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## Foreword

I feel lucky to be in a position where, as a Mathematics teacher, I had the fortuity to go back to university and study and write a Master's thesis. It is something I think all future and present mathematics teachers anywhere should get the opportunity to engage in.

I have to admit that contrary to what I envisioned and expected, writing this Master's thesis was really interesting. I was able to use this interest to invest the time necessary every day, believe it or not, with joy. This would not have been possible if the topic did not resonate as well as it did. Writing and researching questions and question use in instruction have been incredibly thought-provoking and alluring. For this I first need to extend my sincere thanks to Mark Hoover, professor at the University of Michigan. He gave me the idea to expand on the nature of questions and suggested that I could write a more theory-based thesis. I also have to thank him for taking time to read and give feedback during my writing, and providing the initial theory and articles. In that regard I also give thanks to assistant professor Esther Enright at Boise State University for quick responses and for granting me permission to use unpublished material.

Thanks are of course also due to my supervisor professor Raymond Bjuland. He was always available and we had some good talks about how to continue the process. The rest of the staff at UIS have always been helpful, and a special thanks to Professor Reidar Mosvold for giving me the opportunity to attend a very memorable SCK workshop at the University of Michigan and to meet and be inspired by some of the leading people in our field.

Sincere thanks to BBG and CCC, Mari Skiftestad, Krisoffer Fauske Helgås and Lars Slettebø for making an old man feel accepted and for sharing our office, almost on a daily basis. I am still waiting for the real mudslide-burger party though. Additionally a great thank you to Line Siggerud for invaluable help and friendship throughout the Master's study. Not to be forgotten, a resounding thanks to my best man and friend Petter Viksveen Ph.D. for always being available and extending his help and of course to my biking colleague Dean Retallack for proofreading in a hectic training period.

To my wife, Malee Saisomboon, you always supported me and you understood that I had to sacrifice some of our time.

Tron Rød

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## Abstract

Even in today's society with electronic devices abundantly available to most western world learners to aid their learning, classroom instruction and discussions still are the most common practices of teachers everywhere. There have been many reports and studies on the instructional aspect of teaching. Mathematical discourse is one of these aspects and questions definitely are an integral part of discourse. Some researchers have identified several tasks that are common for the work of teaching mathematics. Fewer have contributed with a conceptual view on the nature of instructional questioning in the teaching of mathematics. The purpose of this thesis was to show a relationship between questions and the Mathematical tasks of teaching and to point out why elucidating this could be beneficial. To achieve this some segments from a teacher's plenary questions were analyzed. As part of this analysis they were coded using the Mathematical discourse of instruction framework and selected Mathematical tasks of teaching. By coding in this manner an irrefutable connection was found between many of the Mathematical tasks of teaching and instructional questions. Establishing such a close relation enables questions to be viewed as an integral part of teaching and a core practice that deserves to be paid more attention to in research, in teacher education and in the work of teaching. It was further shown that different types of questions indeed do influence learners' responses.

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# 1 Introduction

“In other words, teaching is *purposeful work*” (Sleep, 2012, p. 937).

Socrates from ancient Greece is made famous partly for his asking of questions. He used them to elicit reflection from his students and this is known as the Socratic method (of teaching). “Questioning, in fact, may be the most frequently used teacher instructional intervention. Consider for a moment how many questions an average teacher asks in a day, month, or year” (Tienken, Goldberg, & Dirocco, 2009, p. 39). They then rhetorically asked, to what extent do teachers really exploit this resource?

As a lower secondary teacher and Master student at the University of Stavanger, UIS, I have become really interested in how to instigate, facilitate and develop the mathematical discourse with the use of questions in plenary in my classroom. A guide or tools and recommended practices for how to effectively initiate mathematical discourse with questions, how to use ritual questions most efficiently and with the greatest benefit, how to find and use good exploratory questions and how to sustain and scaffold students’ responses during my own teacher education were virtually nonexistent.

*Who in here has read Donald Duck? Yes, who in here has read, seen the cartoon about Scrooge McDuck when he makes a lot of money and makes a table and a graph from it? What does it look like?*

(Transcript 5 of MERG, Week 7, Thursday 1<sup>st</sup> lesson)

This was taken from an observation of a teacher who attempted, with the use of questions, to invite the learners into a discourse about line graphs. The teacher had what Graesser and Person (1994) calls a presupposition, an anticipation, that everyone is familiar with the current topic. In this example the teacher had a presupposition that all of the learners in this class knew and could identify with this cartoon. The learners evidently did not share the presupposition that was assumed, which of course was essential for a response and the ensuing discourse. At first none of them reacted at all, they were very unsure as to which discourse was offered and it was clear that they could not partake in the discourse that the teacher was inviting them into. This was

very interesting for many different reasons. Even if questions have not been prepared, they have a purpose. Among other things it could be to strengthen social bonds or get learners to engage in discourse. In addition it showed that questions are used as a gateway to discourses but clearly this does not happen automatically. It also highlights a necessity of participating in the same discourses. In addition it shows that the refining and narrowing of questions will serve a purpose of getting the subsequent discourse on the wanted track. Also these few lines could serve as an illustration that questions do play a major role in the work of teaching and instruction. On the other hand it could just be that the learners in this case were not at all used to the teacher introducing elements that did not directly pertain to their mathematical discourses.

Whatever thoughts questions like these from the teacher evoke, it will in cases like this also have a bearing on how the questions are formulated and by how well the teacher knows the learners, which is important as also Sánchez and García (2013) points out. There are many other interchangeable elements such as grade, school-building, socio-economic background, learners in class and the classroom itself to name a few. Not only does the question have to have recipients and a purpose, it can take on different forms and have different anticipated responses or it can be asked without any presuppositions at all. The purpose of the question can sometimes be identified by what kind of question it is, but this is not always the case. If the purpose is obvious it is still far from certain that the response is realized according to the purpose. The same age appropriate questions might also be interpreted differently by other learners. By age appropriate it is meant that the questions asked are suitable for the grade-level the learners are at. This could and maybe should be read as a way to point out that we need to understand more about questioning in teaching.

In addition to questions, the work of teaching and instruction entails an array of different chores, Ball, Thames, and Phelps (2008) identified and named sixteen of these which they referred to as Mathematical tasks of teaching. These uncontested mathematical tasks of teaching might, if connected in a meaningful way to instructional questions, bring forward a greater incentive to pay more attention as to how questions are asked in plenary mathematical instruction and teaching and what kind of questions are being asked as well. The point over about uncontested tasks is made because it seems researchers agree that there indeed are tasks that are common for all teachers. Later a point will be made that questions are essential in discourses.

The following statement supports this; “I suggest that questioning and responding can be added to this list of what might be referred to as discursive acts of teaching.” (Mosvold, 2016, p. 194). He continues by saying;

*Regarding tasks of teaching in terms of discourse, and defining them in terms of the discursive acts involved, might thus be useful, I propose, in that it enables the development of more comprehensive language for considering the work of teaching mathematics and its components.*

(Mosvold, 2016, p. 194)

It is the understanding of this author that as questions are an integral part of discourses, and that by looking at questions and the relation to the Mathematical tasks of teaching, this would correspond to what Mosvold (2016) proposes. Another statement that really made an impression and in a way also substantiates this research is what Boaler (2015) likes to tell students in mathematics classes; “ Questions are really important” (Boaler, 2015, p. 269). This leads to the main question;

### **What is the nature of instructional questioning and its use in teaching?**

The commognitive framework of Sfard (2008) will be used in attempting to connect questions to the mathematical tasks of teaching in this way. In addition to Sfard (2008)’s commognitive framework Adler and Ronda (2015) built a framework, Mathematical discourse of instruction, MDI. This framework uses some of the Mathematical tasks of teaching as well as some definitions by Sfard (2008). Adler and Ronda (2015) used MDI to analyze differences in instruction in mathematical teaching and what was presented for the students by the teacher. Part of that framework together with some of the Mathematical tasks of teaching will be used to analyze chosen sequences of plenary discussion from an 8<sup>th</sup> grade mathematics class in an attempt to answer the research question.



## 1.1 Research question

When considering the nature of instructional questioning, it opens up for an array of alternate ways to shed a more conceptual light on it. Among others the explicit statement; “It is important to continue with this type of fine-grained analysis of the types of questions asked in classrooms as well as the purposes and roles those questions play in instruction,” (Enright & Ball, 2013, p. 4)<sup>1</sup> shows that there is a need for more research on different aspects of questions and questioning in classrooms from different cultures, languages and nations. They also claim that the art of questioning is something that needs to be “... taught, practiced and developed over time ...” (Enright & Ball, 2013, p. 11). This falls in line with the main question regarding the nature of instructional questioning and its use in teaching. Questions are prevalent in instruction and teaching and we need to better understand their use. This indicates that a better conceptual understanding of questions could be accomplished if it was possible to irrevocably link the instructional use of questions to the Mathematical tasks of teaching. Thus the focus is both on the connections and relationships that might be found and explicitly what we might gain from this. The research question will then be;

**How can the Mathematical tasks of teaching be connected to ritual and exploratory questions in plenary mathematical discourse and what can be achieved by making these connections?**

## 1.2 Structure of this Master’s thesis and limitations

This Master’s thesis will be structured in the following manner. There will after this second chapter, the introduction, follow seven chapters with subchapters. The first of these chapters (2), Theoretical background, will deal with the theory that is essential. Here some earlier studies and research will be brought to light and this will be used to place this Master’s thesis. We will then take a closer look at the Mathematical tasks of teaching from Ball et al. (2008) before introducing the framework of Sfard (2008) and

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<sup>1</sup> Have been given permission to cite from and reference this unpublished article by Esther Enright, assistant professor at Boise State University as of February 2018.

looking at the parts of Adler and Ronda (2015)'s MDI that will be used. The next chapter (3), Method, deal with the method used and data collected from a 8<sup>th</sup> grade class, which is the empirical data that will be analyzed. Following this a subchapter about ethics will be included. We will then take a closer look at the way in which the MDI will be used in the analysis. Chapter 4, Results, is all about the analyzed excerpts from the 8<sup>th</sup> grade classroom, before chapter 5, Discussion, mulls over the findings in chapter 4 and looks at them in connection to MDI, the Mathematical tasks of teaching and the research questions. The last of the chapters (6), Conclusion, provides a summary and a proposed look ahead including some implications of this Master's thesis findings. Chapter 7 is a reference list and chapter 8 completes this work with all the attachments.

There are a number of limitations to a study of this kind. Some of these are associated with the influence that observers have on the persons being observed. This will be addressed later and does have a bearing on how questions are used, framed, formulated and responded to. It should be safe to argue that different observers have a different effect on different people and this would entail that the transfer value of a single study like this one is limited. On the other hand this study's aim is to add to previous and current research on the instructional use of questions in teaching and instruction so all new information should increase our knowledge of this topic. Additionally the instructional questions that are being analyzed here should be recognizable for most mathematics teachers.

A few clarifications in regard to some of the words being used, need to be addressed. There will in this Master's thesis be differentiated between the words pupil, student and learner. "Pupil" will be used when referring to the participants of the research project, the Mathematical Education Research Group, MERG, i.e. the 8<sup>th</sup> graders where the data material was collected. The use of the word "student" or "learner" in singular or plural will mean any others who are subjected to instruction by some kind of expert, or any teacher or lecturer. These others include fellow students at UIS, students in general and it will be lucid given the context. As often as possible in this thesis the teacher that was observed will be referred to as "teacher", but sometimes for the sake of the flow of the text the teacher will also be referred to as "she". This should not be taken as an indicator that the teacher in question was female merely that this was the choice of this author.

## 2 Theoretical background

This chapter is divided into five subchapters. The first of these subchapters will position this study in terms of earlier research and the proposed further research. The next three subchapters, all in their own right, are instrumental to be able to answer the research question. The first of these explains the background of Mathematical tasks of teaching and clarifies the reasons for the ones selected for this study. The next chapter is comprehensive in definitions given by Sfard (2008) and outlines the parts of her framework which is essential and is the theoretical backbone in this study's analysis. In addition related theory will be used to expand on the exegesis. The fourth subchapter in the theory part provides an account of Adler and Ronda (2015)'s Mathematics Discourse in Instruction, MDI as the chosen tool used in the analysis. The last subchapter is a short summary.

### 2.1 Earlier studies regarding questions

In recent times there has been increased interest in classroom dialogue and what it consists of. Tienken et al. (2009) for example, tried to find out what kind of questions teachers used. The categories they used to analyze the questions were productive and reproductive. The productive ones gave the students opportunities to reflect, analyze and evaluate. The reproductive questions on the other hand, were more of a recollecting nature, (Tienken et al., 2009). They found in their study that the results gathered were consistent with studies carried out 30 years earlier, and that the ratio between productive and reproductive was about 1 to 4 (76%).

In yet another earlier article Graesser and Person (1994) stated that; "Few teachers adopt sophisticated Socratic methods in which the teacher constructs sequences of thought-provoking questions..." (p. 106). They also wrote that teachers are not good role models for their students insofar as they refer to other studies and claim that a very small percentage of teacher questions are high-level, (i.e. productive, only about 4%), the rest is just testing the recollecting skills of their students (Graesser & Person, 1994). It is understood that by saying they are not being good role models; Graesser and Person (1994) infer this will be a repeating pattern. It is repetitive in the way that

the next generation of teachers use questions the same way they were taught, thus implying the need for change. This ratio of high-level vs low-level questions seems to be the case in other disciplines as well.

In the discipline of health science Tofade, Elsner, and Haines (2013) referred to two different classroom based studies of what they refer to as lower-order and higher-order questions, which relate to reproductive and productive questions respectively. In the first of these studies the percentage was 68.9 out of 3407 total questions. In the second the percentage was as high as 91.2, though the number of questions in this latter study was not reported, it was only stated that it was a similar study. This percentage is similar to my own findings in a small research paper on explorative vs ritual questions in an 8<sup>th</sup> grade class. From a total of 153 questions over a period of three lessons, it showed that 96.7% were reproductive or ritual (Rød, 2017). In still another, yet even older study Hargreaves (1984) reported that earlier coding of questions used the distinction factual and interpretive. Factual being the same as reproductive and interpretive would then equal productive. Hargreaves (1984) used yet another label, namely open and closed questions respectively and even extrapolated on these codes to include the category of half-open. Half-open would be yes or no questions that he felt would not be covered properly with only two categories. Thus work on questions in the sense of working to get better at asking questions and further research on how to ask better questions seems to be most advantageous when used together.

Still other researchers that worked on questions like Di Teodoro, Donders, Kemp-Davidson, Robertson, and Schuyler (2011) based their research on Tienken et al. (2009)'s article on questions and found that working on improving question asking was very fruitful. They had analyzed their own use of questions and labeled them deeper and surface questions where Tienken et al. (2009) categorized them productive and reproductive. The categories of factual, surface, lower-order or reproductive would, according to the way the Sfard (2008) framework is used in this Master's thesis equate to her ritual routine or ritual questions. Definitions on all of Sfard's terms in regard to what are needed for this thesis and the questions analyzed here will be given in full later in this chapter. Hargreaves (1984)'s half-open category will also be included as a ritual routine given that they on the surface just confirm or negate a question or statement. Should they materialize into a more productive answer then

they would be in Sfard (2008)'s exploratory routine. It is in this category interpretive, deeper, higher-order and productive questions would fall.

