study

In the following section, I give an account of what is stated in the Swedish Education Act, national curriculum and national syllabus that has relevance

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<sup>44</sup> In 2008, additional goals were included for the third year of school (which was after the data gathering period of this study) (Skolverket, 2008).

to the purpose of this study.<sup>45</sup> It should be noted that I do not view my role as a researcher to include checking whether teachers in the classrooms visited are following the stipulations in these documents. Rather, as described in the first chapter of the thesis, I am driven by curiosity about what the discipline of mathematics education can learn from mathematics classrooms with respect to assessment.

In the Education Act (SKOLFS 1985:1100) in force during the time the data for this study were gathered, it is stated that all children and young people shall have equal access to education in the national school system. Moreover, education shall be of equal standards in each type of school, regardless of where in the country it is provided (Chapter 1, §2). Linked to this right to receive education is an obligation for all children to attend compulsory school (Chapter 3, §1). The norms for the equivalence of education are specified by national goals in the national curriculum, as well as by goals in the national syllabi. I find connections to this study in terms of students' equal access to education of equal standards. This presupposes that assessment practices in different classrooms should provide equal affordances for students' active agency and learning of mathematics.

In the Education Act, it is stipulated that students are expected to have influence over their education (Chapter 4, §2). This is also reflected in the national curriculum for compulsory school (SKOLFS 2006:23):

By participating in the planning and evaluation of their daily education, and exercising choices over courses, subjects, themes and activities, pupils will develop their ability to exercise influence and take responsibility (SKOLFS 2006:23, p. 5).

I regard this as an example of affordances for students' active agency explicitly mentioned in the Education Act. Furthermore, in the national curriculum it is stated that the school should make the goals of education clear to pupils and parents, as well as the requirements of the school and the rights and obligations of pupils and guardians. This is related to fundamental democratic values and respect for the value of every human being that are specified in the Education Act (Chapter 1, §2; see also Chapter 4, §1). Education must provide pupils with knowledge and skills and support their harmonious development into responsible human beings and members of the community.

Below are the goals in the national curriculum for assessment in compulsory school.

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<sup>45</sup> The documents whose aim is to steer classroom work in Sweden are the Swedish Education Act, national curriculum, national syllabi, municipal school plans and a local work plan for each school. The first three were selected for this discussion since they are superordinate to the other two.

The school should strive to ensure that all pupils:

- develop increasingly greater responsibility for their studies and
- develop the ability to assess their results themselves and to place their own and others' assessment in relation to their own achievements and circumstances.

The teacher should:

- through personal interviews further the pupils' development in terms of knowledge and social awareness,
- on the basis of the requirements stipulated in the syllabi comprehensively assess each pupil's learning, and report this orally and in writing to the pupil and the home as well as inform the head teacher,
- taking as the starting point the wishes of the parents, keep the pupils and the home continuously informed about progress in school, what is needed for development and
- when awarding grades, make use of all available information on the pupil's knowledge in relation to the requirements of the syllabus and make a comprehensive assessment of the knowledge acquired (SKOLFS 2006:23, p. 17).

In this quote, notions are emphasised that are similar to the research on classroom assessment referred to in Section 2.2. The student should take an active part in the assessment practice through self-assessments; at the same time, the teacher has a responsibility to make well-informed assessments which the students (and parents) are well aware of. This is of interest to this study in terms of assessment acts in the mathematics classrooms.

As for affordances for students' learning of mathematics, I suggest that some aspects of mathematics competence, including "critically reflecting" and others mentioned in Section 2.4, are expected to be present in classroom communication since the Education Act refers to students' learning of fundamental democratic values. Critical aspects of students' knowing are also made clear in the national curriculum, as in the following:

It is also necessary for pupils to develop their ability to critically examine facts and relationships and appreciate the consequences of the various alternatives facing them (SKOLFS 2006:23, p. 5).

The quote above refers to teaching in general and not specifically to mathematics, although it applies to mathematics as well. The goal in the national curriculum regarding mathematics is that students: "have a mastery of basic mathematical principles and can use these in everyday life" (p. 10). The critical aspect of mathematics competence is not clearly present here; nevertheless, the other two aspects according to Skovsmose (1990, 2005), "dealing with mathematics notions" and "applying mathematics notions" (see Section 2.4.1), are. In the national syllabus for mathematics (Skolverket, 2008), emphasis is placed on similar values, including critical ones relating to democracy, as already mentioned ("be able to follow and participate in

decision-making processes in society”, p. 23). Looking more specifically at the goals stated in the syllabus, “dealing with mathematics notions” dominates the goals that students should attain by the fifth year of school. Also among the goals to aim for are “applying mathematics notions” and “critically reflecting on such applications”, particularly expressed as follows:

The school in its teaching of mathematics should aim to ensure that pupils [...] – develop their ability to use simple mathematical models, as well as critically examine the assumptions, limitations and uses of these models (Skolverket, 2008, p. 24).

However, the critical aspect here concerns the models that students have chosen to apply. There is nothing explicit in the syllabus about a critical reflecting on mathematics models used by others affecting, for example, students’ everyday life.

Nor is there much specified in the national curriculum about multimodal aspects. When different forms of expression are specified, it is not clear whether this regards all school subjects, and it seems to be more a matter of creativity alongside more theoretical subjects like mathematics, for instance. In the national syllabus, communicating in mathematical language and expressions is taken up in the aim of the subject.

In the Education Act as well as the national curriculum, the role of the whole school is addressed. Here, the head of the school is mentioned explicitly as having responsibility for ensuring that the activities of the school as a whole are focused on attaining the national goals. In the Education Act, the responsibilities of municipalities and authorities responsible for independent schools are also specified.

One rule stipulated in SKOLFS (2005:179) is that at least once a semester, teachers must have discussions about progress with the student and the student’s guardians. The purpose of these discussions is described as to “jointly come to the conclusion on how the pupil’s knowledge and social development can be best supported, and to formulate and document this in an individual development plan” (Skolverket, 2010a). In this thesis, these meetings are called student/teacher/parent meetings. As will be shown, some of the data in this study come from these meetings.

### 2.7.3 Critical Issues Concerning the Institutional Framing of Classroom Work in Sweden

In the literature, there are examples of acceptance of the system with proposals of how to play along with the rules for the benefit of students’ learning

(e.g. H. Johansson, 2002<sup>46</sup>). There are also more critical approaches adopted. One example is I. Emanuelsson (2002), who discusses issues regarding normalisation based on a special education perspective. He writes that, despite the fact that the system claims that all students have the possibility to reach the stated goals, this is, in fact, a myth. For some students in the regular compulsory school, it is not possible to reach these goals under the current circumstances, including time limits. Moreover, the proportion of students that fail to achieve the stated goals could be predicted before the goals were introduced.

Another issue concerns the trust in teachers in the Swedish system that was mentioned at the beginning of this section. Pettersson (2010b) summarises how mathematics is a school subject frequently mentioned in relation to investigations, inspections and evaluations. Almost everything initiated by the state is done in the name of greater effectiveness in terms of students' achievements reaching the stated goals. There is great concern about results, for example, in TIMSS (Skolverket, 2009) and PISA (Skolverket, 2007), and the most frequently discussed topic in reports and the media according to Pettersson (2010) is errors or shortcomings. The staffs in schools and teacher training programmes are designated as being responsible for the situation. Pettersson emphasises trust in the dedicated work of teachers and offers alternative explanations for the current situation, with cuts in funding and in the number of teachers in school being one. She also considers the fact that the number of teachers with an adequate education in mathematics has decreased. Pettersson also proposes several means to improve the situation. The development of teacher education is one means, as is providing schools with the conditions to perform their work with long-term dedication. She also emphasises paying attention to schools' strengths and possibilities and argues that this responsibility must be shared by many, not just teachers and schools. In Forsberg and Wallin (2006) the issue of trust in teachers' work is also addressed, and it is argued that the goal-based system, in which teachers have scope for their own interpretations in terms of their students, and the local context have been replaced by a regime of control. One type of situation where the teachers' scope is reduced is the teacher/student/parent meetings (see Section 2.7.2), which have been supplemented with documents to be filled out before and during the meetings both by students (with their parents) and teachers (Hofvendahl, 2006). Depending on the documents and how they are used during the meetings, this may or may not be beneficial for these meetings in terms of students' learning. What Hofvendahl has identi-

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<sup>46</sup> H. Johansson (2002) describes a project where the staff at a school relying on the national curriculum for compulsory school worked at bringing in the students more and more into the assessment processes. This included giving the students the responsibility of being active in their learning. He also emphasises the importance of the students' awareness of the current goals for learning and teaching. Portfolios constitute part of the students' own assessment (see e.g. Wiggins, 1998).

fied is that the meetings are more about reading from and comparing the notes on these papers than open discussions. Lundahl and Forsberg (2006) analyse the spectrum of assessment in Swedish education. They write that assessments on the local and national level are taking on a more distinct function as a steering instrument in contrast to once having been a foundation for planning and decision processes. One example of this is local authorities being given the assignment to prepare quality reports. They were first collected in 2004 and presented in a public database. They conclude that in Sweden there is a lack of:

- discussions about what assessment in education is in school practice, i.e. what functions it has in the day-to-day teaching and learning.
- discussions about the ways in which national results measurements affect teachers' strategies, attitudes and practical work for teaching and assessment.
- discussions about how results of assessment in education fill a function in the public and municipal steering of Swedish schools, from both a contemporary and historical perspective.
- distinct strategies for the development of knowledge about the consequences of assessment in education on a national and local level (Lundahl & Forsberg, 2006, p. 36, my translation).

The interest of this study lies in the first and last points, and the outcomes will contribute to the field of assessment, especially in relation to mathematics education. In the Discussion of this thesis, I consider how the thesis' outcomes can be understood both in relation to the content in steering documents and to some of the critical issues given account for in this chapter.

### 3 Theoretical Considerations

The main concern of this chapter is the theories chosen for the purpose of this study. As previously noted, the purpose is to analyse and understand explicit and implicit assessment acts and discourses in mathematics classroom communication in terms of affordances for students' active agency and learning. The research questions concern assessment acts with respect to feedback, focuses in the mathematics classroom, roles of semiotic resources and discourses of assessment in mathematics classroom including institutional traces.<sup>47</sup> As explained in the introduction of the thesis, I have chosen a fictional story about Pippi Longstocking as an illustration of the analytical process. The beginning of the story was offered, where Pippi sees her friends Tommy and Annika go to school every morning. In this excerpt, Pippi has decided to go to school herself:

“Hi, there,” cried Pippi waving her big hat.

[...]

Pippi threw herself down on a vacant bench. The teacher said in a friendly voice, “Welcome to school, little Pippi. I hope that you will enjoy yourself here and learn a great deal.”

“Yes, and I hope that I’ll get some Christmas vacation,” said Pippi. “That is the reason I’ve come.”

[...]

“But now,” [the teacher] continued, “suppose we test you a little and see what you know. Let us begin with arithmetic. Pippi, can you tell me what seven plus five is?”

(Lindgren, 1998, p.14f, translation by F. Lamborn)

When considering the story about Pippi from the perspective of the purpose of this thesis, I would like to say something about assessment acts that may emerge from an analysis of the communication between Pippi and the teacher, such as the last paragraph, where the teacher says “suppose we test you a little and see what you know. Let us begin with arithmetic”. Pippi’s response and the teacher’s reaction to that response are also relevant. I discuss this excerpt later in the chapter.

In earlier research described in the preceding chapter, it is argued from mainly an empirical stance that assessment has an impact on affordances for

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<sup>47</sup> The purpose of my research and research questions can be found in full in Section 1.4.

students' active agency and learning of mathematics in school. This can also be argued from a theoretical point of view. One example is Bernstein (1973), who considers assessment to be one of three central features maintaining current social orders. According to Bernstein, curriculum determines what counts as valid knowledge, and pedagogy determines what counts as valid transmission of knowledge. Assessment<sup>48</sup> determines what counts as a "valid realisation of that knowledge on the part of the taught" (Bernstein, 1973, p. 85). Another example is Foucault (2003), who writes about the role of assessment in education. He argues that, in assessment, surveillance is combined with normalisation. Through the assessment, there is both qualification and classification taking place, as well as the exercise of power and education of a specific knowing (see also Gipps, 2001; Torrance, 2000). Broadfoot (1996) describes sociological analyses of assessment drawing on the work of Weber, Durkheim, Bernstein and Foucault. In the theoretical considerations of this thesis, I have chosen to coordinate social semiotics with some of Foucault's concepts. This will be elaborated further on, but first I position the framework and thesis in a "social and critical paradigm in mathematics education research"<sup>49</sup>. Paradigm is understood here according to Lincoln and Guba (2000); see also Lerman (2006). By this, I mean that theoretical perspectives can be grouped together into paradigms. These paradigms are not stable; instead they change over time.

### 3.1 Overarching Considerations – a Social and Critical Paradigm in Mathematics Education Research

A social and critical paradigm in mathematics education is connected to sociology and critical theories (Valero & Zevenbergen, 2004; see also Ernest, Greer, & Sriraman, 2009). Valero and Zevenbergen (2004) write:

In mathematics education it is always possible to ask whose knowledge is being represented in society, schools and classrooms, and with what effects for the different participants in it. The recognition of the different and multiple positions that social actors can adopt in relation to and with the use of (school) mathematical knowledge is at the core of discussions of equity, social justice and democracy in mathematics education (p. 2).

They continue to argue that the social aspects noted in the quote above are essential to an understanding of mathematics education practices in broader

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<sup>48</sup> Bernstein uses the term evaluation.

<sup>49</sup> This paradigm is labelled differently in mathematics education research. Valero & Zevenbergen (Eds) (2004) write about socio-political perspectives whereas Bishop, Greer, and Sriraman (Eds) (2009) use the heading "Critical issues in mathematics education". I use the terms social and critical.

institutional contexts (see also Valero, 2004a; Swanson, 2005). At the same time, such aspects form this broader understanding of the “social”. In terms of research on assessment in mathematics, I believe that such an understanding incorporates an acknowledgement of different, multiple positions that teachers and students (can) adopt vis-à-vis assessment in the mathematics classroom. This includes an interest in whose and what kind of knowing is represented in assessment in mathematics and also how this is connected to the broader social context. Morgan (2000) argues that, from this perspective, research on assessment in mathematics must involve asking the following questions:

- Who benefits and who is disadvantaged?
- How do assessment processes and systems act to benefit or disadvantage individuals or groups? (Morgan, 2000, p. 230)

In this study, the second question is highly relevant as the conclusions are drawn in terms of affordances for students’ active agency and learning of mathematics. The first is addressed indirectly until the Discussion of the thesis, where it is emphasised in relation to future research proceeding from this study.

Mathematics incorporates means for understanding, building or changing a society (Mellin-Olsen, 1987). Skovsmose (2005; see also Jablonka, 2003; Gellert & Jablonka, 2009) acknowledges this, also stressing that mathematics does not hold any intrinsic good; instead mathematics can be used for different purposes in society and people’s lives. Thus, there is a need to address the role of the use of mathematics in society. Skovsmose (2005) argues that critical education “cannot just represent an adaptation to the political and economic priorities (whatever they might be); education must also engage in political processes including a concern for democracy” (2005, p. x). With respect to assessment in mathematics, this is significant in terms of what aspects of mathematics competence, including “critically reflecting”, are present in various kinds of assessment.

What I would like to achieve with this study, in Popkewitz’s (2004) words, is to: “move between empirical studies of mathematics classrooms and interdisciplinary discussions about assumptions, implications and consequences of teaching and the sciences that explain classrooms” (p. 251). Positioning this study in a social and critical paradigm in mathematics education, I aim to provide a basis for a well-founded discussion about affordances for students’ active agency and learning in assessment practices in the mathematics classroom. Constructing a theoretically informed analytical framework, I see a need to also draw on disciplines other than mathematics education. According to Lerman (2000; 2006) and Prediger, Bikner-Ahsbahr, and Arzarello (2008), this course of action is typical of and fruitful for mathematics education research (as well as other educational disciplines). While

positioning my study in a social and critical paradigm, I coordinate social semiotics with a discursive and institutional theory to form my theoretical framework.

### 3.2 Theoretical Framework of the Study

The theories that I incorporate into my theoretical framework are social semiotics (Hodge & Kress, 1988; Van Leeuwen, 2005) and a discursive and institutional perspective (Foucault, e.g. 1993, 2002, 2003). I also coordinate this with a design-theoretical perspective to define meaning making and learning (Selander, 2008a; Rostvall & Selander, 2008). The term coordinate is used here according to Prediger et al. (2008), which is the use of two or more theories that are compatible with respect to their underlying assumptions.

#### 3.2.1 Discursive and Institutional Aspects

The discursive-institutional context is always present (e.g. Foucault, 1993). An early example of a theoretical discussion of this is Popkewitz (1988), who considers institutional framings as one way to address social and critical aspects in studies of school mathematics (see also Mellin-Olsen, 1987). Valero (2004b) emphasises the importance of not losing the multi-contextuality in research on mathematics classrooms, by narrowing the setting to a classroom (see also Swanson, 2005). Even when the classroom is the empirical basis, Valero argues for a research process that takes into account the social arenas in which the classroom is immersed. In elaborating on the presence of institutions, it can be argued that communication in classrooms is situated in a context characterised by dominant (mathematics) education discourses, the use of artefacts developed over time, framings in terms of specific resources for learning, division of time, structures within and between schools, classification of students into schools and learning groups, established routines, classroom structure and authoritative rules (Selander, 2008a, drawing on Douglas, 1986; see also Björklund Boistrup & Selander, 2009).

In this study, I take these characteristics into account in my analyses to construe discourses of assessment in mathematics, viewing these as not related solely to the classrooms visited but also as discourses that are likely to be construed from (Swedish) mathematics classrooms in general. I also acknowledge the broader context, as a consequence of having captured institutional traces from my view of the classrooms visited. In doing so, processes of describing and ordering, as well as sorting, things in particular ways are fundamental (Bowker & Star, 1999, Foucault, 1993).

In the following section, I present a social semiotic theory. There is an acknowledgement of the institutional context in social semiotics, but the main contribution of this theory for this study concerns concepts used for the micro-analysis of the teacher-student communication in the classrooms visited.

### 3.2.2 Social Semiotics

In social semiotics, the interest is directed towards communication in a broad sense, with special attention given to semiotic resources and their relation to each other and the social practice (Hodge & Kress, 1988; Van Leeuwen, 2005). Hodge and Kress (1988) write that social semiotics concerns:

functions and social uses of semiotic systems, the complex interrelations of semiotic systems in social practice, all of the factors which provide their motivation, their origins, their form and substance [...] speakers and writers or other participants in semiotic activity as connected and *interacting* in a variety of ways in concrete social contexts. (Hodge & Kress, 1988, p. 1, italics in original)

According to Van Leeuwen (2005), social semiotics is not a “pure” theory. A primary idea in social semiotics is to apply it to specific problems. In doing so, one has to throw oneself into semiotic concepts and methods as well as into other “fields”. Furthermore, Van Leeuwen (2005), like Hodge and Kress (1988), writes that social semiotics can contribute ideas for formulating questions and ways of looking for answers.

The quote by Hodge and Kress (1988) above and the arguments by Van Leeuwen (2005) capture the role that social semiotics plays in this study. That is, the focus is on assessment as communication present in the day-to-day classroom work. Moreover, social semiotic concepts are operationalised in the analysis. I also connect this with other disciplines, like mathematics education, in order to perform the analysis.

In social semiotics, according to Hodge and Kress (1988) and Van Leeuwen (2005), all semiotic resources including artefacts are recognised. This means that all kinds of semiotic resources need to be taken into consideration, for example, in assessment in mathematics and in research on assessment. For Hodge and Kress (1988), this was something new:

[W]e see the limitation to verbal language in our earlier work as a major inconvenience in terms of our main purpose. Meaning resides so strongly and pervasively in other systems of meaning, in a multiplicity of visual, aural, behavioural and other codes, that a concentration on words alone is not enough (Hodge & Kress, 1988, preface).

In adopting a social semiotic perspective, a central notion is that what a semiotic resource represents and communicates depends on the interest of the

person using that semiotic resource, the existing situation and the broader institutional context.

### 3.2.3 Semiotic Resources – Actions and Artefacts

As noted in Chapter 2, there is often an open view of what are to be considered possible semiotic resources for communication and representation in mathematics education research. This open view is also acknowledged in a social and critical mathematics education paradigm. Mellin-Olsen (1987) emphasises the close relationship between mathematics learning and semiotic resources<sup>50</sup>. He writes that the conception of the learner “as ‘one who knows’ also implies that we have to sharpen our analysis of *non-verbal* mathematics as contrasted with *verbal* or *formalised* mathematics” (1987, p. 77). Mellin-Olsen continues by reviewing various kinds of semiotic resources, including informal symbols and pictures. Ernest (2004) also addresses multimodal aspects in his development of a broad definition of what teacher “texts” can include: body language, inscriptions on boards, arrangements of material, layout of furniture, pre-prepared books, tests and so on. Cotton and Hardy (2004) contend that a consideration of discursive aspects of mathematics education engenders an emphasis on language and texts. In my view, the concept of semiotic resources according to social semiotics (Van Leeuwen, 2005) provides a theoretical base for matters concerning these aspects.

Semiotic resources such as gestures and gazes, pictorial elements and moving images, speech and the like constitute, and are at the same time part of, for example, assessment acts in the mathematics classroom. To compare the concepts of mode and semiotic resource, a mode, according to Kress et al. (2001), is an organised, regular, socially specific means of representation and communication, such as writing. The same strong “rule” is not applied to the notion of semiotic resource. This is apparent when Kress and Van Leeuwen (2001) emphasise the materiality of the body by describing, for example, voice quality, which “is yet another semiotic resource which has not developed into a mode” (p. 81). In my analysis, for the sake of openness to the roles of modes as well as of semiotic resources “not yet developed into modes”, I use the term *semiotic resources*. The following definition is offered by Van Leeuwen (2005):

In this book I [...] define semiotic resources as the actions and artefacts we use to communicate, whether they are produced physiologically – with our vocal apparatus; with the muscles we use to create facial expressions and gestures, etc. – or by means of technologies – with pen, ink and paper; with computer hardware and software; with fabrics, scissors and sewing machines, etc (Van Leeuwen, 2005, p. 3).

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<sup>50</sup> Mellin-Olsen (1987) uses the term language.

Each semiotic resource, action and/or artefact provides different communicational potentials and constraints for making meaning (affordances). According to Kress et al. (2001), Kress and Van Leeuwen (2001) and Van Leeuwen (2005), for example, semiotic resources are seen as socially and culturally designed in different processes of meaning making, so their meaning changes over time. The semiotic resources that are “chosen” in a specific situation reflect the interest of the sign maker, and they are therefore not arbitrary (Kress, 1993; Kress & Van Leeuwen, 1996). The notion of meaning making is essential in social semiotics and is elaborated on later in the study when learning is also discussed.

I would like to add a note here with respect to the notion of *sign* (see e.g. Hodge & Kress, 1988; Kress & Van Leeuwen, 1996; Kress et al., 2001). In this thesis, I concur with Van Leeuwen (2005). He writes that sign was once considered to be a fundamental concept of semiotics. He continues: “In social semiotics the term ‘resource’ is preferred, because it avoids the impression that ‘what a sign stands for’ is something pre-given, and not affected by its use” (p. 3). Thus, I use the term semiotic resource instead of sign as far as possible.

### 3.2.4 Assessment in Mathematics as Communicative Acts

Understanding the “meaning” of different semiotic resources in different situations is a matter of understanding communication. For Kress and Van Leeuwen (2001), this is key issue. Their first idea was to write a guide to multimodal analysis, but they ended up addressing questions regarding how people use the variety of semiotic resources to communicate in concrete social contexts.

From a social semiotic perspective, assessment of knowing and learning is an instance of communication, a matter of acts taking place between teacher and student, or student and student, where students’ demonstrated learning by means of a variety of semiotic resources is an essential part. Kress (2009) writes:

[Multimodality and social semiotic theory] together enable an account of communication, of meaning, of learning and, with that, of assessment, in which these issues can be treated as distinct and yet remain connected, in theory and in practice”. (Kress, 2009, p. 21)

In this thesis, the term act is understood according to Van Leeuwen (2005). He describes multimodal communicative acts as a way to outline a social semiotic approach to the “how” of communication. In all communication, meaning is made through different semiotic resources that are co-present in a communicational ensemble (Kress & Van Leeuwen, 2001). Furthermore, Van Leeuwen (2005) argues that understanding meaning making in such

ensembles is not a straightforward process; instead it is a matter of seeing meaning making through communicative acts as being inserted into a range of communicative practices (see also Hodge & Kress, 1988). These practices affect the meanings made through the semiotic resources, as do the specific situations. With respect to classroom assessment in mathematics, the meanings made are affected by the semiotic resources that constitute the acts, existing assessment systems and procedures, and the assessment practices in the various classrooms. Kress (2009) emphasises the importance of understanding multimodal communication in order to fully understand a phenomenon like assessment (see also Kress et al., 2001; Björklund Boistrup & Selander, 2009; Pettersson & Björklund Boistrup, 2010; Selander & Kress, 2010). Language, in the sense of communication, “may serve as a crucial window for researchers on to the process of teaching, learning and doing mathematics” (Morgan, 2006, p. 219).

In this thesis, the notion of communicative acts is used when I undertake to identify the acts in the classroom that constitute the assessment related to feedback. Consequently, I use the term assessment acts. Communicative acts, for example, assessment acts, involve both communication and representation (Hodge & Kress, 1988; Kress & Van Leeuwen, 2001). We communicate through ensembles of semiotic resources. We address other people, we debate, we take in what other people show us and so on. These communicative acts are linked to some form of representational “content”. Representation here refers to something that is part of communication and as such is not interpreted as standing for something pre-given. A representation refers to something a person has an interest in communicating about, and the representation is distinct from this “about” (see also Foucault, 2002). Three functions can be identified in communicative acts: (1) the communication, where we, for example, address other people, (2) the representational “content” and (3) the semiotic resources that are a constituent for the communication and representation. These three functions are labelled meta-functions in social semiotics.

### 3.2.5 Meta-functions

Drawing on Halliday, social semioticians usually recognise three communicative *meta-functions*: the ideational, the interpersonal and the textual. With these meta-functions, it is possible to address basic functions of semiotic resources in relation to our ecological and social environment (Halliday, 2004).

There are several examples in research incorporating the use of these meta-functions in analysis. The main reference here is Halliday (see e.g. Jewitt, 2005; Kress et al., 2001; Van Leeuwen, 2005; and Morgan, 2006). Similarly, I refer to Halliday (2004) for definitions of the three meta-functions and use the meta-functions according to a multimodal approach,

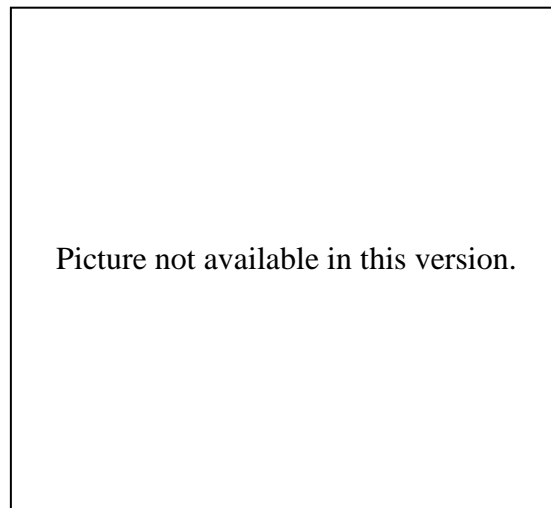
such as in Kress et al. (2001) and Van Leeuwen (2005). The meta-functions correspond to the first three research questions of this thesis.

The *interpersonal* meta-function involves how semiotic resources enact “our personal and social relationships with the other people around us” (Halliday, 2004, p. 29). In this thesis, it concerns how assessment acts related to feedback take place in teacher-student communication in mathematics classrooms.

The *ideational* meta-function is related to human experience and representations of the world (Halliday, 2004). In this thesis, it concerns the focuses of the assessment acts in the mathematics classroom.

The *textual* meta-function is related to the construction of a “text”, that is, a multimodal ensemble, and refers to the formation of whole entities that are communicatively meaningful (Halliday, 2004). In this thesis, it concerns what roles different semiotic resources play in assessment acts in mathematics classrooms.

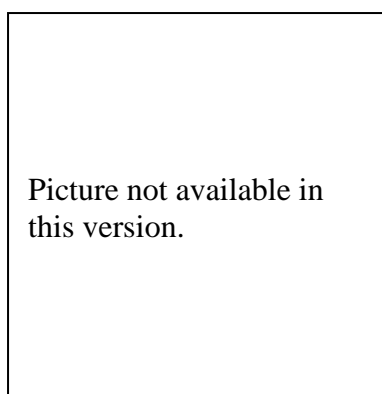
These three meta-functions are simultaneously “present” in all communication. To illustrate this, I return to the Pippi excerpt at the beginning of this chapter. I will briefly illustrate how a communication between Pippi and the teacher can be connected to these meta-functions. The *interpersonal* meta-function is present when Pippi and the teacher address each other. Pippi enters the classroom and greets the teacher and the students with a “Hi, there” while waving her hat.



Picture 2. Illustration from Pippi Goes to School (Lindgren, 1998, p. 14, illustration by M. Chesworth).

The teacher welcomes her and says that she hopes that Pippi will enjoy school and learn a lot. In an assessment act, the teacher says “suppose we

test you a little and see what you know”. Here, the teacher takes the role of the one who assesses. At the same time, through the *ideational* meta-function, the excerpt represents various concepts. There are references to elements such as school, which the teacher labels as a place where one can enjoy oneself and learn. In Pippi’s answer, another experience related to school is noted, Christmas vacation. At the end of the excerpt, the mathematics term arithmetic is introduced by the teacher as a focus of the assessment. Finally, the *textual* meta-function is present through the way Pippi’s and the teacher’s communication is constituted. Sometimes we can only capture what is said, but sometimes we are supplied with more semiotic resources through the pictures. When Pippi enters the classroom, she greets the people present in the classroom not only by saying “Hi, there”, but also by looking at them and smiling, and by waving her big hat. This is an example of how a multimodal ensemble constitutes a communication. Picture 2 and 3 contribute to this analysis since we can *see* aspects that are not present in the text.



Picture 3. Illustration from Pippi Goes to School (Lindgren, 1998, p. 15, illustration by M. Chesworth).

This is also true when the teacher addresses Pippi. We can read that she welcomes Pippi through her words, but we also learn that she uses a friendly voice. Moreover, in picture 3 we can see that she is smiling. If the teacher had looked angry when she said “welcome” to Pippi, the analysis for the interpersonal meta-function may not have been that the teacher welcomed Pippi to the classroom, despite the fact that she says so. In the beginning of each analysis and outcomes chapter, I elaborate more on each of the meta-functions in relation to the analyses for the different chapters.

Examining the example of Pippi going to school sheds light on the fact that there are functions that are not captured through the use of these meta-functions. A discursive and institutional function is included here (Selander, 2008c; see also Björklund Boistrup & Selander, 2009). The communication between Pippi and the teacher in the classroom is related to, and part of, an

institutional context. This classroom is similar to many other classrooms, both those found when the book about Pippi was written (in 1950) and in classrooms today (at least in the Western world). There are rules about what students should learn, how many students can be in each classroom and so on. There are also traditions with implicit rules about how a student is expected to behave, what clothes are appropriate and so on. The relation to the institutional context is addressed in the fourth research question, where I rely on a discursive and institutional theory.<sup>51</sup>

### 3.2.6 Discourses and Institutions

Social semioticians like Hodge and Kress (1988), Kress and Van Leeuwen (2001) and Van Leeuwen (2005) refer to Foucault with respect to *discourse*. I have chosen to rely on the main source here, that is, Foucault's discussions of the term.<sup>52</sup>

Discourse is considered in a number of Foucault's work (e.g. 1980; 1993; 2002; 2008). In these accounts, discourse is conceptualised as a broad notion that incorporates not only all statements but also the rules that affect the formation of possible statements in the discourse. Consequently, the discourse is more than the entirety of what is communicated and the way it is communicated. The discourse is also present in what is not communicated, or what is communicated through gestures, attitudes, presentations, patterns of actions, and the rooms and furniture. According to Foucault, discourses contain a limited number of statements; that is, discourses are finite. Other features are that they have a history (although they are constantly changing), they have social distribution and they can be realised in different ways (Foucault, 1993, 2002; Van Leeuwen, 2005). Discourses materialise into discursive practices where the discourses are maintained (and possibly changed) by those participating in the practice. Lerman (1994b) describes discursive practises as "domains of social interaction, by which is meant the interactions of language, power relations, knowledge and social practices" (p. 193).

For the people who are part of a discursive practice, the rules of the discourses affect what actions it is possible to take (Foucault, 1993, 2002; see

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<sup>51</sup> Björklund Boistrup and Selander (2009) started out with the meta-functions as used by Kress et al. (2001), focusing on assessment in mathematics, and then added a fourth, institutional, meta-function (proposed by Selander 2008c). In this thesis, I instead use the three meta-functions as a basis for the construal of the discourses.

<sup>52</sup> There are differences between discourse according to Foucault and how Hodge & Kress (1988), Kress & Van Leeuwen (2001) and Van Leeuwen (2005) use the term. In for example Kress & Van Leeuwen, discourse is one of four strata (with reference to Halliday). The four strata are Discourse, Design, Production and Distribution, and discourse is said to concern socially constructed knowledge of aspects of reality. Design refers to the use of a combination of semiotic resources and production; Distribution concerns different steps in the communication process. The Foucauldian term discourse as used in this thesis does not make distinctions between these four strata, which are seen more as part of the discourse.

also Jablonka, 2006). For example, there are certain things that are “allowed” to be communicated, and certain ways to communicate them. Often these limitations are something not noticed by the people in the discursive practice. It is easier to perceive when a person breaks the rules of a discourse. In the excerpt from *Pippi Goes to School*, we can see that Pippi breaks several rules of the discourses found in the classroom. She does not start school at the start of the school day, and she enters the room shouting. From the gaze of the student in picture 3, we can assume that this is nothing he would think of doing, since he is acting according to another discourse. With respect to this, it should be said that discourse according to Foucault (2002) is to be conceptualised in line with a dynamic view (see also Björklund Boistrup & Selander, 2009; Lenz Taguchi, 2004). This dynamic view holds that the participants are not to be seen as imprisoned in a discourse. They can both be part of a long-term change in the discourse and “leave” a discourse and instead take active agency in another discourse.

In terms of this study, the Foucauldian concept of discourse is interpreted as a broad concept. The term statement is viewed as multimodal, which is consistent with Foucault (e.g. 1993, 2002, 2008). Cotton and Hardy (2004) use a similar multimodal notion in relation to a Foucauldian concept of discourse (see also Jablonka, 2006). Based on the thesis’ purpose and the theories presented in this study, a discourse of assessment in mathematics classrooms is about how teacher and student address each other, for example, through different kinds of feedback in discursive practices. It is also about what aspects of mathematics competence are present and not present in the assessment. The roles of different semiotic resources are part of the discourses including promotion and/or restriction of certain semiotic resources.

Discursive assessment practices in mathematics classrooms take place in school, where there are institutional framings present. Institutional framings have both direct and indirect effects (Foucault, 1993, 2003). Decisions may be made on different “levels” in the school system, which have a direct impact on the classroom work. There are also indirect aspects, such as classificatory systems, norms and dominant discourses (traditions) developed over time. As Skovsmose (2005) notes: “the point is that the school mathematics tradition is represented by variation of the same organisational structure” (p. 10).

A key concept for discourse is *power*, and related to this is *agency* (described by Klein, 2002). One could say that in the institutionally situated discourses of classroom assessment in mathematics, a variety of affordances for students’ agency are produced.

### 3.2.7 Power and Agency

Valero (2004ab, 2009), drawing on Foucault, considers power to be a relational capacity that social actors position themselves in.<sup>53</sup> Power is not something fixed; instead it is constantly being transformed in relation to discursive and institutional aspects. With a notion of power like this:

“it becomes possible to perform a very fine grained analysis of how mathematics and mathematics education are used by people in particular discourses and of the effects of those discourses on social practices and, consequently, on people’s lives” (Valero, 2004b, p. 16).

With respect to classroom assessment, the affordances for students’ agency and learning differ according to discursive practices, including power relations (Anderson, 1993; Mellin-Olsen, 1993). When power, on one hand, is seen as something that emerges in all communication between people all the time (Foucault, 1980; 1993), I see an opportunity to consider power aspects present in assessment acts during classroom communication in mathematics classrooms. On the other hand, drawing on Foucault (e.g. 1980, 1993, 2003, 2008), when power is considered in relation to institutions, I see an opportunity to consider, in this case, framings of assessment in mathematics classrooms through norms, rules, dominant discourses and the like.

Using his notion of power, Foucault opens up the role the individual takes for consideration, as the oppressed or as someone who resists the oppression. Foucault (1980) writes:

Power must be analysed as something which circulates, or rather as something which only functions in the form of a chain. It is never localised here or there, never in anybody’s hands, never appropriated as a commodity or piece of organisation. And not only do individuals circulate between its threads; they are always in the position of simultaneously undergoing and exercising this power (p. 98).

Agency is understood here as a capacity for people, in this study mainly students, to make choices and to impose those choices on the world. This is a matter of a person being active or passive; s/he is “getting things done”. This notion of agency<sup>54</sup> is operationalised in my analysis. Foucault’s notion of power is a way to shed light on affordances for students to take active agency in the assessment discourses in the mathematics classroom. A notion of agency as something that people have affordances to take is also emphasised by for example Hodge and Kress (1988) and Van Leeuwen (2005).

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<sup>53</sup> Valero (2004b) describes three notions of power, with the one discussed here being the third, and proposed, one.

<sup>54</sup> Foucault does not emphasise the term agency, but he writes about agents.

### 3.2.8 Meaning Making, Learning and Knowing

Neither social semiotics nor a discursive and institutional perspective includes a theory for learning. This has been acknowledged by Kress (2009) and Selander (2008a), vis-à-vis social semiotics and institutional aspects, in the work of developing a design-theoretical perspective for learning.

I first consider meaning making. Selander and Rostvall (2008), for example, contend that when certain aspects of a phenomenon are emphasised over and over again in social contexts, a communicative regularity arises. Meaning is made when our consciousness is directed toward these regularities. An example in mathematics is when a small child learns how to count the number of things. Adults in the child's environment count together with the child in different situations, at the same time pointing at the things that are being counted. There is a rhythm in this counting, which is one regularity that the child may perceive. Another regularity is the names of the numbers counted, "one, two, three, and so on". A third regularity is that one counting word can be said for each thing counted. Finally, a fourth regularity is that the number mentioned last represents the total number of things. For the child, meaning is made when more and more of these regularities<sup>55</sup> are apprehended. The meta-functions described earlier – interpersonal, ideational and textual – are fundamental in processes of meaning making (Kress et al., 2001). Kress et al. write that the meaning of any multimodal ensemble is made from the interplay between these three meanings. Examples of this are the meanings made in assessment acts in the classrooms visited in this study.

In this thesis, meaning making is seen as strongly related to learning. In order to define learning, I draw on a design-theoretical perspective according to Rostvall and Selander (2008; see also Selander & Kress, 2010). From a design-theoretical perspective, *learning* is understood as meaning making towards an increased readiness to engage in the world with an increased use of semiotic resources in a discipline such as mathematics (Selander 2008ab; Selander & Rostvall 2008). One reason for choosing to view learning from this perspective is that it has a strong interest in learning with respect to use of semiotic resources. This is compatible with Pettersson (2007), who notes that we can not draw conclusions about a student's hidden learning in the assessment. What we can assess is what knowing a student has demonstrated or not demonstrated. This view is quite different from one in which it is assumed that individuals possess knowledge that is discoverable and measurable (similar arguments are made by Morgan, 2000; Broadfoot, 1996; Lerman, 2005; see also Foucault, 2002). Another reason for this choice is that there are strong connections in this perspective both to social semiotics and to an institutional perspective (Selander & Rostvall, 2008). In operationalising learning in this thesis, I discuss affordances for learning rather than dis-

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<sup>55</sup> The order of these regularities in this account is not aimed at reflecting a certain order regarding young children's learning of mathematics.

cussing learning as such. Here, the focuses of the assessment acts are central. When the teacher includes a certain focus (one often also introduced and/or maintained by some kind of institution) in her/his feedback to the student, this shapes expectations of the student. Some focuses are categorised as valuable and others are sorted out (Bowker & Star, 1999). Similarly, Morgan (2000) argues:

To be successful in gaining credit, therefore, the student must learn to produce texts that will be judged to be legitimate texts (Bernstein, 1996) within the practices of the mathematics classroom (Morgan, 2000, p. 232).

Another consideration is that, in this thesis, I use the term *knowing* instead of knowledge. By doing so, I make clear that I do not take into account an objective knowledge “out there” to be learnt or brought into the teaching. Instead, knowing is viewed as constructed and construed in communication among humans throughout history (Foucault, 2002; see also e.g. Delandshere, 2002; Selander & Rostvall, 2008; Valero, 2004b, Volmink, 1994). What valid knowing is and how it is demonstrated in communication is not given once and for all. At different times in history, what qualifies as important knowing has changed. One example of this in mathematics is that, a few decades ago, one kind of important mathematics knowing was an ability to perform complex calculations using pencil and paper. Today too, pencil and paper calculations are part of the curriculum in mathematics education, but for more complex calculations it is acceptable to use an electronic device, such as a computer or calculator.

### 3.3 Operationalising Theories

In order to operationalise the theories presented so far in this section, I also include some additional theoretical considerations. These additions are relevant structures identified in the research literature. As will be shown, parts of Hattie and Timperley’s (2007) model will be adapted along with a substantial part of my analytical framework. This choice is on account of consistencies between Hattie and Timperley’s model and the research questions in this study, since they are divided between interpersonal aspects such as kinds of feedback and ideational aspects, in what they call levels. There are a number of other aspects relevant to analysis in terms of feedback (see Shute, 2008), but they are peripheral to the purpose of this study.

#### 3.3.1 Assessment Acts in Mathematics Classrooms

The first research question is connected to the social semiotic interpersonal meta-function. When I combine this with an interest in classroom assess-

ment, the objective is to determine how assessment acts related to feedback take place in teacher-student communication. For analysis relating to this first question, I draw on Hattie and Timperley's (2007) model, presented in Section 2.2.1. The part of the model that is of interest here concerns the three different kinds of feedback: feed back, feed forward and feed up.

One feature that has influenced the way I operationalise the three feedback questions is *agency*. This implies that the affordances for students' active agency in the assessment acts have affected the categories that constitute a starting point for the analysis. For this, I draw on Mellin-Olsen (1993; see also Delandshere, 2002; Norén, work in progress; Torrance & Pryor, 1998).

The analytical framework for the first analysis is also affected by Tunstall and Gipps's (1996) typology and Hargreaves et al.'s (2000) strategies; see Section 2.2.1. Specifically, I bring in rewarding, punishing, approving and disapproving as potential directions of feedback. The analytical work is also affected by the notion of describing what is operationalised as recognising (drawing on Kress, 2009; Selander & Kress, 2010). The analytical framework as a whole is described in Chapter 5.

### 3.3.2 Focuses of Assessment Acts

I also draw on Hattie and Timperley's (2007; see Section 2.2.1) model for the second research question, relating to the social semiotic ideational meta-function, which concerns human experience and representations of the world. The experiences and representations that are of interest in this thesis are what the focuses of assessment acts are with respect to the mathematics classroom. I use what Hattie and Timperley (2007) refer to as "levels" for an initial analysis. However, I do not use the term levels; instead I consider which focuses the assessment acts have: self, task, process and/or self-regulation.

In order to incorporate an enhanced framework with respect to mathematics competence (see Section 2.4), I see a need for additions to the framework. Before elaborating on this, I would like to make a comment about mathematics. I adopt a view of mathematics as activity (like other disciplines, of course). Skovsmose (2005) refers to Freudenthal, noting that he started a trend in mathematics education when he stressed a view of mathematics as activity. This thesis maintains the view that what we perceive as mathematics is connected to us as humans, to our histories, and our cultures (Jablonka, 2003; see also Valero, 2009). Davies and Hersh (1981) define mathematics as the activity that mathematicians actually do. This allows for a plurality of activity. Taking this one step further, Skovsmose (2005) proposes a stronger plurality:

'Mathematics' need not only to refer to advanced mathematics, or to applied mathematics, or to mathematics in packages being part of the apparatus of reason. Mathematics is also represented in everyday context (Skovsmose, 2005, p. 160).

This is the notion of mathematics that is used in this thesis.

The additions to Hattie and Timperley's four focuses are connected to the process focus. Here, I draw on the notion of competence as a whole. Ellström (1992) describes competence as an individual's readiness for action with respect to a certain task, situation or context. Wedege (2001) links this to a similar view and opposes a view of competence as consisting of "objective" competencies defined as being independent of individuals and situations. According to Wedege (2001), competence is:

- always linked to a subject (person or institution)
- a readiness for action and thought and/or an authorisation for action based on knowledge, know-how and attitudes/feelings (dispositions)
- a result of learning or development processes both in everyday practice and education
- is [*sic*] always linked to a specific situation context (Wedge, 2001, p. 27).

The term competence can be divided in two meanings: (1) formal competence in terms of authorisation, for example, that a person has adequate education for a position and (2) real competence in terms of whether a person will really be able to demonstrate the abilities that are identified, for example, in a certificate (Wedge, 2001; 2003).<sup>56</sup> For my research interest, the second meaning is relevant. I am interested in the assessment acts that take place during teacher-student communication. Here, students' performances are assessed in terms of what aspects of mathematics competence they demonstrate in different situations. The first meaning is also relevant despite the fact that students 10 years old are not authorised in the same way as adults. Wedege (2003, p. 75) notes that an important part of a person's self-assessment as a competent person is authorisation. This study presents different situations where a teacher, through explicit and implicit assessment acts, gives authority to students' demonstrated aspects of mathematics competence. Skovsmose's (1990, 2005) division of mathematics competence into three main aspects ("dealing with mathematics notions", "applying mathematics notions" and "critically reflecting"; see Section 2.4.1) is operationalised in the analysis. For a fine-grained analysis of mathematics processes in assessment acts in the classrooms visited, I have merged the processes included in the models by Björklund et al. (2002) and Lindenskov and

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<sup>56</sup> Ellström (1992), who writes in Swedish, uses the term qualification for formal competence and the term competence for what Wedege (2003) labels real competence.

Wedge (2001<sup>57</sup>); see Section 2.4.2. In this thesis, the notion of “understanding” is not identified in the analysis. I am interested in the visible assessment acts and affordances for visible learning in the mathematics classroom. It may be possible to interpret understanding through a person’s different actions as describing concepts, using mathematics knowing in a new situation and so on, but it is not visible in itself (Lerman, 1994b).<sup>58</sup>

The definition of learning used in this thesis (Section 3.2.8) is operationalised in developing the findings with respect to affordances for students’ learning of mathematics (described in more detail in Chapter 6).