The aim of this study is to look at questions in teaching and connect them to the Mathematical tasks of teaching as core teaching practices. Tienken et al. (2009) stated that their research made them much more aware of the quality of their questions. In fact they used even more questions during and after the implementation of the study. Di Teodoro et al., (2011) also made a point from Tienken et al., (2009) as they taught and made their own students more aware of what kind of questions they would ask their peers as well, "Students developed a sense of ownership over the questions they asked" (Di Teodoro et al., 2011, p. 26), and they got better at analyzing their use of questions themselves, just as the teachers did. They say it is important to continue the teaching of questioning, Di Teodoro et al. (2011). In their article on re-imagining teacher education Grossman, Hammerness, and McDonald (2009) is looking to identify core practices of teaching and single out important components that teacher students could focus on. They state that leading classroom discussions and being the instigator of mathematical discourse, is a complicated and compound practice that could take years to be able to do well. They also write that it is important to know how to ask and what to ask students to elicit their concept of the task at hand, whether in plenary class discussion or in smaller groups (Grossman et al., 2009). They also continue their argument:

*... however, within teacher education, novices might focus on developing on some of the instructional routines that constitute the practice of leading discussions, including identifying generative questions or choosing rich problems to discuss, as well as learning to take up, or revoice, student ideas in the midst of a discussion.*

(Grossman et al., 2009, p. 277)

The preceding statement is interpreted as a very intentional and clear view that teachers in general would benefit from more knowledge about instructional questioning. This additionally can be seen in connection with the review of over 3000 articles that was narrowed down to about 350, on what is known about research on mathematical knowledge for teaching (Hoover, Mosvold, Loewenberg Ball, & Lai, 2016). This identified at least five different directions they suggested could be

followed to explore and advance this topic more thoroughly. The first one was described in the following way:

*One area of need that stands out is the investigation of the mathematical knowledge demands associated with particular domains of the work of teaching, such as leading a discussion, launching students to do mathematical work, or deciding the instructional implications of particular student work.*

(Hoover et al., 2016, p. 18)

With the objective of looking at questions and the work that teachers do, the point about leading discussions will be taken in this context to be inseparable. Leading would thus indicate asking, probing, guiding, steering and evaluating with the use of different types or categories of mathematical questions. When it comes to leading or steering teaching towards a mathematical point, we have to use the time available working on the intended mathematics, not on the unintended (Sleep, 2012). She also argues that if we do not get students to work on the intended mathematics, they will definitely not work on them. Even if the teaching time is spent on intended mathematical points, we cannot take for granted that the students work exclusively on what we planned. Sleep (2012) suggests that “Asking questions that engage students in mathematical reasoning can help address this issue” (Sleep, 2012, p. 952). This also more than suggests that more work is needed in regard to questions. It can not be stated more clearly and be more agreed upon by this author, than when Di Teodoro et al. (2011) say that they realized the importance of preparing questions ahead of teaching and cited Tienken et al. (2009) “Teachers, like lawyers, can prepare a list of questions prior to starting a lesson. Question preparation guarantees that some questions will foster productive thinking,” (p. 42). They say that producing explorative questions ad hoc is still more difficult than having prepared some, and lastly they claim that good question preparation is an area where teachers can benefit very much indeed (Di Teodoro et al., 2011). Questions asked ad hoc are here defined as questions asked in the spur of the moment, and not planned in advance.

The preceding paragraphs corroborates the goal of this research that focuses on, and analyses questions to show coherence with the Mathematical Tasks of Teaching and why this could be beneficiary. Showing this coherence will hopefully to a degree

illuminate the nature of instructional questioning and substantiate the claim that there is much more to both learn and teach about questions.

## 2.2 Mathematical Tasks of Teaching

A little background on these Mathematical tasks is needed. To be able to accurately pinpoint the content knowledge necessary to know for a teacher generally, and for a mathematics teacher particularly, has over the years proved to be difficult. With Lee Shulman's 1986 article, "Those Who Understand: Knowledge Growth in Teaching", he and colleagues identified what they called "the missing paradigm" and proposed a different focus on research regarding teaching. "The missing paradigm refers to a blind spot with respect to content that now characterizes most research on teaching ..." (Shulman, 1986, p. 7). Earlier research often studied pedagogical issues while he suggested studying what content knowledge is important for teachers to know. Shulman (1986) introduced three types of knowledge; subject matter content, pedagogical content and curricular knowledge. He defined subject matter content knowledge as "... the amount and organization of knowledge per se in the mind of the teacher" (Shulman, 1986, p. 9). He explains that this teacher content knowledge goes further than just "knowing" the subject as in being able to recount the important facts of the subject. They must also know the relation to other propositions in and across different subjects and why this information is deemed important to know. The pedagogical knowledge would include which representations and examples would be most suitable and how to best present and explain. These ideas were developed into questions about how much and what kind of knowledge is needed to teach. Shulman (1987) presented seven categories (p 8) of what he referred to as "the knowledge base".

Later work by researchers like Chapman (2013), identify knowledge needed for the work of teaching, and knowledge needed by teachers when assigning and working with tasks or problems specifically. Building upon Shulman's (1987) seven original categories Loewenberg Ball, Hoover Thames and Phelps however set out to identify the specific mathematical knowledge that teachers need to know (Ball et al., 2008). They presented a list consisting of 16 tasks (Table 1) of teaching teachers regularly do and

that “these tasks demand unique mathematical understanding and reasoning” (Ball et al., 2008, p. 400).

Ball et al. (2008) continued in their article to divide the subject matter knowledge into three different categories; common content knowledge, CCK, horizon content knowledge, HCK and specialized content knowledge, SCK. CCK is the mathematics that is commonly known by others who use and know mathematics. Horizon content knowledge is the understanding of how mathematical ideas and topics are related and connected within the curriculum. The SCK is what special knowledge is consequential for the task of teaching mathematics. “The notion of specialized content knowledge is in need of further work in order to understand the most important dimensions of teachers’ professional knowledge” (Ball et al., 2008, p. 405). This, they say, should be addressed thoughtfully and leading to the possibility of improving the understanding of teaching and the content preparation of teachers.

**Table 1 Mathematical tasks of teaching**

<b>Mathematical Tasks of Teaching</b>
Presenting mathematical ideas
Responding to students «why» questions
Finding an example to make a specific mathematical point
Recognizing what is involved in using a particular representation
Linking representations to underlying ideas and to other representations
Connecting a topic being taught to topics from prior or future years
Explaining mathematical goals and purposes to parents
Appraising and adapting the mathematical content of textbooks
Modifying tasks to be either easier or harder
Evaluating the plausibility of students claims (often quickly)
Giving or evaluating mathematical explanations
Choosing and developing usable definitions
Using mathematical notation and language and critiquing its use
Asking productive mathematical questions
Selecting representations for particular purposes
Inspecting equivalencies

(Ball et al., 2008, p. 400)



This is almost exactly how Lampert (2001) and D. Ball and Forzani (2007) also write about teaching and instruction. They explain that teaching involves an active decision and selection from the educator as to what should be presented in each lesson, according to a set of guidelines and regulations. That could be a set of guidelines and regulations such as curriculum, the common core, (mathematical) topic and group of learners etc. I argue that among these active decisions and selections, teachers also chose the questions they use. Not only chose, in all but special instances teachers have to choose and use questions in instruction. Some of these are actively chosen by way of being part of the planning of the lesson in which they occur. Other questions could more or less impulsively take place or they happen as a result of an ongoing discussion or discourse. These actions are then assessed by the learners, who also assess the situation, the teacher and their classmates and then they will respond or react in some manner. A non-response is also understood by this author as a reaction. This reaction is in turn evaluated by the educator.

It should come as no surprise that these mathematical tasks of teaching encompass all levels of the work in mathematical instruction. They do not cover all aspects of teaching at the same time and this study thus focuses on some of these defined Mathematical tasks of teaching and why teacher's questions can illustrate some of the specific demands of teacher knowledge. This should then indicate the necessity of great thought concerning questions in teaching and instruction, and question asking. On these grounds, nine of these tasks have been chosen:

1. Asking productive mathematical questions.
2. Evaluating the plausibility of student claims, (often quickly).
3. Giving or evaluating mathematical explanations.
4. Presenting mathematical ideas.
5. Using mathematical notation and language and critiquing its use.
6. Responding to students «why» questions
7. Selecting representations for particular purposes.
8. Recognizing what is involved in using a particular representation.
9. Finding an example to make a specific mathematical point.

The reasons for selecting these are as follows. Boaler (2015) refers to Wolfram (2010) who states that mathematics consists of four stages; posing a question, going from the real world to mathematical models, doing the calculation and going back from the model to the real world i.e. analyzing. According to Boaler, Wolfram emphasizes that we need people that ask good questions and interpret. Interpreting is here understood as evaluating questions responses or answers, and this is in agreement with what Wolfram (2010) calls interpreting mathematical answers. We can connect this first one to the first of the listed mathematical tasks for teaching (1). The third core practice that Grossman et al. (2009) have identified is about leading classroom discussions and this is divided into three parts. In adherence to the task of asking productive mathematical questions, the first part Grossman et al. (2009) focus on is about asking questions. Better yet, asking questions to start a discussion. The second and third of these Mathematical tasks are included since Evaluating the plausibility of student claims (often quickly) (2) and Giving or evaluating mathematical explanations (3), either from students or for example from textbooks are an essential part of teaching as well as important when researching teacher questions. We find this in Wolfram (2010)'s statements regarding the interpreting of mathematical answers, as referred to by Boaler (2015).

This is again in accordance with Grossman et al.'s (2009) second and third part of their classroom discussions core practice, namely "... monitoring student participation during discussion, and responding to student ideas" (Grossman et al., 2009, p. 281). They state that these two and the first one mentioned, about asking questions to start the discussion, are critical to the task of teaching. The fourth task (4) is connected to the third one insofar as it could be argued that when you are presenting a mathematical idea you can do that by giving an explanation or that your initial idea is substantiated by an explanation. I argue that in addition to this, most, if not all questions that a teacher asks would be a continuation from a mathematical idea or explanation. This would also be the case for questions asked by students as long as they are confined to a mathematical discourse. Discourse and more specific mathematical discourse definitions will be addressed in the next chapter. Following questions from students it would be interesting to monitor if representations (7 and 8) and explanations (9) yielded any follow-up or why (6) questions. It would be interesting for the sake of the discourse, not to analyze the representations (7 and 8) or examples (9). The fifth of the mathematical tasks of teaching included here, regarding the use of mathematical language and notations (5)

are important when evaluating both questions and responses in plenary discourse and could be deciding in determining which discourse is taking place. It could also tell something relating to who the participants in the discourse are and also why follow-up questions take the form they do. This task is also pertinent to examples, explanations, representations and instruction as a whole.

Presented here were the Mathematical tasks of teaching which were chosen to illustrate a connection to instructional questioning. Next follows a presentation of the chosen framework.

## 2.3 Thinking as communicating

In her book “Thinking as Communicating” Anna Sfard (2008) presents a commognitive framework based on ideas from Vygotsky’s sociocultural theory of cognitive development and Wittgenstein’s focus on language and its importance, making language and social interaction the base for learning in her perspective. Sfard (2008) redefines many common terms such as learning, communication, discourse, research, routines and thinking and introduces a completely new word *commognition* which is a combination of cognitive and communicational and her definition on this term follows directly after this paragraph. Since her framework will be used as the theoretical foundation for this Master’s thesis the framework with the necessary definitions will be presented in the following of this chapter.

### 2.3.1 Commognition

*Communication is a collectively performed patterned activity in which action A of an individual is followed by action B of another individual so that*

- 1. A belong to a certain well-defined repertoire of actions known as communicational*
- 2. Action B belongs to a repertoire of re-actions that fit A, that is, actions recurrently observed in conjunction with A. This latter repertoire is not exclusively a function of A, and it depends, among others, on factors such*

*as the history of a (what happened prior to A), the situation in which A and B are performed and the identities of the actor and re-actor.*

(Sfard, 2008, pp. 86-87)

From this definition we see that communication comprises of more than spoken words. Some actions like a question from a person, provokes a re-action from the intended recipient(s). This re-action could be verbal or non-verbal but this activity has to be directly connected to the initial action. The response to this initial action can be in form of words, facial expressions, body language or any kind of sound. This response can in turn be, as Sfard (2008) elaborates on this topic, an action that requires a re-action from the first person (p. 87). In the continuation of this Sfard (2008) emphasizes, and it is essential to bear in mind when analyzing questions, that these (A) actions do not specify one specific re-action, but rather a type of action. For instance if one asks what time it is, a response could be to tell the exact time, 12:45, say almost 1, answer they do not know, point to a watch for the person to look at for himself or shake their head to indicate they do not know. The first action thereby warrants a response, sometimes only yes or no will suffice, other times a more elaborate response is the goal of the action depending on the situation. “More often than not, both action and re-action are a matter of construction, to be formed according to rules that constrain but do not dictate” (Sfard, 2008, p. 88). People that initially engage in communication are by Sfard (2008) referred to as actors and those that answer are re-actors. If the re-actors response would warrant a reply, then the re- actor would be the actor, thus these roles change back and forth.

A silent talk or communication with oneself is known as thinking. Thinking is thus defined as “... the individualized version of interpersonal communication” (Sfard, 2008, pp. xvii, 81, 302). Understanding this as thinking being the way in which an individual communicates with him or herself, alas the inner conversation you have with yourself. From these two definitions, communication and thinking, Sfard (2008) coins the term commognition, the cognitive, thinking and the communication. “According to commognitivism, therefore, to think mathematically means communicating – with others or with oneself – in the special way called “mathematical” ”(Adler & Sfard, 2017, p. 42). When observing in a classroom or undertaking an interview only the interpersonal aspect of commognition will be open

for analyzes, the individualized form, what the participants think, will thus be hidden, reminding us that we should be wary of assuming to know what they were thinking at the time.

### 2.3.2 Discourse

The author of this thesis is in accordance with Enright and Ball (2013) when they state that questions and the act of questioning "... need to be considered as part of a chain of discourse in order to better comprehend their role in supporting the complex work of teaching and learning" (Enright & Ball, 2013, p. 3). The position that questions have in regard to discourse, from the author of this Master's thesis point of view and for the sake of this research, is that a question, in any form other than rhetorical, will be the accelerator for the following discourse. In any form, is to be understood as it could be asked directly, as a disguised question in an explanation, like if you explain a particular thing and with body-language show that you want a response. It could also be by body-language alone or gestures indicating that a response is anticipated.

Shreyar, Zolkower, and Perez (2010) argue that there are two positions in speech roles, giving and receiving, as Sfard's (2008) action and re-action in communication. As the focus is on the teachers questions here, the giving would then be from the teacher perspective and the receiving, of the questions, by the pupils. Shreyar et al. (2010) list five functions of the speech; as a statement, offers, questions, as commands and lastly, for checking. For this Master's thesis statements will be regarded as examples and instruction by the teacher, offers would for example be when the teacher helps students. Questions are therefore as previously stated to be regarded as the start of the discourse. Commands would be imperative statements, as in "open your books", "write in your rulebook" and checking would be what is here coded and analyzed as rhetorical. The imperative commands can also function as a question, hence you can imagine a silent, "can you" in front of the command, (Shreyar et al., 2010). Like if the teacher says "Find example 5.5 on page 163!", you could silently add "can you" in front and then it would become a question and thus a possible start of a discourse. As will be addressed in regard to the excerpts from the transcriptions later on, the context in which the questions analyzed occur in, have bearing on the discourse in which it is part of and for this reason the term discourse needs to be given a full and functional definition.

A random search on Google gave more or less the same definition to the term discourse, “written or spoken communication between people about a subject, often serious”. For everyday purposes this definition will suffice. To use an open definition like this in research would on the other hand immediately result in problems. For example how should “serious” be understood? How can one say that one thing is more or less serious, are there or should there be levels of seriousness?

In contrast to these kinds of menial and common definitions Sfard (2008) in her framework on the other hand defines discourse and identifies certain characteristics that distinguish the mathematical discourse. “The different types of communication, and thus of commognition, that draw some individuals together while excluding some others will be called discourses” (Sfard, 2008, p. 91), taken to be understood quite literally a discussion where some are part of it and others, for different reasons, are not. Anna Sfard stated directly in Adler and Sfard (2017) that being a participant in a mathematical discourse indicates that you are giving narratives about mathematical objects.

A popular notion is that the teacher is the one who instigates and drives the discourse and Sfard (2008) said that on the surface it may seem like it is the teacher that is responsible for the mathematical discourse. The teacher is the expert and the student is the novice. The expert has the authority that comes with content and subject matter knowledge and thus should be able to dictate the discourse. This is not the case.

*The incessant process of discourse modifying that takes place in any community is reflexive. Discursive rules of the mathematics classroom, rather than being implicitly dictated by the teacher through her own discursive actions, are an evolving product of the teachers’ and students’ collaborative efforts.*

(Sfard, 2008, p. 202)

Still the teacher’s questions are as earlier stated what is being scrutinized here and the analyzed discourses are instigated by the teacher. Bearing in mind that the mathematical discourse is a collaborative effort, it would point in the direction of what Ball et al. (2008) in their domains of mathematical knowledge call Knowledge of Content and Students (KCS). This should be an indication that knowing your students

is important in the quest to help students achieve their full potential. Besides Ball et al. (2008) there are other researchers (Chapin, Anderson, & O'Connor, 2003; Martino & Maher, 1999; Sánchez & García, 2013) that emphasize this aim. Chapin et al. (2003) write that as learners have to engage in discourse they automatically have to structure their thoughts. This discourse then enables the educators to detect misunderstandings or lack of understanding that would go undetected if it was not part of a spoken discourse. Sánchez and García (2013) point out that knowing your learners is a prerequisite for teachers that want to optimize the scaffolding of students.

Scaffolding is a concept that was according to (Hammond & Gibbons, 2005; Turuk, 2008) first used in the context of education and learning in Wood, Bruner, and Ross (1976), while Bakker, Smit, and Wegerif (2015) claim that Bruner had talked about it before. Later it is by many associated with Bruner and Lev Vygotsky's theories. It relates to the teacher, who by word use, (definition follows later), and conditions that are favorable, build on the learners previous knowledge to reach a new level of competence, (Turuk, 2008). For the purpose of this Master's thesis the three points that Bakker et al. (2015) cite (p. 1050) should suffice as a definition on scaffolding. Small adjustments to their original points will be made for the sake of clarity. The first one is that the teacher supports the learner by carefully guiding while the second is the step by step fading of offered support. The last of their points is two-fold and the second of these, although not very important for this thesis, is none the less extremely important to bear in mind in day to day work in schools, and for this reason it will be included. With this fading of support from the teachers, Bakker et al. (2015) maintains that the learners now take responsibility, or are handed the responsibility of continuing exploring the task at hand and in conjunction with this it follows that this will only work if the learners are willing to take that responsibility. That willingness or unwillingness on the part of the learners should as indicated, be taken into account when conducting and analyzing classrooms and observations as well as in "normal" classrooms when planning the lessons. Williams and Baxter (1996) stated that mathematical discourse needed to be guided by the teacher at all times, like scaffolding, and one of the essential aspects was regarding fading. One thing to keep in mind was when to give small bits of information and when to guide them, but not to leave the students alone to themselves. This adheres to exploratory routines (Sfard, 2008), (definition later).

Scaffolding should then eventually lead to Vygotsky's 1978 zone of proximal development (ZPD). ZPD is thereby the peak of what a learner can achieve of competence with skillful guidance.

*As teacher knowledge of student thinking continues to grow and evolve with time, it provides the teacher with a framework for posing timely questions to facilitate the cognitive growth of his/her students"*

(Martino & Maher, 1999, p. 54)

It should be noted that Martino and Maher (1999) continue by stating that getting to know your learners takes time and effort. In addition, building the necessary subject matter knowledge can also be time-consuming. Nonetheless they are valuable tools that should result in more explorative questions as teachers get to know the learners better. Shreyar et al. (2010) claims in this regard that, "At stake in a whole-class conversation is creating and maintaining interpersonal relationships between teacher and students and among students as a condition for doing and thinking within multiple proximal development zones" (Shreyar et al., 2010, p. 28).

Learning is then defined as permanent or continuing change in discourse (Sfard, 2008). There are Sfard (2008) says, two ways in which this change in discourse can take place, and terms them endogenous and exogenous. Endogenous is the change that occurs when the sheer volume of the discourse increases and evolves and as the participants see connections, change follows as a result. Exogenous would be when new elements, as new discourses are connected to the ongoing discourse (Sfard, 2008). There must be Sfard (2008) says, willingness by the learner first of all to participate in the mathematical discourse and for the teachers to let and lead learners into the discourse. Again we encounter the subject of learners' willingness to engage (Sleep, 2012) and the importance of it. Williams and Baxter (1996) wrote as early as 1996 and well before this book by Anna Sfard, about something they referred to as discourse-oriented teaching. They said that this was to make possible mathematical knowledge for students through this discourse and it would provide what they termed useful knowledge. Shreyar et al. (2010) refers to a 1994 book by M.A.K. Halliday which is reprinted in Halliday and Matthiessen (2004), when they present a social semiotic theory which is called systemic functional linguistics. Here language is thought of as a tool to create meaning, not to express meaning. When teachers and students are



working together the students could justify, explain and hypothesize mathematics and by expressing these, ideas and knowledge are constructed together, (Williams & Baxter, 1996). The way that the discussion or preferably the discourse are formed in regard to word use and the way they are spoken are central in what possibilities learners are given to learn about mathematics, and the responsibility of creating these opportunities rests with the educators, (Hintz & Kazemi, 2014). They also state that it falls upon teachers to facilitate for learners to be active in both sharing and hearkening. Despite Sfard (2008)'s statement that the ensuing discourses are evolving occurrences between teacher and student, the author of this Master's thesis is in accordance with Kazemi and Hintz (2014), who focus on the teacher as being the most important in the development of discourses by use of questions. We are all taking part in a multitude of different discourses every day so it is imperative to provide the best environment possible to obtain the participants that are wanted in any given discourse.

The mathematical discourse is unique compared to other discourses and can be recognized by four distinctive characteristics or properties as Sfard (2008) terms them. That is; word use, visual mediators, narrative and routines. Visual mediators are not focused on here and will not be explained, but for the sake of this study both word use and narrative will be explained in this context. Routines will be more extensively reviewed as it paramount to the analysis of the teacher's questions. To comprehend these properties and before the explanation commences a definition of the term object will be presented.

### 2.3.3 Objects

There are more than one definition on objects and Sfard (2008) writes about primary (p-objects) and discursive objects (d-objects). P-objects are a thing that exist in the real world, like a car or a straightedge and are not yet part of a discussion. A d-object is further divided into concrete d-objects and abstract d-objects, were concrete d-objects are p-objects that have entered into a discussion, like when the term straightedge is talked about in an explanation on how to draw a straight line. Simply put the abstract d-objects are according to Sfard (2008), mathematical objects in the discourse that we cannot find in the real world except for representations of them. An example could be

a graph. There is no such thing as one real graph that we can go and pick up in the store or get as a gift, but we can draw a representation of one or we can write down an equation that could represent one. In the following all references to objects will mean the abstract d-objects as defined by Sfard (2008).

### 2.3.4 Word use

The use of words will not necessarily indicate which kind of discourse they belong to, but there are certain keywords that would do a better job of that. Sfard (2008) says that there are words that can and often will occur in colloquial discourses, but that institutions and places that often engage in mathematical discourses have a more subject specific use of these words. The reason for the importance of the words that are used, written, spoken or pictured is that they are the sole bearers of meaning conveyed by the participants in the (mathematical) discourse (Sfard, 2008). In layman's terms this means that we, all people, use words in some form to express what's on our mind, questions, answers, statements and thoughts. This also is the case in more formal discussions like mathematical discourse but the words here can take on different meanings.

It is thus not surprising that Sfard (2008) makes it clear that she finds word use very important and also Lampert (2001) points out that every single word an educator utters can potentially adhere to the learners understanding of mathematics. In her article Berger (2013) uses Sfard's theory and also makes a point of how important word use is and how words are used in mathematical discourse. Berger (2013) claims that it is important for the educators to listen to the learners' specific use of words in the discourse to be able to say something about their learning. I would expand on her claim and say that this is imperative for researchers when analyzing discourse in general. Furthermore in this context it worth keeping in mind, as Rowland (2003) writes while referencing (Stubbs, 1986), that no utterances are neutral in regard to the intention of the speaker. As we cannot know the speakers' thoughts while responding to or asking questions, it is still incumbent to try to envision some of the possible agenda the learners might have with their utterances. This should be remembered by

researchers in their analysis of discourses. Finally, word use or the use of words in most cases, form sentences and sentences are at the core of narratives.

### 2.3.5 Narrative

*Narrative is any sequence of utterances framed as a description of objects, of relations between objects, or of processes with or by objects, that is subject to endorsement or rejection with the help of discourse-specific substantiation procedures.*

Sfard (2008, p. 134).

Understanding and using this term in the following; as consisting of word use about objects and most often used in the mathematical discourse. In the citation above Sfard mentions the endorsement (or rejection) of the narrative, she says that in (scholarly) mathematical discourse it would manifest itself as mathematical theories, definitions and proofs. The endorsed narrative would then be word use about mathematical objects that are agreed on by the mathematical community, or a teacher as the expert in the case of a mathematic lesson, to be verifiably true.

### 2.3.6 Routines

When talking to people on an everyday basis their connotations of the term routine would be predominantly non positive. Not necessarily negative because people recognize that we need some routines like going to work or taking a shower, but still not entirely positive since it is seen as bordering on dull on occasion. If the words used at some point in time, like in a mathematics lesson, follow a pattern then we can call it a routine according to Sfard (2008). She says that routines are a set of meta-discursive rules. This is interpreted as a metacognitive level because while being an actor in her discourse (on) discourses, she applies this theory on others that are being studied or observed. Sfard (2008) also points out that routines are confining and indispensable at the same time. It would be anarchy without any familiar situations, and yet too much routine would curb ingenuity. We need routines, alas teachers, students and learners

need routines. I would go as far as to say that routines are paramount for learners' ability to evolve as we are in dire need of some kind of structure. In some instances you could substitute the term routine with predictability. When something becomes predictable we can see that there is a pattern.

If some kind of pattern is then discovered in our observations, we are able to label them. Sfard (2008) have labeled three different patterns of routines and named them deeds, explorations and rituals.

### 2.3.7 Deeds

We find in the footnote (21) that Sfard (2008) writes that we could "... say that deeds are performative routines" (p. 239). She also explains them as object changing or object producing sequences of actions (p. 237). If you just account for the menial steps you went through to add two numbers for example, that would indicate a deed that changed the objects that were added together and gave a new number, the sum, but this would not lead to any new endorsed narrative.

In pertaining to this definition of deeds, I would on the basis of my experience argue that very often the work of teaching i.e. the way teaching is often carried out would be categorized as a deed. For instance giving an example on the blackboard, the explanation often is a step by step instruction on how to get the "correct" answer since teachers don't want to have any of their students uttering the wrong answers. Thinking this may be the case far more often than we like to imagine. Boaler (2015) addresses the topic of getting the correct answers by the importance of the opposite. She refers to Sims (2011) and his claim that even though we are all imperfect we still live in a world absolutely terrified of making mistakes. She also recognizes that many teachers for a long time have told their students that wrong answers are helpful and now she presents new research on the brain which shows that this is truer than first imagined, "that when the student made this mistake, it was good, because they were in a stage of cognitive struggle and their brain was sparking and growing" (Boaler, 2015, p. 17).

If learners performing deeds instead are steered towards a new understanding, then we could be talking about the routine of exploration.

### 2.3.8 Explorative

The end result of an exploratory routine is to construct new meaning, which is mathematically true and can be proven. “A routine will be called exploration if its implementation contributes to a mathematical theory” (Sfard, 2008, p. 224), and in the book she more explicitly writes that the main objective is to manufacture an endorsed narrative. Following this would mean that proving mathematical hypothesis, testing of mathematical models and problem solving would count as exploratory routines. In all of these cases there would be the need to use previously endorsed narratives, thus recalling them (Sfard, 2008), to contemplate these new tasks and then arrive at a new narrative that could and should be endorsed. This can be seen as what Piccolo, Harbaugh, Carter, Capraro, and Capraro (2008) call a rich meaningful discourse. They define this as “... interactive and sustained discourses of a dialogic nature between teachers and students aligned to the content of the lesson that addresses specific student learning issues” (Piccolo et al., 2008, p. 378). They argue that this is the kind of discourse they want to occur more often in classrooms. This falls in line with (Hargreaves, 1984; Tienken et al., 2009; Tofade et al., 2013) that want to see more of interpretive, deeper, higher-order and productive questions that more or less mirror the exploratory routine and exploratory questions of (Sfard, 2008).