### 3.3.3 Semiotic Resources in Classrooms

The third research question is related to the social semiotic textual metafunction. This involves the construction of “text” (multimodal ensembles), and the interest here is in what roles different semiotic resources play in assessment acts. I am inspired to find that there is an interest in different semiotic resources in the field of mathematics education. However, in constructing an analytical framework that is theoretically aligned, I have chosen to rely on previous research on classroom communication in other educational disciplines where social semiotics with a multimodal approach has been used as a theory. In Kress et al. (2001), there is an interest in science education and the role various semiotic resources including artefacts play in the teaching. They describe teacher’s communicative shifts between semiotic resources under the headings Speech/Writing, Action, and Visual. In Rostvall and West (2005; also described in West, 2007), the objective is the interaction between teacher and student during instrumental teaching. These interactions were “analysed as a series of connected or disconnected communicative signs or messages in three separate modes: music, speech, and gesture” (West, 2007, p. 141). Similar notions are identified in the analytical framework presented in Chapter 7.

### 3.3.4 Discourses of Assessment in Mathematics Classrooms

For the fourth research question, on discourses of assessment in mathematics classrooms, I have looked in the research literature for discourses to use as inspiration for the analysis. One set of discourses used for this purpose is Palmer (2005), presented earlier in Section 2.6.2. I have also relied on other dichotomous pictures in models, for example, Broadfoot and Pollard (2000),

<sup>57</sup> Lindenskov and Wedge have positioned the processes in the personal intentions dimension. I do not examine agents’ intentions, but these processes still have a good deal in common with the theoretical underpinnings of this study.

<sup>58</sup> One example is the revised version of Bloom’s taxonomy by Anderson & Krathwohl (2001), in which understanding is operationalised through the verbs: classify, describe, discuss, explain, identify, locate, recognise, report, select, translate and paraphrase.

Lindström (2005) Ljung and Pettersson (1990), and Torrance & Pryor (1998). In Björklund Boistrup and Selander (2009), two dichotomous discourses were created as a basis of analysis (figure 10).

<i>“Traditional” discourse</i>	<i>“Active participant” discourse</i>
The teacher is the only one who assesses	The student is also part of the assessment
Focus on teacher’s guidance	Focus on the teacher promoting thinking
Focus on the correct answer, the product	Focus also on processes
Focus on the number of tasks finished in the textbook in mathematics	Focus on the quality of the mathematical accomplishments
Focus only on the aspects of mathematical competence the student demonstrates on her/his own	Focus also on the aspects of mathematical competence the student demonstrates when working with peers
Focus only on written tests in mathematics	Focus also on the documentation of learning in mathematics

Figure 10. Two dichotomous discourses (Björklund Boistrup & Selander, 2009, p. 1571).

In this thesis, this dichotomy constitutes a starting point in construing the discourses of assessment in mathematics classrooms, presented in Chapter 8. The discourses are construed in terms of affordances for students’ active agency and learning in the mathematics classroom.

## 4 Methodology

A social and critical paradigm has methodological consequences, such as “posing critical questions to the way in which we as researchers, in our activity, build theories, construct ‘objects’ of study and influence our world with the knowledge that we produce” (Valero, 2004b, p. 5). In this chapter, I clarify *why* I, as a researcher, made my methodological decisions in a certain way (Burton, 2002). In the previous chapter, a description is given of how the theoretical framework can be connected with the purpose and research questions of this thesis. The multimodal approach incorporating a variety of semiotic resources is also found in the process of data gathering (for example, video recording) and transcribing (performed multimodally). For my analyses, the different semiotic resources are the means to capture assessment acts and focuses in the classrooms visited. In addition, there is one research question explicitly concerned with semiotic resources and the roles that they play.

In this study, my view is that “social phenomena and categories are not only produced through social interaction but that they are in a constant state of revision” (Bryman, 2004, p. 17). This way of reasoning is considered to be a social constructionist view. A researcher’s descriptions of findings are also constructions, as is my thesis (Tedlock, 2000). However, this does not mean that all social constructions, like institutional facts, are arbitrary. Most are temporarily regular, but in a different way than in the physical world (Selander & Rostvall, 2008; see also Searle 1997). This affects the claims I make in the study. It also puts emphasis on what questions I ask and how I make my findings trustworthy. I want to understand people’s actions, but in doing so, I acknowledge that these people act within and are part of a broader institutional context where there are temporarily regular institutional facts.

### 4.1 Research Design and Research Methods

The research design of this study is a case study. When using the term case study, I draw on Yin’s definition (1989):

A case study is an empirical inquiry that:

- investigates a contemporary phenomenon within its real-life context, when
- the boundaries between phenomenon and context are not clearly evident, and in which
- multiple sources of evidence are used (Yin, 1989, p. 23).

The “phenomenon” I am interested in is assessment in the mathematics classroom, and the reason for choosing a case study design is that I want to find different potential assessment acts in mathematics. It has been possible to capture many aspects of assessment acts in mathematics by including a variety of classrooms. The number of participating classrooms (five) enabled the differences and similarities between assessment acts to become apparent, permitting a more comprehensive picture of classroom assessment to develop along with the construal of the discourses.

The overall method of this study is inspired by ethnography. I visited each of the five grade four classrooms (with students aged around 10 years) during mathematics lessons for one week. My first contact with the teachers took place several months prior to this week, and I started my data collection at this point, using a research log. I met the students twice a few weeks prior to my week in the classroom. I limited my data collection to the communication during mathematics teaching between the teacher in each of the classes and two of her/his students. I met the teachers at least twice following the week in the classroom, both for quality discussions of my analyses and for an opportunity to pose supplementary questions. The teachers and I had contact for at least three years, though not on a continuous basis, and I had contact with the two students in focus for several months, prior to, during and following my week-long visit to the class.

I do not claim that this study fulfils any set of criteria for an ethnographic study as such. However, there are similarities; I adopt Bryman’s definition of ethnography and view my research in terms of the criteria he uses (Bryman, 2004; see also Tedlock, 2000). I also describe my reasons for gathering data accordingly (Burton, 2002). “[T]he researcher”:

- “is immersed in a social setting for an extended period of time” (Bryman, 2004, p. 293).

I was involved in the institutional life of the teachers and students in “my” classrooms for an extended period of time. This enabled adequate time for reflection for both myself and the teacher. I had time to reflect and to perform analyses before I met the teachers the first time following my week in the classroom. The teachers had time to reflect between our meetings.

- “makes regular observations of the behaviour of members of that setting” (ibid).

I performed observations in this environment, mainly for one week,

which may seem short. However, since I made video recordings, I also spent much time reviewing the communication in the classroom. As I see it, the only way one can say anything about assessment in mathematics in the communication between teacher and student is to actually study this communication. Considering what could be accomplished within the framework for this study, I had a choice: a long period of time for observation in each classroom and limiting it to one or two classrooms, or a short period of time in each classroom and expanding it to more classrooms. It was my decision that one week recorded on video would provide the opportunity to capture sufficient communication between teacher and student in mathematics, and thus several assessment acts. In my first pilot study, I performed an analysis of the assessment processes in mathematics in the communication between the teacher and three students during one mathematics lesson (described in part in Björklund Boistrup, 2007, 2008). This experience gave me an indication that one week of observations would be sufficient for my research purpose.

- “listens to and engages in conversations” (ibid).

I listened to, and engaged in, conversations of various kinds: explicitly, the teachers’ and students’ communication; implicitly, other conversations at each school, which are described in my log. Since this study is on assessment acts in mathematics in teacher-student communication, the various kinds of conversations are an important object of interest. I randomly selected two students in each classroom and examined their communication with the teacher. The teachers’ communication with the rest of the students constitutes a basis for my research log via synopses (see Section 4.5.2) and is thus also part of the study.

- “interviews informants on issues that are not directly amenable to observation or that the ethnographer is unclear about (or indeed for other reasons)” (ibid).

I met each teacher at least twice and the two randomly chosen students once after the week of video filming. This material is not analysed in detail but provides background.

- “collects documents about the group” (ibid).

I collected written documents related to the teachers’ and students’ communication in mathematics. This provided an additional means of capturing assessment acts in teacher-student communication along with the work done during the lessons. In the written material, I included documents related to mathematics that were written prior to and during my week-long visit in the classroom.

- “develops an understanding of the culture of the group and people’s behaviour within the context of that culture” (ibid).

I do not use the term “culture”. Apart from that, this point is in agreement with my discursive and institutional purpose. The communication between teachers and students is part of and is affected by discourses of as-

assessment in mathematics as well as by institutional decisions made outside the classroom.

- “writes up a detailed account of that setting” (ibid).

I formulated a detailed account of the communication in mathematics between teacher and students with respect to the purpose of the study. This is consistent with my aim to provide in-depth descriptions of assessment acts in mathematics classrooms as well as a thorough description of my course of action during the research process.

### 4.3 Researcher’s and Participants’ Roles

Kvale (1997) uses two metaphors to describe the consequences of interview research, which are applicable to other qualitative research. One of the metaphors is the researcher as an ore searcher, one “who brings the precious metal out in the open” (Kvale, 1997, p. 11, my translation). The ore is there, ready to be discovered. In this view, the knowledge is not affected by the research process; it is simply clarified and written down. The other metaphor is the wanderer. S/he “wanders through the landscape and initiates conversations with the people s/he meets. [...] What the author of the account of the journey hears and sees is described qualitatively and is reconstructed as stories that are expected to be told to the [researcher’s] compatriots and perhaps also to the [researcher’s] wandering comrades” (Kvale, 1997, p. 12, my translation). The second of these metaphors describes how I view myself as a researcher. I regard the teachers and students as “wandering comrades”. The knowing my research “brings” is not a given from the beginning, in an absolute sense; instead the data are reconstructed based on my theoretical perspectives and research purpose. I performed my research and then I communicate it in the world of academia as well as to other teachers, my “compatriots”.

One issue to consider is the disturbance created by the presence of the researcher (Goodchild, 2009). I was present in the classroom making the video recordings. Clearly, this made me part of the situation and I cannot determine the impact I had. Both teachers and students describe how, after a while, they disregarded my presence, so my assumption is that there are some similarities between the setting where I was present and the one where I was not (described also by e.g. Goodchild, 2001; Savola, 2008). This was also acknowledged when I and the teachers, as well as I and the students, discussed the video filming. My impression is that, on the whole, things proceeded as usual. In a couple of classes, I could detect more “disruptive” noise at the end of the week. In terms of my research purpose, I could not capture any differences as the week progressed, and the participants became more and more used to the video taping. A beneficial effect of the video taping concerns my potentially disruptive role as a researcher. Since I was

filming, I was occupied and in a sense not there as a person. The students did not address me during their work, which in a way decreased the disturbance of my presence.

I considered teachers and students to some extent to be participants and not “merely” informants. This was apparent when I first described the project to the teachers and also to the students (see also Cooper & McIntyre, 1996). Wagner (1997) discusses three forms of researcher-practitioner cooperation in educational research: data extraction agreement, clinical partnership and co-learning agreement. Different parts of my study reflect these different agreements. On a general level, I declared that my aim was to learn from the teachers and students. The teachers all declared that the reason for their participation in the project was to learn as teachers. In this sense, we had a co-learning agreement. In terms of my research purpose and the research process, the agreement was on data extraction; it could be said that I was the one steering the research process. With respect to context and stance as well as expert roles, it was a clinical partnership. I was a researcher and collaborator, outside the schools, engaged in reflection, while the teachers were practitioners and collaborators, inside the schools, engaged in action and reflection. As for the video study, it was mostly a data extraction agreement, and at the end, when each teacher and I met to discuss and scrutinise the analyses, it evolved more to a co-learning agreement.

## 4.4 Selection of Participants

To get a high degree of variation in my data, I visited classrooms where the teachers had different backgrounds (a similar empirical base is described in Tunstall and Gipps, 1996). All are educated to be teachers in mathematics for this grade, but some had more education for this than others. They had different levels of experience as teachers and they work in different socio-economic areas. Some of the participating teachers had not paid much attention to matters of assessment in mathematics. At the same time, there were teachers represented who had paid some or a good deal of attention to assessment in mathematics, through studies and/or collaboration at the school or elsewhere. My way of finding the teachers was to ask people in my research group network and also ask these people to suggest teachers they knew. I also asked the audience at lectures I held on assessment in mathematics. The five schools are located in large cities as well as smaller towns, all within two hours' travel from Stockholm. Some of the schools are in suburbs and some are in the city centre. All five teachers expressed positive feelings about the teaching of mathematics. My aim was to also include classrooms with teachers who were not that positive, but I did not manage to find a classroom like this where the teacher wanted to participate.

The two students in each class who were filmed with a fixed camera were randomly chosen. This random choice is for ethical reasons. A deliberate choice of two students risked producing a (negative or positive) feeling of being singled out and possibly a feeling among the other students who wanted to participate or not being chosen. In terms of the research objectives of the study, there was no need to choose students, for example, with different performance “levels” in mathematics (Cotton & Hardy, 2004, reason in a similar way). All the students and their parents filled out a form in which they indicated whether they want to participate or not (appendix A).

In order to keep track of the participants, I named them according to which classroom they belong to. The teachers’ names are Anna, Britta, Cecilia, Diana and Erika. The students’ names are Ali, Angelica, Beatrice, Belinda, Catrin, Cilla, Denise, Daniel, Eddie and Enzo. I chose the names so that they are taken from the same language as the original names.

In this study, it is not the individual’s acts that are the focus as such; rather attention is given to the assessment acts that are part of and affected by institutionally situated assessment practices. Consequently, an account will not be specifically provided for each of the classrooms. My inspiration here is Persson (2009).

## 4.5 Data Material

So far in this chapter, I have mentioned different kinds of data that are the basis for this study. The primary data were collected from autumn 2006 to spring 2008. I summarise the material below.

### 4.5.1 Researcher’s log

I kept a log throughout the study. The first time I wrote anything down was when I initiated contact with each teacher. Contacts that took place during the research, through email and so on, are described in the log. I continued writing in the log during my week-long visit to the class. The log includes field notes and my own reflections. I recorded information and reflections that could be of relevance to my study. These notes concern all of my research questions, with a special interest in institutional aspects. Synopses are included along with the log.

### 4.5.2 Video Material and Transcripts

One video camera was focused on the two students, while I followed the teacher and her communication with the students in the classroom with a hand-held camera. The teacher and students also had portable voice recorders. With the fixed video camera and the students’ portable voice recorders, I

was able to capture what was going on just before the teacher arrived. I then became aware of what the teacher possibly could capture of the student's work in mathematics when s/he approached the student(s). With the portable video camera, it was possible to see the communication from two angles (this is described in Section 4.8.1). I could also approach the students' desks and record the page in the textbook that was being discussed with the teacher and capture what the student was writing, drawing and so on. I recorded the teacher's communication with other students using the portable video camera. These recordings are summarised in synopses, which are part of my researcher's log. A similar set-up, but with three cameras, was used by Clarke, Keitel, and Shimizu, (2006; described in Clarke, 2006; see also Clarke, Emanuelsson, Jablonka, & Mok, 2006).

The video recordings are not considered to be "objective" (Hall, 2000). I chose when and what to film based on the purpose of my study although I could not capture "everything" in the situation. There were other acts taking place in the classroom at the same time, which neither the video cameras nor the voice recorders captured. In the case of this study, the recordings foreground the teacher-student communication.

Overall, 29 mathematics lessons comprising a total time of more than 22 hours were recorded. All of these lessons were summarised in synopses; 111 sequences were chosen for a full transcription (described in more detail in the following section). The shortest sequence is 10 seconds and the longest is more than 27 minutes. On whole, more than 9 hours of video recordings are transcribed. I regard the transcripts of the films as the primary data.

#### 4.5.3 Written Material

With the teachers' help, I photocopied written material concerning the two students in grade four. The copied material is accessible to both the teacher and student (a similar addition to the empirical material is made in Tunstall and Gipps, 1996; see also Clarke, 2006). This consists of:

- Notations from teacher/student/parent meetings concerning the student's learning in mathematics
- Diagnostic tests
- Tests
- Worksheets, pre-produced
- Worksheets, constructed by the teacher (and student)
- Notations in the notebook (at least the last 3-4 pages)
- Self-assessments and evaluations
- Content of portfolios
- Other relevant materials

I call this data written material. However, not all of the material may consist of written words. This may also consist of drawings, for example. I sorted

the written material from each classroom into groups according to the list above. Overall, the material consists of around 500 pages organised into 65 document groups. The smallest group is one page and the largest 48 pages.

#### 4.5.4 Data Loss

Together with the sound track from the two video cameras, a sound recorder for the teacher and each of the two students provided me with five sources of sound. As a result, there are very few instances where I was not able to hear what was said. The Mp3 players that were used to record the students' voices malfunctioned on a few occasions, but with supplementary sound from the teacher and the other student, this was not a problem. During one lesson, both the teacher's and one of the student's sound recorders malfunctioned, and the lesson was transcribed relying mostly on the video. There were instances where data material was deliberately removed; this was when one of the participants did not seem at ease with the filming situation. On some occasions, I asked a participant if this was the case. One lesson was removed from the data for this reason. The students were not always visible on the film. They may have moved to another table without me noticing, subsequently being missed the camera. On these occasions, which are limited in number, I had to rely solely on the sound.

### 4.6 Ethical Considerations

Gustafsson, Hermerén, and Petersson (2005) divide ethical considerations into two groups: researcher-ethical considerations and research-ethical considerations. Researcher-ethical considerations take note of "the quality of the research, the researcher's honesty and integrity" (p. 19, my translation). Research-ethics considerations concern "how to protect participants, informants, subjects of experiments and others in the research who are in contact with the research and how to take all these people into consideration during the research" (p. 19, my translation). I refer to researcher-ethical considerations in other parts of the thesis, especially in the next section (4.7 Trustworthiness). I address research-ethics concerns below.

In my research, I follow the ethical rules stipulated for research in the social sciences (Vetenskapsrådet, 2008). However, inspired by Bauman (1993), I want to take this one step further. Bauman writes from a historical and global perspective that it is not enough to follow rules. He argues that everyone has a personal moral responsibility, concluding that postmodernity "has dashed modern ambitions of the universal and solidly grounded ethical legislation" (p. 223). Bauman insists that we must always try to envisage the future influence that our actions may have and always aim for no negative consequences for any of our actions, or to minimise at least. Bauman has

influenced my ethical considerations. Even though it is impossible to act entirely according to his consequence-ethical reasoning, I became aware that it is not enough to follow the official rules. I also concluded that I needed to consider all my decisions in my work in order to minimise the negative consequences of my research for the participants.

In the ethical principles for research (Vetenskapsrådet, 2008), there are requirements in four areas: information, consent, confidentiality and use. The communication between each teacher and myself regarding ethical requirements initially occurred in an oral discussion, where I described the most important aspects. After this, the teacher got to read about it in writing (appendix B). I describe below how I followed Vetenskapsrådet's (2008) official requirements in my work and also present further considerations, which are inspired by Bauman (1993).

*Information.* I informed my participants, both teachers and students (and their parents), about the research project, orally and in writing. I described my research interest broadly and all activities in the project as well as the participants' roles. I communicated that this research was important and that the participation of the teacher and the students who chose to be part of it would be a great help in my work. I informed the participants that their participation was voluntary and that they could refuse to participate further at any time. Throughout the research, I checked with the teachers to see what they thought of the cooperation of the participants. I carefully observed their reactions to video recordings, for example. The same is true for the students. On two occasions, students agreed to participate, but when they turned out to be one of the randomly chosen students and we talked about the practical matters, they changed their mind. I then assured them that this was perfectly fine and that someone else would take their place instead.

*Consent.* All participants were asked to sign a consent form (appendix A and B, developed with inspiration from Lenz Taguchi, 2000). On the student's form, both the student and parent were asked to sign. They could choose between three "levels" of student participation. One choice was that the student could be the focus of the study, that is, it was alright for the student to be randomly chosen and then have a video camera fixed on her/him. Another option was to agree to be in the background of the video films, but not to be one of the students in focus. The third choice was to refuse to be filmed at all. I see these three levels of choices as an opportunity for the student and parent to make an informed choice. There were very few students who chose not to be video-recorded at all.

*Confidentiality.* I did everything I could to keep the participants' identity confidential and they were also informed about this. I stored films, consent forms, sound files and written material where others can not gain access to them. In my log and in all my analyses and so forth, I use other names for the participants. The primary person making use of the material is me. A few other people looked at and/or listened to some of the material. These people

are the ones I discussed my analyses with during the process. I met some of the teachers in other situations. In these situations, I did not say anything about the research project, in order to preserve their anonymity. In a small number of cases, for example, it may be possible for colleagues of participating teachers, for instance, to determine the identity of one of the participants. I am fully aware of this, for example, in my descriptions of the acts of participating teachers.

*Use.* I use the material for research purposes, for this dissertation, conference papers, articles and perhaps for new analyses in the future. I also present the findings in articles and papers. The participants were informed that this was the case.

In a way, it is comforting to read Bauman's reasoning. He writes that ethics of a kind where we have "the other" in our field of vision at all times means it is unavoidable that we live with a certain amount of worries and a great deal of reflection. Drawing on this, it is apparent that I had a fair number of concerns and reflected a good deal on this study, both in terms of research-ethical and researcher-ethical considerations such as trustworthiness.

## 4.7 Trustworthiness

Goodchild (2009) gives a similar emphasis to ethical aspects as in the previous section and includes the long-term effects of classroom research in the broader educational context as well. His response to this ethical issue is to ensure that research "attains the *highest standards of scientific rigour*" (p. 218, italics in original). Gustafsson et al. (2005) stress the importance of researchers making their account of their research as open and accurate as possible. They also emphasise the significance of making the theoretical and methodological assumptions clear to the reader. Bryman (2004<sup>59</sup>) suggests alternative terms for validity and reliability in qualitative research. In the description of trustworthiness for this study, I use Bryman's structure and discuss the trustworthiness of my work. The corresponding features in brackets are used mainly in relation to quantitative methods. I add ecological validity to the four aspects since this reflects critical considerations in my study.

*Credibility* (internal validity). One way to make my findings credible is through respondent "validation" (Bryman, 2004). I met each of the participating teachers two or more times and had an open discussion about my analyses. If the teacher and I did not agree, both interpretations were published (see Goodchild, 2001). Another way to increase credibility is to use different methods of data gathering (Bryman, 2004). In the analysis and outcomes chapter, there are examples of how the written material together with

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<sup>59</sup> With reference to Lincoln and Guba (1985).

the video/audio transcripts allows for an understanding of the communication. There are also occasions where the log contributes to the analyses.

*Transferability* (external validity). My aim is not to create a complete picture that is applicable to other contexts in an absolute sense. What I hope is that, with in-depth descriptions based on different classrooms and thus contexts, I create a picture that many people can use. Adopting a discursive and institutional perspective is one way to increase transferability. The fact that I collected material from classrooms with teachers from different backgrounds provides broad variation, which makes transferability as great as possible within the framework of the project.

*Dependability* (reliability). My aim is to take an auditing approach. In doing so, I describe all phases of my research process: research questions, choices of participants, field notes, data collection, transcriptions, decisions concerning analyses and so on. My aim is to have my work reflect a high degree of transparency. I have also had quality discussions about my analyses with two researcher friends. We spent several days on my material and they reviewed and discussed my coding in categories<sup>60</sup> as well as the overall outcomes. These discussions, along with those with the participating teachers, were a way to enhance the quality of the analyses.

*Confirmability* (objectivity). My aim is to ensure that my values do not bias my work in an unprofessional way. Quality discussions with the teachers involved and the two researcher friends were a way to achieve this. However, I recognise that my background influences my work (as any background does), so I strive for as much accuracy and transparency as possible.

*Ecological validity*. Are my findings useful for teachers in their work? This is certainly something I desire, and my aim is to offer findings that can provide some support for teachers in their work. The participating teachers and I learned a great deal during the study, and I would like this experience to be a basis for support, understanding and discussions among teachers in mathematics, as well as other agents, in general.

## 4.8 Transcribing the Video and Audio material

In this part of the Methodology, I describe the transcription and analysing process for the video and audio material.

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<sup>60</sup> The analyses of the excerpts presented in the analysis and outcomes chapters were all subject to a thorough discussion. The researchers also checked analyses of sequences randomly chosen from the material.

### 4.8.1 The Set-up – Videograph

For the transcription and coding process, I used software called Videograph<sup>61</sup> (described in Savola, 2008). Different media clips can be combined using this program. For this project, the clips consisted of two video clips, one from the camera focused on the two randomly chosen students, and one from the hand-held camera, which I used to follow the teacher, and three audio clips from the three Mp3 players carried by the teacher and two students. I chose one of the five clips as the main clip and connected the rest of the clips so they are aligned time-wise. The set-up may look like that shown in figure 11.

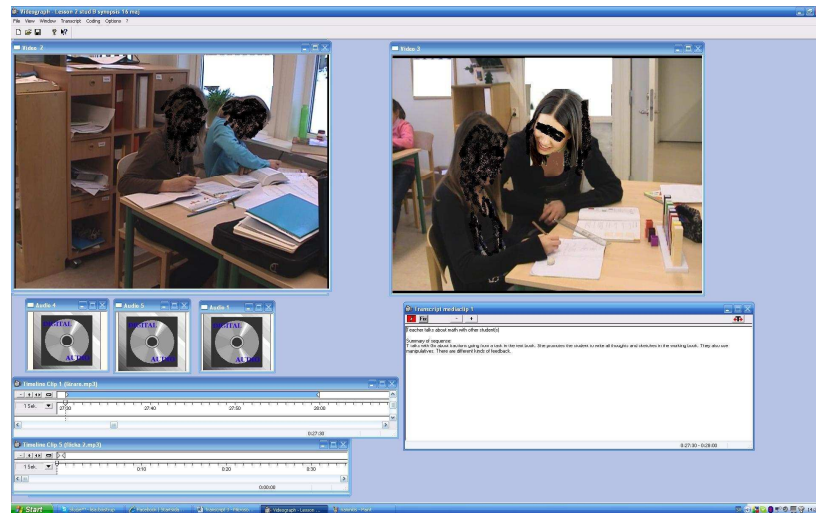


Figure 11. One possible set-up in Videograph. The two video clips are positioned at the top. The three audio clips are placed on the left. Timelines for the clips are shown on the left at the bottom. Beneath the second video frame is a writing window. (The pictures are altered in order to preserve the anonymity of the participants.)

Once I went through the material, I could choose which audio source to listen to. The two video cameras were used in different ways. When the teacher was close to the two students in focus, the fixed camera was still aimed at the two students and, at this point, the teacher as well. Most of the time, I also aimed the hand-held camera at the two students and the teacher. This gave me the opportunity to see what was taking place from two directions (figure 12).

<sup>61</sup> A description of the program was retrieved from <http://www.dervideograph.de/enhtmStart.html>, September 30, 2010.

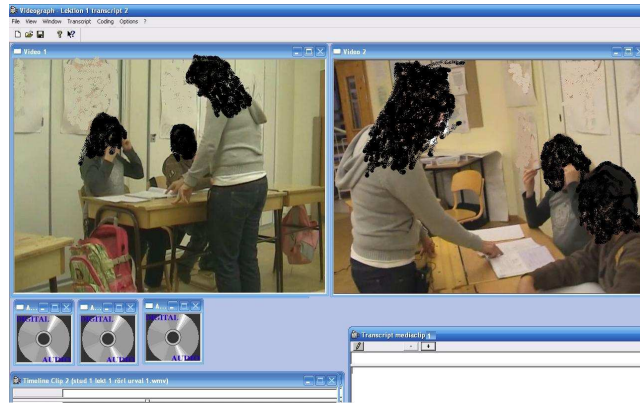


Figure 12. The same communication shown from two camera perspectives. (The pictures are altered in order to preserve the anonymity of the participants.)

Using two cameras for the same communication also allowed for a close-up of the students' work (figure 13).



Figure 13. The video frame to the right shows a close-up of one of the student's worksheets. (The pictures are altered in order to preserve the anonymity of the participants.)

When the teacher was at the front of the classroom, or when the teacher was communicating with students other than the two randomly chosen ones (like in figure 11), I was able to follow the actions of both the teacher and other students, while at the same time follow what was going on with the two students in focus.

#### 4.8.2 Synopsis

An early step in the transcription process has been to write a synopsis for each lesson. In writing the synopsis, I marked the sequences that I would later transcribe in detail (how I chose these sequences is described later in

this chapter). The synopsis (written in English) is a short summary of what was going on for all teacher-student communication in mathematics. These summaries constitute background material and also affect the final version of the log. With this done, it was easier to navigate the material and also make transcriptions since it was easier for me, having examined all teacher-student communication, to create an understanding of the communication constituted by semiotic resources in each particular classroom. I entered the synopsis in a window for writing, indicating briefly what was taking place. Once finished, I exported these notes into a text file, which is shown in excerpt 1.

```

01:15:30 - 01:16:00
          Teacher OT with other student(s).
01:16:00 - 01:16:30
          Teacher OT with other student(s).
          Teacher OT with G1 or G2.

1:16:15: SEQUENCE 2 STARTS
          T asks G1 what she wanted to ask. G1 responds that she already
has solved it. T asks G1 to explain how she went about.
01:16:30 - 01:17:00
          G1 says that she had read the task wrong, but after many
readings she figured it out. T says that this is a good method.

1:17:00: SEQUENCE 2 ENDS

01:17:00 - 01:17:30
          Teacher OT with other student(s).

```

Excerpt 1. Example of synopsis. OT stands for off topic, G1 and G2 for the participating girls, and T for teacher.

### 4.8.3 Choice of Sequences for Transcription and Coding

During the writing of the synopsis, I made an initial decision about where the sequences for transcription and coding start and end. The sequences chosen are:

1. Sequences where the students are working independently, by themselves or in a group, and there is communication by way of semiotic resources in multimodal ensembles in the mathematics classroom between the teacher and (one of) the two students in focus. Also included in the sequence are a few seconds just before and up to 30 seconds of the students' work after the teacher-student communication. A communication here refers to when there is some kind of interaction between the teacher (T) and the student (S), by way of various semiotic resources. Speech is not always included.

2. Discussions in the mathematics classroom where the teacher and one or both of the students address each other. Also included here are sequences

where the students in focus address the teacher, for example by raising a hand. When the teacher does not pay attention to this, the teacher's communication with other students is summarised.

3. Instructions and meta-discussions in class about assessment with respect to the mathematics classroom (also when it is about assessment of learning in general, that is, it is not clearly stated that the focus is on mathematics).

I use the notion of the mathematics classroom to make clear that I do not transcribe communication, for example, about another school subject. I do not refer to the mathematics classroom as a physical position. If the teaching took place outdoors but was still on mathematics, this would also be included in the mathematics classroom. The students in the classrooms visited often worked on different school subjects side by side during independent work lessons. For me as a researcher, the mathematics classroom was present when one, or both, of the students in focus worked on mathematics.

A valid comment here is that, since I followed two students in each class, there were many situations containing implicit and explicit assessment acts in the mathematics classroom that are not part of the data. This, of course, means that I missed out on the opportunity to capture even more assessment acts in the classrooms chosen. I acknowledge this. The reason I chose to set the limitations mentioned in selecting sequences was largely a strategic choice. I wanted as many *different* examples of assessment acts as possible. I therefore decided to follow two students in five classrooms instead of more students in a smaller number of classrooms.

#### 4.8.4 Transcription

Each sequence chosen was transcribed in detail (in the software's transcript window). Following the theoretical considerations with respect to social semiotics, the transcription was done multimodally, meaning that different kinds of semiotic resources were captured, including all the kinds of artefacts used. I transcribed what the teacher and the two students in focus (and potential group members) said. From the beginning, speech was written as whole sentences, incorporating extra symbols, such as stress marks and question marks, in order to make it clearer. When the voice was at a high frequency, this was marked with (h), and similarly with an (l) for low or (n) for narrow<sup>62</sup> voice. I did not see the need for a more detailed transcription of the speech and voice since I also had access to body movements, gestures and so on. Secondly, hand gestures, incorporating any held objects, was transcribed as long as it was an act that makes meaning in terms of my interest in

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<sup>62</sup> I have chosen the word narrow to describe what I consider to be a constriction of air flow, producing a narrow voice. This is often interpreted as "creaky".

assessment acts in mathematics classrooms. At times, I discussed an act with others during the process. Thirdly, where they look, their facial expressions, how their bodies are positioned and whether there is any change in body position were transcribed. Finally, I took notes on what the students wrote in their notebooks or worksheets during the communication and what they or the teacher wrote, for example, on the whiteboard. Also included in the transcript are other artefacts used, such as manipulatives.

Usually in studies based on social semiotics with a multimodal approach, the transcription is done in columns (Rostvall & West, 2005; Kress et al., 2001; Insulander, 2010; see also Björklund Boistrup, 2007). In these transcripts, the different kinds of semiotic resources are placed in separate columns. In the software used, it was not possible to write in columns in the transcript window so I decided to enter the different semiotic resources in rows instead (shown in Björklund Boistrup & Selander, 2009). I converted the original transcripts into excerpts in columns in the analysis and outcomes chapters, an example of which is shown in excerpt 2. In the columns for Gestures, and Body and Gaze, only changes in acts are recorded, along with acts with artefacts. The people involved in excerpt 2 are the students Angelica (S) and Ali (S) and the teacher Anna (T). To limit the amount of text, Angelica (S) is labelled Ang the second time she is mentioned in each column. Similarly, Ali (S) is labelled Ali. Anna (T) is labelled T the second time in each column. In order to maintain authenticity in the data excerpts, I show the original transcript of speech in Swedish in footnotes here as well as in the analysis and outcomes chapters.

Time	Speech	Gestures	Body and Gaze
29:24	Angelica (S): Yes. <sup>63</sup>	Ali (S) points at the answer to question D.  Ali takes hand away.	Ali (S) looks at paper Angelica (S) looks down. Ali looks at T. Anna (T) looks at Ali and his work.
29:25	Anna (T): What does it say?		Ali looks at his paper.
29:26	Ang: One hundred sixty eight. [Ali (S): One hundred sixty eight]		Ang looks at Ali's paper.

<sup>63</sup> Original transcript of speech in Swedish:  
 Angelica (S): Ja.  
 Anna (T): Vad står det?  
 Ang: Hundrasextioåtta [Ali (S): Hundrasextioåtta].  
 T: Hundrasextioåtta! Hur visste ni det?

29:27	One hundred sixty eight! How did you arrive at that?		Ali looks up (in the air).  Ali looks at T. Ang looks down.
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Excerpt 2. Example of excerpt from video material. “T” is short for Anna (T). “Ali” is short for Ali (S), and “Ang” for Angelica (S). Brackets, “[ ]”, signal simultaneous speech.

Thanks to the multimodal transcripts, I rarely had to watch the actual films after transcribing them for my analyses. Most of the time, it was enough just to read the transcript, which captures what is to be analysed.

## 4.9 Data Analysis

I call the next step of the process Analysing. However, I am fully aware that the analysing process can be seen as taking place in a much longer time-frame. One example is when I visited each of the five classes. How I placed the cameras and what data I collected were strongly affected by the analysing process (see Rostvall & West, 2005). That is, I made choices of what to include and what to exclude. These choices were, of course, strongly affected by the overall purpose of the study as well as theoretical considerations.

### 4.9.1 Analysing the Video and Audio Material

During the analysing part of the process, I again used the Videograph software. I defined categories in the program and then went through the material, aligning codes with parts of the communication based on my analytical framework, including categories that emerged during the analytical process. I describe below how I went about the coding process in practice.

I looked at one sequence at a time and went through all the communication the sequence consisted of. The excerpt from the previous section can serve as an example. I looked at the communication and examined which categories I considered to be present for several seconds. Some of the categories are shown in figure 14<sup>64</sup>.

<sup>64</sup> Some categories (figure 14) are slightly modified in order to make the process clearer at this point.

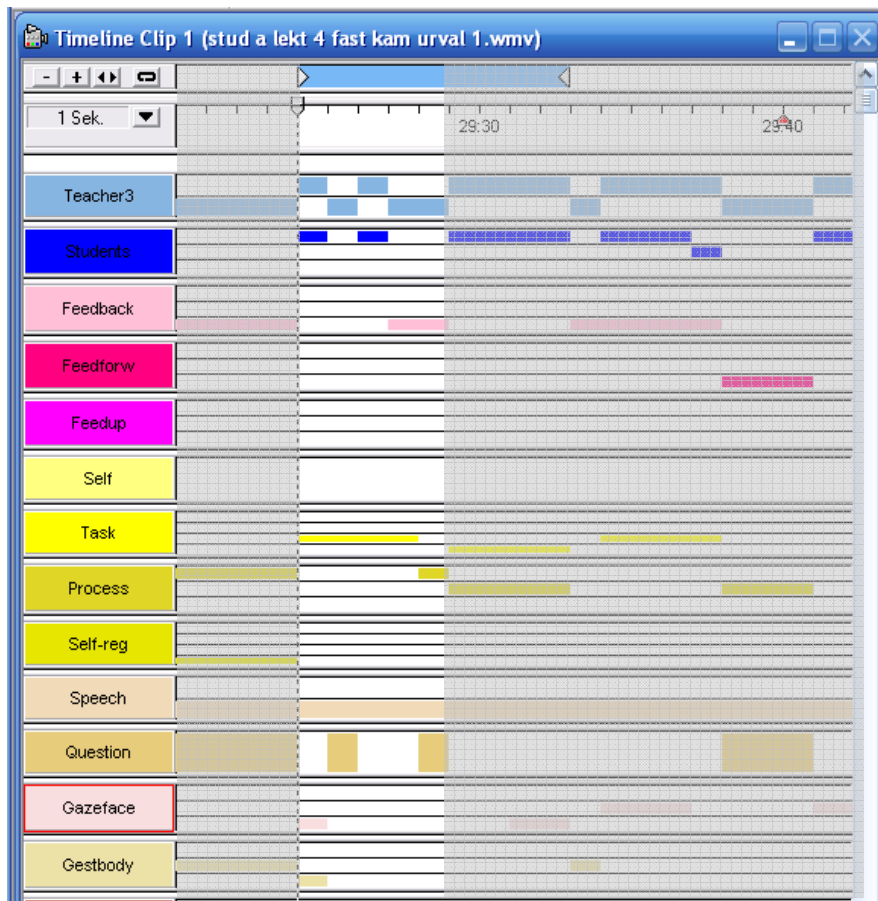


Figure 14. Examples of coding categories. Categories from top to bottom: Teacher, Students, Feed Back, Feed Forward, Feed Up, Self, Task, Process, Self-regulation, Speech, Question, Gaze and Face, Gestures and Body. (The grey areas are not discussed here.)

We can see in figure 14 that both the teacher and students are active. One could object that both the teacher and student are clearly constantly active during communication, at least with different semiotic resources. While the teacher is speaking, the students communicate with other semiotic resources at the same time. That is true, and I chose the person whose acts I mainly analysed. At times, codes were entered for both the teacher and student concurrently and this was denoted by dividing the time slot into two. Looking carefully at this figure, we can see in my analysis that I considered the teacher to communicate feed back and that part of this feed back is through a question. A reader may question how an utterance such as “One hundred and sixty eight! How did you arrive at that?” can be considered feed back. It is

one point in the thesis, specifically that utterances like this can also be understood as assessment acts (as one of possible understandings), and this will be developed in the following analysis and outcomes chapter. Further down, we can see that I analysed the focus of the students' actions in the beginning as being on task (the right answer), with the teacher's feedback first having the same focus before switching to the process (when she asks how they know the answer). At the bottom of the diagram, it is apparent that in my analysis I considered there to be different semiotic resources present in the analysis, at least in the beginning, when the students are talking and using gestures (Speech, and Gestures and Body). In order to perform an analysis like this, I looked beyond only considering communication like this separately. The analysis also involved looking at what took place before and after a communicative act as well as relying on the assessment practice as a whole in a classroom, as is shown in all the data (video material, written material and my researcher's log). One may question whether this detailed analysis is really necessary. My answer would be that it is not important to know whether an aspect goes on for one or two seconds. What is of benefit to the concluding analyses is that the detailed analyses, as shown here, provide the opportunity to capture interplay between different categories. The analysis and outcomes chapter presents examples of how this interplay makes meaning as part of the findings.

#### 4.9.2 Analysing the Written Material and Researcher's log

The written material, divided into document groups, was analysed using similar categories as for the video/audio transcripts. What I refer to here is the written material photocopied with the help of the participating teachers. This material was collected over a longer period of time than my week-long visit to each classroom. The written material filmed in the video sequences is part of the multimodal ensembles, together with gestures, speech and the like, and consequently part of the analyses of the video material. The researcher's log was consulted during the analyses, contributing to my analyses by providing a description of each classroom's assessment practice as a whole.

#### 4.9.3 The Reflective Process

My categories are presented in the analysis and outcomes chapters that follow. These categories evolved in a reflective process, in which I went back and forth between theoretically based structures in the research literature, data and preliminary analyses (Wodak, 2004). Often a category was taken from a structure in the research literature, and then sub-categories evolved from the empirical material. The choice of theoretically based structures was affected by data and the preliminary findings. The empirically derived cate-

gories resulted from an aspect that caught my attention during the analyses, and they were tentative at first. After a while, some of these were merged with similar ones or removed because they were not considered relevant to the final analyses. The conceptualisations of all the categories were refined throughout the process. Since new categories were added during the analyses, I re-analysed data, paying attention as well to these new categories, which may not have existed during the first analysis. In the analysis and outcomes chapters, I present the analytical, mainly theoretically derived, framework for each research question along with the categories that emerged during the analyses. As the reader will find, there are a large number of categories in play. I chose to keep the process open to new categories for as long as possible as it affords the research process many opportunities to reveal unexpected findings, patterns and relationships.

#### 4.9.4 Finalising Analyses Into Findings

For each research objective, there are methodological considerations made in finalising the analyses into findings. These methodological matters are addressed for each research objective in the corresponding analysis and outcomes chapters.

The main outcomes of this thesis are the construed discourses and how they provide affordances for students' active agency and learning in the mathematics classroom. The basis for the construal of these discourses is the assessment practices in the classrooms visited as they are demonstrated in student-teacher communication. In order to create a basis for the construal of discourses, I performed a detailed analysis with respect to the first three research questions. The basis for dividing up these three research questions is the three social semiotic meta-functions. Other studies relying on social semiotics, for example Insulander (2010), Lindstrand (2006) and Öhman-Gullberg (2008), served as inspiration for this.

The following four analysis and outcomes chapters are each connected to one research question. Throughout the account of analyses and findings, there are excerpts from video and written material. I have chosen excerpts so that all five classrooms are present in the thesis. There are excerpts that are considered to include more affordances as well as fewer affordances for students' active agency and learning in the mathematics classrooms. I have also chosen excerpts from different types of classroom situations, for example independent work, full class sessions and so on. My aim in choosing them is to give the reader a sense of the data and findings as a whole. As a consequence, I have not always showed the most typical excerpt relating to a specific finding.

## 5 Assessment Acts in Mathematics Classrooms: Analysis and Outcomes

In this chapter, I describe my analysis and outcomes for how assessment acts related to feedback take place in teacher-student communication in the assessment practices of the mathematics classrooms visited. As noted earlier, this research objective is connected to the interpersonal social-semiotic meta-function (Halliday, 2004; Van Leeuwen, 2005). The findings for assessment acts are developed in relation to affordances for students' active agency in the mathematics classroom. As mentioned, in this thesis I operationalise power according to Foucault (e.g. 1980, 2003) through the notion of agency. In this instance, agency is understood to be a capacity for students to make choices and impose those choices on the world. The outcomes in this chapter constitute a basis for determining the roles of assessment acts in the construed discourses.

The following classroom communication in *Pippi Goes to School* serves the illustrations of my analyses for the four analysis and outcomes chapters:

(Earlier in the story, the teacher asked Pippi what seven plus five is.)

Pippi, astonished and dismayed, looked at her and said, "Well, if you don't know that yourself, you needn't think I'm going to tell you."

All the children stared in horror at Pippi, and the teacher explained that one couldn't answer that way in school.

"I beg your pardon," said Pippi contritely. "I didn't know that. I won't do it again."

"No, let us hope not," said the teacher. "And now I will tell you that seven plus five is twelve."

"See that!" said Pippi. "You knew it yourself. Why are you asking then?"

The teacher decided to act as if nothing unusual were happening and went on with her examination.

"Well now, Pippi, how much do you think eight plus four is?"

[...]

The teacher decided there was no point in trying to teach Pippi any more arithmetic. "Can Tommy answer this one?" she asked. "If Lisa has seven apples and Axel has nine apples, how many apples do they have together?"

"Yes, you tell, Tommy," Pippi interrupted, "and tell me too, if Lisa gets a stomach-ache and Axel gets more stomach-ache, whose fault is it and where they get hold of the apples in the first place?" (Lindgren, 1998, p. 16 ff, translation by F. Lamborn).

The analysis of what is taking place initially indicates that the teacher communicates *feed back* to Pippi. The teacher explains through speech and through her gaze, as do the other students, how to answer questions like this in school. Here, the affordances for Pippi's active agency are considered low. At the same time, Pippi communicates *feed back* to the teacher about her teaching. From Pippi's point of view, it does not seem to be relevant to pose a question whose answer is already known. Pippi also takes active agency in the mathematics classroom in this instance with respect to the teaching. This *feed back* is not acknowledged by the teacher. When the teacher continues by asking Pippi how much she thinks eight plus four is, it may be a case of the teacher allowing for *feed back* and *feed forward*. This means that the teacher poses questions to Pippi in order to gain information about Pippi's demonstrated mathematics knowing. This information can be used by the teacher in different ways. She can communicate *feed back* to Pippi about her demonstrated knowing or *feed forward* regarding her continued learning. The teacher can also use Pippi's demonstrated knowing as *feed forward* for subsequent teaching. This interpretation seems more reliable when earlier events in the sequence are considered, where the teacher says "suppose we test you a little and see what you know". At the end of this excerpt, there is another act where Pippi takes active agency and communicates *feed back* with respect to the teaching when she tries to include more reality in the mathematics task. It is also quite clear that Pippi *disapproves* of the unrealistic question posed by the teacher.

In this chapter, the assessment acts present in the Pippi excerpt will be considered and also supplemented with acts that emerged during the analysis. All categories connected to the findings of this chapter are written in italics. Similarly, as in Tunstall and Gipps's (1996) typology, it should be remembered that I see the categories as being on a continuum rather than categorical, so there are overlaps and the use of two types together in the analysis.

## 5.1 Analytical Framework for Assessment Acts

The categories used in this chapter cover various kinds of assessment acts that take place. The original categories by Hattie and Timperley (2007) have been expanded by bringing in the notion of agency. I also operationalised Hattie and Timperley's own argument about assessment acts in the classroom with respect not only to the student's performance but also to feedback regarding the teacher's teaching in relation to students' learning (see also Hattie, 2009).

In accordance with Hattie and Timperley (2007), I divide assessment acts related to feedback into three types: *feed back*, *feed forward* and *feed up*. As with Hattie's and Timperley's concepts, there is a difference between feed-

back (as one word) and *feed back* (as two words and, in this chapter, in italics). Feedback encompasses three assessment acts: *feed back*, *feed forward* and *feed up*. The assessment acts as they are used in this study are defined below:

*feed back*

Any assessment act that is directed at what has happened, for example, the student's earlier and/or current performances in the mathematics classroom. The *feed back* can be communicated to the student by the teacher and/or the student. If it is the student who does this, it is a matter of *self-assessment*. It can also be the student who communicates *feed back* to the teacher about previous or current teaching and/or the teacher capturing students' demonstrated meaning making as *feed back* to her/his teaching.