It is interesting for the work on developing questions what Di Teodoro et al. (2011) in their study on elementary level learners, promoted as a set of criteria for deeper, or relating to Sfard (2008), explorative questions:

- *Causes the other person to give more detail;*
- *Helps the person connect to other math they have learned;*
- *Helps the other person fix up their thinking;*
- *Requires someone to explain his/her math so that another person understands it better;*
- *And, requires more than a “yes” or “no” answer.*

(Di Teodoro et al., 2011, p. 21)

One could elaborate on that list by adding simple steps to achieve this. It is not a complete list though, just some pointers from (Graesser & Person, 1994) that in brackets mention “why”, “how”, “why not” and “what if”, as a guide to ways of

asking questions in discourse. I would also add; “could you explain?”. As mentioned, the criteria listed above, were made with younger learners in mind but I suggest that it adheres to all levels of learners engaged in mathematical and other kinds of discourse. These are exact steps that an educator definitely could and possibly should be mindful of when attempting to get learners to manufacture a new narrative that can be endorsed. Also noteworthy to emphasize here is that the discourses that are discussed here have to be in a plenary discussion for this research to be able to evaluate and analyze according to the given definitions.

This also adheres to Sfard (2008)’s claim that learning occurs when there is marked and permanent change in discourse, the result of new endorsed narratives added to previous narratives in the discourse. For learners to be able to add new endorsed narratives to their discourse it is important that there is a continuous flow in the discourse and that this flow is not hampered by misconceptions that the learners may have. Misconceptions could be in the words used and how they are understood. For instance a teacher may use a graph to illustrate and exemplify a function and the learners only view this as a graph and could be looking for labels on the x and y axis. Sfard (2008) call this a commognitive conflict that occurs when different participants engage in different discourses in the same discussion, alas incommensurable discourses. Significantly though, these different discourses can lead to new endorsed narratives as a result of the ongoing discussion. When analyzing the transcripts in this Master’s thesis there will be differentiated between exploratory questions and exploratory routines. It will be referred to as an exploratory routine if the answer to an exploratory question yields some new endorsable narratives. Thus it will be regarded as only an explorative question if the response lacks this characteristic.

Building on the premise that questions are an integral part of a mathematical discourse I add what Enright and Ball (2013) explained as a strategy of scaffolding through questions. This seems to be the case when it looks like the teacher asked a question they did not understand or it contained too much information. Then, if the teacher breaks down content into smaller segments and inquire about these smaller parts in an explorative way, it would be used as scaffolding through questions.

### 2.3.9 Rituals

It can be difficult to grasp the metacognitive and metaphorically thin line that is between deeds and exploration. As Anna Sfard (2008) wrote it can be difficult to “graduate” from students performing deeds to exploration, especially if they are very comfortable with the deeds and have no experience in creating new narratives. The opposite in regard to creating narratives is rituals.

The primary focus of ritual routines and the goal of these discourses is to create, maintain, strengthen and improve social relations, it is not about knowing, but about performing (Sfard, 2008). It is about performing for and by the participants of this discourse. In line with Sfard (2008) that states that, removed from the production of new endorsed narratives and changes in objects, as the exploratory and the deeds, are the ritual routines. By implication this should include ritual questions and ritual responses. In the case of both of this happening at the same time the discourse would be a ritual routine. As mentioned earlier routines are important and even if rituals can seem mundane and not leading straight to new knowledge they are very important in creating the foundation for the development of fruitful exploratory routines. Turning again to Tofade et al.’s (2013) article where they state that lower-order i.e. ritual questions indeed should be asked, as they target different cognitive areas, as long as the object of learning, (definition in the next chapter), is kept in mind. Ritual routines and questions can provide the students with the experience, security and confidence needed when adapting to new environments.

The relationship that can be formed by ritual questions, in an otherwise safe environment, might affect the student –teacher relationship positively. In classrooms these good relationships can be a factor which will easily influence the learning situation, (Doll, Zucker, & Brehm, 2014). These authors suggest that “The relationships that characterize resilient classrooms include teacher-student relationships, or the degree to which students feel supported, respected and valued by their teacher...” (Doll et al., 2014, p. 20). Chapin et al. (2003) state that you as a teacher may have many goals with your discourse, which they refer to as structural interaction in this case, and one of these goals may have to do with the social aspect. This could entail for the learners working together with others, to strive to listen to and understand peers as well as educators and even to build on peer’s ideas.

Another key attribute to ritual routines is that they could be performed by others as well. The meaning of this is that as it does not involve the appearance of any new narratives it will be safe to assume that more than just one particular person can, given otherwise comparable circumstances, for example respond the same way to an asked ritual question, (Sfard, 2008). In Sfard (2008)'s own words:

*To sum up, in rituals, the name of the game is high-fidelity reproduction, constancy, and homogeneity- the exact opposite of the innovation, variation, and diversity that characterize genuine explorative behavior.*

(Sfard, 2008, p. 244)

In a more recent article Bakker et al. (2015) talk about dialogic teaching and emphasize the fact that teaching is both for dialog or discourse and through discourse. As they define dialogic teaching they reference Bakhtin, McGee, Holquist, and Emerson (1986) by repeating a previously used quote; “.if an answer does not give rise to a new question from itself, it falls out of the dialogue.” (Bakhtin et al., 1986, p. 168). In consonance with Sfard (2008)'s definition of ritual I suggest that it does not fall out of the dialogue. It would still be part of the dialogue, for that matter even a salient part of it, only that it would count as a ritual routine.

In conjunction with ritual routines it can be maintained that we can recognize the patterns that Sinclair and Coulthard (1975) have identified as patterns of communication in classrooms, following an IRF model. An initiative (I) is often elicited by a teacher, followed by a student response (R), before the teacher gives feedback on the response. Mehan (1979) has also focused on this pattern of communication and denoted this as an IRE (evaluation) model. This is later described among others by Forman and Ansell (2001) and by Sfard (2008) that they all refer to as the I-R-E or I-R-F model. Forman and Ansell (2001) further state, as indicated, that these patterns are found by many sociolinguists to mirror many classroom discussions. First question then response, followed by an evaluating re-action from the teacher, who will in some way sustain or reject the response, or in some other way give feedback. We also recognize a few of the Mathematical tasks of teaching (Ball et al., 2008) in these patterns (i.e. questions, evaluating responses). Should the anticipated response from the students not surface, the teacher could choose to ask again or rephrase the question to try to elicit the intended response. Forman and Ansell (2001)



explain this as prolepsis and define this using a dictionary to be *anticipation*, the occurrence of a happening before it actually happens. This could be the case if the teacher, in Table 5 line 64 last sentence asks if the pupils are ready to move on to range? Here it would be safe to assume that the teacher anticipates a positive response, given the previous statement that they had moved ahead quickly, from the pupils and would be very surprised if somebody said no.

Most people agree that we need to improve mathematics teaching. Boaler (2015) focuses on some of the myths that exist about mathematics and why they can be viewed as part of the problem of producing good results in mathematics. Among them she says that the faster a person is able to calculate an answer in mathematics the better and more apt that person is regarded by many, teachers' included. If you are slow to calculate then of course you could be viewed as bad, if not hopeless at mathematics. I argue that ritual questions although important can reinforce this view. On one hand ritual questions often if not always expect quick and short answers and thus short and quick can by learners be understood as good. On the other hand the evaluation of learner answers thus deems them right or wrong. Often if wrong, follow up questions are posed to elicit the correct answer, often from another learner to avoid talking about the mistaken wrong answer. Another form of feedback could be in the form of revoicing.

Revoicing is "...the reuttering of another person's speech through repetition, expansion, rephrasing, and reporting" (Herbel-Eisenmann, Drake, & Cirillo, 2009, p. 268; O'Connor & Michaels, 1996) which they among other places have found in (O'Connor & Michaels, 1996). This can be used for a multitude of reasons. O'Connor and Michaels (1996) names some of them. Firstly, the teacher uses the student response with revoicing to connect it to the mathematical task at hand. Secondly, it could be used to affiliate this response to preceding responses or discourse. Thirdly, it opens up an opportunity for the student to agree or disagree, if revoiced in connection to another narrative for example. From experience in classrooms, my own and others and also mentioned in Herbel-Eisenmann et al. (2009), there should also be emphasis on those instances where revoicing is used by the teacher to avoid evaluating the student response. Reasons for trying to avoid falling into the IRF or IRE patterns could be that teachers do not have the necessary competence to evaluate the initial response or there are compelling grounds for not wanting to present a vocal evaluation. This

could among other reasons be due to KCS and learner history, if the learner response is wrong and the educator knows that public awareness does not sit well with the learner. Not evaluating student responses should be avoided and Bjuland (2005) says that by evading an evaluation of unintended, unexpected or wrong responses this could make learners focus even more on giving the answer and response that they think the educator want. Still other reasons for why revoicing is used could be to just to try to buy time, for whatever reason, alas use it as a pause or to collect ones thoughts or simply for a strengthening of social belonging in the mathematical community of the classroom.

Yet another type of ritual routine could be what is referred to as rhetorical questions. Rhetorical questions are in the following to be understood as questions formulated in plenary classroom during instructional teacher speech and with no anticipation of any kind of response from pupils. Although sometimes learners would feel compelled to offer a response regardless. The reason for labelling rhetorical questions as a ritual routine is that it seems that these questions are mainly used for four reasons. Firstly, to bridge from one discourse to another, for instance “Should we move on?”. Secondly, to buy some thinking time and thirdly to include the pupils in the instructional talk so that this, lesson, is a joint experience and thus they take part in the monologue, (Viirman, 2015), for example when a teacher asks, “Do you follow?”. The fourth way is common and is “...mostly to direct students’ attention to specific steps in the reasoning or certain aspects of the mathematics worthy of reflection” (Viirman, 2015, p. 1176). If in some instances, there were insignificant ad hoc ritual questions asked by the teacher, which yielded no response, they would be categorized as rhetorical.

## 2.4 MDI framework

In their article, “A Framework for Describing Mathematics Discourse in Instruction and Interpreting Differences in Teaching”, Adler and Ronda (2015) describe an analytical framework MDI, to enable interpreting differences in practice and they use this to analyze two lessons of one teacher. Their goal was to use MDI to illuminate the “...mathematics made available to learn” (Adler & Ronda, 2015, p. 238). The framework builds on the idea that all learning, according to them, is about something

and subsequently introduces Object of Learning, OL. “An object of learning in a mathematics lesson could be a concept, procedure or algorithm, or meta-mathematical practice”(Adler & Ronda, 2015, p. 238), and making it abundantly clear that this should always be the main focus for any teacher. Marton and Tsui (2004) say that there are two aspects of this object of learning, the general and the specific. Where the general “...has to do with the nature of the capability, such as remembering, discerning, interpreting, grasping, or viewing, that is, the act of learning carried out.” (Marton & Tsui, 2004, p. 4). The specific has to do with the topic or subject in which this is taking place. Also Marton and Tsui (2004) say that they have to presume that teachers are working with the OL in mind, though it might differ in how explicitly this is mediated. They also say that this OL might change during for example the time of a lesson. It is also pointed out that this OL is from the perspective of the teacher, and it will be evident for the students in how this is presented and structured, even though whilst observing in classrooms and analyzing transcripts from recordings it is in some cases not always evident what the OL is, not for students and not for researchers. For example would the subject of statistics be the general OL that would be known to all, and if the teacher was explaining mean and distribution that would have to be assumed, by both parties, that is the OL, even if not stated explicitly. Furthermore if the OL should change in this case, if for instance during the discourse a student ask a question that would warrant entering into a different mathematical discourse and the teacher responds and continues this with elaborations thus making this a new OL. Then it could be assumed that some of the participants in the first discourse would be uncertain as to what the OL was or if indeed there were multiple OL’s taking place.

In their article Adler and Ronda (2014) state that MDI started out as a means to analyze the mathematics in the education of mathematics teachers whilst in practice. They presented three important features instrumental in mathematical pedagogy. “First, for something to be learned/taught, it has to be presented in some form.” (Adler & Ronda, 2014, p. 2). This something is understood to be OL. Second they say that reflections on OL are needed to give the object meaning. These reflections take place in the explorative routine of mathematical discourse, (Sfard, 2008). Third reflections on the OL ends when meaning in the case of what can and cannot be true about OL happens, (Adler & Ronda, 2014). This corresponds to new narratives that subsequently adds to the discourse or forms new discourses, (Sfard, 2008).

The way that Adler and Ronda (2015) illustrate the relations between OL and the learners is copied from their article (p. 239) and shown in Figure 1 and they call the mediators cultural tools.

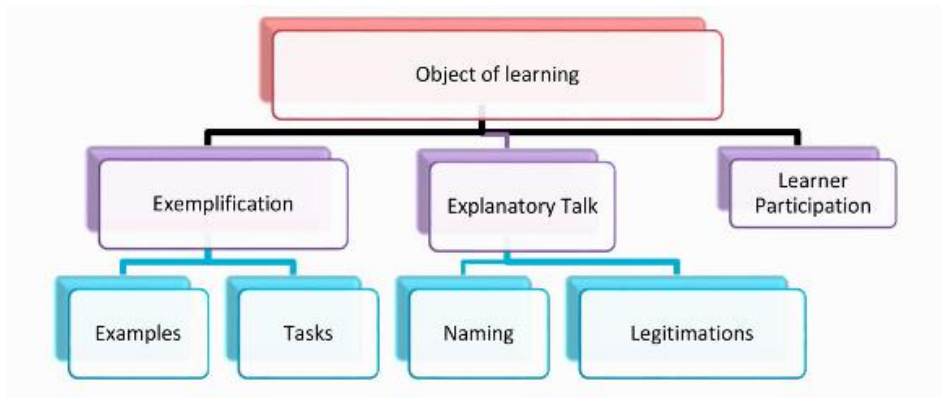


Figure 1 Elements of MDI and the relations (Adler & Ronda, 2015)

Under the OL heading Adler and Ronda (2015) introduced three sub-categories, Exemplification, Explanatory talk and Learner participation. For the sake of the present study the MDI used for analysis will be a reduced version of the one Adler and Ronda (2015) use and have presented. Under the Exemplification category they present examples and tasks. The analysis undertaken in this study will only focus on the questions put forward by the teacher and not seen or analyzed in regard to the examples or tasks at hand. Instead they will be directly evaluated and consequently coded against the Mathematical tasks of teaching. The example or task, (or explanation), that precedes the question will not have any bearing on how the question is analyzed or categorized. This is not to say that this is not important in regard to the questions and how they eventually are formulated, they are indeed. Nor will the responses from the pupils be analyzed in regard to these two sub-categories. It is imperative to stress that these categories could be used in the analysis but in this case the focus of this research is to connect the MDI and the Mathematical tasks of teaching even closer together, to each other and to the questions that are being looked at here. For this reason Exemplification will be excluded from the tools of analysis used here. In this section the category of exploratory talk and learner participation will be addressed. The remaining explaining, including naming, will be done in the method chapter.

Exploratory talk is defined as;

*The transmission of criteria occurs continuously, be it implicitly or explicitly, through messages that are communicated as to what is valued with respect to the object of learning, that is, what is to be known or done, and how.*

(Adler & Ronda, 2015, p. 241).

In other words this is taken to mean the use of language, to explain, answer and ask, with or without the use of aids, tasks or examples, to communicate in regard to the OL. Adler and Ronda (2015) use the MDI framework to analyze to what extent the use of words is mathematical or colloquial and if it is correct or not. This can be related to both word use and endorsable narratives, (Sfard, 2008). The way that the teacher chooses to formulate and express the questions asked have a bearing on how it is perceived and understood by the learners. This will be elaborated on in the method chapter when addressing the chosen subcategory of naming.

When describing the learner participation Adler and Ronda (2015) explain that this category is concerned with how students are invited to respond to the teacher. This is here understood to be on the basis of the expressed teacher questions. What comes into play in regard to this is the exploratory talk (Adler & Ronda, 2015), being used in the questions. The way the question is asked, directly linked to Sfard (2008)'s word use, have a direct significance and impact on how the learners respond. This invitation that the learner participation adheres to, along with other factors, will also indicate what kind of question is being asked. Examples of other factors might include context, topic, tone of voice and intended learner participants, to name a few. Exploratory talk, words used and a combination of these other factors will be what the learners have to interpret and respond to in some way. As is always the case, all these interpretations and responses have to happen almost instantly. It is normal to expect very quick responses and often praise are given if exceedingly quick responses or answers occur. This again adheres to Boaler (2015) and her claim that fast is regarded to be good. These questions could furthermore be ritual or exploratory questions or they could be rhetorical or revoiced questions, each of which could, not necessarily though, lead to a specific way of responding. Thus the learner participation, the way the learners respond, could also be an indicator as to what kind of question is asked. It could also

have a significant bearing on what kind of routine, ritual or exploratory, (Sfard, 2008), that the discourse falls into.

## 2.5 Theoretical summary

In this chapter attention has been brought to earlier research contributions regarding questions in instruction and teaching. Even though researchers define and classify them differently e.g. (Hargreaves, 1984; Tienken et al., 2009), the essence is that continued research on instructional questioning is important. The definitions presented and highlighted from the framework given by Sfard (2008) will be the foundation that permeates this study. These are also visible in the presented framework MDI by Adler and Ronda (2015) as they have used elements from Sfard (2008). It is through discourse that we according to Sfard (2008) are able to learn. Then to be able to analyze questions it was important to show them to be integral to instructional teaching and to be an essential component in discourse. Moreover, questions are shown to be ritual or exploratory Sfard (2008). The Mathematical tasks of teaching by Ball et al. (2008) have been presented and the reasons for selecting from them have been given. There is a linkage to be seen between Adler and Ronda's (2015) MDI to the Mathematical tasks of teaching from Ball et al., (2008). This had a bearing on the elements chosen from MDI which are outlined in the next chapter.

## 3 Method

This chapter will outline the design and method. It will show how and where the material was acquired. Then it details some of the work with the material. In addition to this there will also be paid attention to ethics, which have to be addressed properly when dealing with research.

First of all it is necessary to address the method chosen. By using observation and recordings of a teacher in plenary mathematical instruction and discourse, analyzing chosen excerpts using the MDI (Adler & Ronda, 2015) and coding according to the mathematical tasks of teaching in the hope of making clearer some of the challenges that instructional questioning have. By showing the close connection that instructional

questioning has to many of the Mathematical tasks of teaching and by discussing these connections we might have a better tool for understanding and improving the use of questions in instructing and teaching.

Through my mathematics studies at UIS we, my fellow students and I, under the guidance of our teachers and professors connected to these subjects, conducted a research and development project referred to as MERG.

*Although applied research design places much more emphasis on practical goals than does basic research, you still need to address the issues of what you want to understand by doing the study and how this understanding will contribute to your accomplishing your practical goals.*

(Maxwell, 2008, p. 220)

The aim of choosing a qualitative study was two-fold. First the practical goal was that it was part of the mathematical course at the university, second it was to be used as a foundation for the students in writing a qualitative research paper. This current research is a continuation of the MERG project.

One thing that was realized during the initial work on MERG was how important and how much of an impact we as researchers could have on the results and findings in this particular instance. Thagaard (2013) says that we should be aware of our role as researchers when conducting studies in classrooms. Likely Sfard (2008) wrote that it is impossible to gather data in a classroom without the observers impacting the results in some way. Even if you as a researcher try to have a birds view on the lessons, just to watch and not interfere in any way, or you help or guide as part of your research, you being present will influence the situation in some way. Thagaard (2013) also states that your results will always be affected by this and maybe especially in this research since this researcher use the teachers questions and the responses and answers from the pupils in my analysis, and this is the foundation that I use for answering my research question. In this last sentence the words response and answer were used on purpose, even though they might seem identical. Being aware that it could be interpreted as the same, I will therefore point out that I differentiate between them. An answer would indicate a spoken understandable word as a response to the teachers question or utterances, a

response on the other hand could be a nod, a negating head or hand movement, just a sound as in a non-word sound or no response at all.

Research is not objective, the researchers' values and attitudes have an impact on both what they find interesting to question and how the results of these are interpreted, indeed also how these results are presented, (Kleven, Tveit, & Hjordemaal, 2014). This means that neither research nor observation can be conducted without an unmeasurable degree of influence bestowed by the researchers. They continue to say that this means that all research should be subjected to rigorous assessment regarding validity and reliability.

There are many perspectives on researchers. This Master's thesis follows Sfard (2008) when she focus on two types of researchers' perspective in regard to analyze data and the interpretation of it. She label them the insider's and the outsider's view. The outsider's view is like you are observing something that is completely new, foreign and exotic beyond your comprehension so you are left to just observe and report what you see. The insider's view is like being part of what you are witnessing. Sfard (2008) say in that regard, "The endorser of commognitivist stance is well aware of the importance of both these outlooks" (Sfard, 2008, p. 279). She recommends that the researchers are able to step in and out of these perspectives to enable attention to utterances, context and deeds. As this research' focus is on questions relation and connection to Mathematical tasks of teaching, being able to step in and out of these perspectives was crucial to analyze and elaborate on some theoretically founded qualified guesses and suggestions.

### 3.1 Design

The present study involved conducting a qualitative study with traditional methods of collecting data, such as interview, observation and audio and video recordings (Thagaard, 2013). Silverman (2011) also includes analyzing of texts and documents as one method.

*One real strength of qualitative research is that it can use **naturally occurring data** to find the sequences ("how") in which participants' meanings ("what")*



*are deployed. Having established the character of some phenomenon, it can then (but only then) move on to answer “why” questions by examining the wider contexts in which the phenomenon arises.*

(Silverman, 2011, p. 17)

The “how” and “what” is the groundwork for the interpretative “why”. It is literally what needs to be studied and observed before the analysis begins. Silverman (2011) points out that when you have decided that you are going for a qualitative design you have to consider the ways you can use to collect your data, and then make sure that your method is appropriate. The next thing is making sure you don’t have too much data, and that you don’t have too many different types of data collecting.

We find that Maxwell (2008) describes five different components that are important for the coherence in a qualitative research design. These five are: goals, conceptual framework, research questions, methods and finally validity. Some of these will not be repeated but it is sufficient to say that research question is a further specification of your goals and the methods are accordingly a description of how to achieve the goal. More important here is the validity of the research which has to do with the reliability of the results or findings, how can we trust what we have found and could there be other explanations or interpretations that could be just as believable, (Maxwell, 2008). As is understood by this researcher these five components they are all intertwined. They all influence each other and the end result would be a reflection of the planning and execution of the design.

The validity of research is an important matter. Both (Maxwell, 2008) and (Thagaard, 2013) divides the term validity in two parts. Thagaard (2013) calls them internal and external (my translation) validity. The internal validity has to do with the inner connectivity of the research itself to do. Understanding this to mean that we have thought through and paid attention to all parts of the study and observation and that it is filling a knowledge gap. External validity Thagaard (2013) says has to do with transferability and generalization. Can we transfer the results or findings to other situations, what can we infer from the results and can the results be generalized? Maxwell (2008) calls the two threats to validity for bias and reactivity. The bias he explains, is how the researcher influences the results, especially in a negative manner. Influences being the researchers own preconceptions and values. In the regard to

reactivity Maxwell (2008) says this have to do with the researchers' effect on the participants in the study. These are aspects we should always be wary of they have been thought about throughout this study.

### 3.2 Data collecting

Schools and classrooms are institutional settings where teaching and learning of mathematics occur (Bauersfeld, 1980), forming the framework from wherein the interaction between teachers and pupils happens. This means that both the physical elements such as the building and classroom itself and the institutional aspect, that you have the right and an obligation to attend and complete school, (including mathematics class), have to be addressed and taken into consideration when performing an analysis.

We followed a class of 8<sup>th</sup> graders in a middle sized lower secondary school in one of the bigger cities in Norway for two weeks, the MERG project. Most of the pupils are from middle to lower class income families and the majority of them come from two elementary schools in close proximity to the school where this study was taken place. 8<sup>th</sup> grade is the first year at lower secondary school in Norway followed by 9<sup>th</sup> and 10<sup>th</sup> grade, at which point they graduate from lower secondary. All of the pupils supposed to be there, were present and accounted for the first week of recordings. This class had been together as classmates for approximately six months. They had completely new textbooks for mathematics which they had only had for about four weeks. They had gone from a one set of textbooks called Mega to one called Faktor, (Hjardar, Pedersen, & Jerner, 2014).

This class also used *Flipped classroom* to some degree. *Flipped classroom* is where the pupils are given instructional videos to watch as homework. "Flipped classrooms are considered as an effective mode for engaging students in active learning." (Lai & Hwang, 2016, p. 127). New material would be presented for them when they themselves wanted to go through it. The intention being that pupils, and students, will be more motivated to learn and allowing for the time at school for repeating the material if the need for that should arise. So instead of always spending time introducing new material in class, more time could be spent on answering questions, clarification and

working on related tasks. There are of course inherent pitfalls in this method of teaching as well but to address them goes beyond what this research is trying to illuminate.

In total we observed and videotaped eight lessons of 45 minutes each. Additionally we attained two group interviews with pupils and one interview with the teacher, prior to the majority of the observed lessons. The interview took place after one observed lesson.

### 3.2.1 Interview

The teacher interview is included to provide for an insider's view and thoughts on instruction, plenary discussion, discourse and additional subject education. The teacher gave detailed descriptions on her thoughts, which are valuable when trying to understand the nature of questioning in instruction. The interview clearly showed, when juxtaposed to the lessons, that it can be very challenging to always teach the way you want or the way you have an idea that would be the best way to teach (Marton & Tsui, 2004; Skott, 2009). The teacher was also very clear on not wanting just to give answers, (Skott, 2001), but wants to elicit more information from her pupils by the use of questions. Skott (2001) describes what he calls critical incidents of practice and how a novice teacher, Christopher, is adamant that he will not just give his students the answers to their questions of help. He wants to scaffold their questions to enable them to find the solutions, but as it turns out he in some cases and for various reasons abandons this idea and almost hands them the answer on a plate. This brings to mind the famous quote: "The best teachers are those who show you where to look, but don't tell you what to see." by someone yet, as far as I can tell, unidentified that is known by the pseudonym Alexandra K. Trenfor.

Interviews can be regarded as a collective name Kleven et al. (2014) propose, for a way of acquiring data. There are in literature on the topic, (Kleven et al., 2014; Kvale, Brinkmann, Anderssen, & Rygge, 2015), described different types of interview, ranging from what they refer to as structured interview to the other end of the scale which they call unstructured. "Det er imidlertid ikke slik at et intervju er enten strukturert eller ustrukturert, det kan ligge hvor som helst på et kontinuum mellom det helt strukturerte og det helt ustrukturerte" (Kleven et al., 2014, p. 38). A translation of this could be that

it is not either completely structured nor completely unstructured, it is on a continuum somewhere between the two.

A structured interview is almost like an oral questionnaire in so far as to the questions are predetermined, they are asked in a specific order and it is decided how they should be asked, (Kleven et al., 2014). You get more or less the same information as in a questionnaire, but you still have the opportunity to clear up misunderstandings. On the other hand, the interviewees may not be as candid as they would in a written form, (Kleven et al., 2014).

An unstructured interview often starts off with a set of predetermined questions but the rest of the interview would be follow-up and ad hoc questions in tune to whichever way the interview unfolds, (Kvale et al., 2015). I think for explanatory purposes one could make a distinction between gathering data and collecting data, the same way you could distinguish between structured and unstructured interview. Gathering data would be to acquire data more randomly. You are not certain about what you are able to get, there could be lots of different things. This could be like a structured interview, you know you get some information, to your questions, but you are bound by your predetermined questions. In contrast to this would be the collection of data and the unstructured interview. Collection of data would here be equal to getting a specific kind of data, you know what you are looking for and you only want this kind. This would also be case for unstructured interviews. It would enable the possibility for gaining more in-depth information and maybe because of a more trusting relationship with the interviewee.

Both of these types would demand for detailed preparations before starting the interviews. The unstructured interview calls for even more subject matter knowledge on the part of the interviewer for him to get the in-depth information he seeks. He would need to detect and follow-up on interesting moments in the conversation, (Kleven et al., 2014).

The interview we conducted on the teacher is a semi-structured interview, (interview-guide in Attachment 5), (Kvale et al., 2015). They define this as planned flexible conversation with the intent of getting the interviewee's view on the world and the topic at hand based on the described phenomena. We wanted an informal conversation with some formal questions prepared that would be the foundation for each topic, but we were free to follow up on interesting answers. Dalen (2004) says that the most

important thing is that we show and have a genuine interest in the interviewee and in the response and answers given us, this should be shown in both the way we ask the questions and in the way we listen. Dalen (2004) also reminds us that this can and should be shown verbally as well as non-verbally i.e. through body language the use of eye communication. All these points were addressed in the preparation and execution of the interview.

The excerpts from the interview will be presented as shown (Table 2).

**Table 2 Teacher interview example**

115	10.30	Int 1	MmmMmm How do you think in regard to plenary-situations, how are they (pupils) in plenary instructions?
116	10.35	Tea	As a rule it works out just fine in my opinion, they are calm they pay attention, ehh it is of course easy for some to drift off and not pay attention at all, but at least they are quiet and calm.

In the excerpts from the interview Int 1, first seen in line 115, third column refers to the interviewer asking the questions, this author was the second interviewer and controlled the recordings.

### **3.2.2 Transcriptions of the data material collected through MERG**

We were eight students and we divided the observations, the recordings as well as the interviewing process between us. In every lesson there were two students and one of the tutors from the university present.

When recording the lessons we used two video cameras. I will address the topic of how the lessons unfolded more thoroughly later but for now it suffices to say that especially the first week the lessons started with a greeting from the teacher. Followed by a, at times lengthy, repetition from last lesson and/or presentation of new material and then the pupils were given tasks to work with, mainly in groups. I say mainly in groups since when planning the MERG project with the teacher we agreed to follow two groups of

pre-selected groups formed by the teacher, but a couple of pupils worked mostly alone. The class consisted of 26 pupils and six of them were selected by the teacher for the groups. According to the teacher, these individuals were chosen as they were at the top-end of academic achievement in this class and were thought to be able to make for more interesting mathematical discourse during group-work.