The student can ask for *feed back* from the teacher, for example, whether a suggested solution can be regarded as productive or not.<sup>65</sup> The teacher can provide for *feed back* when s/he invites the student to answer questions about her/his view of the teaching in relation to her/his own meaning making and learning. Allowing for *feed back* is also at hand when the teacher lets the student make a *self-assessment* or when the teacher allows for her/his own giving of *feed back* to the student.

*feed forward*

Any assessment expression that is directed at the future. A question directed forward as a "reaction" to something the students communicates belongs here. The *feed forward* can be communicated to the student. The teacher or student "states" what the student could/should do/learn. The *feed forward* can also be communicated to the teacher. The students' demonstrated meaning making can be counted by the teacher as *feed forward* to the teacher. In this case, it is clear that the teacher uses the student's actions and demonstrated (lack of) knowing as a basis for continued teaching.

The student can ask for *feed forward* from the teacher, for example, how to go about solving a problem. The teacher can provide for *feed forward* when s/he invites the student to give her/his view of the teaching, which is then feed forward for the teacher's teaching.

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<sup>65</sup> Inspiration from personal communication with Guri Nortvedt, summer 2009.

*feed up* Any assessment expression that relates the students' demonstrated knowing or teacher's teaching to explicit goals/criteria that should/could have been reached and/or are to be reached in the future. If the reference is vague, for example, referring to mathematics content that the class is working on, it is not counted as *feed up* in this study.

## 5.2 Feed Back, Feed Forward and Feed Up in Mathematics Classrooms

In the following section, I describe different kinds of assessment acts and at the same time consider affordances for students' active agency in mathematics classrooms. I also consider examples of direct institutional traces<sup>66</sup> judged to be present. As mentioned, the assessment acts are one basis for the construal of discourses (Chapter 8), and the institutional traces are examined in relation to the discourses.

### 5.2.1 Evaluative Feed Back

Drawing on Hargreaves et al. (2000) as well as Tunstall and Gipps (1996), I call the first group of assessment acts evaluative *feed back*. Here, the teacher evaluates the student's demonstrated performances in terms of "good" or "bad". The assessment acts that belong here are *rewarding*, *punishing*, *approval* and *disapproval*.

In this study, *feed back* as *rewarding* or *punishing* was not clearly present, that is, there were no instances where students are clearly *rewarded*, for example, with golden stars for their performances in the mathematics classroom. Nor is there any communication where students are clearly *punished*.

*Feed back* as *approval* from teacher to student is considered to be present in the material. Typical communication in the data is when a student describes her/his solving a task and the teacher says "Mm!". Because of the raised voice frequency, I determined that the teacher can communicate that s/he is pleased with what the student communicates. Other examples are when the teacher says things like "Great" or "Exactly" as a single word or in sentence. Smiling, nodding and looking are ways to communicate and/or emphasise *approval*. It should be noted that, in this study, ascribing assessment acts to single utterances, communicated in multimodal ensembles, is an interpretative act. Not only is the current utterance taken into consideration here, but also what happened in the communication prior to this and what

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<sup>66</sup> The notion of institutional traces is inspired by Norén (in press), who writes about the voice of the institution.

takes place afterwards (Van Leeuwen, 2005; Selander & Kress, 2010). Moreover, as noted in the Methodology, I discussed the analyses with two researcher friends as well as with the relevant teacher.

In the analysis, I considered *feed back* as *approval* from teacher to student to also be present in the written material. The teacher can write “Good” or “Well done” beside the student’s work. An example of more elaborate written *feed back* as *approval* is when Anna (T) makes an entry in a home communication book (a book where the student can write plans for the week and assessments of the work for the week) to Angelica (S) (excerpt 3).

[Anna (T):] This week, you were really good when we solved the math problems about how much everyone should pay for the party.<sup>67</sup>

[Angelica (S):] Thank you, Anna. Really, thanks.

Excerpt 3. Teacher-student communication from the written material.

In analysing this excerpt in relation to affordances for students’ active agency, I considered it to show how the teacher, Anna, takes on the role as the one who evaluates, in this case, in terms of “good”. Angelica (S) responds to this *approval* with gratitude, as the one who is being assessed.

In the following excerpt, instances of *feed back* as *disapproval* are considered to be present. The students are working on their own, and their assignment is to organise the results of a survey they carried out in class. The results of the survey are written by Cecilia (T) on the whiteboard. Cecilia (T) instructs the students to turn their results into a ranking list and then into a diagram of their choice. Cecilia (T) walks around in the classroom, *checking* (addressed below) the students’ work. She passes Cilla (S) and is on her way to next student when Cilla (S) calls for her attention (excerpt 4). This is the first excerpt from the video material in this chapter, and I have chosen to include an extensive portion in order to give the reader more information about the situation. In the rest of the chapter, the excerpts will be summarised in part. The original excerpt in Swedish is in Appendix C.

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<sup>67</sup> Original excerpt in Swedish:

Anna (T): Den här veckan var du verkligen duktig när vi löste problemen med hur mycket var och en skulle betala till festen.

Angelica (S): Tack Anna. Verkligen tack.

Time	Speech	Gestures	Body and Gaze
12:38		Cilla (S) is sitting at her desk. Cecilia (T) is standing behind Cilla (S).	Cilla (S) looks at Cecilia (T). Cecilia (T): Looks at Cilla's (S) work.
12:40			T turns to other student.
12:41	Cilla (S): Cecilia, can I do like this?	Cil's hand on notebook.	Cil looks at notebook, at T. T turns back to Cil. T looks at Cil's work.
12:43	Cecilia (T): Well, have you ranked them then?		T's mouth downturned and forehead wrinkled.
12:44	T: Have you written them in order now? ( <i>low</i> )		T looks at Cil and Cil's work.
12:46	Cil: So I do like this.	Cil points at notebook.	Cil looks at notebook.
12:47	T: You don't need to copy, because that's already on the board. You should write them in order ( <i>low</i> )!	Cil stops pointing.	T's mouth downturned and forehead wrinkled. T looks at whiteboard. T looks at Cil. Cil looks at T.
12:53	T: Then it will be easier to read.		T's mouth downturned. Cil looks at T T looks at Cil and Cil's work
12:54	Cil: Mm		Cil looks at notebook.
12:56	T: Sort them in order! Then I would do it like this. Do you want a hint ( <i>high</i> )?		T turns to other student. Cil looks at whiteboard. Turns back. Leans over Cil's desk.
12:59	Cil: Mm		
13:00		Cil's pencil in hand on notebook.	Cil looks at notebook.
13:01	T: I would take this one with many, I would move that further down.	T points at word in notebook, moves finger to bottom of page.	T looks at notebook.
13:05	Cil: But [inaudible] it is	Cil points at whiteboard.	Cil looks at whiteboard.

13:08	T: But you don't have to use my order ( <i>narrow</i> ).	Cil stops pointing.	T looks at whiteboard.
13:10	T: Move that further down as well. So it is in order ( <i>narrow</i> ). Order, one, two, three or ten, nine, eight, so they are in order ( <i>narrow</i> ),	T points at whiteboard at notebook. T points from top to bottom with hand. T stops pointing.	Cil looks back and forth at notebook and whiteboard. T looks at notebook and Cil.
13:18	Cil: Yes		Cil looks at T.
13:19	Cil: Can I not write in your order?	Cil points at whiteboard. Stops	Cil looks at whiteboard. T looks at Cil.
13:21	T: If you copy that, you haven't ranked them, then you haven't followed the instructions ( <i>narrow</i> )!	T points at whiteboard Stops	T: forehead wrinkled. T looks at whiteboard. Stands up. Looks at Cil. Cil looks at T.

Excerpt 4. Transcript from video material. Original transcript in Swedish is in Appendix C. “Low” refers to voice at a low frequency, “high” refers to voice at a high frequency, and “narrow” refers to voice with restricted air flow (creaky). “T” is short for Cecilia (T), and “Cil” is short for Cilla (S).

In excerpt 4, when, after 12 minutes and 41 seconds of the lesson has gone by (12:41), Cilla (S) asks whether she can write a certain way, she is considered to ask for *feed back* and/or *feed forward* on her work. She is considered here to take active agency in her learning of mathematics through this assessment act. Cecilia (T) looks (at approximately 12:42) at Cilla's work, providing for *feed forward*. Her face looks serious (12:43), which is communicated with her mouth and forehead, and she asks Cilla (S) whether she has ranked the items (that is, put the items in order according to the voting results). Cecilia (T) asks again (12:44), this time with a lower voice. It is clear from the communication between Cecilia (T) and Cilla (S) that Cilla (S) has written the items in the same order as they are written on the whiteboard. Based on voice (low and narrow) and facial expression (wrinkled forehead), I considered Cecilia (T) to communicate *feed back* as *disapproval* to Cilla (S). Cilla (S) does not follow Cecilia's (T) *feed forward* (or the initial instructions) that she should rank the items. After a while, at 13:19, she asks “Can I not write in your order?” Cecilia (T) makes clear, communicating *feed back* as *disapproval*, through her speech, voice, gestures and facial ex-

pression, that Cilla (S) has not followed the instructions. Here, I considered Cecilia (T) to take the role as the one who evaluates Cilla's (S) performances, in this case, in terms of "bad". The affordances for Cilla's (S) active agency are considered to be low. However, Cilla (S) does not give up. She really wants to know how to go about the task and she asks again (at 13:19), which is followed by *disapproval* from Cecilia (T) at 13:21. Cilla (S) then stops asking; she takes passive agency.

I also looked for instances of students communicating *feed back* as *approval* or *disapproval*. In the following account, I considered Enzo (S) to communicate *feed forward* as *disapproval* to the teacher, Erika (T), in relation to his meaning making and potential learning. The students are working on a task,  $376 - 149 =$ , where they are presented with five different solutions for the same task (excerpt 5).

- |    |  |    |                                |    |                                 |
|----|--|----|--------------------------------|----|---------------------------------|
| 1. | $370-150=220$<br>$220+6-1=225$                           | 2. | $380-150=230$<br>$230-4+1=227$ | 3. | $300-100=200$<br>$200-30-3=167$ |
| 4. | $300-100=200$<br>$70-40=30$<br>$6-9=3$<br>$200+30+3=233$ | 5. | $376-100=276-40=236-9=227$     |    |                                 |

Excerpt 5. Transcript from written material. Assignment presented to students. Five different solutions for one task. Which one is correct?

They are told in groups to find the one solution that is correct and also to find out what is wrong with the other four. Enzo (S) works with two other students. Something that absorbs them is that the correct answer, 227, is to be found in two of the solutions, 2 and 5. Despite this, one of them is regarded as mathematically correct. Erika (T) visits the group and asks them which solution they decided is correct. Enzo (S) points at solutions 2 and 5. Erika (T), looking at the students and their work, then asks what is wrong with solution 1 (excerpt 6).

Time	Speech	Gestures	Body and Gaze
27:51	Enzo (S): I don't know! Is it supposed to be twenty-seven ( <i>narrow</i> )? <sup>68</sup>	Enzo (S) points at numbers at top of page. Stops pointing.	Enzo (S) looks at worksheet, mouth downturned, forehead wrinkled. Looks at Erika (T).

<sup>68</sup> Original transcript of speech in Swedish:

Enzo (S): Jag vet inte! Ska det bli tjugosju?

Erika (T): Ska det det? Det är ni som hade bestämt vilka som skulle vara rätt.

27:56	Erika (T): Is it ( <i>high</i> )? You are the ones who decided what was supposed to be correct.	Erika (T): Gesture towards worksheet. Stops. Points at worksheet.	Enzo (S) looks at worksheet.
-------	--	--	------------------------------

Excerpt 6. Transcript from video material. “Narrow” refers to voice with a restricted air flow (creaky) and “high” refers to voice at a high frequency.

When Enzo (S) answers “I don’t know! Is it supposed to be twenty-seven?” with his mouth downturned and in a narrow voice, it is determined in the analysis that he is communicating some kind of discomfort. The fact that there are two solutions with the correct answer, but only one of them is mathematically correct in terms of the solution as well, seems to decrease his sense of meaning making. Less than a minute later, he says the following (excerpt 7) while Erika (T) stands in front of class watching the students.

Time	Speech	Gestures	Body and Gaze
28:40	Enzo (S): It was bad that it doesn’t make sense ( <i>narrow</i> )! <sup>69</sup>	Enzo (S) points at numbers at top of page. Stops pointing.	Enzo (S) looks down, (forehead wrinkled).

Excerpt 7. Transcript from video material. “Narrow” refers to voice with a restricted air flow (creaky).

In the analysis, I considered Enzo (S) to communicate *feed back* as *disapproval* about the teaching. Erika (T) acknowledges his frustration and active agency as *feed back* when she begins a whole session in which they will discuss the task and solutions (“Hey, let’s talk about this now, otherwise Enzo will go mad if it’s not sorted out”<sup>70</sup>, giggles and smiles, looking at Enzo (S) and the rest of the class).

### 5.2.2 Descriptive Feed Back

This heading refers to the second (of two) feedback strategies described by Hargreaves et al. (2000; see also Tunstall & Gipps, 1996; Askew & Lodge, 2000). A descriptive assessment act is when the teacher or student describes the student’s demonstrated learning instead of applying values in terms of “good” or “bad” to performances. Here, the tone is neutral; in this study, it is

<sup>69</sup> Original transcript of speech in Swedish: Det var dåligt att det inte stämmer!

<sup>70</sup> Original transcript of speech in Swedish: Hör ni, vi gör så att vi pratar om det här nu, för annars blir Enzo tokig på att det inte blir utrett.

about *recognising* (inspiration from Kress, 2009, who writes about assessment as recognition; see also Selander & Kress, 2010) or *agreeing* to students' demonstrated knowing or *recognising* an answer as mathematically incorrect (*disagreeing*). It can also be *recognising* in relation to how sure a student is about a certain mathematics concept or whether a student *agrees* or *disagrees* with the relevance of the teaching in terms of meaning making and learning.

One way for the teachers in this study to communicate *feed back* as *recognising* is to rephrase or acknowledge what a student says without an evaluative voice. In a lesson where the students are sitting on the floor in a circle, Diana (T) *recognises* the students' answers when she rephrases what the students say. In one part of the sequence, they mention different devices to measure length. All the students are active and eager to suggest answers to the questions. They are considered to take active agency. Daniel (S) calls for attention with a raised hand. When he gets to answer, (Diana (T) is looking at him), he suggests a device (excerpt 8).

Time	Speech	Gestures	Body and Gaze
17:03	Daniel (S): Well, that kind of laser thing, if you press on the laser towards the door. <sup>71</sup>	Daniel (S) presses one finger and points at a door.	Daniel (S) looks at T, at door, at T.
17:08	Diana (T): Mm		
17:09	Dan: Then, well, there is a measurer here, how far it is.	Dan points at imaginary tool in his hand.	
17:14	T: Then you can find out the distance and measure without measuring by hand.	Diana (T): Shows distance between hands.	

Excerpt 8. Transcript from video material. "Dan" is short for Daniel (S), and "T" is short for Diana (T).

At 17:03, Daniel describes a measurement device using speech ("a laser thing, if you press on the laser towards the door") and gestures (presses one finger and points at door). When Diana (T) answers, at 17:14, her voice is considered to be neutral, since it is not narrow, low or high. Her body and

<sup>71</sup> Original transcript of speech in Swedish:

Daniel (S): Jo, en sån där lasergrej. Om man trycker på en laser på dörren. Då står det en mätare här hur långt det är.

Diana (T): Mm

Daniel (S): Då står det en mätare här hur långt det är.

Diana (T): Då kan man ta reda på avståndet och mäta utan att gå och mäta själv.

facial expressions are similarly considered to be neutral. She expands on Daniel's (S) answer ("Then you can find out the distance and measure without measuring by hand", showing a distance between her hands). Based on this, I considered her to be communicating the descriptive *feed back* that she *recognises* the answer as an accurate answer. There is not considered to be any added emphasis in terms of "good" or "bad". Later, during the same sequence, Diana (T) discusses different ways to find out the length of a room in a picture in the textbook. Here too, the students have many suggestions and in the analysis I considered them to take active agency. This also goes for Denise (S), who has her hand raised. After a while, she gets to answer. Denise (S) then asks if she can use the unit square metres; in doing so, she is considered to be asking for *feed back* and/or *feed forward*. Diana (T) tells Denise (S) to explain what a square metre is. Denise (S) tries to explain but seems unsure of this. Diana (T) looks at her and encourages her to demonstrate how she went about finding the length of the room in the picture and, accordingly, is considered to bring in affordances for Denise's (S) active agency in the discussion. Denise (S) then shows this with her fingers (excerpt 9).

Time	Speech	Gestures	Body and Gaze
22:27	Denise (S): I measured approximately. Like this. <sup>72</sup>	Denise (S): Measures in textbook with a distance between two fingers. Stops.	Denise (S) looks at textbook.  Den looks at Diana (T).
22:33	Diana (T): You took your fingers and then you measured [Den: Yes] approximately?	Diana (T) shows same distance with fingers. Stops.	Diana (T) looks at Den's textbook.

<sup>72</sup> Original transcript of speech in Swedish:

Denise (S): Jag mätte ungefär, så här.

Diana (T): Du tog fingrarna och så mätte du [Denise: Ja] ungefär?

T: Mätte du längden då? Hur långt det är från den väggen ända bort till den väggen.

Den: Mm

T: För när du säger kvadratmeter, det är när man fyller en hel yta. [Den: Ja.]Hela golvet till exempel.

Den: Men man kan väl ändå göra så här?

22:35	T: Did you measure the length(!) then?  How far it is from this wall all the way to that wall?	T “draws” a length with hand in the air. T points at Den’s textbook. T points at picture.	T looks at Den.  Den looks at textbook. T looks at textbook.  T looks at Den.
22:41	Den: Mm		Den looks at T.
22:42	T: Because when you say square metres, that’s when you fill a whole surface. [Den: Yes] The whole floor for example.	Shows surface in air with flat hands.	  T looks at floor, at Den. Den looks at textbook.
22:47	Den: But you can still do like this?	Den measures length with fingers on picture.	Den looks at textbook. T looks at textbook. Den looks at T.

Excerpt 9. Transcript from video material. (!) indicates a specific word is emphasised. “Den” is short for Denise (S), and “T” is short for Diana (T).

In the analysis, I considered this to be Diana (T) *recognising* Denise’s (S) answer (22:33) through speech and by repeating this with her fingers as an input in the discussion. In the following communication, it is determined, as Diana (T) makes clear, that what Denise (S) has measured is length (22:33). When she *recognises*, at 22:42, that square metres would not be a suitable unit for this (“Because when you say square metres, that’s when you fill a whole surface” – showing surface with two flat hands), she *disagrees*. This is analysed as *recognising/disagreeing* because Diana (T) is asking and describing without any evaluation – the term is used according to Hargreaves et al. (2000) – in terms of “good” or “bad”. After this, at 22:47, Denise (S) also takes active agency when she asks whether her method of using her fingers was appropriate, which is *recognised* as appropriate by Diana (T).

Another excerpt is a *self-assessment* form, where Cilla (S), probably after instructions from Cecilia (T), has marked what degree of confidence she feels about angles with an “X” (excerpt 10):

When I am supposed to: <sup>73</sup>	I feel:		
	Certain	Quite certain	Uncertain
decide whether an angle is right, acute, or obtuse	X		
tell which one of two angles is the smaller one		X	
tell which angle in a figure is biggest		X	

Excerpt 10. Transcript from written material. Self-assessment form.

This particular *self-assessment* (excerpt 10) is considered to be *recognising* since it is not about valuing her own performance, for example, as “good” or “bad” but about *recognising* her degree of confidence. Here, Cilla (S) is invited by Cecilia (T) to take active agency in the assessment through the *self-assessment*.

### 5.2.3 Feed Back as Interest and Engagement

The assessment acts presented in this section are in addition to the categories identified in the research literature on feedback and classroom assessment, although there are connections with the co-constructive feedback discourse proposed by Askew and Lodge (2000). These assessment acts, which were identified during my analysis, are *interest* and *engagement* and their opposites, *disinterest* and *disengagement*. As in the case with *recognising/agreeing*, with *interest* and *engagement* there is also an absence of valuing a student’s performance in terms of “good” or “bad”. Instead, it is about communicating *interest* and/or *engagement* in the mathematics communication.

Before excerpt 11, Belinda (S) has provided a solution that can be regarded as incorrect on a task in a diagnostic test. The task is: “In a jar there were forty pieces of candy. Ida ate one eighth of them. Linda then ate a fifth of the ones that were left. Which of the girls ate the most candy?”<sup>74</sup> On her paper, Belinda (S) has written the number 8 and under this a circle divided in eight parts. One part is coloured. The number 5 is written beside it and under this is another circle. This circle is divided into five parts, and one is coloured. Under this the answer “Linda ate the most”<sup>75</sup> is written. In the first

<sup>73</sup> Original excerpt in Swedish:

När jag ska  
avgöra om en vinkel är rät, spetsig eller trubbig  
säga vilken av två vinklar som är minst  
säga vilken vinkel i en figur som är störst

Känner jag mig  
Säker      Ganska säker      Osäker

<sup>74</sup> Original excerpt in Swedish:

I en burk låg det fyrtio karameller. Ida åt upp en åttondel av dem. Linda åt sedan upp en femtedel av dem som var kvar. Vem av flickorna åt upp mest karameller?

<sup>75</sup> Original excerpt in Swedish:

Linda åt mest.

communication on this task, Britta (T) provides for *feed forward* when she *checks* (described below) Belinda's (S) reasoning. In excerpt 11, Belinda explains how she got the answer (Britta (T) is looking at Belinda (S) and her notebook).

Time	Speech	Gestures	Body and Gaze	
1:05:19	Belinda (S): But I just meant ( <i>giggles</i> ) that is was eighths and fifths. <sup>76</sup>	Belinda (S) points at circles in notebook.	Belinda (S) looks at notebook.	
1:05:23	Britta (T): Yes! Very good.	Britta (T) points at both answers in notebook.		
1:05:24	T: If you would ( <i>high</i> ) [ <i>silence</i> ] ehm, find out how many pieces of candy each of them ate ( <i>high</i> ).	T points at task in textbook.	T looks at textbook.	Bel looks down.
1:05:30	Bel: Yes			
1:05:31	T: Can I ask you to do that? ( <i>high</i> ). Then give an explanation and tell me how you think.			

Excerpt 11. Transcript from video material. "High" refers to voice at a "high" frequency. "Bel" is short for Belinda (S), and "T" is short for Britta (T).

Based on earlier episodes in this sequence as well as Belinda's statement at 1:05:19, I considered it clear that the correct answer (that Linda ate most of the candy) is given on insufficient grounds. Belinda (S) has found, through the pictures, that one fifth is bigger than one eight and hence, the answer is Linda. At 1:05:23, Britta (T) communicates *approval* (see 5.2.1) of Belinda's (S) explanation of how she came up with the answer. She then (1:05:24) communicates to Belinda (S) the *feed forward* to find out how many pieces of candy each child ate. When Britta (T) communicates *feed back* and *feed forward* to Belinda (S), mainly through her voice (*high*) and speech, she is considered to communicate *interest* and *engagement* ("If you could (*high*) (*silence*), ehm, find out how many pieces of candy each of them ate (*high*). Can I ask you to do that? (*high*)"). Belinda (S) is considered here as being invited to take active agency since she is asked and not ordered. I

<sup>76</sup> Original transcript of speech in Swedish:

Belinda (S): Men jag menade bara att det var åttondelar och femtedelar.

Britta (T): Ja! Jättebra.

T Om du skulle ta reda på hur många karameller var och en av dem åt.

Bel: Ja.

T: Får jag be dig att göra det? Och redovisa och tala om för mig hur du tänker.

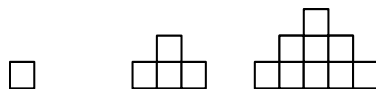
have also considered Britta (T), through her communicated *interest*, to position her and the student on quite equal terms in the discussion. It should be noted here that this particular analysis, like all analyses in this study, is based on the assessment practice as a whole, as captured in all the data from this particular classroom. The analysis is that the student in this case is sincerely asked about finding the number of pieces of candy. Moreover; this is an example of an institutional trace being present, since the textbook in use at this school also includes diagnostic tests. What is clear, however, is that a student might arrive at the correct answer on this task, but without valid reasoning. Britta (T) captures this, but in another classroom (or situation) this might not have been the case.

We now return to the lesson described earlier in Section 5.2.1, where Erika (T) has given the students five solutions to one task. One is correct and the other four are wrong in different ways. Erika (T) allows for *feed back* and *feed forward*. She stands silently somewhere in the classroom, watching and listening to the students as they work. This is considered to be Erika (T) communicating *interest* in her students' work since, in the subsequent sequence, she uses the information gained as *feed forward* for her teaching when they have a whole-class discussion about the task. It should be noted that a teacher standing silently watching students working may also communicate control of their behaviour (see Foucault, 2003). Based on the overall assessment practice in this classroom, especially during this lesson, this act is regarded as Erika (T) communicating *interest* in their mathematics communication. The students are not explicitly invited to take active agency, but their accomplishments are used as valuable input for Erika's (T) planning of teaching, which is also made clear to the students. Implicitly, the *feed back* communicated is an *interest* in all the students' contributions. Hence, the students are implicitly invited to take active agency in the mathematics classroom.

Later on in the lesson, Enzo (S), who earlier communicated *disapproval* of the teaching, changes his *feed back* to the teaching. Erika (T) tells him that she does not understand why he is so angry, and after this the *feed back* changes. While Erika (T) and several of the students discuss the different solutions, Enzo (S) sits silently, looking down, writing on the worksheet. He does not pay any attention to what is taking place in the communication between Erika (T) and the class. In the analysis, this is considered to be *feed back* as *disinterest* in the teaching. This may also be *self-assessment*. It could be the case that he has given up since he did not make sense of parts of the lesson. Here, Enzo (S) is considered to take passive agency in the mathematics classroom. At the same time, it is possible to consider this as Enzo (S) (with active agency) taking part in a different discourse than Erika (T) and the other students; he communicates resistance (Foucault, 1993, 2002).

In the last excerpt of this section, Ali (S) is considered to communicate *interest* and *engagement* to the teaching in relation to his meaning making

and learning. In this class, they have worked in pairs on patterns. The lesson is almost finished and they have discussed the first part of the task, square patterns, as a whole class. Ali (S) has worked with Angelica (S) and has had his hand up for a long time. He now raises his hand higher and higher in the air, as does Angelica (S), until Anna (T) lets him speak (looking at Ali (S)). What he addresses is the next part of the task, which concerns another type of pattern (excerpts 12 and 13).



Excerpt 12. Transcript from written material. First three figures in pattern.

Time	Speech	Gestures	Body and Gaze
55:02	Ali (S): Those other figures, the ones that look like this. <sup>77</sup>	Ali points at his paper.	Ali looks at his paper. Stands up. Ali looks at front. Smiles.
55:06	Anna (T): Yes.	Ali shows "pyramid figures" with his hands.	Anna nods.
55:07	Ali: Well, we thought that [items] B and C. It says the fifteenth figure. Or, I mean, the tenth.	Ali points at the text-book.	Ali looks at his paper, at T.
55:16	Ali: It's just... Do you remember the eighth figure!? Then you just add a layer.	Ali draws a figure in the air, draws a layer in the air.	
55:21	T: Do you know what, Ali. I thought that we would talk about this the next session.		T moves a little closer to Ali.

<sup>77</sup> Original transcript of speech in Swedish:

Ali (S): De andra figurerna, de som ser ut så här.

Anna (T): Ja.

Ali: Ja. Vi tänkte att, B och C. Det stod femtonde figuren. Eller, vad heter det, tionde.

Ali: Det är bara. Kommer du ihåg den åttonde figuren. Då lägger man till ett lager.

T: Vet du vad Ali. Jag har tänkt att vi ska prata om det här nästa gång.

T: Då börjar vi där i stället, så blir det inte så mycket varje gång. Så kom ihåg det, men det gör du väl.

Ali: Ja.

55:25	T: Then we'll start with that. Then it won't be too much at a time. So keep that thought. But I imagine you will.		Ali sits down. Looks down. Stops smiling.
55: 30	Ali: Yes.		

Excerpt 13. Transcript from video material. “T” is short for Anna (T), and “Ali” is short for Ali (S).

Ali (S) and Angelica (S) are eager to describe how they have solved the number of squares in the patterns (hands raised for a long time). In the analysis, I considered them as wanting to take active agency in the classroom discussion of this next pattern. This is communicated by Ali (S) at 55:02, and his *feed back* as *interest* is communicated by his standing up and his smile. This can be considered *self-assessment*. It can (also) be considered *feed back* to the teacher in relation to the meaning making experienced. In this particular sequence, Anna (T) interrupts him (55:21) and tells him and Angelica (S) that this will be the theme for the next lesson. She also tells Ali (S) to keep that thought. During the lesson as a whole, Anna (T) is considered to be communicating *interest* in the students' mathematics communication, and there seems to be a connection to the students' *engagement* and *interest* as well as to their active agency. Here too, at 55:25, I considered Anna (T) as communicating *interest* in Ali's (S) mathematics reasoning. Despite this, Ali (S) is “deflated” (at 55:25, when he sits down, looks down and stops smiling) when he realises that he has to wait, which is considered to communicate that he truly was *interested* in the problem and his and Angelica's solution. Another institutional trace is present here in the form of frames, namely, time slots for lessons (see Foucault, 2003), which are superordinate to the teaching and learning, including assessment acts, as is the case here.

#### 5.2.4 Three Kinds of Feed Forward

Three assessment acts largely concerning the future acts of the students and/or teacher emerged at an early stage of my analysis. They are *checking*, *guiding* and *challenging*.

*Checking* is brought into the framework since I have included assessment acts when the teacher or student allow or ask for *feed back* and/or *feed forward* in the assessment acts analysed. The teacher asks further questions, *checks*, in order to communicate more detailed *feed back* and/or *feed forward* to the student. It can also involve the teacher allowing for *feed forward* for the subsequent teaching. Furthermore, the student can be the one who is

*checking*. During one lesson, the class is sitting on the floor, and Diana (T) has changed from a sitting to a standing position by the whiteboard. They are discussing ways to write lengths. Before excerpt 14, Diana (T) has written “1100 cm” on the whiteboard and Diana (T) asks how many metres that is. Daniel (S) and some other students seem to capture the unit “cm” as metres instead, since they start talking about kilometres. Diana (T) makes it clear that the unit on the board is centimetres and not metres. Daniel starts talking about the task (excerpt 14).

Time	Speech	Gestures	Body and Gaze
15:44	Daniel (S): Then it is just to take one hundred centi... <sup>78</sup>		Daniel (S) looks at Diana (T). Diana (T) looks at Gx.
15:46	Gx: Then it is just eleven metres.	Diana (T) points at Gx.	
15:48	Diana (T): It's eleven (!) metres long.		T looks at class.
15:51	Dan: Aha.		T turns to the whiteboard.
15:53	Dan: If it had been metres, then it would be...		T looks at whiteboard, at Dan.
15:55	T: Then (!) it would have been different. Correct. You must always know what unit it is from the beginning.	T points at Dan. Stops.  T points at “cm” on whiteboard.	T looks at whiteboard, at class.

Excerpt 14. Transcript from video material. (!) indicates a specific word being emphasised. Gx refers to an unspecified student in class. “T” is short for Diana (T), and “Dan” is short for Daniel (S).

My analysis of this part of the sequence is that Diana (T), by posing the question about how many metres 1100 centimetres is, is allowing for *feed back* and/or for *feed forward*; she is *checking*. At 15:53, Daniel *checks* whether his reasoning could be correct given other circumstances, and he then asks for *feed back* and/or *feed forward*. My analysis is that this is a way

<sup>78</sup> Original transcript of speech in Swedish:

Daniel (S): Då är det ju bara att ta ett tusen etthundra centi...

Gx: Då är det ju bara elva meter.

Diana (T): Elva (!) meter långt blir det här.

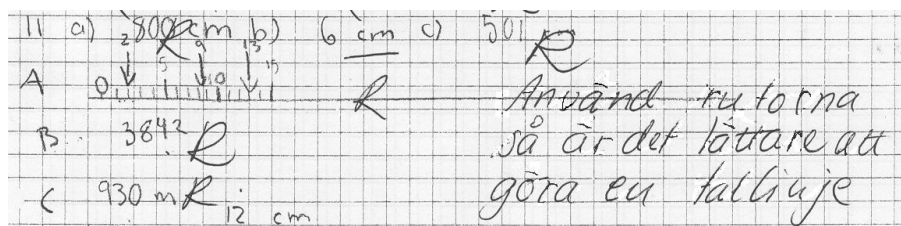
Dan: Aha.

Dan: Om det skulle stått meter då skulle det vara...

T: Då (!) hade det varit annorlunda. Helt riktigt. Så man måste alltid veta vilken enhet det är från början.

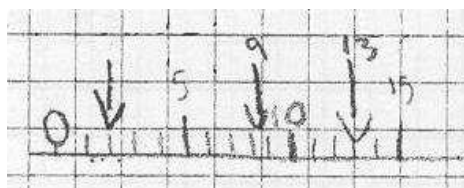
for the student, in this case Daniel (S), to take active agency in the assessment acts, not just to wait for an assessment to take place. What he gets from Diana (T) is both *feed back* and *feed forward*. First Diana (T) through gesture (pointing) and voice and speech (at 15:55, “Then (!) it would have been different. Correct.”), communicates *feed back* and *recognises* and *approves* of Daniel’s (S) question. In the last sentence, she communicates *feed forward* to Daniel (S) and the rest of the class about the importance of being aware of what the unit is. This *feed forward* to Daniel (S) and his classmates illustrates a second category of *feed forward*, namely *guiding*.

In an excerpt (15) from the written material where I have considered *guiding* to be present, Cecilia (T) has had the students take a test on numbers and shapes. In one task, called “A”, the students are asked to draw an axis that shows the numbers 0, 5 and 15. They are also expected to draw arrows to indicate the numbers 2, 0 and 13.



Excerpt 15 (from written material<sup>79</sup>). Part of Cilla’s (S) paper.

Excerpt 16 gives Cilla’s (S) solution in close-up.



Excerpt 16 (from written material). Cilla’s (S) solution. Writing for other tasks has been removed.

Cecilia (T) has marked this solution as being correct, with an “R” (excerpt 15), which can be considered to be *feed back* as *recognising*. Additionally, she has written this *feed forward* as *guiding*: “Use the squares [on the paper] to make it easier to make a number axis” referring to Cilla (S) not using the squares (excerpt 16). This could be seen as an institutional trace. In Sweden, it seems to be an institutional fact – institutional fact being used according to Searle (1997) – that in mathematics, students are supposed to use graph pa-

<sup>79</sup> Translation into English: Use the squares to make it easier to make a number axis

per and notebooks, with squares. The point of these squares is to serve as guidelines for students when they draw lines and the like. If the institutional fact were instead that blank paper and notebooks are used in mathematics, this would have affected what *feed forward* the teacher could communicate to the student. Another aspect relating institutional traces in terms of this test concerns the test itself. On the test paper, which is part of the textbook material, it is written that students can get one point for each correct answer on the first page of the paper. On the second page of the test, students can get 1-3 points for each answer. Thus, here, an assessment is implied where the *feed back* to the student after the test could consist of how many points out of a total number Cilla (S) receives in this case. This is what is represented in the institutional trace of the test paper. However, as shown, this is not what has taken place. Cecilia's (T) writing on Cilla's (S) answer sheet contains no points at all. The solutions that are considered correct are marked "R" and the ones that are considered incorrect are marked with a symbol. Cecilia (T) has written comments here and there, sometimes *feed forward* regarding an incorrect answer and sometimes *feed back* about demonstrated knowing.

The third category in this section related to *feed forward* is *challenging*. Hattie (2009) emphasises the positive effects for students' learning resulting from *challenges* (see also Lee, 2006). During one sequence, Erika (T) has given the students an assignment to create tasks to answers in the key. During the instructions, she uses the first item as an example for the class. The answer is 1325, and they are expected to construct a task that includes addition. A boy suggests  $1300 + 25$ . Erika then asks whether this is a *challenging* task. It is clear that what she means is that, for these students, this is not a *challenge* and she stresses that they should try to *challenge* themselves while working on these tasks. It could be said that she communicates *feed forward* as *challenging* to the boy and the rest of the class. The students have the possibility of affecting the tasks they construct, and there is room for their active agency. At the same time, there are limits regarding what choices they can make since they clearly are expected to create *challenging* tasks. That is, the affordances for the students' active agency are related to affordances for their learning of mathematics.

In another sequence, Ali (S) communicates *feed forward* to Anna (T) regarding her teaching. The situation has Ali (S) and Angelica (S) working together doing *group* work. They are solving tasks on geometrical patterns. Anna approaches Angelica's (S) and Ali's (S) desks and stops there, standing. Ali (S) asks whether she can understand his notes on the paper and, in doing so, he asks for *feed back*; he is *checking*. Anna (T) says that it is easy to see which solution goes with which item (*feed back*). She then suggests that they write down the answers to task 2 on the other side of the paper (*feed forward* through *guiding*). Ali's (S) and Anna's (T) subsequent communication is shown in excerpt 17.

Time	Speech	Gestures	Body and Gaze	
20:56	Ali (S): Hey, you. Anna (T): Mm ( <i>high</i> ). <sup>80</sup>		Ali (S) looks at Anna (T) and smiles.	Anna (T) looks at B and his work.
20:57	Ali: Next time, give me harder tasks than this.			
21:00	T: Well, wait and see down there.	T points at bottom of textbook page.		Ali looks at textbook.
21:01	Ali: But those are really easy.	T stops pointing. Ali points at tasks on upper part of page.		
21:02	T: There are harder tasks coming ( <i>high</i> ).		T turns away and leaves.	

Excerpt 17. Transcript from video material. “T” is short for Anna (T), and “Ali” is short for Ali (S).

In the analysis, Ali (S) is considered to take active agency when he communicates *feed forward* to Anna (T) in regards to her teaching in relation to his learning. What he wants is more *challenging* tasks. This is connected with an agreement made during a student/teacher/parent meeting, shown in the written material, which specifies that the school’s contribution to Ali’s learning in mathematics is to provide assignments suitable for Ali. In Anna’s (T) response, at 21:02, she is considered to communicate awareness of Ali’s (S) need for more *challenging* tasks.

Connected with the assessment acts for future acts is how the questions posed are formulated. A main feature here is the openness of the questions, which may affect affordances for students’ active agency. In this thesis, the openness of tasks is regarded to be a textual aspect. This will be addressed in Chapter 7.

### 5.2.5 Assessment Acts in Relation to Goals

Assessment acts in relation to goals concerns what Hattie and Timperley (2007) have labelled *feed up*. As will be shown, *feed up* is always present

<sup>80</sup> Original transcript of speech in Swedish:  
Ali (S): Men du.  
Anna (T): Mm.  
Ali: Alltså nästa gång, ge mig lite svårare tal än det där.  
T: Ja, ni får väl se där nere.  
Ali: Jamen, det är jättelätt det där.  
T: Det kommer lite svårare.

alongside *feed back* and/or *feed forward* (although there can be occurrences of *feed back* and/or *feed forward* without any *feed up*). In this study, *feed up* has been connected to *national goals*, *textbook goals* or *local goals*.

The same textbook material is used in several of the classrooms. At the beginning of each chapter, the authors of the textbook have expressed goals for the chapter. Also included in the teaching material for the textbook is a *self-assessment* scheme that students are expected to fill out at the end of the teaching unit. Here, the *textbook goals* in the introduction to the chapter are included, and in the analysis this is considered to be simultaneously *feed up* and *feed back* from student to student (*self-assessment*). We saw this form earlier in this chapter, and this time an excerpt for Daniel (S) is shown. Daniel has marked with an “X” (and thus *recognises*) how certain he feels (excerpt 18).

When I am supposed to: <sup>81</sup>	I feel:		
	Certain	Quite certain	Uncertain
explain the difference between a digit and a number		X	
draw a picture of the number 4,312		X	
read the number 4,030	X		

Excerpt 18. Transcript from written material. Self-assessment form.

Here, the *textbook*, with its *goals* and supplementary resources, plays the role of an institutional trace. In the two classrooms where the same textbook is used, the same kind of *feed up* occurs. The student is considered here to be invited to take an active part in the assessment.

In the following excerpt, Erika (T) and Enzo (S) have an assessment discussion about Enzo’s (S) learning in the teaching unit now ending. They have worked in the class on a theme in which mathematics has been a substantial part. The theme is about baking, and the goals for mathematics that were presented at the beginning of the theme are related to measurement and fractions. These goals are regarded as *local goals* since they are articulated at this particular school (however, they are related to *national goals* as well). At the beginning of the lesson, the students are given an assessment matrix indicating different levels of knowing in terms of the *local goals*. The students are asked to look at the matrix but not to mark it until the teacher arrives, since they are going to fill it out together. The first part of the matrix is shown in excerpt 19.

<sup>81</sup> Original excerpt in Swedish:

När jag ska  
förklara skillnaden mellan en siffra och ett tal  
rita en bild av talet 4 312  
läsa talet 4 030

Känner jag mig  
Säker      Ganska säker      Osäker

Name:

Areas in mission baking	On the way to the goals	Reaches the goals	Reaches the goals well	
Volume	Knows what litre and decilitre are.	Also knows how many dl go into a litre.	Knows how many cl go into a l [litre] and dl.	

Excerpt 19. Transcript from written material. Part of assessment matrix.

The basis for the assessment discussion between Erika (T) and Enzo (S) is Enzo's assessment matrix, a diagnostic test taken earlier, a summary that Enzo (S) wrote as homework for the theme, and Erika's (T) notes on Enzo's (S) demonstrated knowing. At the beginning of the sequence, I considered Enzo (S) to take active agency when he reads the first goal in the matrix and marks it. The affordances for him to take active agency are communicated through speech at the beginning of the lesson, when Erika (T) tells the class that they are going to fill out the matrix together. They are also communicated when Erika (T) gives him the marker pen. Enzo (S) and Erika (S) *recognise* that Enzo (S) has demonstrated the knowing described in the goal. The marking of this sentence with the marking pen is considered *feed up* and also *feed back*. A similar communication is involved with the second cell. When they look at the third cell about volume, Enzo (S) says that he knows the first part, that one hundred centilitres goes into one litre. In the following communication, it becomes apparent that Enzo (S) is not sure about the second part, how many centilitres go into a decilitre. Erika (T) finishes this part of the sequence by taking the marking pen and marks the first part of the cell and leaves the last part unmarked. Her subsequent act is shown in excerpt 20.

<sup>82</sup> Original transcript in Swedish: Bedömning – Uppdrag bakning

Namn:

Områden inom uppdrag bakning

Volym

På väg mot målen  
Vet vad liter och  
och deciliter är.

När målen  
Vet också hur  
många dl som  
får plats i en  
liter.

När målen väl  
Vet hur många  
cl som får plats  
i en l resp. dl.

Time	Speech	Gestures	Body and Gaze	
33:57	Erika (T): Then we can leave. Because then this is what you will have to practise remembering. Don't you think? <sup>83</sup>	Erika (T) points at the second half of the square. T gives marker pen back to Enzo (S).	Enzo looks at matrix	Erika (T) looks at matrix.  T looks in Enzo's direction.

Excerpt 20. Transcript from video material. "T" is short for Erika (T), and "Enz" is short for Enzo (S).

In excerpt 20, Erika (T) is considered to communicate *feed up* combined with *feed forward* to Enzo (S). A relevant interpersonal aspect here is when she takes the marker pen from Enzo (S) and then gives it back. This can be discussed in terms of agency. For most of the marking of the matrix, Enzo (S) is the one who gets to mark the cells that he *recognises* he knows. The affordances for Enzo (S) to take active agency are then high. When Erika (T) takes the marking pen, this is changed somewhat.

### 5.2.6 Changes in Assessment Acts

In this section, I present examples of how assessment acts can change over a longer period of time than the excerpts presented so far in the chapter. I am inspired here by Selander (2008a) and Ljung and Pettersson (1990; see also Björklund Boistrup, 2008). I follow the assessment acts along a timeline and consider patterns. Different patterns occurred during the analysing process. One is when a student is working by her/himself and calls for the teacher's attention. Often the student is asking for *feed forward* and sometimes for *feed back*. In order to understand what it entails, the teacher then poses clarifying questions, that is, allowing for *feed back* and/or *feed forward*. Based on this communication, the teacher communicates *feed forward* (and/or *feed back*) to the student. This *feed forward* can be communicated by instructions and sometimes by questions. In order to illustrate this, I return to communication between teacher and student that was previously presented in Section 5.2.2. In this sequence, Diana (T) and the class are discussing different ways to find the length of a room in a picture in the textbook. After a while, Denise (S) gets to answer, and she asks whether she can use the unit square metres (and in doing so asks for *feed back* and /or *feed forward*). However, since Diana (T) does not immediately accept the answer, I determined that

<sup>83</sup> Original transcript of speech in Swedish:  
Erika (T): Så kan vi lämna. För då är det det där du får öva på att komma ihåg. Eller hur?

she communicates *feed back* that something might be wrong with the answer. Following a timeline, there is interplay between Denise's (S) answers through statements, which, by the teacher, are regarded as *feed forward* to the teaching, and Diana's (T) questions, which are regarded as allowing for *feed forward* in combination with *feed back* to the student. In the end, Diana (T) seems to understand what Denise (S) means and asks a clarifying question to confirm her understanding. Then finally, she gives instructions, as *feed back*, to Denise (S) about why it is not appropriate to use square metres here.

Another pattern is that there can be considerable shifts regarding the assessment acts. Here, we return to Cecilia (T), who has told the students to turn the results from a survey in the class into a ranking list and then into a diagram (described in Section 5.2.1). It has already been described how Cecilia (T) communicates *feed back* as *disapproval* to Cilla (S) since she has not ranked the items, as the instructions specified. In the sequence, it is clear that Cecilia (T) realises after a while that the reason for Cilla's (S) "misbehaviour" is that she does not know what the word ranking means. Then the *disapproval* from the first half of the sequence disappears. In the second half, there are longer periods of *feed forward* through instructions to Cilla (S) that constitute *guiding*. There is also an act communicating *feed back* as *approval* in combination with *recognising* and *engagement*.

A third pattern is that there are often different kinds of assessment acts present in different sequences in a single lesson, including different affordances for students' active agency. At the beginning of a lesson, Erika (T) gives instructions for a task (see Section 5.2.4). Later during the same lesson, there is an assessment meeting between Erika (T) and Enzo (S), where they discuss his accomplishments during the most recent unit (see Section 5.2.5). The greatest difference between these two sequences is the presence of *feed up*, which is not identified at all in the first sequence and is very much present in the second one. Another difference is that there are instances of *feed back* as *recognising* and *agreeing* in the second sequence, while there are none in the first. Compared to the second sequence, there are more statements and instructions from the teacher in the first sequence, along with *challenging*. These differences are due to the different purposes, that is, the different kinds of situations. One main outcome of my analysis is that assessment acts are considered to be present in various situations in the classrooms visited and that these assessment acts change over very short periods of time.