This researcher's focus will be on tasks of teaching in relation to and with special attention to the teacher, the teacher's questions and the response on these questions. There will also be material taken from the teacher interview containing incidents and explanations the teacher gave that bears any impact on what occurred in class. It is for these reasons that there will be no focus at all on the groups nor the group-work itself, but its explained to make it easier to understand why the recordings were handled the way they were. One of the cameras was set up in front of the classroom and this one was focused on the pupils. The second camera was set up at the back of the classroom, focusing mainly on the teacher but it also captured some of the pupils. When the pupils were given tasks and moved to settle in their assigned groups, we moved both cameras so they followed one group each.

After the recordings each student transcribed one or two lessons, depending a little bit on the workload given when observing and recording. To ensure that everything was transcribed as close to our predetermined rules there would always be one student that proofread and checked the transcript against the recordings. All the transcriptions were put in a table and we transcribed according to a prearranged set of rules of transcribing, this according to (Markle, West, & Rich, 2011) is valuable when transcribing. The set of rules we used were made as simple as possible since we were eight different students transcribing. Two important aspects need to be pointed out. The first one is that we transcribed in formal Norwegian, bokmål. The second one is that since this Master's thesis is written in English, the transcriptions are translated by this author, and we need to keep in mind that some of the original meaning can get lost. This will be addressed in some cases in the analysis. It is however important to point out like Sfard (2008), that no matter how much thought is put into the transcription process, the mere act of transcribing is already at the outset, interpreted by the researcher or even more so when there are multiple researchers doing the work. "Of course, even transcribing is an act of interpretation (to begin with, the choice of symbol in which to record what is said is

already interpretive)”(Sfard, 2008, p. 277). She makes a point that there is a difference in research with the commognitive lens contra other ways of interpretation.

*Once the researcher decides to investigate transformations in discourse rather than “in people,” the questions asked, the data gathered, and the analytic lens applied change considerably, often beyond recognition”.*

(Sfard, 2008, p. 276)

Sfard (2008) elaborates on this, saying that the researchers need to focus intently on what is being said as well as always remember the setting in which these utterances were put. If they were uttered as a response, to instigate a response, to bond on some social level or made as a question in some form. Even in a one-to-one interview the utterances will always be for an audience or have an audience.

In addition it is important to keep in mind is that although we had agreed upon a set of rules regarding how to transcribe the observations, there are always instances that are hard or impossible to correctly convey in writing. For example if you use, as we did, parenthesis with dots in to show time gone by, like (..), between utterances. Markle et al. (2011) says that all this shows is that time has passed. It does not say anything about the context, was it an awkward silence or a quite natural lapse of time. Another thing they point out that is hard to properly address in transcripts, is overlaps in conversation. How abruptly are the speaker interrupted and which tone is used in the response or interruption. Only by listening to the recordings are we able to pick up on these nuances.

### **3.3 Ethics and classroom research**

All of the collected material was at the time of writing this available for use and will be legally available even after the conclusion of this thesis. With emphasis on legally available, since doing research and collecting data in this manner here in Norway constitutes an approval/license from the Norwegian center for data research, called *Norsk senter for dataforskning*, NSD also referred to as the “Data Protection Authority”. Our tutors at UIS applied for (Attachment 1) and were granted approval (Attachment 2) for the duration of the project plus one additional year.

Prior to the video and sound recordings both the pupils and their parents, guardians, were given an information pamphlet with a written statement (Attachment 3) saying they had read and agreed to participate. They had to return this signed before any recordings could take place. Prior to informing the pupils and their guardians the teacher were also given an information pamphlet detailing this project (Attachment 4) and she willingly agreed to this.

This is what *The Norwegian National Committees for Research Ethic (NESH)* calls the free and informed consent which is “Freely given consent means that the consent has been obtained without external pressure or constraints on individual freedom” (NESH, 2016, p. 15). NESH (2016) explains that informed consent means that the researcher(s) have given enough information about the project so that the participants know what this project entails with regard to their participation. Furthermore the participants, in my case the pupils, “must have real opportunities to refrain from taking part without this presenting an disadvantage, and they must be fully aware that they can end their participation at any time without this having any negative consequences” (NESH, 2016, p. 15). Since this project was done in a classroom with children under the age of 15, at which age they could have given their consent without necessarily getting their parents approval, NESH (2016) says that special consideration have to be taken to ensure their rights and wellbeing.

*Children are developing individuals, and they have different needs and abilities at various phases. Researchers must know enough about children to be able to adapt both their methods and the direction of their research to the ages of the participants. Age-specific information must be provided about the project and the consequences of the research.*

(NESH, 2016, p. 20)

It is the researchers’ obligation to ensure that there is no negative consequences for the participants and to protect them, throughout the process of the project, (Thagaard, 2013).

To ensure the proper consideration for all the participants in this project from the beginning, all of them were anonymized, (Thagaard, 2013). Before and during the transcriptions of the observed lessons all were given fictive names, as were the teacher



and the school. This is an important step in making sure that none of the participants will be recognizable, (Thagaard, 2013). Given the guidelines from NESH (2016) and NSD all of the material will be properly deleted when the obtained license expires.

### 3.3.1 Lesson categorization

The first thing that was done was to go through the transcriptions of all the lessons and find out what had taken place. Determining what was the main focus, if any, in each of the lessons. Then account for how much time was used in plenary juxtaposed to working on tasks. This was put in a table, (Table 3), and a table translated to Norwegian (Attachment 6).

**Table 3 Outline of lesson activities**

<b>Activity</b>	<b>Subject, focus, vocabulary</b>	<b>Plenary/Teacher instruction time</b>
1. lesson	Repetition, observation, frequency, mean	31 min
2. lesson	Repetition, use of calculator, mean	22 min
3. lesson	Averages, median	31 min
4. lesson	Diagrams & charts, line chart, video	23 min
5. lesson	Repetition, diagrams & charts, line chart, phrases	18 min
6. lesson	Computer room, task-work in groups, Diagrams & charts	15 min
7. lesson	Task-work in groups	
8. lesson	Task-work in groups	
Pupil interview 1	Learning, different ways to work and learn, statistics, understanding	
Pupil interview 2	Learning, different ways to work and learn, statistics, understanding	
Teacher interview	Background, some SCK, statistics, teaching, questions, flipped classroom	

Lessons 1 till 5 plus the interviews took place during the first week and lessons 6-8 in the second week.

As the focus here was being the time spent in plenary and teacher instruction means that only the first five lessons were of interest. Incidents and excerpts included here are all from the first week, this includes excerpts from the teacher interview. Below, (Table 4), is a more detailed table that shows the two lessons were excerpts are taken and used in the analysis and the teacher interview.

**Table 4 Outline of activities in the chosen lessons**

<b>Activity</b>	<b>Topics addressed in the chosen observations</b>	<b>Focus of interest</b>
Monday week 7, 1. lesson	Repetition, observation, frequency, mean, tables, frequency tables, column graphs	Proleptic answers
Tuesday week 7, 1. lesson	Repetition, answer keys in the textbook, use of calculator, mean, mean with negative numbers, numbers in ascending and descending order	Exploratory questions and routines, being in different discourses
Teacher interview	Background, some SCK, statistics, teaching, questions, flipped classroom	Questions, SCK

### 3.3.2 Transcription, an example

The next thing that was done was to isolate all teacher questions in the transcripts from these five lessons. This was done with color-markings, red. The same color was used to indicate what type of question was asked. A translated example from the original transcriptions is underneath, Table 5. The original in Norwegian is attached as Transcript 1.

There will in the beginning of the Results chapter be specified which day and lesson the transcripts are from. In the transcriptions themselves the first column shows the line number, the second column shows time and each lesson starts at 00:00. The third column indicates who was talking. Tea is used as an abbreviation for teacher. Other inputs in this column are either a pupils name or if it is impossible to single out who did the talking then “pupil” would be indicated. The fourth column shows what is being

said, the discourse, the fifth shows gestures the last one is headlined comments, showing comments from the students transcribing.

Table 5 Example of transcriptions

Line	Time	Par.	Discourse	Gest	Comments
60		Tea	That is correct. So now it says frequency here. <b>What was it Ans said that was? (.) What can we translate the phrase frequency with? (3s) Dorte?</b>	Point pointing in the textbook. Fingers “quoting” to the word translate.	<b>Refers to Ane, to include.</b>
61		Dorte	Number (of occurrence).		
62		Tea	Number (of occurrence), yes. The same observation. That is correct. Then task five sixteen, we do «a» together there. (3s). Write that one in your rulebook, you know. That way you have some examples and some tasks that we have there. Right, now we deal with (2s) now it is mode.	Nodding	<b>Revoicing</b>  Lær walks over and writes on blackboard.
63	09:15	Tea	We have read through the example. (.) Lets do task five sixteen together (.) Starting with a and let see. Maybe we will do b together as well. Then (.) I am thinking that we look a bit at range as well. Because I think that many of you have understood a lot of this.	Points in an arch.	Lær thumbs through the textbook.
64	09:42	Tea	So I will take the chance and move along a bit quicker than first imagined. <b>What do you think about that? (.) Are you ready for range as well today?</b>	Pointing to the textbook.	<b>One rhetorical and one ritual</b>

The excerpts being discussed in this thesis will be shown like the example in Table 5 only with an added column named coding that will be shown and explained in Table 7. To illustrate how this was used initially here is an example. In line 64 (64) we can see that at 09:42 the teacher says: “So I will take the chance and move along a bit quicker than first imagined. **What do you think about that? (.) Are you ready for range as well today?**». The (.) signifies a pause of up to a second per dot. In (62) we see the use of (3s) and (2s) meaning that the pause between utterances is 3 and 2 seconds respectively. By the red lettering we can see two different questions put forward by the teacher. The next column follows from the comments in (63) where it was indicated that the teacher is turning pages in the textbook, and then this action results in the gesture of pointing to whatever was found while looking. In the comments column “**One rhetorical and one ritual**” is referring to the first question being rhetorical and the second one where the teacher expects an answer, and here it would be logical, by the context and the tone of voice, to assume that a “yes” would be the preferred response.

Excerpts taken from observations often need a larger context to be understood and Bauersfeld (1980) explains this with the concept of indexicality. This is also the case he says, in cases other than just excerpts from transcriptions. It is for example often the case in classrooms, if you present an occurrence from a random lesson when teachers asks a certain question or issues a different instruction, that can only be understood by the participants in that particular environment and would yield no deep understanding for readers that are not part of this discourse. The understanding of this is that even the aid of recordings and transcripts is not always enough to fully grasp the true reality of what is or has been transpiring. To maximize the contextual understanding the excerpts chosen will be of larger segments of the discourse to try to illustrate the role of the questions and how questions affect the discourses with the research question in mind. This is also why the example here contains multiple lines from the discourse.

### **3.4 Analytical approach to the empirical material**

The focus of this study is to connect teachers’ questions to the Mathematical tasks of teaching, so in order to analyze the questions, only the sub-category Naming, from the category of Explanatory talk will be used in addition to Learner participation which is

already addressed. There will be introduced a new category and column to make this analysis work, namely Mathematical tasks of teaching. These selected parts of the MDI along with Mathematical tasks of teaching coding will be used as the means to analyze the discourse involving the teacher and the pupils. It is of great importance to point out again that the focus of this Master's thesis is the teacher's questions, but in order to completely understand how they are used and to what effect, the pupils responses and answers will be subjected to comprehensive discussions but they will not be coded in the same way the questions are. There are multiple reasons for this, among them: by only coding the questions it is emphasized that they are the primary focus and with the perspective offered here the coding of the pupils responses would thus not yield any insight not already visible and it would juxtapose them in a way that is not desirable.

### 3.4.1 Naming

When analyzing using this category, Naming, this study uses the definitions put forward by (Adler & Ronda, 2015) in regard to naming and that is "...the use of words to refer to other words, symbols, images, procedures or relationships." (Adler & Ronda, 2015, p. 244). They argue that the focus on how the objects that are the topic of learning in mathematics class are articulated are very important, and thus they label naming in their analysis as is explained in the first column in Table 3. This category corresponds to the way Sfard (2008) defines word use, and it will convey if the questions asked, and their responses, are colloquial or mathematical. Mathematical word use can in some cases help us in detecting when participants in discourses are in the same discourse or not, (Sfard, 2008).

### 3.4.2 Tool of analyzes

Underneath, Table 6, is the MDI presented as it has been used to code the questions. Under the heading Learner Participation, Adler and Ronda (2015) used (D) to indicate: Learners answer why questions; present ideas in discussion; teacher revoices/ confirms/asks questions.

Table 6 MDI as used in the analysis

Object of learning		
Explanatory talk		
Naming (of questions)	Learner participation	Tasks of teaching
<p>Within and across episodes word use is:</p> <p>Colloquial (<b>NM</b>), e.g. everyday language and/or ambiguous pronouns such as this, that, thing, to refer to objects in focus;</p> <p>Math words used as name only (<b>Ms</b>), e.g. to read string of symbols;</p> <p>Mathematical language used appropriately (<b>Ma</b>) to refer to other words, symbols, images, procedures, etc.</p>	<p>Learners answer yes/no questions or offer single words to the teacher's unfinished sentence <b>Y/N</b>.</p> <p>Learners answer (what/how) questions in phrases/sentences (<b>P/S</b>).</p> <p>Learners answer why questions; present ideas in discussion; <b>teacher revoices/ confirms/asks</b> questions(<b>D</b>)</p>	<p>Asking productive mathematical questions (<b>Ap</b>).</p> <p>Evaluating the plausibility of student claims, (often quickly) (<b>Sc</b>).</p> <p>Giving or evaluating mathematical explanations (<b>Ge</b>).</p> <p>Presenting mathematical ideas (<b>Pi</b>).</p> <p>Using mathematical notation and language and critiquing its use (<b>Lu</b>).</p> <p>Selecting representations for particular purposes (<b>Rp</b>).</p> <p>Responding to students «why» questions (<b>Wq</b>)</p> <p>Recognizing what is involved in using a particular representation (<b>Pr</b>).</p> <p>Finding an example to make a specific mathematical point (<b>Ep</b>).</p>
<p>Use of colloquial and mathematical words:</p> <p>Level1—<b>NM</b>, there is no focused math talk, all colloquial/everyday;</p> <p>Level2—movement between <b>NM</b> and <b>Ms</b>, some <b>Ma</b>;</p> <p>Level3—movement between colloquial <b>NM</b> and formal math talk <b>Ma</b></p>	<p>Opportunity for learners to speak and so use math discourse is at:</p> <p>Level1—<b>Y/N</b> only (single words only);</p> <p>Level2—at least some <b>P/S</b> in more than one episode (phrase and sentences);</p> <p>Level3—<b>P/S</b> and at least some <b>D</b> (discussion) in more than one episode</p>	

Here they are highlighted in red color to indicate that this is not relevant in the initial coding, due to the fact that the questions already are analyzed in the comments column in regard to revoicing. It is not removed entirely because it will be a factor in the overall summary in terms of levels.

The last row in Table 6 details the levels each of the coding belongs to. These levels will be used in the preliminary discussion of the chosen incidents just as a means to indicate in which direction the total of the discourse is heading.

Table 7 Example of analyzed transcript

Line	Time	Par.	Discourse	Gest	Comments	Coding
99	18:58	Tea	Yes. <b>Then we have to find the middle number (4s), yes?</b>	Rubs his/her hands.	Not an addressed question. <b>Ritual</b>	NM, Pr, Sc, Ep
100		Linda	Em, there are two numbers in the middle.			P/S
101		Tea	Now we have two numbers in the middle (2s). You saw this because when you go from the smallest to the one at the end, and then jumps. <b>Are you able to see? (.) There, now my head is in the way, hehe, and there, can you see now?</b> And there (.) we have two middle numbers, (2s). <b>What do we have to do now then? (4s) Anyone that has not yet answered, (.) Lars?</b>	Fingers pointing and touching the blackboard while “jumping” from both sides at the same time of the ascending numbers.  Circles the middle numbers with chalk.	<b>Revoicing</b>  <b>Rhetorical and ritual</b>	NM, Ap, Ge, Sc
102	19:40	Lars	(Unknown) .. maybe you are supposed to take the one in between those two?!		Asking	NM, P/S
103		Tea	You are supposed to find the one in between, yes. (.) <b>How can we do that?</b>		<b>Revoicing</b> <b>Ritual</b>	NM, Sc, Ap,

As to which level the category will be placed in, it can be constraining as to possible outcomes of the analysis. It will for these reasons, not be illustrated in a separate table.

Above, Table 7, is an example of the coding of the chosen excerpts of transcriptions. This is from week 7 Tuesday 1st lesson.

The reason for showing an extensive excerpt here is two-part. First it will show more of the context in which the questions are part, and to illustrate that all will be taken into account when analyzed. Second the coding with respect to the use of the MDI sometimes needs a larger context in order to get an as accurate coding as possible as it can be part of a longer discourse. In the actual analyzing one of these large segments will be sectioned to make it easier to follow the discussion of analysis.

## 4 Results

In this part the focus will be on the selected excerpts from the transcriptions coded according to the MDI model presented and analysis of each of these segments, although it will start off with some excerpts from the teacher interview. This is discussed with the intention of showing thoughts and meanings that should fulfill an enlightening purpose when seen in consonance to what is later presented in the analyzed excerpts. All of the included transcript excerpts are from the first two days that the observers were present in this class and with this teacher. In the end a very short summary is presented. It is important to point out that this chapter displays some instructional use of questions and as that adheres to the main question of this study.

### 4.1 The teachers' view on the use of questions in instruction

As indicated in the method chapter excerpts from the teacher interview are included to provide a valuable insight and background to this teacher's use of questions in discussions. The whole interview in Norwegian is enclosed as Teacher interview under attachments. It should be relatively safe to assume that it is clear from the interview that the teacher is of the opinion that plenary discussions and discourse is vital to the work of teaching. She also indicated that the instruction given by the teacher and the following discussions are instigated and fueled by questions. Again it is important to



remember to view this as an example of how demanding the task of question-asking is (Ball et al., 2008; Enright & Ball, 2013; Graesser & Person, 1994; Tienken et al., 2009), and not to focus on any imagined fault of this generous teacher.

In the spirit of how exacting this work of teaching and discourse is, the teacher early in the interview expressed her accordance with teachers currently involved in getting or teachers having to get additional credits in subjects taught (Table 8). Many in-service teachers in Norway have to get extra credits in the subjects they teach, this applies to the subjects' mathematics, English and Norwegian and especially for teachers in secondary schools. All teachers have to have credits the equivalent of one full year at university in the subjects they teach, in the three subjects mentioned, in order to be qualified for teaching.

**Table 8 Teacher interview regarding extra credits**

42	4:20	Tea	Because you have to have more credits so you have to learn more. And in (lower) secondary I realize that we have to have more subject knowledge. It is not only about being good at teaching, you need subject knowledge to eh get into the spontaneous situations and to be able to give better examples, better enucleations and explanations to the learners.
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This utterance (42), would seem to indicate that spontaneous situations occur all the time. In accordance to this also ad hoc questions, as they would serve the same purpose as prepared questions, namely as accelerators for discourse as well, so they play a major and important part in day to day teacher work.

The next excerpt from the interview (Table 9), could again be seen in connection with this view. It also depicts that the teacher is in conformance with Sfard (2008) that discussions, by definitions given, are important and this entails that discourse is important. The teacher says (118) that she is trying to use questions a lot. In the next sentence she says she uses a lot of blackboard instruction and this need a bit of explanation. This is a direct translation from Norwegian and refers to the instructional teaching where the teacher uses the blackboard as an essential part of teaching, with the use of examples and explanations. She emphasized how much she likes doing it this way (118) but gave no explicit reason for why and why it was important.

**Table 9 Teacher interview regarding importance of discourse**

115	10.30	Int 1	MmmMmm How do you think in regard to plenary-situations, how are they (pupils) in plenary instructions?
116	10.35	Tea	As a rule it works out just fine in my opinion, they are calm they pay attention, ehh it is of course easy for some to drift off and not pay attention at all, but at least they are quiet and calm.
117	10.52	Int 1	MmmMmm
118	10.53	Tea	I am trying to use a lot of question and answer in my teaching. I use a lot of blackboard instruction. I really like that.

It could be that the teacher views blackboard instruction so essential to the work of teaching that it should need no additional explanation.

It is worth mentioning that the teacher's statements and answers substantiates what is seen in the lessons that was observed, that there was a lot of time spent on blackboard instruction and many questions asked during instruction.

**Table 10 Teacher interview regarding how questions are used**

336	29.14	Tea	Eh They are very engaged in asking for help. So then I walk around and help them.
337	29.20	Int 1	MmmMmm
338	29.21	Tea	Eh So in mathematics especially I don't have a lot of time to wander around to just listen to them talking, (when working on tasks).
339	29.26	Int 1	No?!
340	29.27	Tea	But when they ask me for help I can hear what they know and what they need help with. When they ask and show me like this is what I have managed and ehhm then I ask them. Ask them questions if there is a task they wonder about, and then I try to ask. What are you thinking here? If... Trying collectively to figure out the answer. That I don't only; don't just give them the way as to how to solve it.

The teacher does however delineate how she uses questions (Table 10), when the pupils working with tasks need help. From the teacher's answer (340) we can infer that she, while not naming them, still refers to exploratory questions when she gives an example as to how she wants to phrase her questions. Her example is; "what are you thinking here?", this could become an exploratory routine (Sfard, 2008) if the pupil engages and answers. The teacher is showing us in this answer that she wants to use this help-situation to gain information about what her pupils already knows and understands and she very clearly says (340) that she does not want to just give them the answer, just as (Skott, 2001) describes with Christopher's intentions. This research does not focus on the time spent with the pupils solving and working on tasks and not on the teacher helping them. There will for this reason not be any transcript excerpts from this. It is however important to recognize that the teacher in this answer shows, that albeit a later dominance of ritual questions, she is aware of different ways to use questions in both discourse and instruction. The following analysis of question use in the classroom in the excerpts below should therefore be read with some of the teacher's answers and accordingly as far as it can be interpreted, with the thoughts and intentions in mind.

## 4.2 Teachers' use of exploratory questions

This excerpt (Table 11 below), was from the first mathematics lesson Tuesday in week 7, (Transcript 2). The part subjected to analysis here is selected to show an instance when the teacher used an exploratory question (Sfard, 2008), in the discussion about the mathematical mean. It is also used as a way to illustrate the difference between how exploratory questions and exploratory routines (Sfard, 2008), are realized. As mentioned in the method chapter, the way the pupils answer is of significance in how the questions from the teacher are then realized. Three aspects are worth mentioning before engaging in this part of analyzing. First that the mathematical mean in statistics has been the topic in at least three instances before the section selected took place. From the recordings and observations we learned that the teacher had prepared the pupils a little bit on the subject of statistics in the week before we started observing with a run-through of phrases, among others the mathematical mean. It could be of significance that the pupils knew more about the topic when we observed than is

normally the case. This Monday lesson again included an explanation and instruction on the mathematical mean and a brief repetition of the phrase was given in the minutes before this segment. The second thing is that the teacher reminded the pupils of the fact that there is an answer key (28), at the back of the book. While some publishers opt to have a separate publication for answers, many Norwegian textbooks in mathematics in lower secondary schools, have a section in the textbooks where answers to tasks are to be found for referencing as is the case with their textbook Faktor (Hjardar et al., 2014). An important third thing is the fact that this segment is from a discourse about tasks involving the mathematical mean in statistics that the pupils had already finished the day before. We see by the use of the verb to do in the past, did (30 and 34), in both questions that the teacher is asking about how they went about (last week) solving the task. This indicates that whatever answers and responses to the tasks that pupils submit in the ongoing discourses could hail from different sources. For instance it could be work on the tasks that the pupils themselves have solved, it could be with the help from peers or the teacher, it could be copied directly from the answer key, or it could have been received from parental guidance or from Flipped classroom instructional videos.

The first of the questions (28) is purely ritual in that its objective most likely is to make sure all of the pupils know about the answer key, and to invite as many as possible into the discussion, into a mathematical state of mind so to speak. That is to get all of the pupils to be part of whichever mathematical discourse that may follow. Put another way, by the use of a simple ritual question the teacher seem to attempt to be strengthening the social belonging (Chapin et al., 2003), of the group, the class and to prepare them for the following mathematics.

This would be important since the mathematical part of this lesson first was initiated by the teacher after almost five minutes, equal to one ninth of the lesson, had passed. The second question (28) is a half-open question (Hargreaves, 1984), if we just imagine that it could be asked as two separate questions. The first would then be: do you use it before calculating? Y/N? The second would be questioning the opposite of before calculating, namely after calculating, answered by Y/N. This is the reason for labelling the pupil response in this manner.

Table 11 Use of exploratory questions

Line	Time	Par.	Discourse	Gest	Comments	Coding
28		Tea	And this is in accordance with the answer key. As luck will have it, an answer key is at the back of our new (text) books. <b>Who have discovered this?</b> (1s). Yes, that is good. <b>Do you use it before calculating, or after you have calculated?</b>		Most of the pupils raise their hands. <b>Ritual.</b>	NM, Ms
29		Pupils	After		In effect a yes or no question that is answered.	Y/N
30	07:34	Tea	Yes, that is good. That is the way you have to use it. (1s). Eeh, b, here we have four measurements. It is thirteen, fifteen, fifteen, fourteen. <b>What did you do to find the mean?</b> (2s) Liv?		Looking in the textbook at the task. <b>Exploratory</b>	NM, Ms, Ep, Ap, Lu
31		Liv	I added them,(together), and then I took fifty-seven and divided it by four.		<b>Deed, (Exploratory)</b>	P/S
32		Tea	Yes. <b>Then you got?</b>		<b>Ritual</b>	NM, Sc
33		Liv	Fourteen.			Y/N
34		Tea	Yes. Correct. (.) Then we have... yes, Lars needs one. Thank you so much. (3s). <b>On task b, no, c, what did you get there? There we suddenly had negative numbers, so I am curious as to how you did that (.) Linda?</b>		Gustav is back with notebooks. Looking in textbook. <b>Ritual Exploratory</b>	NM, Ap, Ep, Sc, Ge
35	08:19	Linda	Ehm, I took five added two, added (.) you know zero, subtracted three, subtracted two which gave two, then I divided two by five which gave zero point four.		Mostly answered in Ms. <b>Exploratory</b>	P/S NM, Ms

The teacher reads the task directly from the textbook (30) and then formulates a question that does not just focus on the direct answer to that task. She specifically asked what they did do to find the answer (30). When asking and of course analyzing exploratory questions like this one, we need to pay attention to the word use (Adler & Ronda, 2015; Sfard, 2008). From the pupils responses we see that there is a difference in how the questions are being understood. What follows is proposed as a way of

differentiating between these two phrases is of course also subject to different cultures within the Norwegian culture, different contexts and different practices. Based on personal experience in Norwegian classrooms there is, or at least there can be a profound difference in how the question words; what and how, is interpreted by learners. When the question is: “what did you do?”, it focuses more on the deed (Sfard, 2008) then on getting from this narrative into a new narrative. So this way of asking could be understood as a question about what was done prior to getting to the calculating part. If, on the other hand, the word how is used: “how did you do it?”, this would entail a narrative (Sfard, 2008) about the object (Sfard, 2008) mean, which should lead to a new narrative. We are here talking about the whole process, from start with question to finish with answers resulting in a new narrative.

Liv’s reply (31) is a non-spoken referral to the numbers presented by the teacher (30) with the phrase: them. “I added them”. In Norwegian colloquial speech we often use and especially we hear younger learners very often use the word “sammen”, (together), when talking about adding numbers, as Liv did here. This word is in essence redundant, but seems to be used to strengthen the notion of what is being added alas the deed. That is why it is put in parentheses. Then she got an answer, 57, from adding the numbers and performing a division. We could argue that if Liv had done the whole calculation leading up to getting at 57, that this would be an exploratory routine. Going from the narratives of the four numbers and the calculating and getting a new narrative which is endorsed (Sfard, 2008). We could repeat this using an already endorsed routine and we would still arrive at the same answer. Instead of agreeing to this view I argue that the teacher’s question here is not realized as an exploratory routine for two reasons. The pupil emits the numbers in the calculation and it can be argued that because of how the question was phrased the pupil did not calculate the final operation either. This only leaves us with the deed that was performed in this calculation.

In the next part of this segment the teacher points out (34) that they now, in task c, encounter a completely new variation of the subject of a mathematical mean. It involves negative numbers. As far as it is possible to check from the recordings, negative numbers had not been a topic in plenary instruction, discourse or discussion in regard to the subject of statistics. First the teacher asks a ritual question, “What did you get?” Then, it can be assumed, she is reminded while looking and reading in the

textbook that there indeed are negative numbers which she then states, as she elaborates on the initial ritual question. Here we get the variation of how (34) they solved this. The response given by Linda (35) included the complete steps from the adding of the numbers to the result of this calculation with the next operation of dividing and getting the result. Furthermore it is worth noticing that Linda included the adding of the zero. She was a bit hesitant when uttering this calculation, presumably since we are taught from early years we need not perform additions with zero. Zero added to any number results in no change, so it is only rarely that this is made a point of. Especially considering that this is 8<sup>th</sup> grade and a lot of the focus in primary school is on conserving numbers. Linda continues to add the negative numbers by merely subtracting them. We can infer from this that Linda already has a new endorsed narrative in regard to how to handle the adding of negative numbers. She gives the results of adding all these numbers with negatives and zero and uses this result in the next calculation. She vocally states that she took two and divided by five (35), and gives the mathematical mean at the end. This explanation, with all the steps, including all the numbers and the intermediate result which is then repeated and used in the next operation makes it different from the first exploratory question by the teacher (30) in the way it is realized. Here Linda creates the new endorsable narrative of the mathematical mean of integers from previously endorsed narratives on mean with only counting numbers. We could also argue that Linda might have had an exogenous change in the discourse (Sfard, 2008), and thus learned from the ongoing discourse. The result is nonetheless a realized exploratory routine as opposed to just the exploratory question.