### 5.3 Assessment Acts in Mathematics Classrooms: Occurrences and Affordances for Students' Active Agency

The empirical basis for the findings in this study is limited with respect to the number of classrooms. Moreover, the participating teachers and their classes were not randomly chosen. Instead, as described earlier, they were chosen to provide variety in terms of education and experience with respect to assessment and/or mathematics education. All five teachers like teaching mathematics, and a few of them have considerable experience in assessment issues. Keeping this in mind, I would still like to present some of the summarised outcomes relating to the five classrooms. In order to create a fuller picture of assessment in mathematics classrooms in grade four in Sweden, more studies would be required. The findings for these five classrooms would then be a starting point. For video sequences, the outcomes presented here include sequences where there is more than one occurrence of an assessment act present. If a category is present in more than 10 % of the documents in a group, it is included in the outcomes.

A summary of occurrences of assessment acts in the classrooms visited is presented in table 1. It should be noted that there are often various assessment acts present in one video sequence or document group, for example both feed back and feed forward communicated from teacher to student.

Table 1. Presence of Assessment acts in Classrooms Visited<sup>1</sup>

Assessment act	Video sequences with occurrences of an act			Document groups with occurrences of an act		
	T to S	S to T	S to S	T to S	S to T	S to S
Feed back	58	19	29	19	9	16
Feed forward <sup>2</sup>	72	5	0	17	2	4
Feed up	2	0	3	5	0	8
T uses student's acts as feed forward for own acts	84					

<sup>1</sup> The total of number of video sequences is 111; assessment acts related to feedback (*feed back*, *feed forward* and/or *feed up*) are considered to be present in 105 of them. The corresponding numbers for document groups are 39 and 27.

"S to S" refers to students' self-assessment.

<sup>2</sup> "S to T" does not include the sub-category "Checking".

One outcome presented in table 1 is that assessment acts related to feedback (*feed back* and *feed forward*) frequently occurred in the communication between teachers and students in the video material. Assessment acts related to feedback (*feed back*, *feed forward* and/or *feed up*) are considered to be present in all but six of the 111 video sequences. The number of sequences with feedback is 29 in classroom E and around 20 in the other four (classroom A: 21 sequences; B: 18; C: 18; and D: 21). In the written material, there are

assessment acts related to feedback present in 27 of 39 document groups. The number of document groups with assessment acts is around 5 in all the classrooms (A: 6 document groups; B: 4; C: 6; D: 5; and E: 6). It should be noted that the number of documents as a total is considerably higher in classroom E.

Not surprisingly, assessment acts related to feedback are rarely present when a teacher gives instructions to the students at the beginning of a lesson or teaching unit. In the written material, there are document groups for planning where there is also an absence of assessment acts related to feedback. In some of the classrooms, other kinds of document groups without visible assessment acts related to feedback are pages from students' notebooks and various kinds of worksheets. In most of the video sequences with assessment acts, there are instances of both *feed back* and *feed forward* in the communication between teacher and student. In the written material, *feed back* is present in almost all the document groups with assessment. In half of them, there is also *feed forward* present. A common pattern in both the video and written material is that the teacher allows for *feed back* and/or *feed forward* through a question (*checking*). The student answers and the teacher captures the student's acts as *feed forward* to the teacher. The teacher then communicates *feed back* to the student, for example, through *approval* and/or *feed forward* for the student's subsequent actions through *guiding* and/or *challenging*. In the video material, it is also common that the student takes the initiative for assessment acts in communication with the teacher by asking for *feed back* and/ or *feed forward* (*checking*, see table 2). There are also instances in the classrooms where the student communicates *feed back* and/or *feed forward* to the teacher on teaching related to the student's meaning making and learning. In the video material, the students occasionally show *self-assessment*. In the written material, there are document groups for all the classrooms where the student is asked to make a *self-assessment*.

The most significant outcome in this section is that the analysis indicates substantial differences in terms of affordances for students' active agency in different assessment acts in the mathematics classrooms visited. An overview is presented in table 2.

As mentioned, *feed back* as *rewarding* and/or *punishing* was not considered to be present in this study. Based on findings provided in research by Tunstall and Gipps (1996) and Hattie and Timperley (2007), for example, I conclude that the affordances for students' active agency in terms of *rewarding* or *punishing* are very low. Clearly, given her/his role in the classroom, the teacher has the authority to *reward* and/or *punish*, but this is not an object of consideration for the students.

Table 2. Presence of Assessment Acts in Classrooms Visited<sup>3</sup>

Assessment act	Video sequences with occurrences of an act			Document groups with occurrences of an act		
	T to S	S to T	S to S	T to S	S to T	S to S
Feed back – Approval	22	0	8	11	2	6
Feed back – Disapproval	4	7	1	0	1	0
Feed back – Recognising	46	1	28	16	5	12
Feed back – Recognising – incorrect, unsure <sup>4</sup>	25	3	19	13	4	12
Feed back – Interest/engagement	26	12	7	1	7	2
Feed back – Disinterest/disengagement	0	4	0	0	0	0
Feed forward – Checking	66	23	0	14	1	0
Feed forward – Guiding <sup>5</sup>	70	21	0	13	2	4
Feed forward – Challenging <sup>6</sup>	13	2	0	4	0	2
Feed up – local goals	2	0	3	5	0	7
Feed up – textbook goals	0	0	0	0	0	2
Feed up – national goals	0	0	0	1	0	0

<sup>3</sup> The total number of video sequences is 111; assessment acts related to feedback (*feed back*, *feed forward* and/or *feed up*) are considered to be present in 105 of them. The corresponding numbers for document groups are 39 and 27. With respect to various assessment acts, I examined video sequences where there is more than one occurrence of an act present. If a category is present in more than 10 % of the documents in a group, it is included in the outcomes. In one video sequence or document group there are often various assessment acts present, for example both feed back as recognising and feed back as interest communicated from teacher to student.

“S to S” refers to students’ self-assessment.

<sup>4</sup> Here, it is a question of recognising knowing demonstrated by a student that can be considered mathematically incorrect or knowing not demonstrated by a student or recognising a student who is unsure.

<sup>5</sup> “S to T” refers here to the students asking the teacher for guidance.

<sup>6</sup> “S to T” refers here to the students asking the teacher for challenges.

In the analysis, I considered assessment acts where teachers communicate *feed back* as *approval* as being present. Drawing as well on Torrance and Pryor (1998), I contend that, when the teacher communicates *feed back* as *approval* (or *disapproval*), the affordances for student’s to take active agency are low. The teacher adopts a position as the one who evaluates, the one who has the authority to determine whether an answer is “good” or “bad” (see also Mellin-Olsen, 1993). It could be said that the student is positioned as an object of/in the assessment acts more than as someone who is an active part of the assessment practice. As shown in table 2, it was possible to determine that *approval* is present in the data and that *disapproval* is present at a much lower level. In the document groups with assessment acts, the teacher communicates *feed back* as *approval* to the student, and all five classrooms are represented here. In three of the classrooms (A, D and E), there are a few video sequences where there is *feed back* as *approval* com-

municated to the student. In classroom C, this is the case in one third of the sequences in the classroom. In classroom B, the teacher communicates *feed back* as *approval* to the student in almost half the sequences in the classroom. In this classroom, as in A and D, there is no *disapproval* present in the video material. In three video sequences in classroom C and in one in E, there are instances of *disapproval* from teacher to student. In the written material from all the classes, there is an absence of *disapproval* from teacher to student.

The analysis indicates that one way for students to take active agency in the mathematics classroom is to communicate *disapproval* regarding the teaching. As shown in table 2, there are no sequences in the video material where the student communicates *approval* to the teacher and/or teaching in relation to her/his own learning and meaning making. In the written material, *approval* is present in very few document groups, and here the representation is from classrooms A and E. In a few video sequences, there are examples of students communicating *disapproval* of the teaching in relation to their own meaning making and learning. These sequences come primarily from classroom E, and there is also representation from classroom B and D. In some of these sequences, the teacher changes the course of action because of the students' communicated *disapproval*, which holds affordances for students' active agency in the mathematics classroom. In a few sequences in the video material, a student communicates *approval* (classrooms A, B and E) regarding her/his own accomplishments, compared with only one sequence where the student communicates *disapproval* with her/his own acts.

Another finding from this study is that there are other kinds of *feed back* where the communication is on more equal terms than in evaluative *feed back*. In *feed back* as *recognising*, there are considered to be affordances for students' active agency. When the teacher *recognises* a communication act by the student as being either appropriate or not relative the discipline of mathematics, the teacher does not value the student's response in terms of "good" or "bad". One could say that it is more the case of a neutral description here. Overall, *recognising* is considered to be present in almost half the sequences with assessment acts related to feedback. A similar finding comes from analysis of the written material. All the classrooms are well represented in the video and written material. In one quarter of the video sequences with assessment acts related to feedback, the teacher *recognises* something that is not demonstrated or something that is considered to be mathematically incorrect. In the written material, this is the case in almost half the document groups. This is more common in the video sequences from classrooms A, B and E than in those from the other two.

The study reveals how students take active agency in the classroom assessment by *recognising* their own performances as mathematically appropriate or *recognising* their own knowing in mathematics. When a student communicates *feed back* as *recognising* to her/himself (*self-assessment*) in

relation to her/his own meaning making and learning, it is also more the case of a neutral statement than an *approval* or *disapproval*. In about one quarter of the video sequences, this is communicated with respect to the student's demonstrated mathematics knowing or doing (or a student's sureness); in slightly fewer videos, this is communicated with respect to something that is missing or considered to be mathematically incorrect (or a student's unsureness). *Self-assessment* as *recognising* is most frequently present in classroom A (in half the sequences from the classroom). It is also quite common in classrooms B and E. In classrooms C and D, there are a few sequences with *self-assessment* as *recognising* present. A similar finding concerns *recognising* something as being mathematically incorrect or being unsure about something. In the written material, *self-assessment* as *recognising* is present in fewer than half (but more than a third) of the document groups where assessment acts related to feedback are present. In the written material, this is the case in all but one document group for classroom E, followed by classroom C, and then the three other classrooms. Similar findings are identified for *recognising* something as mathematically incorrect or being unsure about something. There are a few instances in the written material where the student takes active agency in the mathematics classroom in communicating *feed back* as *recognising* to the teacher about the teaching in relation to her/his own meaning making and learning. This is most common in classroom E, followed by C and then D. It should be noted that, in these documents, the student is most often invited to communicate *feed back* to the teacher about the teaching. That is, there are questions in the documents regarding the teaching that the students is expected to respond to. There are affordances via these questions for students to take active agency in the mathematics classroom.

Another kind of *feed back* identified in the analysis where the communication is on more equal terms is when the teacher communicates *interest* and/or *engagement* in students' mathematics communication. Here too, there is an absence of valuing the student's demonstrated knowing in terms of "good" or "bad". Often the *interest* is a matter of the student's communication acts being counted as a contribution to the mathematics communication of a group or class that are reasoning and learning together. The student's contribution could also be considered to be mathematically incorrect, but the teacher still communicates *interest* in it and uses it as *feed forward* for the current teaching and learning taking place in a group discussion in class. Students' affordances for taking active agency are considered to be high, and there are several instances of communication in connection to this where the student communicates *interest* and/or *engagement* in her/his own and the teacher's mathematics communication. *Feed back* as *interest* and/or *engagement* is not addressed in the structures referred to earlier. In around a quarter of the video sequences with assessment acts related to feedback, the teacher is considered to communicate *interest* and/or *engagement* in the stu-

dents' communication acts in the mathematics classroom. This is most common in classrooms E and B, followed by classroom A, and then classrooms D and C. This *feed back* from teacher to student could not be identified in the written material. In some of the video sequences (12), students communicate *engagement* in the current teaching and learning of mathematics, which is considered to be *feed back* to the teacher. Here, this is most common in classroom E, followed by classrooms B, A and D. In six document groups, this assessment act from students is present, four from classroom E and one each from A and C.

Assessment acts related to future acts by the student and/or teacher are labelled *feed forward* in this study. In around three quarters of the video sequences, the teacher is considered to communicate *feed forward* to the student. The kinds of *feed forward* emerged in the analysis are, as mentioned, *checking*, *guiding* and *challenging*. The first two, *checking* and *guiding*, are considered to be present in almost every video sequence with *feed forward*. The teacher *checks* students' performances, thereby allowing for *feed forward*<sup>84</sup>, which is then executed through *guiding* and possibly through *challenging*. One finding from the analysis is that *feed forward* as *challenging*, and occasionally *guiding*, holds affordances for students' active agency in the learning and teaching of mathematics. Another finding is that the students in the five mathematics classrooms visited occasionally take active agency in asking for *feed forward* (and/or *feed back*) in relation to their own acts through *checking* and/or asking for *guidance*. In some instances, this asking for *feed forward* by students is combined with *feed back* and/or *feed forward* on the teacher's teaching. The student then states clearly to the teacher that the current task is not sufficient in terms of affordances for learning. *Challenging* is an assessment act that is less frequently present in the data. This act may occur when the teacher changes the task in order to create opportunities for more general mathematics reasoning. It may also be the teacher who tells the students to *challenge* themselves in working on open tasks. In thirteen of the video sequences and two document groups (classrooms A, B and E), there are instances where the teacher *challenges* the students. In very few (two) video sequences students ask for more *challenging* tasks (classrooms A and B), and in four document groups from classroom E the students reflect on the extent to which they have *challenged* themselves in their mathematics work.

In all five classrooms, the teacher looks at the student's work and uses this as *feed forward* for subsequent assessment acts in the current communication. On the other hand, there are differences in how the teachers use the students' accomplishments as *feed forward* for subsequent sequences, that is,

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<sup>84</sup> *Checking* by the teacher is often considered to be allowing for *feed forward* and/or *feed back*. In order to make the account in this section more straightforward, I chose to consider only *checking* in relation to *feed forward*.

as *feed forward* for the lesson planning. In three of the classrooms, A, C and D, all the students worked by themselves on the same tasks in the textbook during one or more of the lessons I visited that week. It seems that assessment did not occur in terms of *feed forward* for planning what tasks suit the different students' learning. They continue to work, using the textbook. In classroom B, the students work at different "levels" that are predefined by the textbook. In the written material for this classroom, there are pre-diagnostic tests that are apparently aimed at indicating which "level" the student should start working at. When the teacher reviews the diagnostic tests at the end of each "level", the students in the video material sometimes use manipulatives to find the correct answer to some of the items whose answer does not correspond to the one in the key. After these sequences, they still move on to the next "level" in the textbook material. The teacher does not seem to use the student's lack of demonstrated knowing as feedback in her own planning for the student. Another course of action may be to let the student work more at the current "level". In the fifth classroom, E, the students work on the same tasks, which are constructed by the teacher. There are occasionally references to previous events and it seems clear that the teacher in this classroom used the students' previously demonstrated knowing as feedback for the planning of current teaching. Often the tasks are open and the students can choose to solve them in a way that suits their own previous knowing and current learning.

When *feed back* or *feed forward* is related to goals for learning, this is (also) labelled *feed up*. *Feed up* is not that common in the communication between teacher and student in this study. *Feed up* was only considered to be present in three of the video sequences, and they are all from the same classroom, E. In the written material, *feed up* is considered to be present in about a third of the document groups. Many of the occurrences come from the same classroom, E, but there is also representation from other classrooms (A, C and D). For example, it is possible to find *feed up* in material from four classrooms in the documents from student/teacher/parent meetings. In two document groups, *feed up* is considered to be present in pre-produced *self-assessment* schemes. Other groups with *feed up* present are assessment matrices, portfolios and written student reflections. The initiative for assessment acts in the form of *feed up* comes, with a single exception, from the teacher. At the same time, there are examples where the student is invited to take part in the assessments on goals, so *feed up* can hold affordances for students' active agency in the mathematics classrooms visited.

## 5.4 Summary and Conclusions Regarding Assessment Acts in Mathematics Classrooms

In this chapter, I described my findings relating to the first research question on how assessment acts take place in teacher-student communication in the mathematics classrooms visited. I described different assessment acts and their occurrences as well as affordances for students' active agency in the mathematics classroom. Some of the assessment acts were already present in the analytical framework, and new categories (*interest/engagement*) emerged during the analysis.

One clear finding is how some assessment acts hold affordances for students' active agency to a higher degree than others. When the teacher communicates *feed back* as *approval* and/or *disapproval*, the teacher adopts the role of the one who makes the judgement about the students' demonstrated knowing. When the teacher communicates *feed back* as *recognising*, more space is given to the affordances for the student to take active agency. New assessment acts that emerged during the analysis are *interest/engagement*. One could argue that these do not constitute assessment at all. I maintain the opposite. When the teacher communicates *interest* in the student's demonstrated knowing, the assessment lies in the student's contribution to mathematics communication being something to build future communication upon. This also holds affordances for the students' active agency in the mathematics classroom. Another aspect of students' possibilities to take active agency in the assessment of mathematics and, as a result, in their learning, is *self-assessment*. There are also instances of affordances for the students' active agency through *feed back* and/or *feed forward* on teaching. The teachers' response to *feed back* and *feed forward* from the students is another aspect related to students' active agency.

One conclusion relating to *feed back* in this study is that *feed back* as *recognising*, *interest* and/or *engagement* are acts essential to include in frameworks on assessment and feedback since they hold considerable affordances for students' active agency in the mathematics classroom. Other assessment acts that are essential to bring into frameworks on assessment and feedback in terms of affordances for students' active agency are students' asking for *feed back* and/or *feed forward*, through *checking*, asking for *guidance*, and *challenging*. The extent to which students are invited to perform these acts as well as *feed back* on the teaching as such is also highly relevant in relation to students' active agency in the mathematics classroom. When the student is an active part of the communication between teacher and student, *feed up* is another assessment act that it is essential to include in the framework.

The outcomes presented in Section 5.3 indicate that there are differences between classrooms' assessment practices in relation to what kind of assessment acts are present. In some classrooms, *feed back* as *approval* is more present than *recognising* and *interest*, and in other classrooms it is the other

way around. Another difference between classrooms is the presence of *feed forward* as *challenging* as well as the presence of *feed up*. This also has consequences in terms of affordances for students' active agency in mathematics learning and teaching. One conclusion is that in the assessment practices of different classrooms, there are more affordances or fewer affordances for students' active agency depending on which assessment acts are frequent. These differences are essential for the construal of assessment discourses in mathematics classrooms (Chapter 8).

In this thesis, the interest lies in assessment acts in *mathematics* classrooms in particular. Here, an essential question is the focuses of assessment acts. That is the subject of the next chapter.

## 6 Focuses of Assessment Acts in the Mathematics Classroom: Analysis and Outcomes

In this chapter, I describe my analysis and outcomes for what focuses of assessment acts in the mathematics classroom are present in teacher-student communication. These outcomes are connected to the social semiotic ideational meta-function. As described earlier, this meta-function is related to human experience and representations of the world (Halliday, 2004; Kress et al., 2001). To put it briefly, it could be said that the “what” question of the assessment acts is addressed here. The findings in this chapter are developed in terms of affordances for students’ learning of mathematics. They then constitute a basis for what focuses of assessment acts in the mathematics classroom are part of the different construed discourses presented in Chapter 8.

Learning is defined in this thesis as meaning making toward an increased readiness to engage in the world with an increased use of semiotic resources and artefacts in a discipline (Selander, 2008ab). As noted earlier in this thesis, I do not claim that all the findings I provide clearly identify students’ learning as it takes place. More than discussing learning as such, I discuss affordances for learning. If we want students to learn (to have a readiness) to engage in mathematics processes, such as arguing and reasoning mathematically, then assessment acts have affordances for students’ learning of this if the acts promote students’ arguing and reasoning in mathematics. If, on the other hand, the focuses of the assessment acts are on things other than mathematics processes, for example, the number of correct answers on a test, clear affordances for students’ learning of mathematics are not considered to be present in the assessment acts. Consequently, it is assumed that what the student focuses on during the assessment acts in mathematics classrooms is connected to affordances for learning mathematics. In order to achieve an increased readiness to use semiotic resources including artefacts in a discipline, students need to be invited to use the semiotic resources of the discipline. In this chapter, I present findings that address this, relative to assessment acts.

We pay another visit to Pippi Longstocking in this chapter to illustrate my analysis of a teacher-student communication in a mathematics classroom. I refer to the same excerpt as in the beginning of Chapter 5. The excerpt concerns the first communication between Pippi and the teacher during her visit to school. A relevant question for this chapter is what focuses of assessment acts in the mathematics classroom are present in this excerpt. In the beginning of the excerpt, it is clear to Pippi (through the teacher's and the other students' feed back) that Pippi's way of answering a question is not appropriate in school. My analysis suggests that the focus of the assessment act is on the *task* as such, and not on the mathematics *process* related to the work on the task. Pippi's feed back to the teacher about the teaching also has a focus on the *process*. This focus is considered to be present when Pippi communicates that she regards the questions as unrealistic. Why would anyone ask something they already know? A question about seven plus five can also be considered to focus on the first aspect of Skovsmose's (1990, 2005) mathematics competence, *dealing with mathematics notions*, with a special interest in Pippi's experiences with addition. When the teacher asks Pippi how much she thinks eight plus four is, the teacher is providing for feed forward in the same aspect of mathematics competence, *dealing with mathematics notions*. She wants to know about Pippi's knowing in terms of calculating (addition). Further on, the teacher poses a question to Tommy about Lisa, who has seven apples, and Axel, who has nine, and how many they have together. The question is related to the second aspect of mathematics competence, *applying mathematics notions*. It is possible to imagine a "real" situation where people the age of Pippi, Tommy and Annika (or older) pick apples for a particular reason. They want to know how many apples there are all together, and they add seven apples picked by Lisa and nine picked by Axel to see if there are enough apples. This is a question that could address a *process* focus on *practicing/routine*. If the teacher were to ask Tommy to describe his way of solving the task, it would be more of a *process* focus on *reasoning/arguing*. From Pippi's point of view, the contextualisation of this arithmetic task is confusing, and she starts to picture herself and the children eating all the apples and getting a stomach ache. So from Pippi's point of view, the task context is unrealistic. To summarise, my illustration of an analysis of the classroom situation described may hold some affordances for students' learning of mathematics with respect to two of Skovsmose's (1990, 2005) aspects of mathematics competence, *dealing with mathematics notions* and *applying mathematics notions*. At least, this could be the case for Pippi if she had been part of/taken part in this classroom's assessment practice. Because of interpersonal aspects, that is, the assessment acts, this seems not to be the case.

I identified focuses of assessment acts similar to those in the Pippi story in the data for this study. These focuses are expanded, and more focuses are addressed in the following section. As in the previous analysis and outcomes

chapter, I start by presenting the analytical framework. In this chapter, the categories (seen as being on a continuum rather than as categorical) are written in italics.

## 6.1 Analytical Framework for Focuses in the Mathematics Classroom

One group of categories in this section concerns the general focuses of the assessment acts (Hattie and Timperley, 2007). A second group of categories concerns aspects of mathematics competence (Skovsmose, 1990, 2005; Lindenskov & Wedege, 2001; Björklund Boistrup et al., 2002).

### 6.1.1 General Focuses of Assessment Acts

Hattie and Timperley (2007) identify four focuses<sup>85</sup> of feedback: *self*, *task*, *process*, and *self-regulating*. I use the same four focuses in this part of the analytical framework, which are defined below:

<i>self</i>	The focus of the assessment act is on the student as a person, one's <i>self</i> , for example "You are (I am) good in mathematics."
<i>task</i>	The focus is on the <i>task</i> as such (and not on the process related to the work on the task), for example, the answer to the <i>task</i> or what the student should do (and less focus on the student's learning).
<i>process</i>	The focus is on the <i>process</i> required, for example, to solve a task. There is a clear connection to (demonstrated) learning of mathematics. Aspects of mathematics competence discussed in the following section are connected to this general category.
<i>self-regulating</i>	The focus is on the student's <i>self-regulation</i> of the learning process. It can be the teacher who communicates feed back in order to provide possibilities for the student to become a more autonomous learner in mathematics.

### 6.1.2 Aspects of Mathematics Competence

Following Skovsmose (1990, 2005), I analyse three aspects of mathematics competence: *dealing with mathematics notions*, *applying mathematics notions* and *critically reflecting*.<sup>86</sup> In my analysis, these aspects including sub-

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<sup>85</sup> Hattie and Timperley (2007) use the term *level*. Since there is no order among these four features, I instead use the term *focus*.

<sup>86</sup> Skovsmose (2005) calls them competencies. However, since I view competence as a whole – as do Ellström (1992) and Wedege (2001) – I label these aspects of competence.

categories (*processes*) are connected to the *process* focus described in the previous section. For the *processes* I draw on Lindenskov and Wedege (2001) and Björklund Boistrup et al. (2002). The three aspects are defined here.

<i>dealing with mathematics notions</i>	<p>Here, the focus is on <i>dealing with mathematics notions</i>, which could be labelled “pure math”. The processes that are connected to this aspect are: <i>defining/describing, constructing/creating, reasoning/arguing, inquiring/problem-solving, practicing/routine, knowing mathematical facts</i>.</p> <p>The <i>process</i> of <i>practicing/routine</i> is analysed as being present if the acts are directed towards learning. When it is clear that the assessment acts refer to <i>practicing/routine</i> tasks that are not regarded in the analysis as providing learning possibilities for the student, this is considered to be a focus on <i>task</i>. A similar argument can be made for <i>knowing facts</i>.</p>
<i>applying mathematics notions</i>	<p>Mathematics knowing is here used in another context. Such processes are focused on the use of mathematics as a tool. The processes that are connected to this aspect are: <i>defining/describing, constructing/creating, reasoning/arguing, inquiring/problem-solving, practicing/routine, gaining information</i>.</p> <p>See comment on <i>practicing/routine</i> above.</p>
<i>critically reflecting</i>	<p>There is a <i>critical</i> meta-discussion on the mathematics used in the context, for example, the consequences of different mathematics decisions in people’s lives.</p>

As can be seen, there are several processes for *dealing with mathematics notions* and *applying mathematics notions* that appear to be the same. The same *processes*, however, are “executed” differently depending on whether it is a sub-category of one or another of the aspects of mathematics competence. When a student demonstrates *reasoning/arguing*, for example, in relation to the aspect of *applying mathematics notions*, it is reasoning about the practical use of the mathematics involved, whereas when it is in relation to the aspect of *dealing with mathematics notions*, the reasoning is about and a part of mathematics knowing.

## 6.2 Focuses in the Mathematics Classroom

In this section, I describe the focuses of assessment acts in the mathematics classrooms visited and also connect to affordances for students’ learning of mathematics. We revisit excerpts described in the previous chapter and en-

counter new excerpts.<sup>87</sup> I provide examples of findings viewed as institutional traces, which are then elaborated on in Chapter 8, the fourth analysis and outcomes chapter. In Chapter 8, an account is given of the presence of the assessment focuses in the construed discourses.

### 6.2.1 Focus on the Student as Self

As previously mentioned, the focus on *self* concerns the student as a person, for example, “You are (I am) good in mathematics” (Hattie & Timperley, 2007; see also Black & Wiliam, 1998). The focus here is on what and/or how the student *is* and, accordingly, on the student’s intrinsic qualities. During the analysis, I considered this focus of assessment to be present. First, we examine a sequence where Ali (S) and Angelica (S) are working in a group with two other students, Bx and Gx. The students are expected to find a certain number. Each group member has one or two clues for the number, but all the clues are needed in order to figure out which number it is. In the sequence, the four students have solved the first task and they are waiting for Anna (T). Ali (S) and the other students look at Anna (T) when she arrives (excerpt 21). Like in the previous chapter, the first video excerpt is extensive, whereas the subsequent excerpts in this chapter are summarised to a greater extent. The point of interest in this excerpt is mainly the last part.

Time	Speech	Gestures	Body and Gaze
30:12	Anna (T): Well.		Anna (T) approaches the group. Looks at the group.
30:13	Bx: Then we have come to Ali (S): that this(!) is the answer!	Ali (S) points at a number on the paper. Stops.	Angelica (S) looks at the paper. Ali (S) and T look at the paper. Ali and Ang look at T.
30:17		Anna (T) holds up her thumb to students. Stops.	T smiles.
30:18	Gx: Wow.		Ali and Ang smile.
30:19	T: Great!		

<sup>87</sup> The “problem” in writing this dissertation was usually choosing from among all the possible excerpts, rather than finding examples. The reason I use the same sequences for different purposes is that, this way, the reader will have fewer classroom situations to grasp. Another advantage is that it illustrates how the three social semiotic meta-functions are “present” at the same time in communication.

30:20	T: Very good. [Ali (S): We just guessed.]	T moves her hand with the cards upwards. Stops moving hand.	T looks at the paper in her hand.
30:21	T: You did?		T stops smiling and looks at Ali.
30:23	Ang: Yeah.		
30:24	T: I think. Have you guessed all (!) the way?		T looks mostly at B and Bx. Ali stops smiling.
30:26	Ali: Well, we solved it. [Ang: No, we]	Ali waves with his hand.	Ang looks up (in the air), stops smiling.
30:28	Ali: Then we guessed that this was the one. We wondered. We didn't know whether it was this or that.	Ali points at their paper, points at numbers.	Ali looks at T and the paper. T looks at the paper, smiles.
30:31	T: Okay.		T nods.
<i>T starts considering information in the clues with respect to possible answers written on the group's paper.</i>			
30:49	T: But the biggest one that's Ali: There. Bx: [That one.]	Ali points at 731.	T looks at the paper. Ali looks at the paper. (Ang is not visible)
30:51	T: That one, yes. And since it was not this and not this, there was only one to choose from.	T points at 731 and 137, at 173.	Ang looks at the paper. T looks at Ang and Bx.
30:56	Ali: No, there were those as well.	Ali points at 713, 317 and 371.	Ali looks at T.
30:58	Bx (to T): That's clever! Gx: But that.		
31:01	T: But you have written this one or this. Those are not part of the other clues. Gx: No.	T points at 173 and 137. T points at the other numbers.	T looks at the paper. T looks at Ali and Gx. Ali leans forward.

31:06	T: Do you want to try another one? ( <i>high</i> ) S: Yes Ali: Yes, please!	T displays new cards.	T looks at Ang and Bx. Ali looks at T. Ali looks at the cards in T's hand.
31:09	T: You're really good ( <i>high</i> ).		T smiles.
T gives instructions for next task.			

Excerpt 21. Transcript from video material. Original transcript of speech in Swedish is in Appendix C. “High” refers to voice at a “high” frequency. The use of brackets, [ ], indicates simultaneous speech. (!) indicates a specific word being emphasised. “T” is short for Anna (T), “Ali” is short for Ali (S), and “Ang” is short for Angelica (S). “Bx”, “Gx” and “S” refer to unspecified students in the class.

In the analysis, I considered Anna (T), at 30:19 and 31:09, to communicate feed back with approval to the students. In the second of her approvals, the focus is considered to be on the students as *selves*, since Anna (T) focuses on how they are (“really good”). As shown, there are also other focuses in this excerpt given that they are discussing the mathematics *processes* involved in solving the task. If this were not the case, the affordances for the students’ learning of mathematics in this sequence would be considered to be low. I suggest that a focus on how a student is as a person is far from being a focus on students’ engagement in the world using semiotic resources and artefacts in the discipline of mathematics. Even though there is also a focus on mathematics *processes* in this excerpt, the focus on the students as *selves* also seems to have an impact on what the student focuses on later in the lesson. We will return to this in Section 6.2.7.

The second excerpt related to *self* as focus comes from the written material. The students in Britta’s (T) classroom have exhibited self statements on a form for a teacher/student/parent meeting, with alternative 5 indicating the strongest agreement. One of the questions related to mathematics is shown in excerpt 22.

I am good at mathematics <sup>88</sup>	1 2 3 4 5
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Excerpt 22. Transcript from written material. Question from a teacher/student/parent meeting form.

Beatrice (S) has circled the number “3” on her paper, and Belinda (S) has circled the number “5” on her paper. This is a typical example of self-assessment with a focus on the student as *self*. This is also an institutional

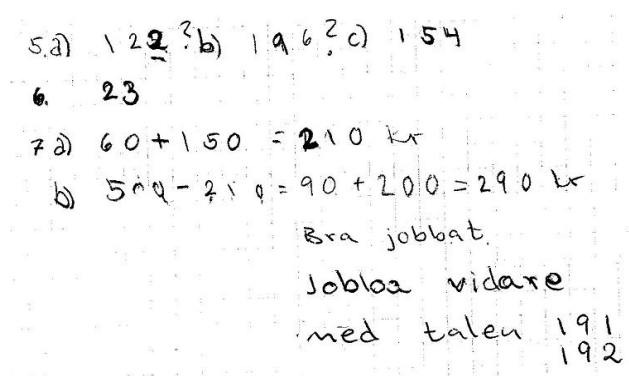
<sup>88</sup> Original excerpt in Swedish: Jag är bra på matematik.

trace since this form comes from the school, with the school logo at the top of it. It is therefore likely that all or at least many of the students at the school answer the same questions before their teacher/student/parent meetings.

### 6.2.2 Focus on Task

The next focus of assessment acts considered by Hattie and Timperley (2007) is *task*. As noted above, the focus here is on the *task* and “non-reflective” doing. In my analysis, the focus on *task* was demonstrated through a focus on the correct or incorrect *answer* for the task, and/or doing the *right thing* without an explanation (*right answer/thing*). A second way of illustrating this focus concerns the *number of* tasks completed or correct answers (*number of*). Inspired by Lundgren (1977; see also B. Johansson, 2000), I added *piloting*<sup>89</sup> as a sub-category of the *task* focus (see also Löwing, 2004; Persson, 2009). This third kind of *task* focus is when a student solves a task when “helped” by the teacher in a step by step process, without reasoning about the whole process. The fourth way for *task* focus to be present is when the focus is on doing (as opposed to meaning making and learning) in *general*.

In the data, a common way to represent a focus on *task* is when the teacher or student compares the answers written in their notebook with the key. When they are the same, the teacher or student recognises the answer as being correct (*right answer*) and writes an “R” beside it; when they do not correspond, another symbol is written. We encounter this in excerpt 23, where Denise (S) has completed a diagnostic test on arithmetic that Diana (T) has checked.



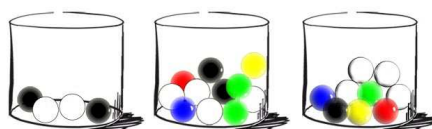
Excerpt 23 (from written material<sup>90</sup>). Denise’s (S) answers to a diagnostic test with Diana’s (T) markings.

<sup>89</sup> In Sweden, this phenomenon in mathematics education is called “lotsning”.

<sup>90</sup> Translation into English: Well done. Continue working on items 191, 192.

In excerpt 23, Diana (T) has recognised the answers that did not correspond with those in the key with a question mark, which is considered in the analysis to be a *task* focus on *right answer*. Beneath that, she has written “Well done”, which is considered to be feed back with a *general task* focus. This is followed by feed forward using the words “Continue working on items 191, 192”. In the analysis, I considered the latter instance to be a focus on *task* related to doing the *right thing*. An analysis of the assessment acts in this excerpt in terms of affordances for students’ learning is that these are considered to be quite small. It should be noted that there could be affordances for students’ learning when Denise (S) works on the tasks for these answers, but they are not part of this analysis. One example of low affordances for learning is when Denise (S) is told to work on specific tasks, without any indication about what learning these tasks would give affordances for. This information could, of course, have been given orally by Diana (T). However, there are several similar assessment acts with a *task* focus present from the classrooms visited in the video material as well.

When the focus is considered to be on *piloting*, the student, having arrived at the correct answer, has solved different small tasks but not the “larger” task that was the problem from the beginning. In the sequence that excerpt 24 is taken from, there are several shifts between the focuses of the assessment acts. Britta (T) is discussing a diagnostic test with Belinda (S). The task reads as follows: “Which of the jars has the biggest proportion of white marbles?”<sup>91</sup> Beside this is a picture (excerpt 25).



Excerpt 24. Picture drawn with the picture from the textbook as a model. In Jar A there are 2 white and 2 black marbles; in Jar B 4 white, 2 green, 2 black, 1 blue, 1 red and 1 yellow marble; and in Jar C 4 white, 1 green, 1 black, 1 blue, 1 red and 1 yellow marble. Illustration by A. Enmark.

In her notebook, Belinda has written an answer (excerpt 25).

A = 50 %  
B ≈ 20 %  
C = 27 ½ %

Excerpt 25. Transcript from written material. Belinda’s (S) answer from her notebook.

<sup>91</sup> Original excerpt in Swedish: Vilken av burkarna har störst andel vita kulor?

Often, there is a focus on mathematics *processes* during this sequence. In some instances, there is also a *task* focus, and here, more specifically, a focus on *piloting*. What is causing problems for Belinda (S) in this specific question is that there are odd numbers of marbles in Jars B and C. She communicates to Britta (T) that she has run into trouble trying to draw elevenths (Jar B) or ninths (Jar C). After several minutes, in which Belinda tries in different ways to draw circles that she can divide in a way to find fractions for Jars B and C, Britta (T) brings out manipulatives. These manipulatives consists of “poles” on which coloured blocks are stacked (excerpt 26).



Excerpt 26. Part of a frame from a video sequence showing manipulatives.

Using these manipulatives, they reason, step by step, about the fraction of white marbles in each jar. Sometimes the entirety of the task context is lost, and their communication is only about a tiny part of the complexity of what they are trying to accomplish. In one instance, it is really clear that the *task* focus is on *piloting*. In the beginning of excerpt 27, Belinda (S) is looking at the manipulatives on the desk.

Time	Speech	Gestures	Body and Gaze
1:20:19	Britta (T): Four twelfths! Can one express that in another way? <sup>92</sup>	Britta (T) touches 4/12 in blocks.	Britta (T) looks at 4/12 in blocks.
1:20:23	Belinda (S): Yees.  One third.	T takes hand away. Belinda (S) takes 1/3 in blocks. Puts 1/3 beside 4/12. Stops using blocks.	Belinda (S) looks at 1/3 in blocks.  Bel looks down.
1:20:26	T: One third ( <i>high</i> ).		T looks at Bel.

<sup>92</sup> Original transcript of speech in Swedish:

Britta (T): Fyra tolfedelar! Kan man uttrycka det på något annat sätt?

Belinda (S): Jaa. En tredjedel.

T: En tredjedel!

T: Det sa du bara sådär.

Bel: Jag kollade på de där.

1:20:28	T: You said that just like that.		Bel looks at the manipulatives.
1:20:30	Bel: By looking at that ( <i>laughs</i> ).	Bel points at 1/3 in blocks.	T looks at 1/3 in blocks.

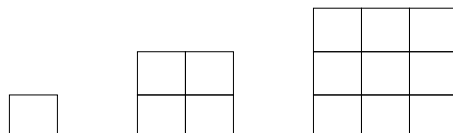
Excerpt 27. “High” refers to voice at a “high” frequency. “T” is short for Britta (T), and “Bel” is short for Belinda (S).

In the beginning of excerpt 27, when Britta (T) asks whether one can express four twelfths in another way, Belinda (S) takes one third of the manipulatives and puts them beside the four twelfths that are already on the desk. She then answers “one third”. When Britta (T) at 1:20:26 determines that Belinda (S) has come up with the answer “just like that”, Belinda (S) answers: “By looking at that”, and points at the manipulatives. One could say that Belinda (S) is using the manipulatives as feed forward with the *task focus piloting*. There is no detailed mathematics argument about the relation between the two fraction-expressions reflected in her answer; it is merely a matter of finding the pieces that look like the same height. If this were one of Belinda’s (S) early encounters with fractions, the analysis could be different. Analysing this sequence as a whole, I did not consider there to be many affordances for learning in this part of the sequence. Still, it is possible to add one comment. The task that Britta (T) and Belinda (S) are discussing, finding fractions for the proportion of white marbles in the jars, is different than the actual task in the textbook. That task was to determine in which jar the proportion of white marbles was biggest. This could have been solved through reasoning whether half, or almost half, or not even close to half of the white marbles were in each jar. This may be something that Britta (T) was perfectly aware of, but she chose to engage in a more complex discussion.

### 6.2.3 Processes Relating to Dealing With Mathematics Notions

According to my analytical framework, when there is a focus on *process* in the mathematics classroom, this implies a focus on aspects of mathematics competence. Here, the objective is the first aspect of mathematics competence, *dealing with mathematics notions* (Skovsmose, 1990, 2005). The processes I have connected to this are *defining/describing*, *constructing/creating*, *reasoning/arguing*, *inquiring/problem-solving*, *practicing/routine* and *knowing mathematical facts*; all are considered to be present in the study. In this section, a number of these *processes* are examined and also connected to affordances for students’ learning.

Anna (T) has introduced a page in the textbook on patterns, and Ali (S) and Angelica (S) are just about to start working together on the first item. In the beginning of this sequence, Angelica (S) is asking Anna (T) for help, for feed forward. Anna (T) stands by their desks and reads the first task out loud, “Draw the figures”<sup>93</sup>, and comments that they have already done this part. Ali (S) is still drawing the figures, but Anna (T) does not comment on this. In excerpt 28, the first three figures of the pattern are presented.



Excerpt 28. Transcript from written material. First three figures of pattern.

The following task is to draw the next figure of the pattern, and this is the item on which Angelica (S) is communicating with Anna (T). In excerpt 29, Anna T communicates feed forward through a question (Angelica (S) looks in Anna’s (T) direction).

Time	Speech	Gestures	Body and Gaze
8:40	Anna (T): What do you think they mean by “draw the next one”, what will the next figure look like? <sup>94</sup>	Anna (T) points at the item in Angelica’s (S) textbook. She stops pointing.	Anna (T) looks at Angelica’s (S) and Ali’s (S) work.
8:44	Angelica (S): Well, kind of that it. This one increases, so you’re supposed to draw the next figure. And perhaps how much it increases.	Angelica (S) points at the top of her paper. She taps with her pencil on the paper. She waves with her pencil.	Angelica (S) looks at her paper. T looks at Ang.
8:53	T: Mm, exactly ( <i>high</i> ). Will you draw the next figure now?		T looks at Ang’s paper. Ang smiles.

<sup>93</sup> Original excerpt in Swedish: Rita figurerna.

<sup>94</sup> Original transcript of speech in Swedish:

Anna (T): Vad tror ni de menar med att rita nästa, hur nästa figur kommer att se ut?

Angelica (S): Ja, typ att den. Den här ökar ju, så att man ska rita nästa figur. Och hur mycket den ökar kanske.

T: Mm, precis. Ska ni rita nästa figur nu då?

Ang: Ja, men jag vet inte vad den ska innehålla riktigt.

8:56	Ang: Yes, but I don't really know what it should contain.		T looks at Ali's (S) paper. Ang looks at Ali's paper. Smiles.
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Excerpt 29. “High” refers to voice at a “high” frequency. “T” is short for Anna (T), “Ang” is short for Angelica (S), and “Ali” is short for Ali (S).

The *processes* related to *dealing with mathematics notions* that are considered to be present here are *inquiring/problem-solving* since, based on Angelica's (S) acts, the task is a problem for the students to solve. When Anna (T) communicates her feed forward at 8:40 (looking at the students' work), she is considered to also address the *processes* of *reasoning/arguing*: “What do you think they mean by “draw the next”, what will the next figure look like?” At 8:53, Anna poses (T) a similar question, where she is also considered to again stress the *processes* of *inquiry/problem-solving* in her feed forward. Neither Ali (S) (perhaps since he is occupied with his drawing) nor Angelica (S) figures out what the next figure in the pattern should look like (8:56) during this sequence. Anna (T) seems reluctant in the subsequent communication to say anything specific about how to go about the task. All her feed forward has the *process* focus on *inquiring/problem-solving* and sometimes also on *reasoning/arguing*. An analysis in terms of affordances for students' learning indicates that Anna (S), with her feed forward, produces affordances for Angelica's (S) and Ali's (S) learning of the *processes* mentioned. In the end of the sequence (and also after Anna (T) has left), Ali (S) and Angelica (S) *reason* with each other with a *process* focus on *inquiring/problem-solving*. A subsequent sequence from this lesson is presented in Section 5.2.4 (excerpt 17), and there we can see that Angelica (S) and Ali (S) manage to solve the problem for the following figures in the pattern.

In the next section, we first revisit a sequence presented earlier in Section 5.2.2 (excerpt 9), where Denise (S) has tried to use square metres as a unit, which is considered not mathematically appropriate for the current task. Diana (T) makes clear, through speech and gestures, that what Denise (S) has measured is length and that she disagrees that square metres would be a suitable unit for this. When Diana (T) recognises that Denise's (S) answer could be viewed as not correct in the discipline of (school) mathematics, she focuses on the *process* of *knowing mathematical facts*. It should be noted that, in my analysis, this is considered to be a *process* focus since Diana (T) explains the difference between length and area and explains a little about suitable units. Had she told Denise (S) the correct unit and nothing more, I would have considered it a focus on *task*. When Diana (T) engages in the explanation mentioned, taking a *process* focus on *knowing* mathematical facts, I considered there to be affordances for Denise's (S) learning.

In one document from the written material, Erika (T) has provided for feed back, feed forward and also feed up about volume, fractions and estimates. At the top of the paper, a question is asked: “How has the work on meeting the standards been accomplished?”<sup>95</sup> On the rest of the paper, goals are mixed with tasks. One of the first goals is: “knows how to switch between the units l [litre] and dl”<sup>96</sup>. A task related to this goal is: “How many litres is 150 cl?”<sup>97</sup> Enzo’s (S) answer to this task is “one and a half litres”<sup>98</sup>. The focus of the assessment acts is considered here to be the *process* of *practicing/routine*. Enzo (S) solves the task and during his and Erika’s (T) discussion on this and other documents (described in Section 5.2.6), I considered there to be affordances for Enzo’s (S) learning of mathematics.

#### 6.2.4 Processes Relating to Applying Mathematics Notions

In this section, the subject is the second aspect of *mathematics competence*, that is, *applying mathematics notions* (Skovsmose, 1990, 2005). As noted, mathematics knowing is used in another context in this aspect. The *processes* (Section 6.1.2) are *defining/describing*, *constructing/creating*, *reasoning/arguing*, *inquiring/problem-solving*, *practicing/routine* and *gaining information*, and they are all considered to be present in the analysis. With few exceptions, the following excerpts indicate *applying mathematics notions* only in a specialised classroom discourse (see Goodchild, 2001). That is, the questions or problems are posed by the teacher and/or the textbook, and it is not clear the extent to which the meaning making from working on these tasks goes beyond the classroom (see also Jablonka & Gellert, 2007; Keitel, 2006; Lerman & Zevenbergen 2004). However, the task in the first excerpt has a real life context.

Cecilia (T) has led a survey in her class. Parts of this lesson were addressed previously in Sections 5.2.1 and 5.2.6. From my researcher’s log, I can read that Cecilia (T) has talked about recent problems in class, when some students found other students’ behaviour to be disgusting and gross. Cecilia (T) then initiates a survey about all the possible things the students in the class perceive as gross. The results of the vote (which was done anonymously) are displayed on the whiteboard. The students are given the assignment to write the items in a ranked order and then to draw a diagram of their choice. When the students start working, Cecilia (T) walks around, looking at their work, providing for feed back and feed forward. She then communicates feed back to two students about their work. She does this in a loud voice at a high frequency, so I considered this to be feed forward to all the

<sup>95</sup> Original excerpt in Swedish: Hur har arbetet med att nå målen gått?

<sup>96</sup> Original excerpt in Swedish: Kunna göra enhetsbyten mellan l och dl.

<sup>97</sup> Original excerpt in Swedish: Hur många liter är 150 cl?

<sup>98</sup> Original excerpt in Swedish: en och en halv liter.

students. She addresses the variety of ways the students are approaching the assignment: “And you are doing it differently! That’s good.”<sup>99</sup> The *processes* that are in focus in this feed forward (and feed back) are considered to be *constructing/creating*. The students are *constructing* diagrams using various semiotic resources (drawings, figures, symbols and the like), and since Cecilia (T) acknowledges the fact that they are *constructing* a diagram of the students’ own choice, it is also considered to be addressing the *creating* process. The affordances for the students’ learning that were already present in the assignment (*constructing/creating* diagrams) are emphasised in this short assessment act. A few minutes later, Cecilia (T) communicates with Cilla (S) about her work (see excerpt 4 in Section 5.2.1). I considered the *process* of *inquiring* to be in focus in Cilla’s (S) asking for feed forward. Producing a ranking and a diagram from the results of a survey is considered to be an *inquiry*. For Cilla (S), it does not seem to be something she knows how to go about doing, and hence, in the analysis it is also considered to be a focus on *problem-solving*. At the end of the sequence, Cecilia (T) acknowledges that Cilla (S) needs feed forward on what ranking means and tells Cilla (S) that she can show the order in the diagram, “little, more, most” (showing bars with her hand, looking at Cilla (S)). Cilla (S) then offers a *definition* of ranking of her own (excerpt 30).

Time	Speech	Gestures	Body and Gaze
8:40	Cilla (S): Then you can do like that, little, middle, most. <sup>100</sup>	Cilla (S) shows bars in the air with her hand.	Cilla (S) looks down.
8:42	Cecilia (T): Yes ( <i>high</i> ). Cil: Okay.	Cil stops showing bars.	Cecilia (T) looks at Cil. Cil looks at T.

Excerpt 30. “High” refers to voice at a high frequency. “T” is short for Cecilia (T), and “Cil” is short for Cilla (S).

I considered the *process* of *defining/describing* to be present in excerpt 30; the *defining/describing* of the meaning of ranking in the sequence referred to is done in an interplay between Cecilia (T) and Cilla (S). The assessment acts are considered to hold affordances for Cilla’s (S) *problem-solving*. Through the assessment acts, at 8:40, she demonstrates an increased readiness to use semiotic resources, to *solve problems* about ranking as part of executing an *inquiry*. She is also invited to *define*, which she does both orally and with gestures.

<sup>99</sup> Original transcript of speech in Swedish: Och ni gör olika! Det är bra.

<sup>100</sup> Original transcript of speech in Swedish:

Cilla (S): Så då kan man göra så där, liten mellan mest.

Cecilia (T): Ja.

Cil: Jaha.

Another *process* present in much of the communication during the lesson that was referred to above is *gaining information*. For the students, there is a real interest in finding out what things they, as a class, find to be the gross-est. When Cecilia (T) turns the matter of “grossness” into mathematics, different kinds of gross behaviour are made apparent, without mentioning any names. The students are demonstrating different *processes* such as *gaining information* that relate to them. In the final sequence of this lesson, the students and Cecilia (T) are sitting in a circle on the floor and they all get to demonstrate and *reason* about their *constructed* diagrams. One process present in Cecilia’s (T) feed back is how different diagrams are useful when it comes to matters of *gaining information*.

Turning to another classroom, we now return to the written document where Erika (T) has allowed for feed back, feed forward and feed up about volume, fractions and estimates (see previous section). One goal stated in the document is: “Knowing how to state a proportion of a whole in plain fractional form”<sup>101</sup>. One of the items connected to this goal is as follows: “I divide a candy cane into six pieces, then I eat two of these pieces. How big a proportion of the candy cane have I eaten? Show how you solve the task”<sup>102</sup>. Enzo (S) answers “one third” to this question and also draws a picture (excerpt 31).



Excerpt 31. Transcript from written material. Enzo’s (S) drawing.

This question is considered in the analysis to be an unrealistic one (since it is really impractical trying to divide a Swedish candy cane into equal pieces). For a student like Enzo (S), who here is part of this kind of classroom discourse, I considered this question to be holding affordances relative to the *processes* of *practising/routine* and *reasoning/arguing*. The latter is considered to be present since the students are asked to demonstrate their solution to the task, which Enzo (S) does here through writing and drawing. For a student who finds this a challenging task, the process may also involve the *process* of *inquiring/problem-solving*.

<sup>101</sup> Original excerpt in Swedish: Kunna ange del av en hel i enkel bråkform.

<sup>102</sup> Original excerpt in Swedish: Jag delar en polkagris i sex bitar sedan äter jag upp två av dessa bitar. Hur stor del av polkagrisen har jag ätit? Visa hur du tänker.

## 6.2.5 Processes Relating to Critically Reflecting on Mathematics

In this section, I address the third of Skovsmose's (1990, 2005) aspects of mathematics competence, *critically reflecting*. In this study, the students are quite young, and one question is how this aspect can be made apparent in the assessment acts in the mathematics classrooms visited and, consequently, what affordances these acts hold for students' learning of the *critically reflecting* aspect. I found it hard to consider *critically reflecting* in the sense of Skovsmose's meaning as being present in the data of this study. In performing the analysis, I also looked for any other kind of meta-discussion about mathematics used relative to the context of the task. A finding was that an additional *process* was identified, a *reflecting on models*. Here, there is *reflecting* communication present about why a certain model is used for an assignment and whether the method served its purpose. In the "main" *process* of *critically reflecting*, drawing on Skovsmose (1990, 2005), the student is invited to look *critically* at mathematics methods used in different contexts and their consequences for people. In the following paragraph, I address how the *process* of *reflecting on models* to some extent was demonstrated in the data analysis.

We return to a sequence where Britta (T) is discussing the results of a diagnostic test with Belinda (S) (see excerpt 11 in Section 5.2.3). As described, Belinda (S) has given a correct answer (concerning which of two children ate more candy) using reasoning based on irrelevant grounds. At 1:05:24 in excerpt 11, Britta (T) is considered to communicate feed forward with the *process* focus of *reasoning/arguing* as well as *inquiring/problem-solving*. (She says "If you would (*high*) [silence] ehm, find out how many pieces of candy each of them ate (*high*)" while pointing and looking at the textbook. After this, Belinda (S) makes changes in her solution. Britta (T) then poses a follow-up question (which is not part of the diagnostic test), shown in excerpt 32.

Time	Speech	Gestures	Body and Gaze	
1:09:13	Britta (T): But is it always (!) the one who eats the biggest part who gets the most candy? <sup>103</sup>	Britta (T) points at the textbook.	Britta (T) looks at Belinda (S).	Belinda (S) looks at the textbook and at diagnostic test. She shakes her head.

Excerpt 32. Transcript from video material. (!) indicates a specific word being emphasised.

<sup>103</sup> Original transcript of speech in Swedish: Men är det så att det alltid är den som äter störst del som får flest karameller?

Here, Britta (T) represents the *process* of *inquiry/problem-solving* when she initiates further discussions. She also initiates a meta-discussion where she relates the current mathematics to other likely situations. This is considered to be *reflection* on the *model* used. From Belinda's (S) perspective, this seems clear, as shown in excerpt 32, through head shaking and in the following through saying: "But I have answered this here"<sup>104</sup> (pointing at her diagnostic test to the solution in question as well as to the solution for a subsequent task). Further on, Britta (T) acknowledges this, and then she represents *reflection* through feed forward: "It's exactly as you've written. It depends on the numbers included. That a fourth of a hundred is actually more than a third of twenty one"<sup>105</sup> (pointing at figures on Belinda's (S) diagnostic test).

### 6.2.6 Focus on Self-regulating

In the structure used by Hattie and Timperley (2007), the fourth possible focus of assessment acts is on *self-regulating* (see also Andrade, 2010). Hattie and Timperley consider three sub-categories for this focus. I considered all three to be present in the analysis for this chapter: *monitoring*, *directing* and *regulating*. This focus is related to affordances for students' active agency in the mathematics classroom, although there is a stronger emphasis on the focus of the assessment acts as such. In the analysis with respect to *self-regulation*, the interest lies in how assessment acts can have students' *monitoring*, *directing* and/or *regulating* as a focus. This is related to the students' potential to take increasing responsibility for their work in the mathematics classroom. A key outcome of the analysis is that the focus on *self-regulation* is seldom the only focus of assessment acts. Often it is combined with a *process* focus, as in the sequences referred to in this section. Of course it can also be combined with a *task focus*, which would decrease the affordances for students' learning of mathematics. However, this combination was not often considered to be present in the analysis.

We once again consider a video sequence where Ali (S) and Angelica (S) are solving tasks on geometrical patterns (see excerpt 17 in Section 5.2.4). In this sequence, Ali (S) is requesting more challenging tasks ("Hey you. Next time, give me harder tasks than this", looking and smiling at Anna (T)). When Ali asks for more challenging tasks, he is considered to be *self-regulating* by *monitoring* his meaning making and learning process and then *directing* towards more challenging tasks. When Ali (S) *monitors* his learning process, he then decides to *regulate* it by addressing Anna (T). Anna's (T) response ("Wait and see down there", looking at Ali (S) and pointing at the bottom of the page) is considered to represent an acknowledgement of

<sup>104</sup> Original transcript of speech in Swedish: Men det har jag svarat på här.

<sup>105</sup> Original transcript of speech in Swedish: Precis som du har skrivit. Det beror på vad det är för tal. Att en fjärdedel av hundra är faktiskt fler än en tredjedel av tjugooett.

Ali's (S) *self-regulation* with his need for more challenging tasks. In analysing this sequence, my analysis is that Ali's (S) affordances for learning mathematics are increased when he takes responsibility for his learning through this *self-regulation*, as he does here.

In another classroom, Britta (T) has arranged a help list on the whiteboard, for the "independent work" sessions. Above the space for the list, there are written instructions (excerpt 33).

If you need help, ask three classmates. If you still need help, write your name on the help list.<sup>106</sup>

Excerpt 33. Transcript from video material. Text from whiteboard in classroom B.

In the analysis, I considered Britta (T) to represent feed forward with the focus on *self-regulation* (as well as peer regulation). In following these instructions, the students first discuss their problems with peers; the affordances for their learning processes may increase (which is shown by Black & Wiliam, 2006). Moreover, when they are helping their classmates, they are encouraged, for example, to *monitor* and *direct* another person's course of action. The instructions are considered to communicate to the students that Britta (T) is not the only one responsible for teaching and learning; instead it is a shared responsibility between her and the students.

When the teacher provides for students' self-assessment, these assessment acts are considered to clearly address students' *self-regulation*. Self-assessment is present in the sequence referred to earlier (excerpt 20 in Section 5.2.5), where Erika (T) and Enzo (S) have an assessment discussion about Enzo's (S) learning during the just-completed unit. Throughout this sequence, there is a focus on mathematics *processes*. When Enzo (S) looks at the assessment matrix (excerpt 19 in Section 5.2.5) and reflects on which of the stated goals corresponds to his demonstrated knowing, this (also) represents an assessment focus on *self-regulation*. In the beginning of this sequence, Erika (T) points at the first row of the matrix and reads the first cell (about knowing what a litre and decilitre are) out loud. Enzo (S) agrees and Erika (T) tells him to mark this sentence with the marking pen. The *self-regulation* represented in the assessment is mainly *monitoring*. Enzo (S) is *monitoring* his past learning during the teaching unit. When he is invited to *monitor* his learning in mathematics as he is here, this is considered to hold affordances for his learning. At the same time, the *monitoring* focus is on mathematics *processes*.

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<sup>106</sup> Original excerpt in Swedish: Om du behöver hjälp, fråga tre kamrater. Om du fortfarande behöver hjälp, skriv upp dig på hjälplistan.

### 6.2.7 Focuses of Assessment Acts During a Lesson

In this section I address how the focuses of the assessment acts can change (or not) during and between sequences (with inspiration from Ljung & Petersson, 1990; Selander, 2008a). We will follow assessment acts along a timeline, where the focuses in the initial instructions are also included.

During the first sequence in a lesson, Anna (T) introduces a group task to the students (the third sequence of this lesson has been described in section 6.2.1). In this task, the students are expected to find a certain number, using clues for the number. There are not many assessment acts related to feedback present in this first sequence. In the beginning of the sequence, the instructions mainly concern a *task focus*. The teacher explains how to go about the task in more practical terms. In the end, there is also a *process focus* present when Anna (T) explains that the idea is that they should work together (*reasoning*) to find out which number fits all the clues (*problem-solving*).

In the second sequence, another common pattern is identified. Angelica (S), Ali (S), Bx and Gx<sup>107</sup> have started working together and after a while they get into an argument about which student should sit in which seat. This is regarded as a *general focus on task*. Anna (T) comes by and communicates feed forward on how they should be seated. She then continues her feed forward, explaining the importance of them sitting so that they can hear each other since they are supposed to *solve a problem* together. I considered Anna (T) to communicate feed forward here with a shift from the students' focus on *task* to a *process focus*. The *processes* represented here are mainly *reasoning/arguing* and *inquiring/problem-solving*. In the discussion between the students that immediately follows, the *process focus* is maintained as they *reason* together about which number corresponds to the clues. This pattern, where the focus introduced (or maintained) in the teacher-student communication is still present once the teacher has left, is often identified in the analysis. In this case, this holds increased affordances for the learning of mathematics compared to the focus of their communication before Anna (T) approached the group.

When the third sequence starts, the students have been sitting for a while, waiting for Anna (T). Anna approaches and the students demonstrate their answer (see excerpt 21 in Section 6.2.1). Anna (T) communicates approval with a thumbs up and a smile. In an analysis of her feed back, the focus is considered to be on *task* and on the *right answer*. In the following communication, it becomes apparent that the students are still not sure about why the answer is correct and Ali (S) introduces a focus on *processes* and mainly on *inquiring/problem-solving*. In Anna's (T) feed back, there is mainly a focus on the *processes* of *inquiring/problem-solving*. She explains her interpretation of their *process* to them while looking at their notes, and consequently

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<sup>107</sup> "Bx" and "Gx" refer to unspecified students in the class.

why their solution can be considered correct. In the end of the sequence, she tells them that they are about to get a new task and that they were “really good”. Here, the focus is on *self*. Anna (T) then communicates feed forward when she gives them clues to a new number *problem* and the students start working without Anna (T). After a short amount of time, their focus represents the *processes inquiring/problem-solving* and *reasoning/arguing*. In this sequence, most of the teacher-student communication has a *process* focus and, again, this is maintained after Anna (T) has left the group.

In the fourth sequence, the four students in the group are again sitting waiting for Anna (T). When she arrives, they show her that they have solved this task as well. In the beginning of the sequence, the students (the boys) show their notes and tell Anna (T) their answer. Anna (T) communicates feed back through a smile. In the analysis, the focus of the feed back here in the beginning of the excerpt is considered to be on the *task*, on the *right answer*. Then the boys in the group introduce a focus on *self*. They say that they are very clever and that the boys are cleverer than the girls. Anna (T) does not respond to this. Instead she communicates approval to them through a “Good” (a *general task* focus) and then tells them that they should now start working in the textbook for the remaining minutes of the lesson. She then leaves the group. Ali (S) once again claims that the boys are smart and the girls are not. Gx then claims that they discussed everything together, thus addressing a *process* focus. Ali (S) modifies what he just said and instead claims that the boys are smart but the girls are smart too. I also considered this instance as a focus on *self*. After this, the group split up and they start working on their own in their textbooks.

In the sequences referred to here, is not possible to tell for certain whether the focus of *process* during the students’ problem-solving following the teacher’s first intervention is a consequence of the *process* focus in Anna’s (T) feed forward to the students that just took place. Likewise, it is not possible to tell whether the students’ focus on *self* in the last excerpt was a consequence of the earlier feed back from the teacher containing a *self* focus. However, it was possible for me to compare the focuses during communication between the teacher and student(s), to the focuses in the same students’ work following this communication. As I alluded before, there is a relation, which I examine in Section 6.3.2.

## 6.3 Focuses of Assessment Acts: Occurrences, Affordances for Students' Learning, and Relationships

Similar to the first analysis and outcomes chapter, I present below some summarised outcomes, based on the findings in the five mathematics classrooms visited.<sup>108</sup> These findings are linked to affordances for students' learning.

### 6.3.1 Occurrences and Affordances for Students' Learning

Below is a summary of outcomes of the focuses considered to be present in the assessment acts in the mathematics classrooms visited. There are often several focuses present in a video sequence or document group. An overview of occurrences of focuses is shown in table 3.

Table 3. Overview of Presence of Assessment Focuses in Classrooms Visited<sup>7</sup>

Focus	Video sequences with occurrences of an assessment focus	Document groups with occurrences of an assessment focus
Self	1	2
Task	53	18
Process	80	23
Self-regulating	49	15

<sup>7</sup> The total number of video sequences with assessment acts related to feedback (feed back, feed forward and/or feed up) is 105. The corresponding number for document groups is 27. In one video sequence or document group there are often various assessment focuses present, for example both task and process.

As shown in table 3, the *process* focus appears in the largest number of video sequences and document groups. It is rare for it to be considered that there are no representations of a *process* focus in the document groups. At the same time, there is a number of video sequences (twenty-five) without a clear focus on mathematics *processes*. The next most frequently occurring focus observed in video sequences and documents is *task*. The *task* focus is common as a focus of assessment acts in situations where the teacher gives instructions to students about assignments to be done. There are also several other types of communication in the day-to-day work in the classrooms visited where there are more than single occurrences of a focus on *task*.

<sup>108</sup> For video sequences, the outcomes presented here include sequences where there is more than one occurrence of an assessment act present. If a category is present in more than 10 % of the documents in a group, it is included in the outcomes. The number of sequences with feed back, feed forward, or feed up is 29 in classroom E and around 20 in the other four. The number of document groups with feedback is around 5 in all the classrooms. The number of documents as a total is considerably larger in classroom E.

Table 4. Presence of Assessment Focuses in Classrooms Visited<sup>8</sup>

Focus	Video sequences with occurrences of an assessment focus	Document groups with occurrences of an assessment focus
Self	1	2
Task:	53	18
– right answer/thing	29	11
– number of	8	4
– piloting	10	0
– general task	32	9
Process, dealing with mathematical notions:	59	20
– mathematical facts	19	6
– practicing/routine	34	17
– inquiry/problem-solving	26	6
– reasoning/arguing	26	7
– constructing/creating	12	1
– defining/describing	10	6
Process, applying mathematics notions:	34	14
– practicing/routine	10	9
– inquiry/problem-solving	17	12
– reasoning/arguing	15	6
– constructing/creating	5	2
– defining/describing	13	3
– gain information	9	4
Process, critically reflecting:	6	0
– reflecting on models	6	0
– critically reflecting	0	0
Self-regulating:	49	15
– regulating	14	6
– monitoring	33	9
– directing	24	7

<sup>8</sup> The total number of video sequences with assessment acts related to feedback (feed back, feed forward and/or feed up) is 105. The corresponding number for document groups is 27. In one video sequence or document group there are often various assessment focuses present, for example the processes inquiry/problem-solving *and* reasoning/arguing.

The third most common focus is *self-regulating*, and there is a pattern in which this focus has been considered to mostly be present along with a focus on *process*. The least common focus in the analysis is a focus on *self*. There is just one video sequence and two document groups where there is more than a single occurrence of this focus.

A key finding in this section is that the analysis suggests substantial differences in terms of affordances for students' learning of mathematics relative different focuses of assessment acts. I describe this in this section, and a more detailed overview of occurrences is shown in table 4.

The first focus described in this chapter was *self*, for example “*You are good at mathematics*”. I do not consider this focus to contribute to affordances for students’ learning since it does not promote students’ use of semiotic resources in the discipline of mathematics. Studies described both in Hattie and Timperley (2007) and in Black and Wiliam (1998) indicate that this focus does not contribute to students’ achievements. As mentioned, in the analysis, this focus was considered not to be present much in the assessment acts. If I also include single occurrences (sequences with only one occurrence, which are not part of table 4), this focus was considered to be present in classroom A, C and E. As described earlier in this chapter, the focus is present when the teacher quickly tells the students in the group that they were very good in doing the task (see sequences 6.2.1 and 6.2.7) and also later, during the same lesson, in student communication with the teacher present. In the analysis of the written material, the focus is considered to be present twice (classroom A and B).

A focus on *task* in the teaching and learning of mathematics may be inevitable. As part of the feed forward, there will be instances where the teacher tells the student what to do, for example, what tasks to work on, and there may not always be reasons or possibilities to also discuss why these tasks were chosen. However, mathematics *processes* are not addressed when the focus of assessment acts exclusively is on *task*. Use of semiotic resources is not promoted to the students in mathematics during assessment acts, and hence this focus of assessment acts is not considered to hold many affordances for students’ learning of mathematics. Hattie and Timperley (2007) claim in their review that assessment acts with this focus did not have a big impact on students’ achievements, especially for knowing other than surface knowing. As shown in table 4, the two sub-categories present in most video sequences are a *general* focus on *task* and a focus on the *right answer/thing*. A *general* task focus is on doing (as opposed to meaning making and learning). The dominant focus in the outcomes of the analysis of the document groups is a *task* focus on the *right answer/thing*. The most typical move here is that the teacher checks the students’ performances and marks “R” when the answer is correct and a symbol when it is incorrect (relative the key). *Piloting* is a *task* focus where the teacher helps the student with different parts of a mathematics problem. In the end, the student does not have the possibility to grasp the entirety of the task and the possibilities for learning are low. As shown in table 4, this focus is not considered to be present in many of the video sequences. The focus on the *number of* completed tasks or correct answers is also present in a few video sequences. In classrooms C and D, the *task* focus is considered to be present in around two thirds of the video sequences. Classroom A and B follow, with around a half of such sequences, and classroom E, with a few video sequences. In the written material, the *task* focus is present in half the document groups with assessment in

classroom E. In the other classrooms, the *task* focus is present in two thirds or more of the document groups.

*Process* as focus is also a term used in the model by Hattie and Timperley (2007) and as described previously, I combined this with Skovsmose's (1990, 2005) three aspects of mathematics competence: *dealing with mathematics notions*, *applying mathematics notions* and *critically reflecting*. Not surprisingly, the *process* focus is an assessment focus that I consider to have affordances for students' learning of mathematics. To some extent, this follows the definition and arguments of learning at the beginning of this chapter, but I also examined this in Section 6.2 with respect to excerpts from the data. I showed how students are invited to use semiotic resources in the discipline of mathematics during assessment acts when mathematics *processes* are focused on.

The first aspect of mathematics competence, *dealing with mathematics notions*, is conceptualised in this thesis through processes such as *defining/describing*, *inquiring/problem-solving* and *knowing mathematical facts*. The competence aspect *dealing with mathematics notions* was considered to be present in more video sequences and document groups than the other two aspects. All *processes* related to this aspect are substantially represented in the video material as well as in the document groups. The three *processes* considered to be present in the largest number of video sequences are *practicing/routine*, *inquiry/problem-solving* and *reasoning/arguing* (see table 4). For the document groups, the picture is somewhat different, with *practicing/routine* present in significantly more groups than the other processes. The competence aspect *dealing with mathematics notions* is considered to be present in many video sequences among those from classroom A and B. In the video material from classroom E, the aspect is considered to be present in around half the sequences, followed by fewer than half the sequences from classrooms C and D. In the written material, this focus is present in between half and two thirds of the document groups from all classrooms except classroom E, where it is present in all but one document group.

The second aspect of mathematics competence, *applying mathematics notions*, is conceptualised through similar *processes* as for *dealing with mathematics notions*, but here the focuses are on the use of mathematics in a context. When this aspect of mathematics competence is focused on in the assessment acts, there is considered to be affordances present regarding students' learning of the practical use of mathematics in a context (nevertheless, largely in the "specialised classroom discourse"<sup>109</sup> in the findings from this study). This competence aspect is present in around one third of the video sequences with assessment acts. In the written material, the aspect is almost as common as the competence aspect of *dealing with mathematics notions*. Table 4 shows that the *processes* of *inquiry/problem-solving*, *reason-*

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<sup>109</sup> The expression used according to Goodchild (2001; see also Keitel 2006).

*ing/arguing* and *defining/describing* are considered to be present in the largest number of video sequences. Similarly with the competence aspect *dealing with mathematics notions*, the picture is different for the written material. The processes of *inquiry/problem-solving* are present in the largest number of document groups, followed by *practicing/routine*. In classroom E, the competence aspect of *applying mathematics notions* is present in around half the video sequences from that classroom. In classroom B and C, the focus is present one third of the sequences from each classroom, followed by D and then A, where this aspect is considered to be present in one sequence. In the written material, this *process* focus is present in one fourth or fewer of the document groups in classroom B and D. In classrooms A and C, it is present in half and in classroom E in all document groups.

The third aspect of mathematics competence, *critically reflecting*, drawing on Skovsmose (1990, 2005), concerns a *critical* meta-discussion of the mathematics used in relation to the context, especially the consequences of mathematics decisions in people's lives. As mentioned in Section 6.2.5, this aspect of mathematics competence is not really considered to be present in the data. In a few sequences, there is a *reflection on the mathematics models* used in another context.

The fourth focus of assessment acts according to Hattie and Timperley (2007) is on *self-regulating*. This focus is related to potentials for the student, through *monitoring*, *directing* and/or *regulating*, to take greater responsibility for their work in the mathematics classroom. As described previously, the focus on *self-regulating* is seldom the only focus of assessment acts in the analysis in this study. It is often combined with a *process* focus, but there are examples of it being combined with a *focus on task*. A combination of a focus on *self-regulating* and *process* is considered to increase the affordances for students' learning of mathematics. As shown in table 4, the focus on *self-regulating* is considered to be present in fewer than half the video sequences and in half the document groups. This focus is present in around three quarters of the video sequences from classroom E and B, and almost half of the sequences from A. In the video sequences from the other two classrooms, *self-regulating* is considered to be present in a few of the video sequences. In the written material, the *self-regulating* focus is present in material from all the classrooms. In classrooms A, B, C and D, this focus is present in half or fewer of the document groups, whereas in classroom E *self-regulating* is present in all document groups with assessment acts.

As shown, there is quite a large amount of variation in the outcomes in this section, especially for the presence of the different focuses in the assessment practices of the five classrooms. This is addressed in Section 6.4.

### 6.3.2 A Relationship Between the Focuses of the Assessment Acts and Students' Subsequent Work

During the analysis of focuses of assessment acts, one key pattern emerged. After looking into this more thoroughly, a finding was that there actually was a relationship between the focuses of assessment acts in teacher-student communication and the focuses of students' acts immediately following their communication with the teacher. Here, I analysed the sequences taking place during students' independent work or group-work. Some sequences are not part of this analysis since there was a change in activity after the communication with the teacher. I examined the students' work in the thirty seconds following the teacher's departure. In forty-seven sequences of a possible fifty-nine, the focus of the assessment acts is the same as in the students' work after the teacher-student communication. In nine video sequences, the focus is partly the same and in three it is not the same. What this implies is that if the focus in the assessment acts is on mathematics processes, for example, then it is likely that this will be the focus in the student's subsequent independent work. This outcome of analysis is discussed below.

## 6.4 Summary and Conclusions Regarding Focuses of Assessment Acts

In this chapter, I presented the outcomes of the analysis concerning the second research question regarding the focuses of assessment acts in the mathematics classroom. I described different focuses and their occurrences as well as affordances for students' learning of mathematics. Many categories were present early in the analytical framework, and new categories emerged during the analysis.

A key outcome of analysis is that there are some focuses of assessment acts in the mathematics classroom that hold more affordances for students' learning of mathematics than others.

The affordances for students' learning for the focuses *self* and *task* are considered to be low. The student is not promoted to engage in the use of semiotic resources in the discipline of mathematics during the assessment act when either of these focuses are present. The focus on *self* is about the student as a person, and *task* is about non-reflective doing in the mathematics classroom. Four sub-categories for the *task* focus emerged in the analysis: *right answer/thing*, *number of*, *piloting* and *general*. For the third focus, *process*, there are considerable affordances for students' learning of mathematics. This focus is connected to mathematics competence drawing on Skovsmose (1990, 2005). When the *process* focus is present in assessment acts, there are considered to be affordances for students' learning of *dealing with mathematics notions*, *applying mathematics notions* and/or *critically*

*reflecting* in the assessment acts. When the fourth focus *self-regulation* is combined with a focus on *process*, the affordances for students' learning are considered to increase. It should be noted that there is an absence of the third of these aspects of mathematics competence, *critically reflecting*. It is possible to question the relevance of looking for this kind of *process* in assessment acts in mathematics classrooms with this age group, grade four in Sweden. I argue that it is clearly relevant since there is nothing in the study that implies that these students are too young to engage in this aspect of mathematics competence. I support this with my finding that there was still a meta-reflective aspect related to mathematics present in the data (*reflecting on models*) and that students critically and constructively take agency in the mathematics classroom in relation to their own learning when there are affordances for this in the classroom's assessment practice. Based on the absence of this aspect, I suggest that mathematics is mainly treated as being an "intrinsic good" in the classrooms visited (Skovsmose 2005, see Section 3.1). I return to the *critically reflecting* aspect of mathematics competence in the final Discussion.

In this chapter, the focus of *self-regulation* is mainly connected to affordances for learning. There is clearly also a clear connection to students' active agency in the mathematics classroom. With a focus on *self-regulation*, the student is invited to increasingly take active agency in her/his learning of mathematics.

In my analytical framework, I expanded on Hattie and Timperley's (2007) original focuses of assessment (which they call levels). I then chose to add categories from frameworks in mathematics education. Moreover, the categories that emerged during the analysis derive from mathematics education, from the mathematics classrooms visited. This enabled me to expand my analysis with respect to the ideational meta-function in combination with my research interest in assessment discourses in mathematics classrooms. One conclusion is that, in performing research on classroom assessment in a specific discipline, like mathematics education, it is essential not only to address general notions, but also to address specific notions from the discipline itself.

As previously discussed in this chapter, one outcome of analysis in terms of relationships is that the main focus of the assessment acts between teacher and student is often present during the students' subsequent work on their own or with peers. If the focus is on mathematics *processes*, the student is then invited, through the assessment acts, to engage in activities with a focus on mathematics *processes*, with affordances for the learning of mathematics as a consequence. From this, I draw the conclusion that the focuses of assessment acts are not just a matter of affordances for students' learning in the assessment practice of a classroom, but also a matter of affordances for students' learning in the classroom practice as a whole. I am not claiming that the teacher is the one who always introduces the focus. Sometimes the focus is already there when the teacher approaches the student(s). However, there

are video sequences in the data where the students' focus changes from *task* to *process* through the assessment acts in the teacher-student communication and the *process* focus is maintained after the teacher has left. The findings presented here emphasise the affordances for students' learning of mathematics that are among the teachers' responsibilities for the focuses of assessment acts and indicate that these affordances go beyond the assessment acts.

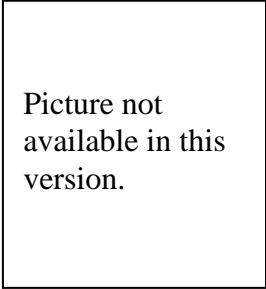
As described in Section 6.3.1, there are differences between classrooms when it comes to focuses of assessment acts. In the assessment practice of some classrooms, the *task* focus is just as present as the *process* focus, whereas for other classrooms, the *process* focus is most common. One conclusion is that there are different affordances for learning mathematics during assessment acts in different classrooms' assessment practices. This also holds true for the focus of *self-regulation*, which is present to a far greater extent in some classrooms than in others.

The differences in terms of affordances for students' learning of mathematics with respect to different focuses were a basis for the construal of the assessment discourses in mathematics classrooms, which is the subject of Chapter 8. But first, in the next chapter, I examine the roles of semiotic resources in the assessment acts.

## 7 Semiotic Resources in Assessment in Mathematics Classrooms: Analysis and Outcomes

In this chapter, I describe my analysis and outcomes for the third research question about what roles different semiotic resources play in the assessment acts of the mathematics classrooms visited. I also consider affordances that can be linked to students' active agency and learning with respect to semiotic resources. This research question is connected to the social semiotic textual meta-function. As noted earlier, the textual meta-function is related to the construction of a "text", that is, a multimodal ensemble, which involves the formation of whole entities that are communicatively meaningful (Halliday, 2004). In this thesis, I view semiotic resources as the actions and artefacts we use to communicate, such as gestures and gazes, pictorial elements, speech, symbols and the like (Van Leeuwen, 2005). The outcomes addressed in this chapter constitute a basis for the roles of semiotic resources in the different construed discourses presented in Chapter 8.

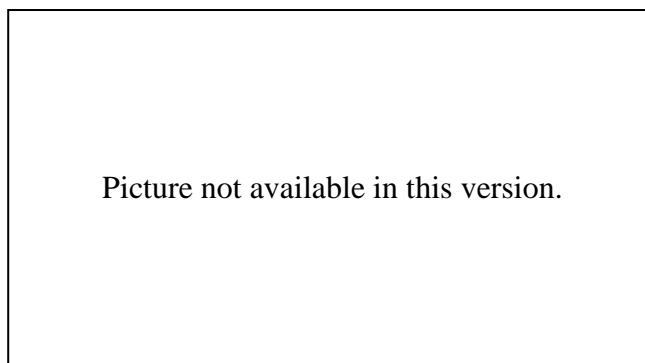
The Pippi Longstocking excerpt found at the beginning of Chapter 5 is also relevant in this chapter. I use it as an illustration of my analysis of the communication in considering textual aspects. There are many semiotic resources present in this excerpt and it could be said that multimodal ensembles constitute the information conveyed us, the readers. Yet we are not simply readers; we are also viewers since there are pictures as well.



Picture not  
available in this  
version.

Picture 4. Illustration from *Pippi Goes to School* (Lindgren 1998, p. 15, illustration by M. Chesworth).

In the excerpt, it is made clear what is said through *speech*. We also learn that the other children “stared in horror”, which says something about their *gaze* (including *facial expression*). This is also apparent in picture 4. We can see one of the students and his *gaze* as he stares at Pippi, and we can see how he crouches. An analysis indicates that he represents his “horror” using *body* language as well. The teacher is also present in the picture. We can see her *gaze* and *body* position. She seems to lower herself to the same level as Pippi. This and the fact that she is smiling at Pippi is the basis for my analysis that, when she explains that people cannot answer the way Pippi does in school, she does so gently. Thus, my analyses with respect to assessment acts taking place (in Chapter 5) and the focuses of these acts (in Chapter 6) are based on an ensemble of the semiotic resources mentioned.



Picture 5. Illustration from *Pippi Goes to School* (Lindgren, 1998, p. 17, illustration by M. Chesworth).

When the teacher poses the next two questions, her *body* position is to stand by the blackboard (picture 5). I assume that her *gaze* and *body* are directed toward the student she is addressing. The first question is directed to Pippi (“Well now, Pippi, how much do you think eight plus four is?”) and then Tommy (“Can Tommy answer this one? If Lisa has seven apples and Axel has nine apples, how many apples do they have together?”). There are *symbols* written on the blackboard, clearly communicating that the focus is mathematics.

In the following section, I address the semiotic resources that were part of the initial analytical framework for this chapter.

## 7.1 Analytical Framework for Semiotic Resources

The following analytical framework has similarities with the transcription structure presented in the methodology chapter. In order to analyse the roles

of semiotic resources, the first step was to determine the presence of semiotic resources. Below is a list of the resources I started out with, based on Kress et al. (2001) and Rostvall and West (2005). I also drew on the two pilot studies carried out (Björklund Boistrup, 2007; Björklund Boistrup, Ljungberg, Sjöholm, & Pettersson, 2007; see also Pettersson & Björklund Boistrup, 2010):

<i>speech</i>	The teacher or student talks.
<i>gestures</i>	The teacher or student uses gestures.
<i>body</i>	The body movement is significant for the analysis.
<i>gaze</i>	The gaze makes meaning. This mostly concerns where a person looks.
<i>words</i>	Words are written.
<i>symbols</i>	A symbol is written or drawn.
<i>pictures</i>	A picture is drawn.
<i>figures</i>	A figure, such as a rectangle, is drawn.

In this study, as in Kress et al. (2001) and Rostvall and West (2005), artefacts also play essential roles as semiotic resources in classroom communication as discussed below. Additional resources that were later identified to be present in the analysis are part of the findings presented below. In this chapter, I connect to Kress (2009) and Selander and Kress (2010), who write with respect to assessment regarding how different practices can show different ways of recognising students' demonstrated knowing.

## 7.2 Semiotic Resources and Their Roles in Assessment Acts in Mathematics Classrooms

In this section, I describe the findings of the study with respect to semiotic resources and their roles in assessment acts in mathematics classrooms. I also connect to affordances for students' active agency and learning. As in the previous chapter, I return to earlier excerpts from the data and present some new ones. I also give examples of the findings that are viewed as institutional traces. These are then linked to the construed discourses in Chapter 8.

### 7.2.1 Body-related Semiotic Resources

I here address semiotic resources related to the *body*. The semiotic resources in this section, like *gestures*, are present in structures by Kress et al. (2001) and Rostvall and West (2005). Several sub-categories emerged during the analysis, along with a new "main" category. In the analysis, *gestures*, and

similarly *body* movements, were part of multimodal ensembles relating to assessment acts and/or focuses of assessment acts. One new sub-category, *voice*, is connected to *speech* (see Kress et al., 2005). It is not simply what is said that contributes to the assessment acts, but also the character of the *voice* (for example, if the *voice* is at a higher frequency than usual). *Gaze* concerns where a person looks. One sub-category here is *facial expression*, which is when the teacher or student makes a *facial expression* that I considered to communicate something relevant to the situation (from the perspective of this study's purpose). The reason for connecting it to *gaze* is that *facial expressions* are most often accompanied by *gaze* in the teacher-student communication, and *gaze* and *facial expressions* are both expressed using the same part of the *body*. Drawing on Black et al. (2003; see also Black & Wiliam, 2006) in combination with what emerged as relevant in the analysis, I added *silence* to the categories. In Black et al. (2003), a silence is counted if it is three seconds or longer. In my transcripts, I noted silences one second or longer; I will return to the significance of silences of three seconds or longer in Section 7.3. I regarded *silence* as a “main” category here since it is expressed not only through an absence of speaking, no *speech*, but is also often combined with a lack of accentuated *body* movements. In a subsequent paragraph, I examine *silence* as part of assessment acts in the classrooms visited, but I first address the other categories related to the *body*.

Denise (S) is standing in the classroom looking for items of certain lengths. Diana (T) passes by and asks Denise which side of the measurement tape she is using (excerpt 34).

Time	Speech	Gestures	Body and Gaze
1:01:28	Diana (T): Ehm, Denise.  Denise (S): Yes. <sup>110</sup>	Denise (S) holds measurement tape in hand.	Diana (T) looks at Denise (S). Denise (S) looks at T.
1:01:29	T: Do you remember? Which side do you use?	T touches Den's m tape. T retracts hand.	Den looks at m tape. T looks at m tape.
1:01:33	Den: Yes. One should use	Den changes the way she holds m tape.	

<sup>110</sup> Original excerpt in Swedish:

Diana (T): Eh, Denise.

Denise (S): Ja.

T: Kommer du ihåg? Vilken sida använder du?

Den: Ja. Det ska vara

T: Ja, du använder [Den: den här.] centimeter, så du inte tar baksidan där det var inch.

1:01:34	T: Yes, you are using [Den: this one] centime- tres, just so you don't use the other side where it's inches.		T looks at Den. Den walks away.
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Excerpt 34. Transcript from video material. The use of brackets, [ ], signals simultaneous speech. “T” refers to Diana (T), “Den” is short for Denise (S), and “m tape” is short for measurement tape.

At 1:01:33 in excerpt 34, Diana (T) is considered to recognise the answer from Denise (S). Here, the meaning making is made through the interplay of semiotic resources, as it is in all communication. Both Diana’s (T) and Denise’s (S) *gazes* are directed towards the measurement tape. When Denise (S) is asked which side she is using, she changes the way she holds the tape in order to see the end where the unit is written. Here, she uses *gestures*. Both *body* positions are standing. The means by which Diana (T) captures what kind of activity (measuring things in the classroom) Denise (S) is engaged in (and as a consequence allows for feed back and/or feed forward) are *body* (Denise (S) is standing), *gaze* (looking around the classroom) and *gesture* (holding a measurement tape). The *artefact* (addressed in a later section) of measurement tape also plays a role here, since it is possible to make a mistake when one side is marked according the metric system and the other side in inches. Apparently, Denise (S) is using the intended side. The activity that Denise (S) is engaged in in this sequence is quite different from sitting quietly at her desk solving the task in the *textbook*. The activity is initiated by a *textbook* (an institutional trace) and offers affordances for students’ active agency in the mathematics classroom since the students are asked to look for things in their own classroom with a certain length. There are possibilities for students’ own choice relative to their interest here. This is not explicitly addressed in the assessment acts in this sequence, but there is considered to be implicit promotion since Diana (T) makes sure that Denise (S) has the right means (the correct side of the measuring tape) to complete the assignment.

One finding with respect to *body* as a semiotic resource is that *body* can play a substantial role in assessment acts, which is examined below. Beatrice (S) wants help solving a task about fractions in the *textbook*, which is: “One day almost all of the 24 students in Marika’s class wore jeans. There were only 4 students who did not. How big a proportion of the students wore jeans?”<sup>111</sup> Britta (T) and Beatrice (S) communicate almost ten minutes on

<sup>111</sup> Original excerpt in Swedish: “En dag hade nästan alla 24 elever i Marikas klass jeans. Det var bara 4 elever som inte hade det. Hur stor andel av eleverna hade jeans?”

this task. Following Britta's (T) *body* position during the sequence, it is possible to note that she is first standing, leaning over Beatrice's (S) desk. After a couple of minutes, when Beatrice (S) says that she does not understand the word "proportion", Britta (T) changes her *body* position and sits back on her heels. After a few more minutes, Britta (S) changes her *body* position again, takes a chair and sits besides Beatrice (S), leaning over her desk. These *body* changes, together with other semiotic resources, are considered to be Britta (T) communicating engagement in Beatrice's (S) reasoning. The latter movement, when she brings the chair over, is also considered to be Britta (T) communicating that this will take some time and that it is okay. We will return to matters concerning time when I describe the construed discourses in Chapter 8.

In the same sequence, Beatrice (S) uses *gaze* to communicate that she is asking Britta (T) for feed back and/or feed forward. Quite early in the sequence, Beatrice (S) has a suggestion for the correct answer (excerpt 35).

Time	Speech	Gestures	Body and Gaze	
07:44	Beatrice (S): Four who weren't wearing jeans and then twenty four. Then it's twenty who are wearing Jeans. <sup>112</sup>		Britta (T) looks at Beatrice (S).  T nods.	Beatrice (S) looks down.  Bea looks at T.
07:49	Britta (T): Mm!			
07:50	Bea: Then it is ( <i>silence 4 s</i> )			Bea looks down.
07:56	Bea: Then it is a f...i...fth who are not wearing jeans.			Bea looks at T, down and at T again.

Excerpt 35. Transcript from video material. "f...i...fth" indicates how Beatrice (S) speaks in this instance. "Bea" is short for Beatrice (S), and "T" is short for Britta (T).

At about 07:48 in excerpt 35, Beatrice (S) does not pose a question and still it is considered that she is asking Britta (T) for feed back. The reason for this is to be found, firstly, in what takes place before and after this particular episode. So far in the sequence, Beatrice (S) has mostly been looking down,

<sup>112</sup> Original transcript of speech in Swedish:

Beatrice (S): Fyra stycken som inte hade jeans och så tjugofyra. Då är det tjugo stycken som har jeans.

Britta (T): Mm!

Bea: Och då är det

Bea: Då är det en femtedel som inte har jeans.

so when she looks at Britta (T) at this point, I considered it to communicate an interest in Britta's (T) opinion about her suggestion. This becomes clearer after this, when Beatrice (S) poses more of a question while at the same time changing her answer: "Or a sixth who are not wearing jeans", followed by "Or?"<sup>113</sup> Here too, Beatrice (S) looks at Britta (T). Secondly, this interpretation is made since it is a pattern in this class (as in every class I visited) that the student's *gaze* is directed towards the teacher when s/he asks for feed forward or feed back. I suggest that, in this kind of situation, *gaze* is a semiotic resource by which the student can take active agency in the mathematics classroom.

In the following sequence, we again encounter Enzo (S), who I considered to communicate disapproval of the task they are working on in groups (see excerpts 6 and 7 in Section 5.2.1). At 27:51 in excerpt 6, Enzo (S) answers Erika's (T): "I don't know! Is it supposed to be twenty seven?" with his mouth downturned (*facial expression*) and with a narrow *voice*. This is considered in the analysis to indicate that he is communicating disapproval of the teaching. He communicates something similar at 28:40 in excerpt 7. *Voice* and *facial expression* play another role in the following excerpt. Here, Erika (T) acknowledges Enzo's (S) disapproval (excerpt 36).

Time	Speech	Gestures	Body and Gaze
28:43	Erika (T): Hey, let's talk about this now; otherwise Enzo will go mad if it's not sorted out (giggles). <sup>114</sup>	Erika (T) has paper with task in hand.	Erika (T) looks at class. T looks at Enzo (S). T smiles.

Excerpt 36. Transcript from video material. "T" is short for Erika (T).

In excerpt 36, Erika (T) recognises Enzo's (S) disapproval, still communicated by *gesture* and *gaze*, along with *facial expression* (waves hand quickly, has wrinkled forehead, corners of mouth are downturned). Using her *speech*, along with *voice* (giggles), *gaze* and *facial expression* (smiling), Erika (T) communicates feed forward to him that they will discuss the task together in order to sort it out. In this sequence, *voice* and *facial expression* are considered to offer affordances for Enzo's active agency in the mathematics classroom since, in this discursive practice, he could express disapproval constituted by these and other semiotic resources. When Erika (T) acknowledges this through *voice* and *facial expression*, this is also considered to offer these affordances. On the other hand, if Erika (T), for example, had spoken with a narrow *voice* and had a *facial expression* such as a wrinkled forehead, the same *speech* would be understood in a different way and consequently offer

<sup>113</sup> Original transcript of speech in Swedish: Eller en sjättedel som inte har jeans. Eller?

<sup>114</sup> Original transcript of speech in Swedish: Hör ni, vi gör så att vi pratar om det här nu, för annars blir Enzo tokig på att det inte blir utrett.


fewer, if any, affordances for students' active agency. It should be noted that a teacher may choose not to accept disapproval as a means for a student to communicate feed back about the teaching, and invite her/him to express this instead through less assertive disagreeing. The point here is the teacher's acknowledging the feed back, where semiotic resources such as *speech*, *voice* and *facial expressions* play an essential role.

As mentioned, a semiotic resource that emerged as a sub-category during the analytical process is *silence*. One sequence where *silence* is present is the one with Britta (T) and Beatrice (S) referred to earlier in this section. As shown in excerpt 35, there are silences during Beatrice's *speech* ("Then it's (*silence of four seconds*). Then it's a f...i...fth who are not wearing jeans"). During this sequence, there are several instances where Britta (T), by being silent herself, communicates to Beatrice (S) that she should take her time in reasoning through the problem. I also considered this to be because she gives herself time to communicate well-reasoned feed back and/or feed forward to Beatrice (S) using *speech* and other semiotic resources. The focuses of the assessment acts in communication about this task are on mathematical processes related to two aspects of mathematics competence: "dealing with mathematics notions" and "applying mathematics notions". Occasionally, there is also a focus on Beatrice's (S) self-regulation. Consequently, there are considered to be affordances for Beatrice's (S) learning of mathematics here. In the analysis of this part of the sequence, there seems to be a connection between the silences and the focuses of the assessment. When Beatrice (S) takes time to be silent and then answers, she takes active agency in her learning and her demonstrated knowing is mathematical processes. I will return to this pattern in Section 7.3.

### 7.2.2 Semiotic Resources in Writing

In my analysis, I considered semiotic resources in writing to play roles in the assessment acts in the mathematics classrooms visited. Here, in contrast to the preceding section, no new categories emerged during the analysis. The semiotic resources in this section are *words* (which refers to writing in *words*), *symbols*, *pictures* and *figures* (for example, a rectangle). Here, I concentrate on two documents where it is possible to consider self-assessment as being present.

First, we return to Cilla (S) and a self-assessment form from the material connected to the *textbook* (excerpt 37). Cilla (S), probably following instructions from Cecilia (T), has used an "X" to indicate the degree of confidence she feels about angles, figures and scale (excerpt 37 shows the first five of eight questions).

When I am expected to: <sup>115</sup>	I feel:		
	Certain	Quite certain	Uncertain
decide whether an angle is right, acute, or obtuse	X		
say which of two angles is smaller		X	
say which angle in a figure is bigger		X	
say what these figures are called 	X		
calculate how long an item is in reality if it is depicted using a scale 1:10	X		

Excerpt 37. Transcript from written material. Self-assessment form with the first five statements.

In the self-assessment form, Cilla (S) has assessed her degree of confidence about angles, figures and scale using the semiotic resource *symbols* (the X's). There are several semiotic resources in the questions. As shown in excerpt 37, the questions are mainly posed by writing in *words*, but we can also see *figures* (geometrical shapes) and *symbols* ("1:10"). In the final question, the student is asked what was most fun in the chapter and why. Here, the student is invited to answer by writing in *words*. Cilla (S) has not answered this question. As mentioned earlier, this form is regarded as an institutional trace. It is part of the *textbook* material, and similar forms are identified for the students from another class in the study where the same *textbook* was used. This direct institutional trace consists of writing in *words* along with other semiotic resources. Since this is material meant for the student, the use of the form also offers affordances for students' active agency in the mathematics classroom. I reached this conclusion, firstly, due to the student being invited to take an active part in learning mathematics when she reflects on how sure she is about what they just worked on in the last unit, and secondly, due to the opportunity given for her to communicate feed back about the teaching in the questions at the bottom of the paper.

In another document, which Denise (S) has worked on, the only semiotic resource present in the questions is writing in *words*. The point in examining this excerpt here is that, as in several documents in the data, there are still

<sup>115</sup> Original excerpt in Swedish:

När jag ska  
avgöra om en vinkel är rät, spetsig eller trubbig  
säga vilken av två vinklar som är minst  
säga vilken vinkel i en figur som är störst  
tala om vad de här figurerna kallas  
räkna ut hur långt ett föremål är i verkligheten om det är avbildat i skala 1:10

Känner jag mig  
Säker      Ganska säker      Osäker

many semiotic resources present through the activities referred to in the questions (excerpt 38).

**Mission**<sup>116</sup>

- Build a tower out of building blocks. It has to be over 1 metre, and try to do it in 2 minutes at the most.
- Measure the perimeter of a door and try to do it in 3 minutes.
- Try to find something in the classroom that is exactly 21 cm; try to finish in 2 minutes at the most.

This is how we managed

to complete it: [six answering lines] \_\_\_\_\_

I found this task to be: [two answering lines] \_\_\_\_\_

Excerpt 38. Transcript from written material. Worksheet.

This paper serves both as instructions for group work and as an assessment of the work and the task. In the instructions, the semiotic resources referred to are *body* (building, measuring), *speech* (solving the task together) and so on. The *artefacts* (see the next section) needed are the *manipulatives* building blocks, measurement device and some kind of clock. When the student, in this case Denise (S), answers the questions, there are no instructions about what semiotic resources are expected in the answer. It may actually be possible for a student to use written *words*, *symbols*, *drawings* and the like, in her description of her work on the tasks. Denise (S) has used a limited set of resources. For the first three questions, her answers are: “1m, 46; 5 m 92; a book”. Denise’s (S) focuses in her answers are on the correct answer and answering quickly (task). In the fourth question, Diana (T) has provided for self-assessment (feed back to student). The six lines for writing the answer communicate that Denise (S) and the other students are invited to write an extended assessment about how they managed to complete the task. Despite this, Denise’s answer is brief: “We had good cooperation in the group”. In the last question, Diana (T) allows for feed back to her teaching relating to Denise’s (S) experienced meaning making during the activity. Denise’s answer, which is considered to be feed back on the teaching, is even shorter but still quite clear: “Boring”. The two last questions are considered to communicate affordances for Denise’s active agency in the mathematics classroom.

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<sup>116</sup> Original excerpt in Swedish: Uppdrag

Bygg ett torn av kaplastavar som ska vara över 1 meter och försök gör det på högst 2 minuter.

Mät omkretsen på en dörr och försök klara det på 3 minuter.

Ni ska försöka hitta något i klassrummet som är precis 21 cm, försök klara det på högst 2 minuter.

Så här gick det för oss:

Jag tyckte att den här uppgiften var:

Denise (S) has taken advantage of these affordances with her short answers. It may be possible to relate the lack of more or less detailed answers on questions like these to a classroom's assessment practice, in which certain discourses can be construed (see the next chapter). It is also possible to discuss whether a broader range of semiotic resources in the questions would be more inviting to Denise (S) with respect to her active agency.

### 7.2.3 Semiotic Resources as Artefacts

Drawing on Kress et al. (2001) and my analysis of the data, I examine artefacts present in assessment acts in the classrooms visited. One group is artefacts for writing and drawing: *whiteboard* (could also be a large white sheet of paper used for the same purpose, for example), *textbook*, *notebook*, *worksheet* and *other document* (for example, assessment matrix). A second group is artefacts as things: *calculator*, *manipulative*, *measurement device*, and *other resources* (which were used in just a few sequences in the data, for example, scissors and marker pen).

In this section, I explore the roles of *manipulatives* in assessment acts. A mathematical *manipulative* is understood to be an object designed so that a student can learn mathematics by manipulating it. A *manipulative* can be purchased by the school or constructed by the teacher. The analysis revealed that they play different roles. Cecilia (T) uses *manipulatives* in the form of apples which she cuts them in pieces in front of the students. Cecilia (T) introduces fractions by cutting the apples while also writing on a large white sheet of paper. As she cuts the apple, she also poses questions to the students, who answer in unison. In this part of the sequence, Cecilia (T) has asked the students if she can cut a fourth of the apple into two equal pieces, which the students including Cilla (S) acknowledge. Cecilia (T) continues to ask (excerpt 39).

Time	Speech	Gestures	Body and Gaze
04:58	Cecilia (T): What does that make? <sup>117</sup>		Cilla (S) + Catrin (S) look mostly at Cecilia (T). Cecilia looks mostly down at apples.
04:59	S + Cilla (S) + Catrin (S): One eighth.		

<sup>117</sup> Original transcript of speech in Swedish:

Cecilia (T): Vad blir det då?

S + Cilla (S) + Catrin (S): En åttondel.

T: Blir det bara en åttondel?

Bx: Två åttondelar.

T: Ja, en fjärdedel är lika med en åttondel plus en åttondel!

05:00	( <i>silence</i> ) T: Is it only one( <i>high</i> ) eighth?	Cecilia (T) cuts $\frac{1}{4}$ apple into two pieces.	
05:03	Bx: Two eighths.		
05:04	T: Yes(!), one fourth equals one eighth plus one eighth.	T writes on paper: $\frac{1}{4} = \frac{1}{8} + \frac{1}{8}$	

Excerpt 39. Transcript from video material. (!) indicates a specific word being emphasised. “T” is short for Cecilia (T). “S” and “Bx” refer to unspecified students.

In excerpt 39, the role of the *manipulatives* (the apples) is considered to communicate feed forward to the students, to guide them, about the correct answer. This could also be seen as piloting since the students answer different subtasks guided by the other students, answering in unison, as well as by the *manipulatives*. During this guiding or piloting, the affordances for students’ active agency are considered low.

In another sequence, Britta (T) discusses a diagnostic test with Belinda (S) (see excerpts 26 and 27 in Section 6.2.2). The task concerns which of three jars of marbles has the largest proportion of white marbles. As described, Belinda (S) has answered incorrectly on this task, and what seems to create problems for her is that there are odd numbers of marbles in Jars B and C. She has not managed to draw elevenths (Jar B) or ninths (Jar C). After several minutes, during which Belinda (S) tries different ways to draw circles that she can divide in a way to find fractions for Jar B and C, Britta (T) brings out *manipulatives*. These *manipulatives* consists of “poles” on which coloured blocks are stacked (excerpt 40).



Excerpt 40. Part of a frame from a video sequence showing manipulatives.

Through the use of these *manipulatives*, Belinda (S) and Britta (T) reason, step by step, about the fraction of white marbles in the different jars. In analysing the role of *manipulatives* here, one aspect is that Belinda (S) seems to have advanced rather far through the *textbook's* “levels”. Nonetheless, she has problems with several tasks in the diagnostic test and in a few cases,

Britta (T) and Belinda (S) end up using *manipulatives*. There is no discussion about whether Belinda (S) should work on other tasks for a while, and more and more solve the problems without *manipulatives*. Instead, she goes on working at the next “level”, following the *textbook* system. The assessment that Britta (T) communicates here is considered to be that Belinda (S) has demonstrated sufficient knowing during the discussion. As demonstrated in Section 6.2.2, the *manipulatives* as they are used here are not considered to contribute to affordances for Belinda’s (S) learning.

It is possible to view the use of *manipulatives* in this classroom’s assessment acts as an institutional trace. This is supported by information in my research log, where it is possible to read that this school has a certain direction, one in which the use of *manipulatives* is a substantial component. In terms of the roles of artefacts, an essential issue is whether and, if so why and how, semiotic resources are promoted or even restricted.

#### 7.2.4 Promotion or Restriction of Semiotic Resources

In this section, I address the roles of semiotic resources in assessment acts in terms of how the various semiotic resources are *promoted* or *restricted* as ways of demonstrating mathematics competence (see also Kress, 2009; Selander & Kress, 2010). In several of the sequences referred to in the thesis, the teacher and students implicitly communicate *acceptance* of different kinds of semiotic resources, including artefacts. There is no discussion about the benefits of or any restrictions regarding the semiotic resources used. Sometimes *acceptance* of a semiotic resource (or artefact) is communicated more explicitly. Three categories emerged during the analysis. One is *not accepted/restricted*. Here, the teacher and/or student does *not accept* one or several semiotic resources and/or artefacts. There is some kind of *restriction* on what semiotic resources or artefacts are available for communication. The second category is *accepted* and the third category is *promoted*. Here, the teacher and/or student *promotes* certain semiotic resources and/or artefacts. If *acceptance* communicates “you could use this semiotic resource”, then *promotion* communicates “you should (I think it is a good idea to) use this semiotic resource”.

In the following excerpt, a teacher *restricts* the semiotic resources that can be used by the students as part of the assessment acts. Anna (T) and her students discuss the students’ earlier solving of a problem on patterns. Anna is standing at the front by the *whiteboard* and the students are seated at their desks. Anna (T) and the students have covered the first five *figures* in the pattern (small squares organised in triangles; see excerpt 12 in Section 5.2.3). These five *figures* are drawn on the *whiteboard* with the number of small squares written under each *figure* (the first *figure* has 1 square and the following squares have 4, 9, 16 and 25). Anna (T) considers the next question, which is: “Imagine that you have drawn ten figures. How many squares

would the tenth figure then contain?”<sup>118</sup> Anna (T) makes clear that they are not going to draw more *figures* and that she still wants the students to say the number of small squares in the tenth *figure*. During Anna’s (T) talk, Angelica (S) and Ali (S) whisper to each other while looking at their *worksheets*. Ali (S) points at the *figures* they drew earlier. Angelica (S) waves her hand and they get to answer. Angelica (S) first answers 144 squares, but they then change their answer to one hundred. More students suggest the same answer. Anna (T) then tells Angelica (S) and Ali (S) to describe how they came up with the answer (looking at both students). Ali (S) starts walking towards the *whiteboard* (excerpt 41).

Time	Speech	Gestures	Body and Gaze
20:10	Angelica (S): We thought [Ali (S): We took] the highest point. <sup>119</sup>	Angelica (S) points at the top of a figure invis- ible in front of her.	Ali (S) starts walking to- wards the front of the classroom. Angelica (S) looks at the whiteboard.
20:13	Ang: Yes Ali. Anna (T): Try to explain and I’ll point ( <i>high</i> ).	( <i>Anna (T) is not visible</i> )	Ang looks at Ali and at the front of the classroom.  Ali turns around and walks back to his desk. He smiles.

Excerpt 41. Transcript from video material. “High” refers to voice at a “high” frequency. “Ang” is short for Angelica (S), and “Ali” is short for Ali (S).

At 20:13 in excerpt 41, Anna (T) restricts Ali (S) when he wants to go to the *whiteboard* and point at the *figures* drawn there (“Try to explain and I’ll point”, Ali (S) turns around). During an earlier lesson when they discussed the first pattern, it was *accepted* that the students move to the front of the classroom when they explained their solutions. They could then explain their course of action through *speech*, *gestures* (pointing at *figures* on the *whiteboard*) and other semiotic resources. This time, Anna (T) does *not accept* that they move to the front and consequently *restricts* Ali (S) and Angelica (S) from expressing their answer through all the semiotic resource(s) available in the previous lesson. This time, Ali (S) and Angelica (S) describe their reasoning mainly through *speech* and *gestures* while remaining seated

<sup>118</sup> Original excerpt in Swedish: Tänk dig att du har ritat tio figurer. Hur många kvadrater hade den tionde figuren då innehållit?

<sup>119</sup> Original transcript of speech in Swedish:

Angelica (S): Vi tänkte

Ali (S): Vi tog den högsta punkten.

Anna (T): Ja Ali. Försök att förklara så pekar jag.

at their desks. During this part of the sequence, there are several instances of feed back and, as in this excerpt, feed forward mainly from Anna (T) to the students focused on reasoning, describing and problem-solving. In the analysis, I considered Anna (T) to provide affordances through *restriction* for the learning of mathematics processes related to the first aspect of mathematics competence, "dealing with mathematics notions". She "forces" Ali (S) and Angelica (S) to reason and to use *speech* with concepts from the discipline of mathematics, such as figure, side and so on, and thereby actually *promotes* the use of *speech* in relation to mathematics competence.

*Promotion* is also identified when Britta (T) discusses a diagnostic test with Belinda (S). Britta (T) communicates feed back to Belinda on her use of semiotic resources. She points at Belinda's (S) writing and *drawing* in the diagnostic test and says that Belinda shows her solutions clearly and that it is good that she uses many *drawings*. In this way, she *promotes* the semiotic resource *drawing* and is considered to provide affordances for the mathematics processes of defining/describing.

### 7.2.5 Questions in use

One way for teachers to allow for various kinds of feedback is to pose questions. The questions are constituted using various resources in multimodal ensembles. Through the questions, semiotic resources play roles for students' possibilities to demonstrate knowing. Here, the openness of the questions (described in Section 2.2.2; Gipps, 2001; Shepard, 2000; Harlen, 2007) is examined and related to affordances for students' active agency and learning of mathematics.

There are both open and closed questions in the material. In these instances, I refer to a model developed in one of the pilot studies (Björklund Boistrup et al., 2007; see also Pettersson & Björklund Boistrup, 2010). The model is shown in figure 15.

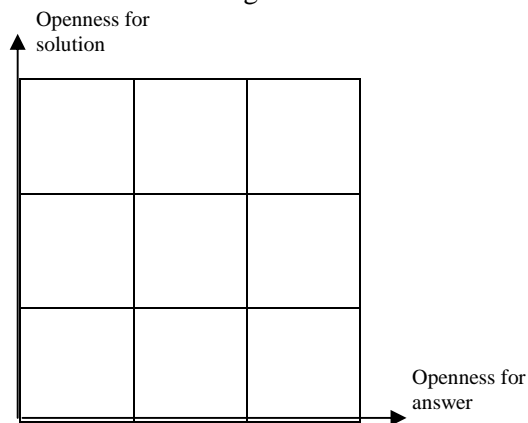


Figure 15 . A model for openness of questions

The first column on the left contains questions where only one answer is expected. The middle column contains questions where two or three correct answers are possible, and the third column contains questions where four or more correct answers are possible. The bottom row contains questions with just one expected solution. A solution is understood here to be the demonstrated course of action for arriving at the answer to the question. Also positioned here are tasks where the student is not asked to demonstrate the solution, only the answer. The middle row contains questions that have two or three solutions possible and the top row contains questions with four or more solutions possible.

A typical instance of a set of closed questions as part of assessment acts in the written material is a test on mental arithmetic. On one piece of paper, Belinda (S) has filled out the answers for the multiplication table. There are spaces at the bottom for the student's name and for how many points out of a total of 45 the student has managed to get. These questions belong in the left most cell of the lowest row, since there is only one possible answer to the questions and the student is not asked to demonstrate her solution. This test is from a Swedish website, where teachers can upload documents that other teachers can download for free. This is seen as a direct institutional trace representing the institution of school through this internet community.

The next question, which is more open, is likewise related to mental arithmetic. In the first item on addition in a diagnostic test, Angelica (S) is asked to divide two piles of beans in as many different ways as she can. Under it is a drawing of ten beans. Angelica (S) has not answered this question; instead she has answered the next question directly. The question is: "Which counting stories can you find for your drawings above? Write in mathematics language and calculate the answers."<sup>120</sup> Angelica's (S) solution is shown in excerpt 42.

1 + 9 = 10  
 2 + 8 = 10  
 3 + 7 = 10  
 4 + 6 = 10  
 5 + 5 = 10  
 6 + 4 = 10  
 7 + 3 = 10  
 8 + 2 = 10  
 9 + 1 = 10

Excerpt 42. Transcript from written material. Angelica's (S) solution.

The presumptive openness of this task lies in the students' possibilities of choosing in what order to write the calculations. Angelica (S) has clearly

<sup>120</sup> Original excerpt in Swedish: Vilka räknehändelser kan du hitta på till dina bilder ovanför? Skriv på mattespråket och räkna ut svaren.

chosen to put them in a logical order, increasing the first term while decreasing the second in each new row. This question belongs to the first cell in the second row since there is a variety of possible ways for the students to come up with all the combinations. This is also considered to be an institutional trace. It comes from supplementary material that schools can buy for diagnostic purposes along with the *textbook* material.

Another excerpt related to mental arithmetic is a paper prepared by Erika (T) on which Enzo (S) has answered questions. One set of questions contains spaces where it is indicated that numbers should be written. The first item is shown in excerpt 43.

$$\square \times \square = 24$$

Excerpt 43. Transcript from written material. First item on paper on mental arithmetic.

In this question, the degree of openness is considered to be high. Enzo (S) has written  $4 \times 6 = 24$ , but other answers are also possible. These questions belong to the right most cell in the lowest row of the model. The only way to solve the question is to put numbers in the squares, but the range of possible answers is infinite. In this open question, Enzo (S) is considered to be provided with affordances for active agency. This, of course, is because of how well acquainted Enzo (S) is with open tasks like this one. Such open tasks are considered to be part of a specialised classroom discourse (see Goodchild, 2001; Keitel, 2006), and a student (like Pippi) who is not familiar with this context, may not be invited to take active agency.

What also emerged during the analysis is that the teachers in the classrooms visited often communicate feed back and/or feed forward through questions. Denise (S) wants to use square metres as a unit for measuring length (described earlier in Section 5.2.2). After this, Diana (T) asks a clarifying question (at 22:10), thus allowing for feed forward: “Well, what are square metres? Could you explain that first?”<sup>121</sup> As noted earlier, this was considered to communicate feed back to Denise (S) as well since Diana (T) does not immediately accept the answer as the correct response, which she had done so prior to that in the sequence. In this study, there are many sequences where the teacher poses questions instead of telling the student the way things are, which is considered to create affordances for the student to take active agency.

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<sup>121</sup> Original excerpt in Swedish: Ja, vad är kvadratmeter? Kan du berätta det först?

### 7.3 Semiotic Resources: Occurrences, Affordances for Students' Active Agency and Learning, and Relationships

Below, I present a summary of outcomes, based on an analysis of data from the five mathematics classrooms visited. I also link this to affordances for students' active agency and learning.

#### 7.3.1 Occurrences and Openness of Semiotic Resources in the Mathematics Classrooms

In this section, I give a summary of findings of semiotic resources and their roles in assessment acts in the mathematics classrooms visited. One outcome related to potential acknowledgement of semiotic resources in the video material is a picture of acceptance. The assessment acts are constituted by multimodal ensembles with semiotic resources such as those related to the *body*. This included *speech* (including *voice*), *gestures*, *body* movements, *gaze* (including *facial expressions*) and *silence*. *Voice*, *facial expressions*, and *silence* are complementary to the analytical framework I started with. One example is how teachers' *speech*, often through *voice*, is part of multimodal ensembles communicating feed back with directions such as approval, disapproval or interest. A second example is teachers' communicating interest in students' reasoning in multimodal ensembles with *body* movements, for example, taking a seated position on a chair next to a student. A third example is a student who signals feed back with the direction of disapproval to the teacher through multimodal ensembles with *voice* and *gestures*. With some exceptions, the students are allowed to use various semiotic resources including artefacts to demonstrate knowing. The students also accept all kinds of resources. There are instances of promotion or restriction of semiotic resources. These are developed in the next section (7.3.2). A clear pattern captured in the video material is that, whenever a student or teacher expects a response, the *gaze* is directed towards this person. For the student, this is a way to take active agency in the communication.

Another group of semiotic resources is related to writing and drawing. The following semiotic resources are considered to take part in the assessment acts in the classrooms visited: *words*, *symbols*, *pictures* and *figures*. An example from this group is teachers communicating feed forward in students' diagnostic tests via writing in *words* or feed back in *symbols* through points.

There are also semiotic resources as artefacts present in the assessment acts. I identified artefacts for reading and writing and artefacts in the form of things. The following artefacts for reading and writing are considered to take part in assessment acts in the classrooms visited: *whiteboard*, *textbook*, *note-*

*book/worksheet* and *other document*. One example is how the *whiteboard* is used in assessment acts when the teacher invites students to demonstrate their solutions in front of the class. During this communication, the students may demonstrate mathematics knowing through *pictures* and *symbols* on the *whiteboard*. They use *speech* at the same time as they point (*gestures*) at what they have drawn. The teacher communicates feed back and feed forward during the assessment acts and, in doing so, she writes on (for example, *symbols*) and points (*gesture*) at the *whiteboard*. The artefacts in the form of things that are identified as taking part in assessment acts in the classrooms visited are *calculator*, *manipulative*, *measurement device* and *other resources*. One example is how a *manipulative* can be used to facilitate a solution to a task.

In the written material, I did not capture the same picture of acknowledgement toward semiotic resources as in the video sequences. With this as a background, I performed a more detailed analysis of the number of semiotic resources used in the part of the written material where assessment acts are present. I concentrated the analysis on document groups involving mathematics tasks for the student to solve. That is, documents such as those from student/teacher/parent meetings are not part of the analysis. In analysing what semiotic resources are present in the task formulations, document groups where only the student's answers are present were also eliminated from the analysis. The outcome of this analysis is summarised in tables 5 and 6.

Table 5. Number of Document Groups Relative to Level of Semiotic Resources in Task Formulations

Level of semiotic resources in task formulations	Number of document groups (total 14)
Most documents with tasks communicated mainly through one semiotic resource.	6
Most documents have two or more semiotic resources in tasks.	5
Document groups with variation between documents regarding semiotic resources used in tasks.	3

The outcome in table 5 shows a picture of variation in how mathematics tasks are constituted in the written data in this study. Many of the documents with one semiotic resource in the task formulation have an assessment focus on arithmetic, as in mental calculation and written calculation. In the video material, there are only a few lessons focusing on this, which can explain the difference with respect to openness toward semiotic resources between the two data sets.

Table 6 shows the outcome of the analysis of the level of semiotic resources the students can use in demonstrating mathematics knowing while working on the tasks in the written material.

Table 6. Number of Document Groups Relative to Level of Semiotic Resources that Students can use

Level of semiotic resources for students to demonstrate mathematics knowing	Number of document groups (total 18)
Most documents with tasks providing mainly one semiotic resource to demonstrate knowing.	6
Most documents with tasks providing two or more semiotic resources to demonstrate knowing.	7
Document groups with variation between documents regarding semiotic resources to demonstrate knowing.	5

The outcome displayed in table 6 gives a varied picture concerning the level of semiotic resources available for students to demonstrate mathematics knowing. The number of documents providing mainly one semiotic resource for the students to demonstrate mathematics knowing is almost equal to the number of document groups where students can use several semiotic resources. It could be said that acknowledgement of the use of semiotic resources varies considerably in the written material. Total acknowledgement may not always be the best way to provide for affordances for learning in the assessment acts. This will be elaborated on in the next section. Prior to this, I will describe my findings concerning the openness of tasks in terms of answers and solutions.

I return here to the model shown in Section 7.2.5. I analysed the tasks in the written material that are part of assessment acts as well as tasks used in the video sequences. I also analysed the questions posed by the teachers during assessment acts in the video sequences. Since I concentrated on questions in assessment acts specifically addressing mathematics content, some video sequences were excluded. An example of a sequence included is when the students are working on a mathematics problem that they ask the teacher to give them guidance on. In the communication, the teacher poses questions to the students about the task. An example of a video sequence excluded is when a teacher discusses the results of a diagnostic test with a student without getting into a discussion about any of the tasks in particular. The total number of video sequences in this analysis is 77. The document groups included are the ones containing mathematics tasks. The total number of document groups is 18. The outcome is shown in figure 16.

	Openness for solution			
Video sequences	15	4	14	
Document groups	4		5	
Video sequences	16	3	8	
Document groups	3	1		
Video sequences	39	2	5	
Document groups	15	1	4	Openness for answer

Figure 16. Outcome for openness of questions. In one video sequence or document group there are often various kinds of openness of questions present. The total number of video sequences in this analysis is 77. The total number of document groups is 18.

In this study, I identified how openness in terms of solving tasks and/or in answers provides possibilities for students to demonstrate processes that are not easily demonstrated in closed tasks (see also e.g. Gipps, 2001; Shepard, 2000; Harlen, 2007). Here, I refer to processes such as reasoning/arguing, inquiring/problem-solving, and creating/constructing. When open questions are also incorporated, the student is invited to take part in the mathematics communication and is then invited to demonstrate a broad spectrum of mathematics competence. I conclude that this, consequently, holds affordances for students' learning of mathematics. Moreover, since open tasks enable the students to make choices, this is also considered to offer affordances for students' active agency in the mathematics classroom. However, these affordances are considered under circumstances where the purpose of the question is clarified to the student and/or the student is aware of what kind of mathematics knowing that s/he is expected to engage in. Figure 16 illustrates that there are closed questions present in many of the video sequences and document groups, that is, questions with one correct answer and one way to solve it. As shown, there are also document groups and video sequences with openness regarding solutions and/or answers. Video sequences and document groups with close questions are present in sequences and groups from all five classrooms. There is a variety of closed and more open questions identified in the data from all the classrooms. Nevertheless, there are differences between classrooms with more open questions in some classrooms than others. This means that students in some classrooms experience a larger quantity of open questions than students in other classrooms. Thus, there are differences between classrooms' assessment practices with

respect to students' affordances for active agency and learning relative to the openness of questions.

### 7.3.2 Relationships Between Semiotic Resources and Focuses of Assessment

During the analysis, relationships between the roles of semiotic resources and the focuses of assessment acts in the classrooms visited emerged. The relationship between the openness of questions and focuses of assessment acts was mentioned in the previous section. In the material, it is clear that closed questions provide opportunities to assess mathematical facts and processes related to practicing/routine. In order to provide affordances as well for any of the other focuses, such as inquiry/problem-solving and reasoning/arguing, during the assessment acts, open questions are needed.

A second relationship identified between semiotic resources and focuses of assessment acts is how promotion or restriction of a semiotic resource can support a certain focus in the assessment acts. In a few sequences, one or more semiotic resources are promoted by the teacher more than is mentioned in the original task. This is developed in Section 7.2.4. Looking at the video material as a whole, I considered the promotion of *drawings* to be present as part of the assessment acts in four video sequences (classroom B and E). One example is when a teacher looks at a diagnostic test that was just finished and tells the student that she shows her solutions clearly and that it is good that she uses many *drawings*. In six sequences (classrooms B and E), the teacher promotes writing in *words* in communicating feed forward to students. One situation is when the students work in groups on a task and, once finished, are told to write down their course of actions including the calculations they made. In two sequences (classroom C), the teacher promotes the use of a *measuring device* (ruler) in feed forward to the student. Finally, I identified the teacher promoting *manipulatives* in two sequences. Overall, I considered the teacher to promote a certain semiotic resource in fifteen instances in the video material (in two video sequences, there were two different instances). In all but three of these, I considered this promotion to support a focus on mathematics processes. There are also some instances where the opposite occurs, that is, instances where the teacher does not accept the use of a semiotic resource. This is present in three sequences in the material, in classrooms A and E. In the three sequences, the restriction is considered to support a certain process to be demonstrated.

A third relationship identified between the focuses of the assessment acts and semiotic resources concerns one of the categories that emerged during the analysis, namely *silence*. During the transcription and coding of the video sequences, I started to perceive a tentative relationship. It seemed as though there was a relation between sequences with a process focus and the

presence of silences in teacher-student communication. As described earlier, Black et al. (2003) describe studies where it is shown that when teachers posed questions to students throughout class sessions and then intentionally waited three seconds before asking another student (or rephrasing or explaining her/himself), this had a positive effect on the quality of the student's answer. In this study, I concentrated the analysis on teacher-student communication during independent work. All kinds of silences are captured, such as when students or teachers give themselves time to reflect before communicating. This also included episodes where teachers watch in silence as the students work. The findings indicate a relationship between the absence or presence of silence and the focus of the assessment acts. Using Black et al. (2003), I counted a silence here if it is three seconds or longer. I looked at sequences where there is one or more silences during the assessment acts. The findings are summarised in table 7. The focuses of self and critically reflecting (process) are not present since they were considered to be present to a very limited extent in the analysis.

Table 7. Sequences With Silence Related to Number of Sequences With the Different Assessment Focuses

Assessment focus	Task	Process, "dealing with mathematics notions"	Process, "applying mathematics notions"	Self-regulating
Number of sequences	6/36	19/40	17/21	20/33

What is clear from table 7 is that six of the sequences with a focus on task have at least one silence. This can be compared to the other focuses in the table. For the competence aspect "dealing with mathematics notions", around half the sequences have at least one silence in the communication, and for the competence aspect of "applying mathematics notions" almost all sequences contain silences. The outcome for the focus on self-regulating is between the two aspects of mathematics competence.

## 7.4 Summary and Conclusions Regarding Semiotic Resources

In this chapter, I addressed the roles of semiotic resources in assessment. I described the many semiotic resources that are present and acknowledged in assessment acts related to feedback in the mathematics classrooms visited. Some semiotic resources are related to the *body* while others appear in writing. I also described semiotic resources as artefacts. I considered roles of semiotic resources in relation to affordances for students' active agency and

learning of mathematics. One way for students to take active agency in assessment acts in the mathematics classroom is through *gaze*. When the student asks the teacher for feed back and/or feed forward, the student directs her/his *gaze* to the teacher.

There are documents in the written material that have tasks formulated in one semiotic resource as well as documents that include two or more semiotic resources in the tasks. A similar finding is identified for the students' possibilities to demonstrate knowing. There are document groups where the student can use one semiotic resource and just as many document groups where they can use a number of semiotic resources. In the analysis of the video sequences one finding is that there is most often an implicit acceptance of any semiotic resource available. In some sequences, though, the teacher restricts or promotes certain semiotic resources. In most instances, this was considered to serve the focuses of the assessment acts and thus provided affordances for students' learning of mathematics.

One conclusion is that an essential aspect that needs to be taken into account in discussing classroom assessment in the mathematics classroom is the semiotic resources available to students for representing mathematics knowing. In such a discussion, there needs to be a connection between the students' meaning making and learning of mathematics and what semiotic resources are provided and why. Another notion to include in this discussion is that restrictions on the semiotic resources available may restrict students' affordances to take active agency in the mathematics classroom.

I analysed the openness of tasks and questions posed by the teacher. Closed questions are considered to be frequently present in the data, both regarding possible answers and possible ways of solving the task, but there are also open questions and tasks present. The findings supports a view that open questions are needed in order to provide possibilities for a focus on processes such as inquiry/problem-solving and reasoning/arguing in assessment acts. One conclusion is that open questions and tasks are essential in providing affordances for students to engage in and demonstrate mathematics processes other than learning mathematical facts or practicing/routines. Open questions also hold affordances for students to take active agency since there are choices to be made by the student in answering the questions.

One relationship identified in the analysis is between silence and the focuses in assessment acts. When there is one or more silences of three seconds or longer in the communication between teacher and student, a focus on mathematics processes is present to a high extent. In very few instances with silence(s) in the video sequences is the focus on the task. One conclusion is that, when the pace in the communication is slowed down, through silences, there is room for a focus on mathematics processes in assessment acts. An alternative conclusion is that a focus on mathematics processes involves more silences since the teacher and/or student allows her/himself time to think. My hypothesis is that both these conclusions are valid. What is clear is

that there is some kind of connection between silences and the focuses of assessment acts in the classrooms visited. There could, of course, be other kinds of silences present in a classroom. I address this in the Discussion of the thesis.

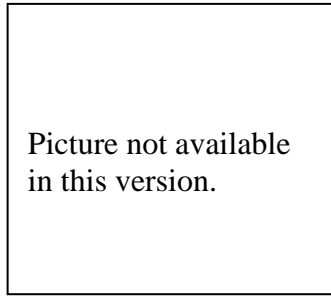
The outcomes and conclusions regarding semiotic resources in this chapter, especially in relation to affordances for students' active agency and learning in the mathematics classroom, are a basis for the construal of the discourses of assessment in mathematics classrooms in the next chapter.

## 8 Discourses of Assessment in Mathematics Classrooms: Analysis and Outcomes

The findings in the previous three chapters provide an overall picture of assessment practices in the mathematics classrooms visited. This picture is based on the first three research questions: assessment acts, focuses of assessment acts in the mathematics classroom, and the roles of semiotic resources. In this chapter, I describe the construed discourses based on this picture of assessment practices. Up until now, in the analysis and outcomes chapters, special attention has been given to affordances for students' active agency and/or learning in the mathematics classroom. These affordances are essential for the construal of the discourses. To connect these findings to a broader institutional context, I also describe institutional traces in relation to the construed discourses. As noted earlier, I use *discourses* as regarded by Foucault (1980, 1993, 2002, 2008). Accordingly, I employ a broad notion of discourse which encompasses all statements (taken here in a multimodal sense according to Van Leeuwen, 2005), "the rules whereby those statements are formed and the processes whereby those statements are circulated and other statements are excluded" (Mills, 2003, p. 62, referring to Foucault). In these processes, institutions are more or less explicitly present.

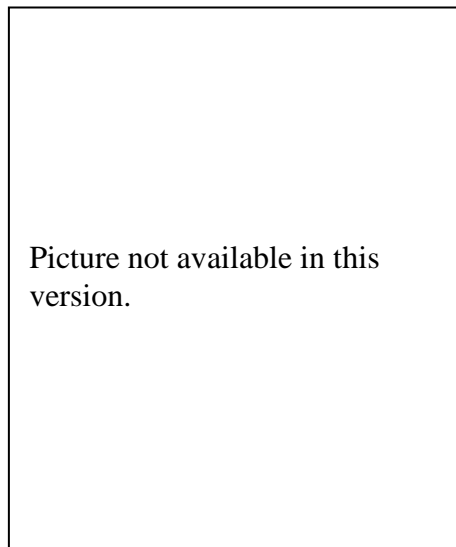
In Björklund Boistrup and Selander (2009), a tentative analysis was presented of assessment discourses in part of the data of this study. Based on Palmer (2005) and, for example, Broadfoot and Pollard (2000), Lindström (2005), and Ljung and Pettersson (1990), the authors constructed a dichotomy of classroom assessment. The two discourses were labelled "traditional" and "active participant" (see Section 3.3.4). An additional feature related to these findings is Walkerdine's (1988) testing discourse (see also Torrance & Pryor, 1998). In this discourse, the teacher poses questions that s/he already knows the answer to.

The same excerpt about Pippi Longstocking found in the previous three chapters also serves to illustrate my analysis in this chapter. Picture 6 shows Pippi in the door opening. We can see a girl, smiling, and her arms up in the air, communicating confidence. It seems clear that Pippi is prepared to take part in some kind of "active participant discourse". This is also clear when Pippi answers the teacher's first question about seven plus five. Pippi does



Picture 6. Illustration from Pippi Goes to School (Lindgren, 1998, p. 14, illustration by M. Chesworth).

not understand the question and subsequently takes active agency in the assessment acts in communicating this. The teacher's questions, which the teacher herself knows the answers to, can be fit into Walkerdine's testing discourse. However, this would be even clearer if the teacher had asked "How much is seven plus five" (this part of the story is included at the beginning of Chapter 3). The teacher actually asks Pippi *if she can tell* her what seven plus five is, which is something that the teacher does not know. The question may be part of a "traditional" discourse of assessment in mathematics, where the responsibility and active agency with respect to assessment lie mainly with the teacher. What I interpret from this situation is that Pippi's acts position the teacher's question in a testing discourse.



Picture 7. Illustration from Pippi Goes to School (Lindgren, 1998, p. 19, illustration by M. Chesworth).

What is quite clear from both the writing and picture 7 is that the teacher and the rest of the students are engaged in a similar discourse. We can see how the other students crouch and/or look aside. Tommy, who together with Annika persuaded Pippi to come to school, tries to hide behind a piece of paper. Pippi is part of another discourse here and seems not to take notice of this. One question that arises is what might a discourse of assessment in mathematics classrooms look like where Pippi would also be invited to take part in mathematics? In this chapter, this will be addressed indirectly through the construal of discourses from the classrooms visited.

## 8.1 Construal of Assessment Discourses in Mathematics Classrooms

In this thesis, the notion of discourse is used as an *analytical* concept. One way to describe assessment practice in a mathematics classroom is through the discourses that can be construed from the classroom communication. It was an interpretative act to construe a number of specific discourses in this study. I have done so in an interplay between the purpose of the study, the data, previous research on discourses and the findings of the first three analysis and outcomes chapters. This was not a straightforward process, and construal was somewhat intuitive. Part of my course of action, to begin with, was to rely on discourses from previous research.

A starting point was the dichotomy of “traditional” and “active participant” discourses in a tentative analysis (described in Björklund Boistrup & Selander, 2009). In that analysis, we identified these two discourses in the data, but variations on them began to appear. Several tentative discourses, similar to the three discourses in Askew and Lodge (2000), emerged during this analysis, and I considered the ones that appeared to be the most “solid” ones. A basis here was Foucault’s argument about discourses containing a limited numbers of statements (Foucault 1993, 2002, see also Van Leeuwen, 2005). Other features, according to Van Leeuwen (2005, referring to Foucault, see 1993), are that they have a history (although they change over time), have social distribution, and can be realised in different ways. In order to continue the process of developing the definitions of discourses, I returned to the three meta-functions.

In this study, the discourses of assessment in mathematics classrooms are aligned with the purpose and research questions of the study. Consequently, the discourses are construed with inspiration from the discourses mentioned above *and* based on the analyses derived from the three meta-functions. For each tentative discourse, I expanded the definitions in relation to the meta-functions, including affordances for students’ active agency and learning of mathematics. I tried to answer the questions below during the construal.

Interpersonal meta-function: Which of the three kinds of assessment acts – *feed back*, *feed forward*, and/or *feed up* – are mainly present in the discourse? In what direction is the feedback – from teacher to student, and/or vice versa? What directions – *(dis)approving*, *(dis)agreeing/recognising*, *(dis)interest/(dis)engagement*, *checking*, *guiding*, *challenging* – are mainly present? What are the affordances for students’ active agency in assessment acts in the mathematics classroom?

Ideational meta-function: Which of the focuses – self, task, process and/or self-regulation – are mainly present in the discourse? Which of the aspects of mathematics competence – “dealing with mathematics notions”, “applying mathematics notions” and/or “critically reflecting on mathematics applications” – are present? What processes are present, for example knowing mathematical facts, practicing/routine, reasoning/arguing, defining/describing, inquiring/problem-solving? What are the affordances for students’ learning of mathematics?

Textual meta-function: What semiotic resources including artefacts are part of the multimodal ensembles in the assessment acts? What roles do semiotic resources play in the assessment acts? How are semiotic resources promoted or restricted? How are open questions and/or silences present in teacher-student communication. What are the affordances for students’ active agency and/or learning of mathematics?

Also included here is the presence, or absence, of a testing discourse with questions posed by the teacher that s/he already knows the answer to (Walkerdine, 1988).

To summarise, the process of construing the discourses (drawing on Foucault, 2002) included these steps: (a) using the dichotomous discourses in an early attempt to interpret discourses in the material, (b) broadening the first two discourses by capturing deviations from, and opposites to, the initially construed discourses, (c) choosing the most durable ones among the discourses initially proposed, (d) aligning the discourses with the purpose of the study in using the meta-functions as a basis as well as bringing in a few new features (agency, learning, testing discourse), and (e) re-checking the discourses against the material (also in discussion with others). Through this process, four discourses were construed.

## 8.2 Findings for Assessment Discourses in Mathematics Classrooms

In the analysis, it was possible to construe four discourses, presented below. The first one, “Do it quick and do it right” has similarities to the traditional discourse mentioned at the beginning of the chapter. The second discourse, “Anything goes”, is more of the opposite to this traditional discourse and, as

demonstrated, is a discourse where students' performances that can be regarded as mathematically inappropriate are left unchallenged. The third discourse, "Anything can be up for a discussion", has similarities with the active participant discourse mentioned at the beginning of the chapter. Finally, the fourth discourse, "Reasoning takes time", takes it one step further with a lower pace and an emphasis on mathematics processes such as reasoning/arguing, inquiring/problem-solving and defining/describing. The discourses are described below.

### **Do it quick and do it right**

In this discourse, the feed back is mostly from teacher to student. Questions posed by the teacher are rarely open with the teacher knowing the answer. There are rarely follow-up questions. Feed forward concerns what to do next (as opposed to what to learn) as guiding, and challenging is not common. Feed up is not present in this discourse. The focus is mostly on task, often whether an answer is right or wrong. Occasionally, there is a focus on student's self. There may be some focus on processes, mainly on knowing mathematical facts or practicing/routine. There is not often a focus on self-regulation. The semiotic resources used, including artefacts, are mainly the ones that are specified in the textbook. Both teacher and student communicate in short utterances, and there are rarely longer silences. The main agent in this discourse is the teacher, and the affordances for students' active agency are not high in this discourse. As a consequence, the lack of focus on mathematics processes allows low affordances for students' learning of mathematics.

### **Anything goes**

There is not much articulated feed back in the discourse "Anything goes"<sup>122</sup>, apart from occasional approval. Here too, the feed back is mainly from teacher to student, but the student is encouraged to contribute to the discussion. There is a presence of also open questions. Feed forward as challenging is not common. Infrequently there are critical discussions about students' solutions, and wrong answers can also be left unchallenged. The focus is mainly on task, but there is also some focus on process. Different semiotic resources, including artefacts, are welcomed, and additional semiotic resources and artefacts (like manipulatives) apart from those mentioned in the textbook, for instance, are introduced occasionally by the teacher and/or the student. Semiotic resources are rarely restricted. The teacher and students use short sentences, and there is not much silence. Often in this discourse, the teacher is the most active agent. There seems to be a high possibility for the student to also take active agency since there is so much "positive" ap-

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<sup>122</sup> Inspiration for the name of this discourse comes from personal communication with Viveca Lindberg.

proval going on. In fact, this is arguably not the case. Because the teacher values the students' performance so often, the teacher, at the same time, takes the role as the main agent, as "the one that is evaluating". Sometimes the teacher takes a more passive role in the discourse. S/he then does not interfere with students' reasoning even though something wrong is demonstrated. The affordances for students' learning in this discourse are considered low.

### **Anything can be up for a discussion**

There are several instances of assessment acts, mainly feed back and feed forward, taking place in this discourse, both in the direction from teacher to student and visa versa. Occasionally goals for the learning are present. There are mostly questions asked, with the teacher not knowing the answer. Quite often the questions posed are open. Often the teacher and student show interest in the communication on mathematics and there is also an awareness of students' alternative interpretations of tasks. Sometimes the student is challenged with respect to her/his continued learning. The focus is mostly on process and sometimes on self-regulation. The two aspects of mathematics competence, "dealing with mathematics notions" and "applying mathematics notions", are present in the discourse. "Wrong" answers are also starting points for a discussion, but, in the end, it is always clear what can be considered mathematically correct. Various kinds of feedback from teacher to student are often communicated through questions. Different semiotic resources are acknowledged and at times the teacher promotes, whilst at other times restricts, the use of semiotic resources dependent upon the meaning making and learning process demonstrated by the student(s). This seems to be in order to serve the continuing process. There is not much silence. The teacher and students communicate in longer utterances, but not more than a few utterances each time. In this discourse, there are considered to be affordances for students' active agency and learning of mathematics.

### **Reasoning takes time**

In this discourse, the three kinds of assessment acts (feed back, feed forward, feed up) can be present and in both directions between teacher and student. There are often instances of recognition of the students' demonstrated knowing, sometimes in relation to stated goals. The questions posed are mostly open ones, with the teacher not knowing the answer. At times feed back as interest and engagement are communicated by the teacher to the student and vice versa. The students are often challenged towards new learning. The focus is mainly on process and self-regulation. The aspects of mathematics competence, "dealing with mathematics notions" and "applying mathematics notions", are present in the discourse. Here most emphasis is on the processes inquiring/problem-solving, reasoning/arguing, defining/describing and occasionally constructing/creating. There is also some presence of the proc-

ess reflecting on models. Different semiotic resources are acknowledged, and the use of semiotic resources can also be promoted or restricted when serving a certain process. In this discourse, silence is common and the possibility (for both teacher and student) to be silent seems to serve the mathematics focus. Various kinds of feedback from teacher to student are often communicated through sometimes open questions. Both the teacher and student can be active for longer periods of time. In this discourse as well, the affordances for students to take active agency are high. The possibility to be quiet and think for a while promotes this potential agency. Similarly, the affordances for students' learning of mathematics are considered to be high, including a wide range of mathematics processes.

### 8.3 The Construed Discourses Based on the Data in the Study

In this sequence, I elaborate the four assessment discourses construed from the discursive practices in the mathematics classrooms visited. I demonstrate how the discourses can be construed using excerpts from and summaries of video sequences and written documents.

#### Elaboration of “Do it quick and do it right”

In addressing the first discourse, “Do it quick and do it right”, we encounter the following excerpt from a lesson where the students are working on their own in the textbook. Catrin (S) sits at her desk waiting for Cecilia (T) to come and check the diagnostic test she completed. Cecilia arrives at Catrin's (S) desk, and they both look at her notebook and textbook (excerpt 44).

Time	Speech	Gestures	Body and Gaze
15:29	Cecilia (T): One. ( <i>silence 2 s</i> ) “Which angles are straight?” A and? <sup>123</sup>	Cecilia (T) has a red pencil in her hand, ready to write. Catrin (S) holds a pencil.	Cecilia is standing behind Catrin (S) and leaning over her.
15:35	Catrin (S): B		Cat looks at the angles in the textbook.

<sup>123</sup> Original transcript of speech in Swedish:  
Cecilia (T): Ett. Vilka vinklar är räta? A och?  
Catrin (S): B  
T: Ja, bra.

15:36	T: Yes, good.		
15:37		T writes an R in Catrin's (S) notebook.	

Excerpt 44. Transcript from video material. Phrases in quotation marks refer to the person reading from the textbook. "Cat" is short for Catrin (S), and "T" is short for Cecilia (T).

In excerpt 44, a pattern is clear, which continues for two more questions; Cecilia (T) reads a question from the diagnostic test (at 15:29) and Catrin (S) answers the same thing she has written in her notebook (at 15:35). Cecilia (T) marks *R* with her red pencil. In excerpt 45 this pattern changes.

Time	Speech	Gestures	Body and Gaze
16:10	Cecilia (T): What big numbers you've made Catrin ( <i>high</i> )! <sup>124</sup>	Cecilia (T) takes Catrin's (S) pencil.	Cecilia (T) and Catrin (S) are looking at Catrin's (S) notebook.
16:14	T: You know ( <i>high</i> ), I could easily have mixed this up if you had not been here to help me.	T writes numbers for the items in Cat's notebook.	

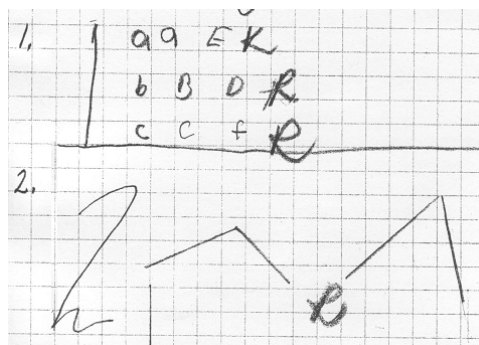
Excerpt 45. Transcript from video material. "High" refers to voice at a high frequency. "T" is short for Cecilia (T), and "Cat" is short for Catrin (S).

At 16:10 in excerpt 45, Cecilia (T) comments on the writing of numbers for the items in Catrin's (S) notebook. "What big numbers you've made!" At 16:14, Cecilia (T) relates her feed back to the problems she experiences herself capturing the notes when the number of the item is written in big numbers. Cecilia (T) writes the numbers in ordinary size in the margin of the page and tells Catrin (S) to do the same in the future. Catrin's (S) notebook is shown in excerpt 46.

<sup>124</sup> Original transcript of speech in Swedish:

Cecilia (T): Oj vilka stora siffror Catrin!

T: Vet du vad. Jag hade kunnat blanda ihop det här lite lätt om du inte hade varit här och hjälpt mig.



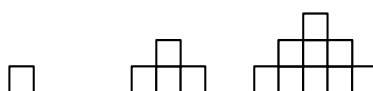
Excerpt 46 (from written material). Part of a page in Catrin's (S) notebook.

In excerpt 46 we can see Cecilia's (T) numbers on the left and Catrin's (S) next to them. During the sequence, the utterances are short.

The reasons for considering this to be an example of the discourse "Do it quick and do it right" are: (a) The only feed back and/or feed forward is in the direction from teacher to student; (b) There is a focus on the correct answers for the tasks (which is communicated at the very beginning of the sequence by the red pencil in Cecilia's (T) hand), and there are no follow-up questions. Later on, the focus is not on mathematics, but on the correct way to write and draw in the notebook (a focus on task); (c) The semiotic resources are the ones used in the textbook, and there are few silences and short utterances; (d) There are few affordances for the student to take active agency and the lack of focus on mathematics processes provides low affordances for the student's learning of mathematics in the assessment acts.

### Elaboration of "Anything goes"

In the following sequence from which the discourse "Anything goes" is construed, Angelica (S) and Ali (S) are working on problems dealing with patterns. These problems were described on several occasions earlier in the thesis, and the sequence referred to here is taken from the second of three lessons, when they are working on these particular problems. Angelica (S) and Ali (S) are working together and have solved the first items in the second pattern, the beginning of which is shown in excerpt 47.



Excerpt 47. Transcript from written material. First figures of the pattern.

Anna (T) and the two students discuss the item “Imagine that you have drawn ten figures. How many squares would the tenth figure then contain?”<sup>125</sup> Anna (T) asks how they found the answer to this question. Ali (S) looks at the calculator and says that they have 64. Anna (T) asks if that refers to the eighth figure, which they have already drawn, and Ali (S) confirms that. Ali (S) then counts the squares one by one along the two upper edges of the eighth triangle, which add up to 17. He calculates  $64 + 17 = 81$  on the calculator. He then counts the squares in the next layer (excerpt 48).

Time	Speech	Gestures	Body and Gaze
15:44	Ali (S): Then I took one, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve, thirteen, fourteen, fifteen, sixteen, seventeen, eighteen, nineteen! <sup>126</sup>	Ali (S) points at squares just above the upper edges of figure 8.	Anna (T) looks at Ali. Ali (S) looks at eighth figure of pattern.  Ali looks at T. T nods.
15:57	Ali: Plus nineteen. Equals a hundred!	Ali enters “+ 19 =” on the calculator.	Ali looks at calculator.  Ali looks at Anna (T).

Excerpt 48. Transcript from video material. “T” refers to Anna (T), and “Ali” is short for Ali (S).

Ali (S) (excerpt 48) adds 19 to the 81 on the calculator and says that this makes a hundred. Anna (T) accepts this answer and then poses questions to check that she has correctly understood their course of action. Anna (T), still looking at them and their work, calls their attention to the next question; “How many squares would the fifteenth figure contain?”<sup>127</sup>. It becomes clear that Angelica (S) and Ali (S) missed this item. Anna (T) repeats the question and the students talk about how to solve it (excerpt 49).

<sup>125</sup> Original excerpt in Swedish: Tänk dig att du har ritat tio figurer. Hur många kvadrater hade den tionde figuren då innehållit?

<sup>126</sup> Original transcript of speech in Swedish:

Ali (S): Sen tog jag en, två, tre, fyra, fem, sex, sju, åtta, nio, tio, elva, tolv, tretton, fjorton, femton, sexton, sjutton, arton, nitton!

Ali: Plus nitton. Är lika med hundra!

<sup>127</sup> Original excerpt in Swedish: "Hur många kvadrater hade den femtonde figuren innehållit då?"

Time	Speech	Gestures	Body and Gaze
16:37			Ali (S) looks at Anna (T). Angelica (S) looks down.
16:38	Ali (S): It is just to count three more layers. Angelica (S): Yes ( <i>sighs</i> ). Ali: Five more layers. <sup>128</sup>	Ali (S) points at figure at his paper and moves fingers. Stops pointing.	Ali looks at his worksheet. Ali looks at T. Ang looks at worksheets and at Ali. Ali's mouth is downturned and forehead is wrinkled.
16:44	Anna (T): Five more layers, yes.		T looks at Ali.
16:46	Ang: Yes ( <i>sighs</i> ) Ali: Wow.		Ali shakes his head. Ang looks at Ali.
16:47	Ang: Then we just have to start counting ( <i>laughs</i> ).		Ang smiles. Ali smiles
16:49	Ali: Yes, then we just have to start counting ( <i>high</i> ).		Ali has his hand over his eyes.

Excerpt 49. Transcript from video material. “High” refers to voice at a high frequency. “T” refers to Anna (T), “Ali” is short Ali (S), and “Ang” is short for Angelica (S).

At 16:38 in excerpt 49, Angelica (S) and Ali (S) state that they then have to start counting five new layers. Ali's (S) mouth is downturned and forehead is wrinkled and Angelica (S) sighs, and this is considered to represent that they think it is annoying. Still they commence to work and then start drawing new layers on top of the figure they already drew. Anna (T) stands by their desks without saying anything for a while and then leaves.

The reasons why this is considered to be an example of the discourse “Anything goes” are: (a) There is not much articulated feed back or feed forward in this sequence. Anna (T) is considered to communicate acceptance to everything the students suggest, without either recognising the suggestions as valid or recognising them as not accurate or fruitful. In neither of the two questions posed by the textbook are they expected to actually draw the

<sup>128</sup> Ali (S): Det är bara att räkna upp tre lager till.  
Angelica (S): Ja.  
Ali: Fem lager till.  
Anna (T) Fem lager till ja.  
Ang: Ja.  
Ali: Wow.  
Ang: Då är det bara att börja räkna.  
Ali: Ja, då är det bara att börja räkna.

figures. The task is to imagine drawing them, and then find the number of squares in the figure; (b) The focus in this communication is on finding the correct answer, regardless of whether the method is really troublesome. Accordingly, the task focus is mainly present, but there is also some focus on process since Anna (T) asks them to describe how they have come up with their answers. However, there is not much discussion focused on mathematics processes and Angelica's (S) and Ali's (S) solutions, (c) All semiotic resources seem welcomed. Here the calculator, which is not mentioned in the instructions, is also present. Angelica (S) and Ali (S) solve the problem by drawing, even though this was not part of the task; (d) Anna (T) does not interfere even though there are possibilities to communicate feed forward to the student in line with the instructions for the item with a stronger focus on mathematics processes. There are affordances for students' active agency here, and the two students really take active agency in solving the task. On the other hand, there are low affordances for students' learning because of the lack of focus on mathematics processes in the assessment acts related to feedback.<sup>129</sup>

### Elaboration of "Anything can be up for a discussion"

The following excerpt is a document from the school concerning parent/teacher/student meetings. The same structure is used for all such meetings in every class at this school. The third discourse, "Anything can be up for a discussion", is construed from this document.

First there are two pages where the student is asked questions. These are expected to be answered before the meeting. Ali (S) has answered yes to the question whether it is *important to gain knowledge at school*<sup>130</sup> and no to the question whether he *takes own responsibility*<sup>131</sup>. One can read that he thinks that *I am good at a few things*<sup>132</sup> in mathematics and that *I want to improve a few things*<sup>133</sup>. Then there are pages for the teacher to fill out before the meeting. One can also see that for mathematics, Anna (T) considers *the knowledge status relative to goals* for Ali to be "G?". G is defined as Good relative to the goals<sup>134</sup>. For *Working concentrated and goal oriented* Anna has marked "G –" (minus)<sup>135</sup> and for *Exercising and accounting for homework*

<sup>129</sup> During one of the quality meetings between the teacher and me, an alternative analysis of this sequences emerged. It was argued that this sequence could be connected to the teacher deliberately letting students struggle with this time-consuming and tiresome course of action in order for them to experience and understand the value of number patterns, later on, as a way to solve this kind of problem.

<sup>130</sup> Original excerpt in Swedish: Tycker du att det är viktigt att få kunskaper i skolan?

<sup>131</sup> Original excerpt in Swedish: Tar du eget ansvar?

<sup>132</sup> Original excerpt in Swedish: Vad jag är bra på: "Några saker".

<sup>133</sup> Original excerpt in Swedish: Vad jag vill förbättra: "Några saker".

<sup>134</sup> Original excerpt in Swedish: Kunskapsläge i förhållande till målen. B? (B = Bra i förhållande till målen).

<sup>135</sup> Original excerpt in Swedish: Arbetar koncentrerat och målinriktat. B- (B=Bra).

and assignments she has marked “MBI” (Must be improved)<sup>136</sup>. The last document is filled out during the actual meeting. There are spaces for comments on both short-term and long-term goals. The comments on long-term goals are found in excerpt 50.

Content <sup>137</sup>	School's contribution	Student's contribution	The contribution from home
<i>Strengthen your math knowledge</i>	<i>Provide assignments suitable for Ali</i>	<i>Work well. Concentrate</i>	<i>Help Ali with homework and remind him</i>

Excerpt 50. Transcript from written material. Comments on long-term goals.

The analysis here is focused on the document as such, not explicitly including the answers from the teacher. The analysis also considers the questions on the document provided to Ali (S) before the meeting. The reasons why these documents are considered to be an example of the discourse “Anything can be up for a discussion” are: (a) There are also possibilities for feed up. Feed forward concerns the student’s as well as teacher’s (school’s) course of action; (b) There is a focus on the learning process and the student’s self-regulating; (c) There are many possibilities for the student to take active agency, for example through the questions posed to the student. These documents are regarded as an institutional trace since they have a direct effect on what takes place during the student/teacher/parent meetings at this school.

As will be noted in Section 8.5.1, this discourse is frequently construed from the data in this study. There are several sequences from the video material where this is the case. One example is at the end of the lesson, where Cecilia (T) and the class together do a survey of what things the students perceive as disgusting and gross (see Section 6.2.4). The students and Cecilia (T) are sitting in a circle on the floor, and they all get to demonstrate and reason about the diagrams they constructed. Anything *is* up for discussion during this sequence, and the students are invited to take active agency. Cecilia (T) poses questions about each student’s way of solving the assignment. One process present in Cecilia’s (T) feed back is how different diagrams are useful for gaining information. Her feed back focuses on some mathematical facts relating to statistics, and she also promotes the students’ reasoning in mathematics.

<sup>136</sup> Original excerpt in Swedish: Utför och redovisar läxor och arbetsuppgifter. MF (MF = Måste förbättras).

<sup>137</sup> Original excerpt in Swedish:

Innehåll	Skolans insatser	Elevers insatser	Hemmets insatser
Stärka dina mattekunskaper	Ge uppgifter som passar Ali	Jobba bra Koncentrera sig	Hjälpa Ali med läxan och påminna honom

### Elaboration of “Reasoning takes time”

In the following sequence, from which “Reasoning takes time” was construed, Eddie (S), Enzo (S) and a third boy, called Bx here, are working on a task. They are presented with five different solutions to the same task ( $376 - 149 =$ ). They are told that the objectives for this assignment are cooperation and subtraction. They should find the suitable solution in groups as well as determine what can be regarded as mathematically wrong with the other four. This task was described earlier in Section 5.2.1, in relation to a sequence later in the lesson. The five solutions are shown in excerpt 51.

- |    |  |    |                                |    |                                 |
|----|--|----|--------------------------------|----|---------------------------------|
| 1. | $370-150=220$<br>$220+6-1=225$                           | 2. | $380-150=230$<br>$230-4+1=227$ | 3. | $300-100=200$<br>$200-30-3=167$ |
| 4. | $300-100=200$<br>$70-40=30$<br>$6-9=3$<br>$200+30+3=233$ | 5. | $376-100=276-40=236-9=227$     |    |                                 |

Excerpt 51. Transcript from written material. Assignment presented to students. Five different solutions to one task. Which one is correct?

After Erika’s (T) instructions at the beginning of the lesson, the groups start working. Erika (T) stands for several minutes in front of the class observing the students’ work. Eddie (S), Enzo (S) and Bx discuss the solutions. After a while, Enzo (S) raises his hand and calls for attention. Erika (T) arrives and Enzo (S) poses a question about there being two solutions with the same, and mathematically correct, answer: solutions 2 and 5. Erika (S) leans over their desks, looking at their work and posing questions to the three students about the purpose of the task (that only one solution is correct). She also asks how they have reasoned so far. Part of the communication is shown in excerpt 52.

Time	Speech	Gestures	Body and Gaze
15:05	Erika (T): What is your thinking then? <sup>138</sup>		Erika (T) looks at the worksheets.
15:07	Enzo (S): Look.		Bx looks at $376 - 149$

<sup>138</sup> Original transcript of speech in Swedish:

Erika (T): Hur tänker ni då?

Enzo (S): Kolla.

Bx: Det där blir ju två hundra tjugosju. [Enz: Och det där är] Det där kan inte bli det där.

Bx: Du tar fyra när det ska vara minus fyra.

Enz: Nej, minus fyra, det blir sex plus ett, det blir också samma.

15:08	Bx: Well, that's two hundred twenty seven. [Enz: And that is] That one can't be right.	Bx points at $376 - 149$ . Enzo (S) points at solution 4. Bx points at solution 2.	Enzo (S) looks at solution 4. Bx looks at solution 2. Enz looks at solution 2.
15:11	( <i>silence 2 s</i> ) Bx: You take plus four when it should be minus four.		
15:16	( <i>silence 3 s</i> ) Enz: No, minus four, that's six plus one, that's also the same. ( <i>silence 3 s</i> )	Enz points at solution 2.  Enz stops pointing.	Students look at worksheet.  Enz looks at Bx.  Enz looks down.

Excerpt 52. Transcript from video material. Speech in brackets, [ ], signals simultaneous speech. “Bx” refers to an unspecified student and “Enz” is short for Enzo (S).

As shown in excerpt 52, there are substantial pauses in the communication. Sometimes these silences are followed by reasoning from one of the students. Subsequently, there are also silences followed by and during Erika’s (T) utterances. After a while, the students’ reasoning becomes more intense with a sustained focus on the mathematics involved in the task. Here, the students communicate their ideas for several seconds each. In one instance, Erika (T) points at solution 5 and asks whether they have done a calculation in that way before in class. The students answer no, and then there is a short discussion about solution 2. Before leaving, Erika (T) tells them that they get a few minutes more to think and also advises them to write down what is wrong with the ones that they know are definitely wrong. After Erika (T) has left them, the students’ reasoning about solutions continues.

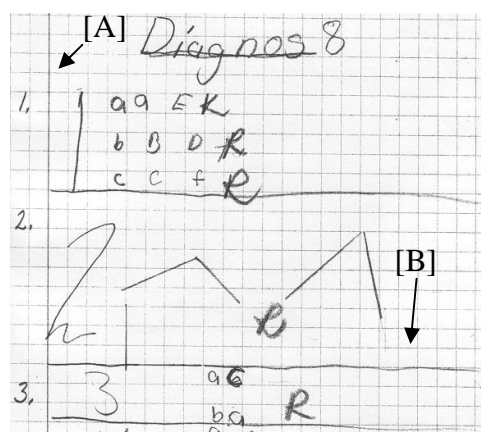
The reasons why this is considered to be an example of the discourse “Reasoning takes time” are: (a) There are several instances of feed back and feed forward. Erika (T) communicates feed back and feed forward to the students about their work. There is no feed up as such, but there is a statement of the mathematics objective (subtraction) at the beginning of the lesson. The students ask for feed forward on the task and their demonstrated knowing is used as feed forward/back by Erika (T) for her future acts; (b) The focus in the feed back and feed forward is mainly on the processes included in the aspect of mathematics competence, “dealing with mathematics notions”. The processes that are present, even after Erika (T) has left, are mainly reasoning/arguing and inquiring/problem-solving. Before leaving,

Erika (T) also initiates the process of defining/describing since she tells them to write down their reasoning so far; (c) The feed back and feed forward from Erika (T) are realised several times by questions to the students. There are many instances of silence followed by utterances from the students as well as from Erika (T). Silence is also present when Erika (T), just prior to this sequence, stands in front of the class observing the students' work. She introduces semiotic resources and then promotes the process of describing when she tells them to write down their work so far; (d) There are considered to be affordances for students' active agency here, and the students take active agency in the sequence. They communicate a great deal about mathematics by way of speech, gestures, symbols on the paper and so on and also do this in longer utterances. There are affordance for students' learning of several mathematics processes here.

## 8.4 Changes of Discourses During Lessons

As illustrated from the sequence in the previous section, the students' focus in the group work continues to be the same immediately following the communication between Erika (T) and the three students in the group. The students start writing down their reasoning for why they are sure one of the solutions is incorrect. In doing so, they use the semiotic resources promoted by the teacher, which then puts the focus on defining/describing. There are also instances of substantial silences in the communication between the three students. My conclusion here is that the discourse in which the students take active agency after their communication with Erika (T) coincides with "Reasoning takes time" in terms of the focus of their activity and the roles of the semiotic resources.

Next, I present another sequence and the student's subsequent work after the teacher-student communication. This sequence is described in part in the example of the "Do it quick and do it right" discourse in the previous section. As described earlier, the first part of the sequence is that Cecilia (T) reads the question of the diagnostic test that Catrin (S) has finished out loud. Catrin (S) answers and Cecilia (T) marks *R* with her red pencil. Cecilia (T) then mentions how Catrin (S) writes the number of the tasks in her notebook. Following this, Cecilia (T) also mentions that Catrin (S) should draw straight margins (vertical lines, see [A] in excerpt 53) with a ruler. Cecilia (T) takes the ruler and draws this line. They continue checking the diagnostic test, and after a few questions Cecilia (T) turns the focus back to the order of the Catrin's (S) notes. This time she emphasises that Catrin (S) should draw horizontal lines (see [B] in excerpt 53) using the ruler, in order to keep the notes for different items apart.

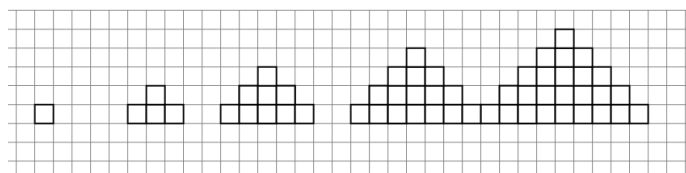


Excerpt 53 (from written material). Notes from Catrin's (S) notebook.

Cecilia (T) stresses that “Mathematics is a ‘ruler subject’” and later that mathematics is a “clear-cut subject”<sup>139</sup>. They go back to checking the diagnostic test with a focus on the right answer (task). Catrin (S) has answered all the items correctly, which Cecilia (T) approves of by saying “Good, Catrin!”. Before leaving, Cecilia (T) returns to the focus on doing right when she says “And from now on, you’ll use the ruler and the margin” (pointing at a line drawn by Cecilia (T)). Catrin (S) nods. During the sequence, there are no long silences and the utterances are short. With some exceptions, the discourse in this sequence is considered to be “Do it quick and do it right”. In my analysis of Catrin's (S) acts prior to this communication, Catrin (S) is working with a paper on scale, which she received from Cecilia (T). From what is visible she has a focus on process, mainly on constructing since she draws figures that are visible on the worksheet according to new scales. She seems to work without rushing and by concentrating on the mathematics involved. This is regarded as mostly corresponding to the assessment discourse “Anything can be up for a discussion” in terms of the focus of the acts and roles of semiotic resources. Observing Catrin's (S) work after the communication with the teacher, it is possible to see how she uses the ruler to draw new lines in her notebook as margins and between the solutions to the items. She erases the figures she drew before and redraws them. Right after the communication with the teacher, it seems as though Catrin's (S) work corresponds largely to the “Do it quick and do it right” assessment discourse in terms of focus and roles of semiotic resources. After a while, she goes back to drawing figures to scale, as mentioned.

<sup>139</sup> Original excerpt in Swedish: Matte är ett sånt där linjalämne. Rakt och tydligt ämne.

The third account aims to show how there can be considered to be an interplay between different discourses during teacher-student communication. The following sequence is from the first lesson, when Angelica (S) and Ali (S) and the other students are working on patterns. When this sequence starts, Angelica (S) and Ali (S) have finished the items for the first pattern and are now working on the next pattern. Anna (T) arrives and, after a while, it becomes clear that Ali (S) has run into problems drawing the figures. What he explains and shows by pointing is that two of his figures are drawn too close together on his paper (excerpt 54).



Excerpt 54. Transcript from written material. Ali's (S) figures.

The communication at the beginning of this sequence is considered to reflect the discourse "Anything can be up for a discussion". Anna (T) is open to discussing what concerns the students; she also offers them feed forward and communicates a focus on self-regulation (asking if Angelica (S) herself understands her notes). Angelica (S) answers yes and Anna (T) says that she also understand the notes. Then there is considered to be a change in discourse introduced by Angelica (S) (excerpt 55). Here, Angelica (S) and Ali (S) are looking at and writing on their worksheets.

Time	Speech	Gestures	Body and Gaze
27:55	Angelica (S): Just so that you don't mark it wrong "here you are wrong". <sup>140</sup>		Anna (T) looks at Angelica's (S) work, and then at Ali's (S) work.
27:57	Anna (T): ( <i>laughs</i> ) Is that what I usually do?		Anna (T) smiles.
28:00	Ang: No, but sometimes you ask. ( <i>laughs</i> ).	Angelica (S) draws figure on worksheet.	Ang smiles.

<sup>140</sup> Original transcript of speech in Swedish:  
Angelica (S): Så att du inte rättar fel här, "här har du fel".  
Anna (T): Brukar jag göra det?  
Ang: Neej, men ibland brukar du fråga.  
T: Det (!) kan jag göra.  
Ang: Ja.  
T: Det är väl smartast om man inte vet, att fråga.  
Ang: Jaa.

28:03	T: That (!) I can do ( <i>high</i> ). Ang: Yes.		
28:04	T Well, isn't that the smartest thing if you don't know, to ask?		T looks at Ang.
28:05	Ang: Yeh ( <i>high</i> ).		Ang smiles wide.

Excerpt 55. Transcript from video material. “High” refers to voice at a high frequency. (!) indicates a specific word being emphasised. “T” is short for Anna (T), and “Ang” is short for Angelica (S).

Angelica’s (S) comment at 27:55 in excerpt 55 is considered to be a reference to the “Do it quick and do it right” discourse, since she proposes that Anna (T) may consider her notes as either wrong or right. Anna (S) continues to take agency in “Anything can be up for a discussion” at 27:57, when she engages in the discussion and asks if that is what Angelica (S) assumes that she normally does as a teacher. Angelica (S) answers no to this question and suggests that the teacher sometimes asks about notes that she does not understand and here she is also considered to take agency in the discourse “Anything can be up for a discussion”. At 28:05 Angelica (S) and Anna (T) seem to agree on the assessment practice in this classroom for the course of action when Anna (T) can not figure out students’ notes. To be able to assess the students’ notes, the teacher may have to ask for clarification. The implicit assessment in the activity described is not just a matter of what is right or wrong. It is a matter of active agency by the student as well. It is impossible to know why Angelica (S) introduces the discourse of “Do it quick and do it right”. A major assumption in a critical paradigm is that the classroom is not isolated, but highly affected by and also part of a broader institutional context. In this institutional context, there are dominant discourses that are traditions, and it is possible that Angelica (S) is referring to such a discourse here.

## 8.5 Discourses of Assessment in Mathematics Classrooms: Occurrences and Institutional Traces

I contend that each of the four discourses is related to one of the discourses in the dichotomous picture described earlier in this chapter and/or earlier research in Swedish mathematics classrooms (J. Emanuelsson, 2001; Löwing, 2004; Persson, 2009), and hence that they have a “history” (Foucault, 2002; see also Van Leeuwen 2005). All four discourses are construed from my analysis of data from two or more of the classrooms visited, which means that they have a “social distribution” (ibid). It is also clear that the discourses are “realised in different ways” (ibid) in the communication be-

tween teacher and student, for example in different kinds of educational situations, in the video material and in written material. All these aspects can be viewed as being indirect; nevertheless, they seem quite clear. In the following section, I examine occurrences of the four discourses.

### 8.5.1 Occurrences of Discourses in the Classrooms Visited

I analysed all the video sequences and document groups where there are considered to be assessment acts related to feedback. The outcome of my analysis of assessment discourses are shown in table 8. There can be more than one discourse construed from a video sequence or document group.

Table 8. Occurrences of Assessment Discourses in Classrooms Visited<sup>9</sup>

Assessment discourse	Number of video sequences with discourse	Number of document groups with discourse
Do it quick and do it right	39	13
Anything goes	8	0
Anything can be up for a discussion	54	11
Reasoning takes time	26	3

<sup>9</sup> The total number of video sequences with assessment acts related to feedback (feed back, feed forward and/or feed up) is 105. The corresponding number for document groups is 27. More than one discourse can be construed from each video sequence and document group.

The discourse “Anything can be up for a discussion” appears most frequently in the video material, followed by “Do it quick and do it right”. In the written material the similar two discourses are construed frequently and here “Do it quick and do it right” is the one appearing most frequently. The discourse “Reasoning takes time” is construed from a quarter of the video sequences and a few document groups. The discourse “Anything goes” is less frequent as a discourse, construed from 8 video sequences.

As in the earlier analysis and outcomes chapters, there are differences between classrooms here. In two of the classrooms (A and B), all four discourses are construed. In two classrooms (C and D), the two most common discourses, “Do it quick and do it right” and “Anything can be up for a discussion”, are construed. In one classroom (E), there is a predominance of the discourses “Anything can be up for a discussion” and “Reasoning takes time”.

### 8.5.2 Institutional Traces and Their Relation to the Presence of Discourses

Institutional traces are present in the assessment practices from which the four assessment discourses in mathematics classrooms are construed. At the same time, the discourses can be viewed as institutional traces on their own,

on one hand since they take place in the institution of school, and on the other hand since the institutional facts (Foucault, 2002, 2003; Searle 1997) in the discourse can be perceived as being as solid for the people involved as other, more easily observed and experienced “facts”. The presence of the institutions is considered to be more direct with respect to “frames”, for example, from documents from municipal authorities or schools. Hence, what I consider here to be institutional traces are such direct traces. In the Discussion of this thesis, I will also address indirect institutional aspects. The direct institutional traces in the data are identified in documents, materials, rules and so on that have a possibility to have a direct impact on classroom work in mathematics. The restriction here is that I draw on the traces that could be captured from the communication between teacher and student in the classrooms during my visit. That is, there are, of course, more frames and rules present in the lives of both teachers and students which have an impact on the discourses of assessment in mathematics that are not clearly identified in the data for this study. In the Discussion, I also address direct traces not identified in the study. The institutional traces relating to the construed discourses that were identified are:

- textbooks including supplementary material,
- other documents or identified resources,
- manipulatives,
- documents from student/teacher/parent meetings, and
- school rules.

In the classrooms where there was a textbook used, the decision about which textbook to use was a matter not only for the teacher, but for the school as a whole. What is analysed here is how parts of the textbooks have been present in the assessment acts during teacher-student communication. There are also other documents and materials identified that are not exclusive to a particular classroom but likely to be identified in other mathematics classrooms in Sweden. The use of manipulatives is also considered to be an institutional trace, especially in one classroom where the school’s profile includes an extensive use of manipulatives. In the classrooms visited, there are documents, clearly designed on the school level, that are expected to be used during teacher/student/parent meetings. These documents are considered to be institutional traces. Since the participants are expected to follow these documents during a parent/teacher/student meeting, these traces have an impact, at least during the meeting. Drawing on Hofvendahl (2006), this impact may not be substantial. There are also rules, for example, regarding time slots, which have an impact on the discourses that the teacher and student can engage in (see Foucault, 2003). Below, I describe the relation between direct institutional traces and the four construed discourses.

As was noted, the discourse “Do it quick and do it right” is construed from between a third and half of the video sequences. In a quarter of these, there are institutional traces that are considered to (partly) carry (introduce and/or maintain) the discourse. In six of the document groups, there are institutional traces that add to this particular discourse. In several of the video sequences and document groups, the textbook plays this role. When the textbook carries the discourse “Do it quick and do it right”, one aspect is how the textbook is structured. In one textbook from two of the classrooms, it is expected that all students should work on the same tasks, at least in the first pages of each chapter (my researcher’s log). The tasks are divided into smaller sub-tasks which do not take much time to solve. As help for the assessment there is a key with correct answers to the items. The focus is on small tasks that can be solved quickly, corrected easily with the key. There is also extra material identified in the data of this study that is connected to the textbook, including diagnostic tests for mental arithmetic. A number of items are expected to be solved within a certain time limit. The results are expected to be summarised as the number of correct answers. Another institutional trace that carries this discourse in part is the use of manipulatives. As mentioned, they are used frequently in one of the classrooms visited. In the video sequences for the randomly chosen students in this class, there are instances where the manipulative pilots the student to a correct answer during assessment acts. That is, the manipulative takes away the essential mathematics reasoning and also takes over parts of the assessment acts. The task is solved faster, but with a task focus instead of a process focus. The last institutional trace here is documents related to student/teacher/parent meetings in one classroom. In these documents, the focus is on self and task, and the student is expected to state to what extent s/he is good in mathematics.

The second discourse, “Anything goes”, is also carried by institutional traces. In four of the eight video sequences with this discourse, there are institutional traces that partly carry the discourse. In one institutional trace, the diagnostic tests in the textbook, the items do not always reveal the student’s reasoning that may be important to capture. One example is described in Section 5.2.3 (excerpt 11), where the numbers in the task are chosen in a way that the student can come up with the correct answer based on what could be considered incorrect mathematics reasoning. The incorrect reasoning may be unchallenged here. Another institutional trace is the rules of a school for time slots. There are sequences in the material where students are solving a problem in a way where a feed forward from the teacher might help them in the problem-solving process. The teacher, however, does not linger with the students, and this is considered to be because the lesson is about to finish. Other rules that have a similar effect are when the teacher has to engage in a discussion during the math lesson with a colleague about some problems related to other students’ social behaviour. In this case, the

student in focus really wanted help on mathematics, but was informed that everything was okay.

The third discourse “Anything can be up for a discussion” is, as noted, construed in around half of the video sequences. In a quarter of these video sequences and five of the document groups, there are institutional traces that partly carry the discourse. Here too, the textbook was influential. In the video material, there are examples of students working in pairs for several lessons with the same problem. The assessments acts in the communication with the teacher that are connected to the work on this problem often reflect this discourse. The textbook page with items about the two geometrical patterns (which are connected to one other) and the problem itself are considered to carry the discourse “Anything can be up for a discussion”. The problem invites mathematics reasoning and problem-solving with different ways of solving the problem. These processes are emphasised by the teacher in several assessment acts. There are self-assessment materials (referred to earlier) coming from the textbook supplement in the written material that belongs to the discourse “Anything can be up for a discussion”. The students have affordances for active agency here and also communicate feed up about their learning. There are also questions about the work from the past unit, and there are possibilities for communicating feed back to the teacher. In Section 8.3, I described one set of documents related to the student/teacher/parent meeting. Here, the discourse of “Anything can be up for a discussion” is regarded to be present. There are similar documents from other classrooms in the study. In these documents there are also rules in some of the classrooms in the form of local and/or national goals present.

One institutional trace that carries the discourse “Reasoning takes time” is the use of matrices (Kjellström, 2005). Potential support for this discourse depends on the matrix itself. The ones that are identified in this study correspond to “Reasoning takes time”. Going through such a matrix takes time, and it is clear that, when the student participates, s/he is indicating her/his own demonstrated knowing in the matrix. The use of matrices is part of an institution, and mainly an institution of teacher education where formative assessment is promoted by (a similar discussion on mathematics education is presented in Persson, 2009). It is also possible to find a large amount of assessment matrices (rubrics) in on-line searches (Kjellström, 2005). Another institutional trace identified in the classrooms visited with respect to this fourth discourse is the use of portfolios. Like the arguments for matrices, the use of portfolios is part of an institution of teacher education where formative assessment is promoted.

## 9 Summarised Outcomes and Conclusions Regarding Assessment Discourses in Mathematics Classrooms

In this thesis, I provided a detailed analysis of explicit and implicit assessment acts and discourses in mathematics classroom communication. The findings are addressed in terms of affordances for students' active agency and learning in the mathematics classroom. I also captured institutional traces and presented their roles in the construed discourses. In this chapter, I present my conclusions on the construed assessment discourses.

One main conclusion of this thesis is how four construed discourses of assessment in the mathematics classrooms visited hold different affordances for students' active agency and learning. The four discourses are (see Section 8.3):

- Do it quick and do it right
- Anything goes
- Anything can be up for a discussion
- Reasoning takes time

A basis for the construal of the discourses is the findings in the first three analysis and outcomes chapters. Consequently, each discourse is construed through (1) what kinds of assessment acts are present, (2) what the focuses of the assessment acts are in the mathematics classroom, and (3) what the roles the semiotic resources play in the assessment acts. The main consideration here is the findings described in Chapters 5, 6 and 7, in which it was possible to draw conclusions in terms of affordances for students' active agency and/or learning. An additional aspect, inspired by Walkerdine (1988), is the notion of a testing discourse where the teacher poses questions that s/he already knows the answer to. These questions are considered to emphasise the role of the teacher as the one who evaluates the students' demonstrated knowing and do not communicate an interest from the teacher with regards to students' mathematics reasoning. Hence, I do not consider them to have affordances for students' active agency in the teaching and learning of mathematics.

The findings in this thesis also indicate that in many cases the students' work after communication with the teacher continues to have a focus similar to that in the last part of the teacher-student communication (see Section 6.3.2). The focuses of the assessment are a substantial part of a discourse, but not the only part. Nevertheless, one conclusion is that the assessment discourses as they are "present" in this study clearly also have more or fewer affordances for learning in relation to the students' acts after teacher-student communication on assessment acts in the mathematics classroom.

The two most common discourses in the data of this thesis are "Anything can be up for a discussion" and "Do it quick and do it right". The third most common discourse is "Reasoning takes time" and the least common is "Anything goes". I argued in Section 6.3 that a task focus can be seen as inevitable now and then in the mathematics classroom. This does not imply that it is inevitable that the discourse "Do it quick and do it right" is expected to occur frequently. In the construal of discourses in teacher-student communication the main focuses in the assessment acts are taken into consideration. Moreover, then construal is based on an interplay between notions from findings in Chapter 5-7 and it is not a given that a few occurrences of a focus like task lead to a construal of the discourse "Do it quick and do it right". With regards to affordances for students' active agency and learning in the mathematics classroom, my conclusion is that there are not enough instances in the data where the two discourses "Anything can be up for a discussion" and "Reasoning takes time" could be construed. As described, there are differences between classrooms' assessment practices in terms of which discourses can be construed. One conclusion is that, depending on the assessment practice in a classroom, the teachers and students take active agency in assessment discourses with more or fewer affordances for students' active agency and learning of mathematics. This is a challenge for the discipline of mathematics education. I will return to this challenge in the Discussion.

A central notion in this thesis is a view of the four construed discourses as institutional. The term institutional here signals the notion of the classroom as part of and also affected by an institutional context. As noted earlier, the discourses can be viewed as institutional traces on their own, for example, since they "take place" in the institution of school with the same discourses considered to be present in several of the classrooms visited. Below, I summarise my findings and present my conclusions regarding direct institutional traces identified in the data (see Section 8.5.2).

The direct institutional traces regarded as present in the construed discourses are the following:

- Textbooks including supplementary material. Parts of textbooks were present in the assessment acts during communication between the teacher and students in the study, and they were considered to be part of the assessment practices.
- Other documents or materials identified that were not exclusive to a particular classroom. One example is arithmetic tests downloaded from a website community for teachers. In some of the classrooms, the use of such material was part of the assessment practices.
- Manipulatives were present in several of the classrooms visited and in one it was an explicit part of the school's profile. Manipulatives were part of assessment acts in teacher-student communication.
- Documents from student/teacher/parent meetings designed by schools. The participants were expected to follow these documents during parent/teacher/student meetings so the documents affected the discursive practice during these meetings.
- School rules, for example time slots, which have an impact on the discourses that the teacher and student can engage in.

The assessment discourse “Do it quick and do it right” is not always carried (introduced and/or maintained) by direct institutional traces. This is the case in around a quarter of the video sequences and half of the document groups where the discourse is considered to be present. In these video sequences and document groups, this discourse is considered to be (partly) carried by a textbook, manipulatives or a form for student/teacher/parent meetings. The assessment discourse least present in the material is “Anything goes”, and in some of the video sequences this discourse is carried by direct institutional traces. This discourse is considered to be carried by the textbook and school rules (for example, time slots). The assessment discourse “Anything can be up for a discussion” is partly carried by institutional traces in a quarter of the video sequences and five of the document groups where it is considered to be present. This discourse is partly carried by a textbook and supplementary resources that include student self-assessment forms. The discourse is also carried by forms for student/teacher/parent meetings in the written material from some of the classrooms. The fourth discourse, “Reasoning takes time”, is carried to a small extent by what could be regarded as direct institutional traces. This concerns the use of assessment matrices and portfolios.

All four assessment discourses are partly carried by direct institutional traces. My conclusion is that, in discussing why there is a certain assessment practice where certain discourses can be construed in a classroom, it is essential to also bring in indirect institutional traces as well as direct traces not identified in the material. This is developed in the Discussion.

## 10 Discussion

Since the very beginning of this project, I have been curious to learn about classroom assessment from teachers and students in the mathematics classrooms I visited. Indeed, I learned a great deal about classroom assessment in mathematics. During the study, I also reflected on the assessment practices I was involved in whilst working as a mathematics teacher. One observation is that I could have performed the analyses on the assessment practice in mathematics of my students and myself and would still have construed the same four, or similar, discourses as those in this study. Conducting research on my own practice was never the objective and, as I noted in the preface, I am most grateful to the teachers and students who were part of making this study come true. The point I want to make here is that, despite the fact that two of the construed discourses are not considered to hold substantial affordances for students' active agency and learning, I do not consider it strange that they appeared as part of the analyses. On the contrary, one assumption is that it is also possible to find quite a number of mathematics classrooms with assessment practices dominated by the discourse "Do it quick and do it right" and/or "Anything goes" (which was not the case in any of the classrooms visited). I am drawing on reports presented, for example, by the mathematics delegation (SOU 2004:97) or in research by J. Emanuelsson (2001), Löwing (2004) and Persson (2009). At the same time, there are clearly other schools and classrooms than those in this thesis to learn from that could be subject to meticulous work on classroom assessment in mathematics. Below, I discuss my thesis and one of the main themes, which is the institutional context as a means to understanding the findings of the study.

### 10.1 Assessment Discourses and Their Relation to the Institutional Context

In the findings of this thesis, I examined direct institutional traces. As mentioned, the four assessment discourses can be viewed as institutional traces on their own. They are construed in the institution of school, where acts in one assessment discourse are taken for granted. There are acts that are

unlikely to appear in other assessment discourses in the mathematics classroom. One example where the discourse “Do it quick and do it right” is present is when a teacher communicating with a student about the student’s performance on a diagnostic test focuses the feedback mainly on how to keep the student’s notebook in order. She states that mathematics is a “clear-cut subject”. In an alternative assessment discourse, for example “Anything can be up for discussion”, there could, of course, be feedback on the preference for mathematics notes being kept in reasonable order. But in this alternative discourse, this could be related to the importance of mathematics processes not getting lost in the student’s notes. Here, the acts could be described as following the “rule” (e.g. Foucault, 1993, 2002) “mathematics processes are the primary focus in the mathematics classroom” instead of “mathematics is a clear-cut subject”. Institutional traces like discourses are more indirect than decisions made by authorities, decisions that teachers have to follow; nevertheless, they can be perceived to be as strong, or even more so, in the discursive practice.

As I see it, a student (or teacher) always takes active agency in discourses, sometimes in a discourse of assessment in the mathematics classroom and sometimes in totally different discourses. The discourse affects the individual in terms of who has the authority to act, what to communicate assessment on, and how communication is (can be) constituted. It could be said that power is executed through assessment acts. The individual, on the other hand, has the possibility to take active agency in another discourse instead or be part of a long-term change in the discourse. The power relationships between teacher and student are clearly not equal, and teachers have specific responsibilities in the assessment practice. In a dynamic view of assessment discourses (drawing on Foucault, 2002; see Section 3.2.6 of this thesis), there are opportunities for teachers and, to some extent, students in the mathematics classroom to take active agency in the teaching and learning through participation in potential alternative assessment discourses. This is not something straight forward since there also are power relationships between the discursive practices of classrooms and institutions.

One power relation where institutional rules affect classroom work is that teachers are expected to follow steering documents (described in Section 2.7) in the day-to-day classroom work. The reason for the absence<sup>141</sup> of these documents as part of the analyses in Chapters 5-8 is that I limited the scope of the data (see Section 1.3). In the following section, I relate the findings of this thesis to national steering documents as well as to some critical issues in Swedish education politics.

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<sup>141</sup> The goals specified in the national syllabus are present in one of the document groups. The content of the syllabus is addressed as a whole here in the discussion chapter (see also Section 2.7.2).

In the Swedish Education Act, it is stated that education shall be of equal standards in all schools all over Sweden (SKOLFS 1985:1100). According to the outcomes of this thesis, there are differences between the assessment practices in the classrooms visited regarding affordances for students' active agency and learning of mathematics. Given that the five teachers were not randomly chosen, it is likely that greater differences are to be identified among mathematics classrooms in Sweden. Different kinds of assessment acts, focuses of assessment acts and roles of semiotic resources are part of the discourses construed in this thesis. Assessment acts in line with those in the discourses "Anything can be up for a discussion" and "Reasoning takes time" are well represented in the steering documents. With respect to focuses of assessment acts, two aspects of mathematics competence, "dealing with mathematics notions" and "applying mathematics notions", are also clearly represented in the steering documents, especially in the national syllabus for mathematics (Skolverket, 2008). As described in Section 2.7 the aspect "critically reflecting" of mathematics competence is only present in part in the steering documents. This coincides with the outcomes of my thesis since no discourse was construed in my analysis where critically reflecting on the use of mathematics were clearly present (compare Jablonka, 2003; see also Gellert & Jablonka, 2009). The roles of semiotic resources are not clearly addressed in the steering documents. Despite this, the assessment practices in the classrooms visited allowed for these roles in the construed discourses, as did a social semiotic perspective.

My assumption is that if steering documents steered assessment practices in Swedish mathematics classrooms to the full extent, there would be affordances for students' active agency and learning in every mathematics classroom (with the exception of "critically reflecting"), in line with the theoretical considerations of this study. As was demonstrated in Chapter 8, direct institutional traces are also considered to "carry" (introduce and/or maintain) all four discourses. This occurs when a situation also includes a direct institutional trace, such as a diagnostic test in a textbook, and may have an impact on a discourse or discourses that could be construed from the situation. Why things are the way they are with respect to assessment in the mathematics classroom is far from simply being a question of the individual teacher. Pettersson (2010b) discusses the view of mathematics education depicted in the media, arguing that a bleak picture is often conveyed. Moreover, the agents that often bear the brunt of criticism are teachers and heads of schools. One example of this is an argument put forward by a recently established national agency, the Swedish Schools Inspectorate<sup>142</sup> (Skolinspektionen, 2009). Their report on mathematics education in compulsory education was produced in collaboration with researchers in mathematics educa-

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<sup>142</sup> The inspectorate's English website: <http://www.skolinspektionen.se/en/About-Skolinspektionen/About-the-Swedish-Schools-Inspectorate/>

tion. It is maintained in the results of the inspectorate's study, for example, that many students in compulsory education do not get the mathematics education specified. Among their recommendations, school heads and teachers should develop the work on grading and assessment. More importantly for this thesis, aspects relating to the institutional context which could broaden the understanding of the situation are excluded from the discussion. The quote below illustrates the view expressed in the report:

They [Many teachers] experience the syllabus as having difficult vocabulary, that it is fuzzy and that it is possible to interpret it in many different ways. Some teachers indicate in their comments that interpreting the goals to be attained also causes difficulties. *A reasonable assumption is that these teachers have not tried to develop and interpret the different parts of the syllabus.* A number of teachers believe that it would help matters if they could discuss and reason about the syllabus with their peers and that there is not sufficient shared time for that. (My translation and italics; Skolinspektionen, 2009, p. 14)

If the only force affecting work in school were the steering documents, the assumption above would be a reasonable one to make. However, in this thesis, reflected in the findings, it is argued that other forces affect assessment practices in mathematics classrooms. One force is the power executed through dominant discourses. The discourse "Do it quick and do it right" corresponds to a high degree to a traditional discourse of assessment in mathematics (Palmer, 2005<sup>143</sup>, see also Palmer, 2010; Persson, 2006<sup>144</sup>). I argue that, in trying to understand classroom work, it is essential to bring in the power executed by dominant discourses. A teacher who has just finished teacher education often encounters a competition between discourses when s/he starts working as a teacher. On one hand, when things are at their best, s/he is introduced to assessment discourses with affordances for students' active agency and learning of mathematics during her/his studies. When s/he starts working as a teacher, discursive practices with dominant discourses such as "Do it quick and do it right" may be present to a high degree at the school. For a new teacher, there is then competition over which discourse to engage in (see Persson, 2009). The dominant assessment discourses can be construed not just in the classroom or school work. They could also be construed in discussions about school in everyday life, for example, by students (discussed in relation to excerpt 55 in Section 8.4) or among politicians. For politicians, decisions are sometimes made on a national or municipal level that actually counteract what is stated in steering documents. Here I come back to Forsberg and Wallin (2006) who contend that the initial idea of a

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<sup>143</sup> Palmer (2005) describes discourses in mathematics classrooms in general, not with a focus on classroom assessment.

<sup>144</sup> Persson (2006) does not have a specific interest in assessment when she addresses thought styles in mathematics education.

system where the teachers' and schools' freedom regarding how to go through with the education more and more is becoming a regime of control. There is an increase in the control of authorities in Sweden, for example, the Swedish Schools Inspectorate. Changes like these are far removed from factors like respect for teachers and for the work carried out in schools that Pettersson (2010b) emphasises are an alternative to blaming teachers for students' achievements in mathematics.

What assessment discourses can be construed in mathematics classrooms is a matter of a complex interplay between steering documents, decisions made on different levels within and outside the institution of school, and dominant traditional discourses, as well as alternative discourses and agents in discursive practices. In order for there to be a positive change in affordances for students' active agency and learning of mathematics with respect to classroom assessment, like Pettersson (2010b), I am certain that the best way to address this is not to blame teachers. Instead, it is a question of looking at every part of this interplay as a whole. One issue is that decisions about school must be coherent with regards to these affordances and thus not counteract one other. The contribution of this thesis on this issue is addressed in Section 10.3.

## 10.2 Choices Made During the Study

One of my aims for the work on this thesis was to carry out quality research in every aspect, which I link, like Goodchild (2009), to ethical considerations. My view is that quality in research on classrooms pertains not just to the effects of the research on participating teachers and students but also to the long-term effects of classroom research as a whole. In the complex landscape of education research, I found a path that entails choices about theory, methods and so on. Below, I discuss some of these choices.

One choice was to position the study in a social and critical paradigm in mathematics education. This was a fruitful step since it gave me the means to emphasise some aspects of the thesis over others. One example is how I chose to pay attention to affordances for students' active agency and learning in the mathematics classroom throughout my analyses and writing.

The choice of theory was, to some extent, made quite early on. In the pilot study, I used the social semiotic meta-functions as a basis to direct my analyses to three functions of assessment in teacher-student communication (Halliday, 2004; Kress et al., 2001; Van Leeuwen, 2005). I also made multimodal transcripts. I found this rewarding and, since the three meta-functions coincided largely with my initial research questions, including support for an emphasis on mathematics "content", I chose this as one theory for the main study. With respect to social semiotics, which is not a theory for learning, I incorporated a design-theoretical perspective for how I under-

stand learning (Selander, 2008ab) in this thesis. I operationalised the social semiotic meta-functions into three analysis and outcomes chapters. In doing so, I made an analytical distinction between the meta-functions. It could be argued that I was not “true” in full to each of the meta-functions. That is, there are notions, it could be argued, that strictly speaking would be better placed under another meta-function. The choice of which chapter to put the different findings in was also determined by my purpose and the thesis as a whole.

It was not as easy to decide on the next main theory. I knew at an early stage that I wanted a theory that would help me address social aspects. I argued elsewhere that the reason I chose to rely on Foucault is because of his notion of power, which I operationalised in terms of affordances for students’ active agency in the mathematics classroom. For this thesis, the primary contribution is Foucault’s concept of discourse. This provided me with a productive analytical tool that I could operationalise in combination with the other theories. Moreover, the concept of discourse is a means, as noted in the previous section, for understanding and discussing my findings. A secondary, but advantageous, aspect was that it was possible to coordinate Foucault’s not very structured framework with the analytical structures I was already using. Discourse according to Foucault is often understood as large entities encompassing entire disciplines, but can also be conceptualised as smaller discourses construed in relation to specific interests in a discipline. The latter view is the way I use the concept. This is similar to the way Walkerdine’s (1988) use (see also Norén, work in progress; Palmer, 2010).

I also draw on the work of Hattie and Timperley (2007). It could be argued that Hattie and Timperley’s model is not really compatible with a social and critical paradigm. Their review is based on quantitative research where students’ achievements are related to different kinds of feedback. Fully aware of this, I nonetheless chose to incorporate the model since it was structured on similar notions as the two first research questions of this study. Moreover, I adapted my understanding of the assessment acts and focuses to align it with the theoretical underpinnings that this thesis is based on. As for other theories, such as mathematics competence according to Skovsmose (2005), they can be viewed as part of a social and critical paradigm and coordinated with the main theories of this study. I also drew on Mellin-Olsen (e.g. 1991). The theory for learning and teaching addressed in his work is constructivism, which is not theoretically compatible with learning, as it is conceptualised in this thesis based on a design-theoretical perspective (Selander 2008ab). I do not operationalise learning according to Mellin-Olsen, and in the aspects I do refer to him – critical aspects and students’ roles in assessment – I do not see any incompatibilities.

A significant notion with respect to methods in this study is the multimodal approach in social semiotics (Kress et al., 2001; Rostvall & West, 2005). The use of video recordings as one source of data with multimodal tran-

scripts is time-consuming, as is an examination of written material in its multimodal aspects. My conclusion from this research process is that a multimodal approach is a useful means to develop a detailed understanding of classroom communication. There were several instances where I would not have captured assessment acts related to feedback if I had not paid attention to communication in a multimodal sense. This method was productive not just for some of the transcripts where semiotic resources other than speech clearly contributed to the interpretation of speech. It also helped in interpretations I forced myself to pay attention to during the transcription and analyses of semiotic resources, such as gestures and facial expressions, when they were not “calling” for attention. Sometimes this occurred when there was no speech at all. At the same time, if interpersonal communication and ideational representations in assessment acts had been conveyed using speech as one semiotic resource but without access to visual semiotic resources as well, it would have been hard to capture nuances. On the other hand, the use of multimodal transcripts calls for a careful selection of what parts of lessons to transcribe and what semiotic resources, and when, to transcribe (see Sections 4.9.3 and 4.9.4).

### 10.3 The Contributions of This Thesis

As mentioned in Chapter 2, I found no study in Sweden examining research on the assessment in the mathematics classroom that takes place in the communication between teacher and student.<sup>145</sup> In this respect, the findings in the thesis contribute to an understanding of classroom assessment in mathematics in Sweden that was not evident before. Moreover, I did not find any account of research on classroom assessment, even outside Sweden, that combines assessment acts, focuses of the assessment, and roles of semiotic resources. I found discourses of assessment described in Chapter 2 and elsewhere (e.g. Askew and Lodge, 2000; Broadfoot & Pollard, 2000; Morgan et al., 2002), but not assessment discourses in mathematics classrooms with a similar combination of interests as those in this thesis.

The contributions of this thesis are related to the comprehensive view that the construed discourses offer. I construed the four discourses in relation to my purpose, theories and analyses of data, and I do not claim that these are the only possible discourses of assessment in mathematics classrooms to construe (see the next section). They are not only situated in a national institutional context; like all discourses, they also undergo change over time.

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<sup>145</sup> In Chapter 2, I concentrated on research conducted in compulsory education. I found no study similar to this thesis carried out in Swedish upper secondary school or at the university level either. In Boesen (2006), there is an interest in tests constructed by teachers, which can be viewed as part of teacher-student communication. On the whole, the research interest in Boesen is quite different than in this study, with more attention paid to tests.

Clearly, it is possible to construe variations of the four discourses in the study. At the same time, when I presented them to participating teachers and research colleagues, they commented that the discourses make sense in relation to their experiences in the mathematics classroom. Hence, they are considered to be recognisable. The constellation of discourses, with the connections between assessment acts, focuses in the mathematics classroom, and roles of semiotic resources, offers teachers and other agents the means to grasp essential aspects of assessment practices in mathematics classrooms. I argue that there is positive power in an increased awareness of discourses like these in mathematics education relative to a social and critical paradigm. For teachers, the discourses can be a starting point for identifying how various assessment discourses take place in the mathematics classroom. In such an activity, the implicitness in assessment practices is made more explicit. One example here is how the discourse “Do it quick and do it right” takes place in the classroom, possibly contrary to the teacher’s original plan. The reason for this can be institutional traces, for example, through demands from municipalities, where a dominant “traditional” discourse such as “Do it quick and do it right” can be construed. It can also be students “bringing the discourse into” the mathematics classroom (see, for example, excerpt 55 in Section 8.4) and/or the teacher’s prior engagement in the discourse, with colleagues and/or as a (young) student her/himself (drawing on Persson, 2009). In identifying dominant discourses with low affordances for students’ active agency and learning, the identification itself can be part of the forming of resistance in favour of alternative discourses such as “Anything can be up for a discussion” and “Reasoning takes time”, or even a critical discourse in the mathematics classroom. Another beneficial consequence for students could be that aspects involving assessment in the mathematics classroom are made more explicit to all students, such as the goals, criteria and procedures for assessment. The discourses in this thesis can be a starting point for discussions about assessment practices among teachers and school heads, among people responsible on the municipal and national level. During our quality meetings, the participating teachers stressed the potential of the four discourses for directing attention in discussions among school staff members and for teachers’ self-reflection. To summarise, I contend that the construed discourses of assessment in the mathematics classroom, together with other research that takes into account the institutional context (e.g. Morgan et al. 2002), can be powerful in discussions about, understandings of, and positive changes in assessment practices in mathematics classrooms. Similarly, I regard the findings as a fruitful basis for more research on assessment practices in Swedish mathematics classrooms.

Although the discourses are regarded as the main outcomes, I view the detailed findings in Chapters 5-7 as contributions on their own. I operationalised part of Hattie and Timperley’s (2007) structure, and contributed new findings in identifying assessment acts and focuses of assessment as they

appear in mathematics classrooms. I also expanded and modified the assessment acts based on power according to Foucault (e.g. 1980). I added findings that emerged in an interplay between the purpose of the study and my analysis, for example, feed back as interest and engagement, and feed forward as challenging. One original aspect of this thesis is the close attention given to the focuses of assessment acts in the *mathematics* classroom. I operationalised mathematics competence according to Skovsmose (2005). Conducting an analysis on the roles of semiotic resources also produced findings that I consider to be new. This analysis shed light on aspects like the role of silence in focuses of assessment acts (discussed in the following section) and the notion of paying attention to available semiotic resources in assessment acts. Depending on the interest, the findings for each of the first three research questions (Chapters 5-7) can constitute starting points for discussions among teachers and other agents about the mathematics classroom and for further research.

The outcomes of this thesis were produced in a Swedish institutional context so in one sense they are mainly relevant to mathematics education in Sweden. However, the outcomes can be considered to be valid for the institution of mathematics education in formal schooling not just in Sweden (Jablonka, 2006; see also West, 2007). Consequently, the outcomes can also be a contribution to the international discipline of mathematics education. Acknowledging the situatedness of the findings of this thesis, I think they can be a fruitful starting point for research with similar interests, with changes expected and additions made especially with respect to differences in national contexts. Another context-related issue is that the outcomes were produced in mathematics classrooms with rather young students, ten-year-olds. The findings can provide a basis for similar studies performed in mathematics classrooms with younger or older students. I would expect issues about marks to be identified in the discourses for classrooms with older students.

The findings can also be relevant for the assessment “field” in general. Drawing on J. Emanuelsson (2001), my hypothesis is that there would be differences in terms of what kinds of discourses could be construed for different school subjects. The findings of this thesis can be a starting point for this kind of research.

## 10.4 What is Not Addressed in This Thesis? A Basis for Future Research

In this study, as in all research studies, there are closely related themes that I chose to (partly) ignore. One theme not addressed in full in this thesis is how different assessment discourses in the mathematics classroom may be more

or less available for taking active agency in for different groups of students (emphasised by Morgan, 2000). Since I video taped the teachers' communication with all their students, there are possibilities to perform this kind of analysis in the future. I contend that the findings of this thesis, along with findings and arguments presented, for example, by Mercier et al. (2000) and Morgan (2000), constitute a solid basis for further studies on equity issues relating to assessment discourses in the mathematics classroom.

Another theme is all the other potential discourses of assessment in mathematics classrooms that are not construed. The discourses presented in this study are based on data from five classrooms, and I described the four discourses it was possible to construe. With respect to Jablonka (2003), one option that could be added is a critical discourse. In this discourse, there would also be a clear focus on Skovsmose's (1990, 2005) critically reflecting as part of mathematics competence in assessment acts. There could also be critical discussions present with feed back and feed forward between teacher and students regarding semiotic resources and their potentials and constraints. The silences in teacher-student communication in this thesis indicated a positive relationship with focuses in assessment acts. It is also possible to imagine a discourse where silences by the teacher communicate disapproval and/or some kind of ambivalence (Hodgen & Webb, 2008). I can see a discourse, connected to this or on its own, where activities can take time but where the focus is still on the task and there is little reflection about which semiotic resources are the most productive. This discourse could be labelled "Take your time, but it has to be right".

Another theme not emphasised in this thesis is trustworthiness of teachers' assessments. I did not find many instances of communicative acts by the teacher that could be considered mathematically incorrect (which there are examples of in Persson, 2009). Furthermore, I did not compare teachers' assessments of similar student performances (see Watson, 2000). That was not the intention of this thesis. I propose a broader approach to discussing the quality of classroom assessment in mathematics. Hence, the interest of this thesis is assessment discourses in the mathematics classroom. One issue to address in promoting teachers' engagement in assessment discourses with affordances for students' active agency and learning in the mathematics classroom is the mathematics competence of mathematics teachers (Persson, 2009).

It could be argued that I took the presence of goals in the mathematics classrooms for granted. One could ask whether there should also be teaching where the goals for learning are not stated beforehand (see e.g. Mellin-Olsen, 1993). On one hand, I certainly consider it important to have teaching and learning processes in the mathematics classroom where a goal or objective is not always stated. Here, assessment acts like interest in students' mathematics communication and the openness of questions are also a prerequisite for students' active agency. On the other hand, I believe that is

essential to make clear to all students the goals, criteria, and procedures used to assess student performance. For some students, these are obvious since they come from a social/class background where similar qualities are encouraged outside school (see Walkerdine, 1988). Such assessment aspects are crucial for inviting all students into mathematics discourses, and one issue here is the clarity of assessment framings.

Finally, I address the roles of the participants and myself in this research project. As described in Section 4.3, there were different roles over time in the project: data extraction agreement, clinical partnership, and a co-learning agreement. I chose a design where I steered the research focus and research process with regard to the purpose chosen. At the same time, there were instances of co-learning when the teachers and I met for quality meetings. This combination of different roles was fruitful for the project, giving me the possibility to act as a researcher in different ways. One path I see for future research is, like Torrance and Pryor (2001), to use this study as a basis for research projects in which I work together with teachers and students to research assessment practices with respect to affordances for students' active – and critical – agency and learning in the mathematics classroom.

# Summary

This is a study of classroom assessment, which is one feature that influence students' engagement and learning<sup>146</sup> in the mathematics classroom. In this study, I regard classroom assessment as a concept with broad boundaries. Examples of what can be part of classroom assessment are diagnostic tests, documentation such as portfolios, and acts in communication between teacher and student during day-to-day work.

I found no study in Sweden examining the assessment in the mathematics classroom that takes place in the communication between teacher and student. In this respect, the findings in the thesis contribute to an understanding of classroom assessment in mathematics in Sweden that was not evident before. Moreover, I did not find any account of research on classroom assessment, even outside Sweden, that combines assessment acts, focuses of the assessment, and roles of semiotic resources (symbols, gestures, speech and the like), which I do in the thesis. The purpose of the study is to analyse and understand explicit and implicit assessment acts in discursive practices in mathematics classroom communication in terms of affordances for students' active agency<sup>147</sup> and learning. The research questions are as follows:

1. How do assessment acts related to feedback take place in teacher-student communication in mathematics classrooms and what affordances can be connected to students' active agency?
2. What are the focuses of the assessment acts in the mathematics classroom and what affordances can be connected to students' learning?
3. What roles do different semiotic resources play in the assessment acts and what affordances can be connected to students' active agency and learning?
4. What discourses of classroom assessment in mathematics can be construed based on the findings from the previous three questions? Furthermore, what institutional traces can be identified in relation to the construed discourses and what affordances can be connected to students' active agency and learning?

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<sup>146</sup> Learning is understood as meaning making towards an increased readiness to engage in the world with an increased use of semiotic resources and artefacts in a discipline such as mathematics (Selander 2008ab; Selander & Rostvall 2008).

<sup>147</sup> Briefly, agency is understood to be people's capacity to make choices and to impose those choices on the world.

The first three questions are related to three social semiotic meta-functions (Halliday, 2004; Van Leeuwen, 2005). The fourth research question is connected to a Foucauldian concept of discourse (e.g. 2002). The unit of analysis is “assessment acts related to feedback in discursive practices considered to occur in institutionally situated teacher-student communication in mathematics classrooms in grade four”. A multimodal approach is found in theoretical considerations as well as in the process of data gathering (for example, video recording) and transcribing (performed multimodally).

One finding in relation to the first research question is how some assessment acts hold affordances for students’ active agency to a higher degree than others. An example is when the teacher communicates *feed back* as *approval* and/or *disapproval*. The teacher then adopts the role of the one who makes the judgement in terms of good or bad about the students’ demonstrated knowing. If the teacher instead communicates *interest* in the student’s demonstrated knowing, the assessment lies in the student’s contribution to mathematics communication being something to build future communication upon. The latter holds more affordances for the students’ active agency the mathematics classroom than the first ones mentioned.

A key outcome of the analysis for the second research question is that there are some focuses of assessment acts in the mathematics classroom that hold more affordances for students’ learning of mathematics than others. The affordances for students’ learning for the focuses *self* and *task* are considered to be low. The student is not promoted to engage in the use of semiotic resources in the discipline of mathematics during the assessment act when either of the focuses *self* and *task* are present. For the focus on *process* there are considerable affordances for students’ learning of mathematics. This focus is connected to mathematics competence drawing on Skovsmose (1990, 2005). When the *process* focus is present in assessment acts, there are considered to be affordances in the assessment acts for students’ learning of *dealing with mathematics notions*, *applying mathematics notions* and/or *critically reflecting on mathematics applications*.

A conclusion with respect to the third research question is that an essential aspect that needs to be taken into account in discussing classroom assessment in the mathematics classroom is the semiotic resources available to students for representing mathematics knowing. In such a discussion, there needs to be a connection between the students’ meaning making and learning of mathematics and what semiotic resources are provided and why. The findings also indicate that open questions (several possible correct answers and/or solutions) are needed in order to provide possibilities for a focus on processes such as inquiry/problem-solving and reasoning/arguing in assessment acts. Open questions also hold affordances for students to take active agency since there are choices to be made by the student in answering the questions.

One main conclusion of this thesis is how four construed discourses of assessment in the mathematics classrooms visited hold different affordances for students' active agency and learning. The four discourses are:

*Do it quick and do it right*

In this discourse, the feed back is mostly from teacher to student. Questions posed by the teacher are rarely open with the teacher knowing the answer. There are rarely follow-up questions. Feed forward concerns what to do next (as opposed to what to learn) as guiding, and challenging is not common. Feed up (feed back and forward related to goals) is not present in this discourse. The focus is mostly on task, often whether an answer is right or wrong. The semiotic resources used, including artefacts, are mainly the ones that are specified in the textbook. Both teacher and student communicate in short utterances, and there are rarely longer silences. The main agent in this discourse is the teacher, and the affordances for students' active agency are not high. As a consequence, the lack of focus on mathematics processes allows low affordances for students' learning of mathematics.

*Anything goes*

There is not much articulated feed back in the discourse "Anything goes", apart from occasional approval. Here too, the feed back is mainly from teacher to student. There is a presence of also open questions. Challenging is not common. Infrequently there are critical discussions about students' solutions, and answers possible to consider as mathematically wrong can also be left unchallenged. Different semiotic resources, including artefacts, are welcomed, and semiotic resources are rarely restricted. The teacher and students use short sentences, and there is not much silence. Often in this discourse, the teacher is the most active agent. Sometimes the teacher takes a more passive role in the discourse. S/he then does not interfere with students' reasoning even though something possible to consider as mathematically wrong is demonstrated. The affordances for students' active agency and learning in this discourse are considered low.

*Anything can be up for a discussion*

There are several instances of assessment acts, mainly feed back and feed-forward, taking place in this discourse, both in the direction from teacher to student and visa versa. Quite often the questions posed are open. Often the teacher and student show interest in the communication on mathematics and there is also an awareness of students' alternative interpretations of tasks. Sometimes the student is challenged with respect to her/his continued learning. The focus is mostly on process. "Wrong" answers are also starting points for a discussion, but, in the end, it is always clear what can be considered mathematically correct. Different semiotic resources are acknowledged and at times the teacher promotes, whilst at other times restricts, the use of

semiotic resources dependent upon the meaning making and learning process demonstrated by the student(s). In this discourse, there are considered to be affordances for students' active agency and learning of mathematics.

#### *Reasoning takes time*

In this discourse, the three kinds of assessment acts (feed back, feed forward, feed up) can be present and in both directions between teacher and student. There are often instances of recognition of the students' demonstrated knowing, sometimes in relation to stated goals. The students are often challenged towards new learning. The focus is on process, with most emphasis on the processes inquiring/problem-solving, reasoning/arguing, defining/describing and occasionally constructing/creating. There is also some presence of the process reflecting on models. Different semiotic resources are acknowledged, and the use of semiotic resources can also be promoted or restricted when serving a certain process. In this discourse, silence is common and the possibility (for both teacher and student) to be silent seems to serve the mathematics focus. In this discourse as well, the affordances for students to take active agency are high. Similarly, the affordances for students' learning of mathematics are considered to be high, including a wide range of mathematics processes.

In the findings there are differences between the classrooms regarding which discourses were construed in the analysis. In two of the classrooms all four discourses are construed. In two classrooms, the two most common discourses, "Do it quick and do it right" and "Anything can be up for a discussion", are construed. In one classroom there is a predominance of the discourses "Anything can be up for a discussion" and "Reasoning takes time". One conclusion is that, depending on the assessment practice in a classroom, the teachers and students are acting according assessment discourses with more or fewer affordances for students' active agency and learning of mathematics. I argue that, in trying to understand classroom work, it is essential to bring in the power executed by dominant discourses, such as "Do it quick...". What assessment discourses can be construed in mathematics classrooms is a matter of a complex interplay between steering documents, decisions made on different levels within and outside the institution of school, and dominant traditional discourses, as well as alternative discourses and agents in discursive practices. A positive change in affordances for students' active agency and learning of mathematics with respect to classroom assessment is a question of looking at every part of this interplay as a whole. One issue is that decisions about school must be coherent with regards to these affordances, and not counteract one other.

# Sammanfattning

Föreliggande studie handlar om klassrumsbedömning, som är en aspekt som påverkar elevers engagemang och lärande<sup>148</sup> i matematikklassrummet. Bedömning har i min studie vida gränser. Exempel på vad som kan ingå i klassrumsbedömning är diagnoser, dokumentation genom till exempel portföljer samt handlingar i klassrumskommunikation i det dagliga skolarbetet.

Jag har inte kunnat hitta någon svensk forskningsstudie där kommunikationen mellan lärare och elev i matematikklassrum har analyserats med ett uttalat bedömningsintresse. Med avseende på detta bidrar denna studie till en förståelse av klassrumsbedömning i matematik i Sverige. Det var inte heller möjligt att finna forskningsbeskrivningar, internationella studier inräknade, som kombinerar bedömningshandlingar, bedömningsfokus i matematikklassrummet och de roller som semiotiska resurser (symboler, gester, prat och liknande) spelar, vilket görs i föreliggande avhandling. Syftet med studien är att analysera och förstå explicita och implicita bedömningshandlingar i kommunikationen i matematikklassrums diskursiva praktiker. Detta görs i termer av vilka möjligheter som finns för elevers aktiva agens<sup>149</sup> och lärande. Forskningsfrågorna är dessa:

- 1 Hur äger bedömningshandlingar relaterade till feedback rum i kommunikationen mellan lärare och elev i matematikklassrum. Vilka möjligheter kan kopplas till elevers aktiva agens?
- 2 Vilka fokus har bedömningshandlingarna i matematikklassrummet och vilka möjligheter kan kopplas till elevers lärande?
- 3 Vilka roller spelar olika semiotiska resurser i bedömningshandlingarna och vilka möjligheter kan kopplas till elevers aktiva agens och lärande?
- 4 Vilka bedömningsdiskurser i matematikklassrum kan uttolkas utifrån framtagna resultat för de tre ovanstående frågorna. Dessutom, vilka institutionella spår kan identifieras i relation till de uttolkade diskurserna och vilka möjligheter för elevers aktiva agens och lärande kan identifieras?

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<sup>148</sup> Lärande förstås som meningsskapande i riktning mot en ökad beredskap att engagera sig i världen med ett ökat användande av semiotiska resurser inklusive artefakter i en disciplin, till exempel matematik (Selander 2008ab; Selander & Rostvall 2008).

<sup>149</sup> Kortfattat så handlar agens om människors möjligheter att göra val och att låta dessa val påverka världen.

De tre första frågorna hör samman med tre socialsemiotiska metafunktioner (Halliday, 2004; Van Leeuwen, 2005). Den fjärde forskningsfrågan grundas i Foucaults diskursbegrepp (t.ex. 2002). Analysenheten (unit of analysis) i denna studie är ”bedömningshandlingar relaterade till feedback i diskursiva praktiker som antas uppstå i den institutionellt situerade kommunikationen mellan lärare och elev i matematikklassrum i årskurs fyra”. I studien har jag använt mig av en multimodal ansats såväl i teoretiska överväganden som i datainsamling (till exempel videoinspelning) och transkribering (genomförda multimodalt).

Ett resultat av analyserna för den första frågeställningen är hur en del bedömningshandlingar erbjuder större möjligheter till elevers aktiva agens än andra. Ett exempel är när läraren kommunicerar *feed back* som *beröm* eller *missnöje*. Läraren tar då rollen som den som värderar elevens visade kunnande i termer av bra eller dåligt. Om läraren i stället visar *intresse* för elevens visade kunnande, då ligger bedömningen i att elevens bidrag till kommunikationen i matematik är något att bygga den fortsatta kommunikationen på. Den sistnämnda bedömningshandlingen innebär större möjligheter för elevens aktiva agens i matematikklassrummet än den första.

Ett avgörande resultat av analysen för den andra forskningsfrågan är att vissa bedömningshandlingars fokus i matematikklassrummet erbjuder större möjligheter för elevers matematiklärande än andra. Möjligheterna för elevers lärande när det gäller fokus på eleven *själv* och på *uppgiften* som sådan anses låga. Eleven blir inte uppmuntrad att använda matematikens semiotiska resurser under bedömningshandlingarna när ett fokus på eleven *själv* eller *uppgiften* som sådan är närvarande. I avhandlingen lyfter jag fram hur ett fokus på *processer* i stället erbjuder rika möjligheter för elevers lärande i matematik. Jag har kopplat detta fokus till Skovsmose's matematikkompetens (1990, 2005). När bedömningshandlingarna har ett fokus på *process* har jag i studien kommit fram till hur det kan finnas möjligheter för elevers lärande av *hantering av matematiska begrepp och metoder, tillämpande av matematiska begrepp och metoder samt kritiskt reflekterande av matematiska tillämpningar*.

En slutsats jag drar i relation till den tredje frågeställningen är att det är angeläget att i alla diskussioner om bedömning i matematikklassrum ta med de semiotiska resurser med vilka elever erbjuds representera matematiskt kunnande. Här behövs en koppling mellan elevers meningsskapande och lärande och vilka semiotiska resurser som erbjuds och varför. Resultaten visar också betydelsen av öppna frågor. Dessa frågor erbjuder eleven flera möjliga matematiskt korrekta svar och/eller flera möjliga sätt att visa lösningar. Öppna frågor behövs för att erbjuda möjligheter för fokus på processer som undersökning/problemlösning och resonering/argumenterande i bedömningshandlingar. Öppna frågor erbjuder också möjligheter för elever att ta aktiv agens eftersom det ingår att eleven gör val när hon/han svarar på frågorna.

En avgörande slutsats i föreliggande avhandling är hur fyra bedömningsdiskurser uttolkade i de besökta matematikklassrummen medför olika möjligheter för elevers aktiva agens och lärande. De fyra diskurserna är:

#### *Gör det fort och gör det rätt*

I denna diskurs går den "feed back" som finns oftast i riktning från lärare till elev. Frågor som ställs av läraren är sällan öppna och av karaktären att läraren redan vet svaret. Det ställs sällan uppföljande frågor. "Feed forward" handlar oftast om vad som ska göras härnäst (i motsats till vad som är möjligt att lära). Detta görs genom lärarens instruktioner, och det är sällan som eleverna utmanas. "Feed up" ("feed back" och "feed forward" i relation till mål) är sällan närvarande i denna diskurs. Fokus ligger ofta på uppgiften, och då ofta huruvida ett svar är rätt eller fel. De semiotiska resurser som används, inklusive artefakter, är huvudsakligen de som är specificerade i läroboken. Både lärare och elever kommunicerar i korta yttranden och det är sällan längre tystnader. Huvudagenten i denna diskurs är läraren och de erbjudna möjligheterna för elevers aktiva agens är inte stora i diskursen. En konsekvens av frånvaron av fokus på matematiska processer är att de möjligheter till matematiklärande som erbjuds eleverna är låga.

#### *Vad som helst duger*

I denna diskurs är det inte mycket artikulera "feed back" och när det förekommer "feed back" handlar det oftast om beröm. Också här går återkopplingen främst i riktning från lärare till elev. Här finns det en närvaro av också öppna frågor. Utmaningar är inte vanliga. Det förekommer sällan konstruktivt kritiska diskussioner om elevers lösningar och svar som kan anses matematiskt felaktiga kan lämnas utan vidare diskussion och utmaning. Olika semiotiska resurser, inklusive artefakter, välkomnas och det är sällan någon form av begränsning av möjliga resurser. Lärare och elever använder korta yttranden och där är sällan tystnader. Ofta är läraren den aktiva agenten i denna diskurs. Ibland tar läraren en mer passiv roll. Hon/han går då inte in i elevers resonemang trots att sådant som kan anses matematiskt felaktigt visas. De möjligheter som erbjuds för elevers aktiva agens och lärande anses vara låga i denna diskurs.

#### *Allt kan tas som utgångspunkt för en diskussion*

Det finns flera tillfällen av bedömningshandlingar, främst "feed back" och "feed forward" i denna diskurs, både i riktning från lärare till elev och vice versa. Ofta är de frågor som ställs öppna. Lärare och elever visar ofta intresse för kommunikationen i matematik och det finns också en öppenhet gentemot elevers alternativa förståelser av uppgifter. Ibland blir eleven utmanad med avseende på hennes/hans fortsatta lärande i matematik. Bedömningshandlingarnas fokus är oftast på processer. "Felaktiga" svar är också utgångspunkter för diskussioner, men det är alltid, till slut, klart vad som kan

anses som matematiskt korrekt. Olika semiotiska resurser accepteras. Ibland befrämjar, och ibland begränsar, läraren användningen av vissa semiotiska resurser i relation till elevens visade meningsskapande och lärande. I denna diskurs anses det erbjudas möjligheter för elevers aktiva agens och lärande i matematik.

### *Resonemang tar tid*

I denna diskurs ingår tre sorters bedömningshandlingar, "feed back", "feed forward", och "feed up", och i båda riktningarna mellan lärare och elev. Det förekommer ofta att elevens visade kunnande erkänns, och ibland relateras det också till uppställda mål. Eleverna utmanas ofta mot nytt lärande. Bedömningshandlingarnas fokus ligger ofta på processer, med störst betoning på processerna undersökande/problemlösning, resonerande/argumenterande, definierande/beskrivande och konstruerande/skapande. Då och då sker det också ett reflekterande över de matematiska modeller som används i relation till den ursprungliga frågeställningen. Olika semiotiska resurser accepteras, och dessa kan också befrämmas eller begränsas för att tjäna en särskild process. I denna diskurs är tystnader vanliga och möjligheten (för både lärare och elev) att vara tyst verkar befrämja bedömningshandlingarnas matematiska fokus. Även i denna diskurs anses de möjligheter som erbjuds för elevers aktiva agens vara stora. Också för elevers lärande av matematik anses möjligheterna stora och här ingår ett brett spann av matematiska processer.

I studiens resultat visar sig skillnader i förekomsten av de olika diskurserna i de besökta klassrummen. I två av klassrummen är alla fyra ovanstående diskurser uttolkade. I två av klassrummen är de två vanligaste diskurserna uttolkade: "Gör det fort och gör det rätt" samt "Allt kan tas som utgångspunkt för en diskussion". I ett klassrum är det en dominans av diskurserna "Allt kan tas som utgångspunkt för en diskussion" och "Resonemang tar tid". En slutsats jag drar är att lärare och elever, beroende på klassrummets bedömningspraktik, agerar enligt olika bedömningsdiskurser med fler eller färre erbjudna möjligheter för elevers aktiva agens och lärande i matematik. Jag menar att när jag och andra försöker förstå klassrumsarbete, då är det nödvändigt att också räkna med den makt som utövas av dominerande diskurser, som "Gör det fort och gör det rätt". Vilka diskurser som kan uttolkas i ett matematikklassrum är en fråga om en komplex samverkan mellan styrdokument, beslut fattade på olika nivåer i och utanför skolan som institution samt dominerande diskurser i den bredare institutionella kontexten. I denna komplexa samverkan ingår också alternativa diskurser samt agenterna i diskursiva praktiker. En positiv förändring för elevers erbjudna möjligheter för aktiv agens och lärande i matematik i klassrumsbedömning är en fråga om att ta hänsyn till alla delar i denna samverkan och att fånga helheten. En kritisk fråga är att olika beslut som påverkar skolans arbete måste stämma överens med varandra och relaterats till erbjudna möjligheter för elever.

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# Appendices

## Appendix A

### **Bästa föräldrar (målsmän) och elever**

Jag heter Lisa Björklund Boistrup och skriver nu till er i samband med planeringen av ett forskningsprojekt tillsammans med klassens lärare. I grunden är jag mellanstadielärare och jag har i många år varit intresserad av samspelet mellan lärare och elever. Nu är jag doktorand i didaktik. Att vara doktorand innebär att jag går igenom en forskarutbildning där det ingår att göra ett forskningsarbete som resulterar i en doktorsavhandling. Huvudhandledare för mitt arbete är Professor Astrid Pettersson (08-1207 6590, [astrid.pettersson@umn.su.se](mailto:astrid.pettersson@umn.su.se)).

### **Vad handlar projektet om?**

Det övergripande syftet med denna forskningsstudie är att studera kommunikationen mellan lärare och elev i matematikundervisningen, med fokus på bedömningsprocesser i vid mening. Det insamlade materialet kommer att bestå av videoinspelningar, ljudinspelningar och skriftligt material. Det finns oerhört lite kunskap om dessa klassrumsprocesser såväl nationellt som internationellt så därför är en studie som denna värdefull.

### **Hur kommer arbetet med klassen gå till?**

I projektet kommer jag först att vara med i klassrumsarbetet under någon eller några lektioner så att jag och eleverna får vänja oss vid varandra. Sedan kommer jag att med hjälp av videofilmning och ljudinspelning fånga kommunikationen mellan lärare och elev under ungefär en vecka. Jag kommer också att samla in skriftligt material t.ex. arbetsblad och liknande. För att hela materialet inte ska bli allt för omfattande kommer jag att slumpvis lotta ut två elever och det blir kommunikationen mellan dessa elever och lärare som jag i första hand kommer att studera. Allt övrigt insamlat material kan komma att användas i denna och/eller efterföljande studier. Jag vill särskilt framhålla att forskningsfokus inte ligger på enskilda

individer utan på övergripande aspekter när det gäller kommunikationen mellan lärare och elev i matematikundervisningen.

### **Hur ska resultatet redovisas?**

Framför allt kommer resultatet att presenteras i en doktorsavhandling och jag kommer också att skriva artiklar, presentationer på konferenser m.m. I resultatredovisningen kommer inga foton eller filmsekvenser förekomma och alla deltagares namn kommer att avidentifieras. Personuppgifter och andra uppgifter som möjliggör identifiering kommer att behandlas konfidentiellt och under tystnadsplikt i enlighet med personuppgiftslagen.

### **Vad lovar jag?**

Jag lovar att projektet kommer att genomföras i enlighet med Vetenskapsrådets forskningsetiska principer för humanistisk-samhällsvetenskaplig forskning. Alla originaldokument (filmer, ljudinspelningar, pappersdokument) och arbetskopior kommer att förvaras oåtkomliga för obehöriga. Medverkan i studien är frivillig och deltagarna kan när som helst under projektet kan avbryta sin medverkan. I övrigt lovar jag att göra allt för att forskningen ska ske med högsta kvalitet och att resultatet ska vara till nytta för matematikundervisningen i framtiden. Hör gärna av er per mail eller telefon om ni har några frågor! På nästa sida finns en fullmakt som jag ber er att skriva på.

Med vänlig hälsning  
Lisa Björklund Boistrup

## Fullmakt

Denna fullmakt avser tillstånd för Lisa Björklund Boistrup (med eventuell medhjälpare) att video- och ljuddokumentera undervisningssituationer där du/ditt barn medverkar samt tillstånd att använda materialet för den ovan beskrivna forskningen. Kryssa för ett av nedanstående alternativ och skriv under (både elev och målsman).

Elevens namn:

---

- ☐ Vi (elev och målsman) säger ja till elevens medverkan i Lisa Björklund Boistrups forskningsprojekt och vi tillåter videofilmning av undervisning där eleven är med i fokus.
- ☐ Vi (elev och målsman) säger nej till elevens medverkan i Lisa Björklund Boistrups forskningsprojekt, men vi tillåter videofilmning av undervisning där eleven är med i bakgrunden.
- ☐ Vi (elev och målsman) säger nej till all medverkan i Lisa Björklund Boistrups forskningsprojekt.

Datum: \_\_\_\_\_

Underskrift av eleven:

---

Underskrift av målsman:

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## Appendix B

### **Forskningskontrakt**

Jag heter Lisa Björklund Boistrup och detta är en beskrivning av det forskningsprojekt som jag vill genomföra tillsammans med dig. I grunden är jag mellanstadie lärare och jag har i många år varit intresserad av samspelet mellan lärare och elever. Nu är jag doktorand i didaktik. Att vara doktorand innebär att jag går igenom en forskarutbildning där det ingår att göra ett forskningsarbete som resulterar i en doktorsavhandling. Huvudhandledare för mitt arbete är Professor Astrid Pettersson (08-1207 6590, [astrid.pettersson@umn.su.se](mailto:astrid.pettersson@umn.su.se)).

### **Vad handlar projektet om?**

Det övergripande syftet med denna forskningsstudie är att studera kommunikationen mellan lärare och elev i matematikundervisningen, med fokus på bedömningsprocesser i vid mening. Det insamlade materialet kommer att bestå av videoinspelningar, ljudinspelningar och skriftligt material. Det finns oerhört lite kunskap om dessa klassrumsprocesser såväl nationellt som internationellt så därför är en studie som denna värdefull.

### **Hur kommer vårt samarbete att gå till?**

Du och jag kommer att träffas och/eller talas vid per telefon innan vi startar projektet. Då kan vi ställa frågor till varandra och vi lär också känna varandra lite grann, vilket kan underlätta vårt samarbete. Jag behöver din hjälp för att planera projektet tidsmässigt och också med att samla in elevernas påskrivna fullmakter för videofilmning. Jag kan behöva viss praktisk hjälp när jag kommer till skolan, men på det hela taget ska jag göra allt jag kan för att störa undervisningen så lite som möjligt. I samband med mitt analysarbete kommer jag att kontakta dig för en (eventuellt kan det bli två) återträff. När vi då träffas berättar jag i stora drag vad jag har kommit fram till och du har då möjlighet att kommentera analysen. Jag kan också komma att vilja ställa några kompletterande frågor vid detta tillfälle. Denna korta intervju kommer att video- och ljudinspelas.

### **Hur kommer arbetet med klassen gå till?**

I projektet kommer jag först att vara med i klassrumsarbetet under någon eller några lektioner så att jag och eleverna får vänja oss vid varandra. Sedan kommer jag att med hjälp av videofilmning och ljudinspelning fånga kommunikationen mellan lärare och elev un-

der ungefär en vecka. Jag kommer också att samla in skriftligt material t.ex. arbetsblad och liknande. För att hela materialet inte ska bli allt för omfattande kommer jag att slumpvis lotta ut två elever och det blir kommunikationen mellan dessa elever och lärare som jag i första hand kommer att studera. Dessa elever kommer jag också att vilja intervjua. Allt övrigt insamlat material kan komma att användas i denna och/eller efterföljande studier. Jag vill särskilt framhålla att forskningsfokus inte ligger på enskilda individer utan på övergripande aspekter när det gäller kommunikationen mellan lärare och elev i matematikundervisningen.

### **Hur ska resultatet redovisas?**

Framför allt kommer resultatet att presenteras i en doktorsavhandling och jag kommer också att skriva artiklar, presentationer på konferenser m.m. I resultatredovisningen kommer inga foton eller filmsekvenser förekomma och alla deltagares namn kommer att identifieras. Personuppgifter och andra uppgifter som möjliggör identifiering kommer att behandlas konfidentiellt och under tystnadsplikt i enlighet med personuppgiftslagen.

### **Vad lovar jag?**

Jag lovar att projektet kommer att genomföras i enlighet med Vetenskapsrådets forskningsetiska principer för humanistisk-samhällsvetenskaplig forskning. Alla originaldokument (filmer, ljudinspelningar, pappersdokument) och arbetskopior kommer att förvaras oåtkomliga för obehöriga. Medverkan i studien är frivillig och deltagarna kan när som helst under projektet avbryta sin medverkan. I övrigt lovar jag att göra allt för att forskningen ska ske med högsta kvalitet och att resultatet ska vara till nytta för matematikundervisningen i framtiden. Hör gärna av dig per mail eller telefon om du har några frågor! På nästa sida finns en fullmakt som jag ber dig att skriva på.

Med vänlig hälsning

Lisa Björklund Boistrup

## Fullmakt

Denna fullmakt avser tillstånd för Lisa Björklund Boistrup (med eventuell medhjälpare) att video- och ljuddokumentera, dels undervisningssituationer där du medverkar, dels en eller flera intervjuer. Annat material i forskningsprojektet är insamlat skriftligt material gällande ett par elever. Fullmakten omfattar också tillstånd att använda materialet för den ovan beskrivna forskningen.

Lärarens namn:

---

Jag säger ja till att medverka i Lisa Björklund Boistrups forskningsprojekt och tillåter videofilmning av undervisning där jag och elever är med i fokus.

Datum: \_\_\_\_\_

## Appendix C

### Original Swedish Text to Longer Excerpts

#### Excerpt 4, Section 5.2.1

Time	Speech
12:38	
12:40	
12:41	Cilla (S): Cecilia, kan man göra så här?
12:43	Cecilia (T): Mm, har du rangordnat då?
12:44	Cec: Har du skrivit dem i en ordning nu?
12:46	Cil: Alltså jag gör så där.
12:47	Cec: Du behöver ju inte bara skriva av för det har du ju på tavlan redan, utan du ska skriva dem i en ordning!
12:53	Cec: Så att det är lätt att läsa.
12:54	Cil: Mm
12:56	Cec: Sortera upp dem i en ordning! Då skulle jag göra så här. Vill du ha ett tips.
12:59	Cil: mm
13:00	
13:01	Cec: Jag skulle ta den här som har många, skulle jag flytta längre ner.
13:05	Cil: Men [inaudible] den är ju
13:08	Cec: Men du behöver inte ha i min ordning.
13:10	Cec: Flytta den också längre ner, så det blir en ordning. En ordning, ett, två, tre eller tio, nio, åtta, att det är en ordning på dem.
13:18	Cil: Ja
13:19	Cil: Får man inte göra i din ordning?
13:21	Cec: Om du skriver av det där då har du inte gjort en ordning, då har du inte hört instruktionerna!

#### Excerpt 21, Section 6.2.1

Time	Speech
30:12	Anna (T): Japp.
30:13	Bx: Då har vi kommit fram till att Ali (S): det där är svaret!
30:17	
30:18	Gx: Wow.
30:19	T: Bravo.
30:20	T: Jättebra. Ali: Vi bara gissade.
30:21	T: Gjorde ni?
30:23	Ang: Jaa.
30:24	T: Jag tror. Har ni bara(!) gissat?

30:26	Ali: Alltså vi löste det. Ang: Nej, alltså vi
30:28	Ali: Sen gissade vi att det var det. Vi undrade. Vi visste inte om det var det eller det.
30:31	T: Nehe.
30:49	T: Men den största det är ju Ali: Det där. Bx: Där.
30:51	T: Det ja. Och eftersom det inte var det och inte det så fanns det bara en kvar att välja på.
30:56	Ali: Nej, det fanns ju de där också.
30:58	Bx (till T): Ja men vad smart! Gx: Men det där.
31:01	T: Fast ni har ju skrivit det eller det. De här är ju inte med på de andra ledtrådarna. Gx: Nej.
31:06	T: Vill ni försöka på en till? S: Ja. Ali: Ja, gärna.
31:09	T: Ni var ju jätteduktiga.

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