#### **4.3 The teacher and the pupils engage in different discourses**

This excerpt (Table 12) was from the first mathematics lesson Tuesday in week 7, (Transcript 3). There were other observed incidents where one could argue that the teacher and the pupils were in different discourses but the part chosen was special since it had already happened before on the same exact topic. This part is thus chosen to illustrate how the teacher uses questions to keep the discourse going and how, by the use of questions and explanations, recognizes when the participants engage in incommensurable discourses (Sfard, 2008), and how the learners could be brought

back into the same discourse. Some of the pupil responses will be discussed, but only as an attempt to shed more light on the instructional use of the questions. This excerpt from the lesson is a larger segment which for the sake of referencing in the text will be sectioned up into smaller parts in subsequent sub-chapters. The segment in full illustrates the role the questions play in this particular discourse. The context and topics where this excerpt is taken is that the teacher has just had a repetition on how to use calculators and how to calculate the mathematical mean. In addition to this they have in collaboration, written numbers from an example in the book, where they wrote them in ascending order and they also discussed what it means to write something in ascending or descending order. The example that the teacher is using is from the textbook they use, (p 163 and example 5.5, Attachment 8).

#### 4.3.1 Different meaning of a phrase

This section of the excerpt (Table 12), starts after numbers from a new example in the book was already written in ascending order on the blackboard. The teacher (99) puts forward a statement, “then we have to find the middle number”, which, as far as could be ascertained from the recordings, only one of the pupils regarded as an invitation to offer a response to. The teacher thereby invites that pupil into the discourse with a ritual question, yes? This is followed by an uncertain answer, starting with a questioning, ehh, and then a normal ritual response, “there are two numbers in the middle”. The language used (99) shows some mathematical words mixed with colloquial words, “then we have to find the middle number”, where this phrase only makes sense as long as the list of ascending numbers is already present or in some sense is available to the listeners. Here the word middle could be in two different discourses (Sfard, 2008), it could be the colloquial middle, like in the middle of the road, this would normally be an approximating middle of the road, not a measured, exact middle, and it could be the exact middle, namely that there are exactly two numbers in the middle. Also the Sc coding refers to the evaluation of a preceding pupil answer that was affirmed with the first, “yes”. The coding (Pr) and (Ep), i.e. knowing what is in a particular representation and having chosen one to illustrate something, was used to point out that the teacher already had, as it seemed, made a selection of this particular example to use to make a very specific point as to what is the intended



OL, (Adler & Ronda, 2015; Marton & Tsui, 2004). Here that would be to focus on how to find medians, (Attachment 8).

Table 12 Different meaning of a phrase

Line	Time	Par.	Discourse	Gest	Comments	Coding
99	18:58	Tea	Yes. <b>Then we have to find the middle number (4s), yes?</b>	Rubs his/her hands.	Not an addressed question. <b>Ritual</b>	NM, Pr, Ap, Sc, Ep
100		Linda	Em, there are two numbers in the middle.			P/S
101		Tea	Now we have two numbers in the middle (2s). You saw this because when you go from the smallest to the one at the end, and then jumps. <b>Are you able to see? (.) There, now my head is in the way, hehe, and there, can you see now? And there (.) we have two middle numbers, (2s). What do we have to do now then? (4s) Anyone that has not yet answered, (.) Lars?</b>	Fingers pointing and touching the blackboard while “jumping” from both sides at the same time of the ascending numbers.  Circles the middle numbers with chalk.	<b>Revoicing</b>  <b>Rhetorical and ritual</b>	NM, Ap, Ge, Sc, D

The teacher (101) revoices (Herbel-Eisenmann et al., 2009), the previous answer (100), “we have two numbers in the middle”, and even uses the pupil as an expert on her own answer and says “you saw this because..”. This part of the teachers talk is labelled NM because there is inconsistency in the word use, (Sfard, 2008), where it is said “ you go from the smallest to the one at the end”. “Are you able to see?” and “can you see now” are rhetorical questions, (Viirman, 2015), and produces no responses. While asking the rhetorical questions the teacher jumps inward with her fingers at the ends of the ascending row of numbers on the blackboard and arrives at two numbers in the middle and repeats this audibly. Then there is a ritual question (Sfard, 2008) (101). By the way the question is asked it seems ritual because the teacher wants a recipe on how to get the correct answer.

### 4.3.2 Different discourses

The response to this question comes in line 102, (Table 13), where Lars in colloquial language (Adler & Ronda, 2015), answers the what/how (Adler & Ronda, 2015), question with a question of his own (102).

Table 13 Different discourses

Line	Time	Par.	Discourse	Gest	Comments	Coding
102	19:40	Lars	(Unknown) .. maybe you are supposed to take the one in between those two?!		Asking	NM, P/S
103		Tea	You are supposed to find the one in between, yes. (.) <b>How can we do that?</b>		<b>Revoicing Ritual</b>	NM, Sc, Ap,
104		Lars	You take the biggest and take away the smallest (2s) or?			NM, P/S
105		Tea	<b>You want to take away from each other?</b>		Clarifying Ritual	NM, Sc,
106		Lars	Yes, no (unknown)			Y/N
107		Tea	Then you find how much between them, that is the difference, which is zero point two (2s) zero point two is you know, way way smaller than,, than the smallest number (.) then we have to rethink (1s) <b>You want to find something in between, but you cannot take away from each other, so what can we do?</b>		<b>Ritual</b>	NM, Ms, Ge, Ap, Sc

The teacher's (103) response comes after the evaluating of student claims, where the student answer is confirmed with a yes, and then a ritual question is asked (103). Lars answers this unaddressed question, as if he and the teacher are exclusive in this section of the discourse. The proleptic response (Forman & Ansell, 2001), would be the mean value. But here (104), it seems the teacher and Lars are in two different discourses (Sfard, 2008), where he first states that "you are supposed to take the biggest away

from the smallest” then he thinks for about four seconds, presumably when the teacher does not confirm his statement. Then he asks, “or”? It is clear that this commognitive conflict (Sfard, 2008) occurs as a result of different understanding of the phrase “between”. It seems that the teacher’s understanding and intentional use of the phrase is that it means the value that is in the middle between the two numbers; one point six and one point four, whereas the pupil understands between as the value that is the result of the deed of subtraction. This commognitive conflict could probably have been avoided by the appropriately use of mathematical language (Adler & Ronda, 2015). There might on the other hand be a perfectly legitimate reason for the teacher’s decision not to use a more mathematical language in this situation. It could be that a more mathematical language would in a sense give away the answer and the reflection that would necessarily be part of the response. If the question had asked for the mathematical mean of the two numbers that was in the middle of the row of numbers in ascending order according to value, then for at least many of the pupils there would have been only one deed (Sfard, 2008), to do and that was to calculate that value. That may well be assumed to be the reason for choosing the more ambiguous question, though as stated, it seemed that the teacher was unaware of the ambiguous meaning at the time. It is as good as always the case that educators choose between multiple courses of action, all of them may be warranted in the particular moment Lampert (1990). This would then definitely also be the case when choosing and deciding how to phrase questions and of course especially ad hoc questions.

The assumption that they are in two different discourses is reinforced when we read the next question (105). This question is asked in plain colloquial language, to ascertain by evaluating his response that he is indeed in a discourse about subtraction and not in a discourse about medians and means.

The pupil Lars, answers (106) “yes, no”, and it here it looks as if he realizes there is a commognitive conflict (Sfard, 2008), alas that he was wrong in the first response and this was not what the teacher wanted. It could be argued that what the teacher wants supersedes if in reality it is right or wrong, the teacher is the expert (Sfard, 2008), and hence why the pupil is looking for an evaluation from the teacher. It could be he understands the commognitive conflict because the teacher asks again (105), which is not a normal routine (Sfard, 2008). It could also be he has looked at the example in the book, though it seems a bit unlikely since he is so uncertain or maybe more likely

that he understands that this is the wrong procedure to get to the wanted correct answer but he can't figure out how to get there.

We find that the teacher (107) engages in an explanation of Lars' response and tries to make a point by the use of the more appropriate phrase difference, hence why this is also (Ms). In the rephrasing of the question the teacher again resorts to colloquial language and tries to elicit the desired, correct, answer (Boaler, 2015). It could be inferred that the teacher does not want to explicitly use the phrases mean or median in asking the question, thus giving away the narrative that the teacher want the pupils to discover. Even though it is safe to assume that all the pupils have the textbook open on the page where the example is shown, keeping in mind that the teacher wants the pupils to have the textbook open on the pages showing the examples used and follow the instruction both in book and on the blackboard. In this regard it is a productive question, (Ap), as far as the intention of the question, to get the pupils to have the same understanding of "between" but it still does not exhibit any objective to achieve more than a ritual response.

### 4.3.3 Performing a deed

The last part of the question (107), was "...so what can we do?", asking for a way to, even better yet a correct way to get what is wished for. The response (108) (Table 14), is a question, "Isn't it one point five?" There are a couple of things that should be considered in regard to this response. It was asked as a plenary non-addressed question and still Lars maintains the position already occupied as the main participant in the discourse. He offers no way to calculate or arrive at a solution, but merely afford a "correct" answer. Here we need to keep in mind that the example with all answers is in front of him and yet he does not offer the proper algorithm. As the following lines is just for clarification, the next one (111), have the teacher revoicing the pupil with the right answer, one point five. It could be inferred that the revoicing took place to encourage the student after he initially was in a different discourse and to keep him in the enlarged discourse since the teacher poses a plenary question.

Table 14 Performing a deed

Line	Time	Par.	Discourse	Gest	Comments	Coding
108		Lars	Isn't it one point five?			P/S
109		Tea	Hæ?		Asking to repeat	
110		Lars	Isn't it one point five?			P/S
111		Tea	You see that it is one point five, hold that thought (.). How can we calculate this, Pål?		Revoicing Ritual	Ap, Sc, Ms
112		Pål	(2s) Put them together and divide by two.	Tea nods	Deed	P/S, NM

The ritual question, “How can we calculate this?” came after the evaluation of the response given and Pål (112), offers the answer as a deed (Sfard, 2008), what he actually did to arrive at one point five.

#### 4.3.4 Developing questions

The next segment, (Table 15), is interesting again in regard to being in different discourses and changing discourses as a direct result of evaluating the claims from students, the increased use of mathematical language and the gradual honing and refining of the question. It starts with the rhetorical question (113), “all agree?”. It seems safe to assume this is asked intentionally as a rhetorical question, again since all the pupils have the textbook example in front of them. The teacher continues in colloquial language, (NM), and asked “What have we found?”. The comment to this segment is that it is bordering on exploratory only because we can analyze all of what transpired in retrospect and because of what is being said later gives more meaning to initial utterances and questions. Hence we know that the teacher wants the pupils to recall a previously endorsed narrative (Sfard, 2008), into the ongoing discourse. The first attempt (113), yields an answer that corresponds with the discourse on medians. This is also the reply (114) given by a different pupil this time, “I have found the median”. After the quick evaluation of the reply (115), the honing of the question takes place with the use of more mathematical language, “what kind of calculation,

methods have you used to find the median?”. Both Pål and Dagny give the same answer at the same time, (116 and 117), mean. This is marked as an exploratory response, even though it is still only a single word response, since they introduce the new narrative concerning the mathematical mean, to the discourse of median. It would also count as an endorsed new narrative based on the notion that the mathematical mean of two middle numbers in a row of numbers with ascending value is a proven mathematical fact. It should be mentioned that in the textbook, in the paragraph at the top of page 163, (Attachment 8), it is written that the mean-value of two numbers gives the median. The two pupils use their own phrase mean, and not the phrase written in the textbook, so it could be argued that they made, at least the two that responded, the connection between the deed of calculating the median and the deed of finding the mean. This would then entail, as previously stated, a new endorsed narrative in the discourse.

Table 15 Developing questions

Line	Time	Par.	Discourse	Gest	Comments	Coding
113		Tea	All agree? (.) Yes, oki what is it in reality that we have found? Then you have found?	A few of the pupils are nodding	Rhetorical Ritual Bordering on exploratory	NM, Ap
114		Pål	(2s) I have found (2s) the median.			P/S
115		Tea	Yes (.) and you have calculated for, eh (1s) what kind of calculation, method have you used to find the median? Yes?	Pointing at Dagny	Ritual Bordering on exploratory	Ms, Sc, Ap
116		Pål	Mean.		Exploratory	Y/N, (P/S)
117		Dagny	Mean.		Exploratory	Y/N, (P/S)
118		Tea	Yes! You agreed at the same time (1s). Then we have one point four and one point six (.) and divided by two (.) .What does that give us? One point four and one point six (.) this is three, divided by two, Espen, or Lars said that this is one point five, and you were right (2s) right, you saw that is was and here you have the calculation that shows it.	Taps at the blackboard.	Ritual turned rhetorical	NM, MS, Sc, Ge,

From the way the teacher responds (118), with an emphatic “yes!”, it substantiates the claim that this is the narrative and correct answer that the teacher wanted. The following utterance is a description of the deed of this calculation and a summary of this new narrative. The question (118) “What does that give us?” is framed as ritual in the way that it asks for a particular answer, but as the teacher already is explaining it turns rhetorical, as it seems it is used to get the pupils to follow the specific steps of this calculation, (Viirman, 2015).

Regarding the discussion about being in different discourses in this chapter it is necessary to keep in mind what was stated in the last chapter, namely that the subject of the mathematical mean has been repeated in temporal proximity to this lesson. Also and equally important is the fact that an almost identical situation also occurred the day before as shown below.

#### **4.3.5 Another example of being in two different discourses**

Underneath (Table 16), is that passage copied from the transcript from the first lesson Monday week 7. No coding or comments, just another example of two different discourses with the use of the same phrase, “between”. Here it is the pupil that introduces that phrase in to the discourse (80). The teacher acknowledges this in the beginning of the reply (81) and interprets the phrase to be identical to her own immediate understanding of it. This viewpoint would explain the next question asked in regard to the example put forward by the teacher (81). In this case it seems the teacher is taking precautionary steps on behalf of the pupil Espen, when she is trying to ascertain if he wants to answer this question (81). The teacher is still referring to Espen (81) as the expert on this (Sfard, 2008), when asking if he wants to respond. She is thus giving him the opportunity to stay in that role and hopefully extend on it, or declining all together. We can assume that Espen is hesitant about his role as the expert here with his initial response (82), ehh. The following utterances in his answer (82) show that he indeed is in a discourse about dividing and not in the teachers discourse about the mean.

**Table 16 Another example of being in two different discourses**

79	24.00	Tea	When I say mean, what do you know about that? Raise your hand, think.
80	24.18	Espen	If you take two numbers, then you find what is in between them.
81	24.23	Tea	Yes. So if you then have two numbers. For example eight and four. If you want to find the mean of them. What would you have done? Do you want to answer Espen or should I ask the class?
82	24.38	Espen	Ehh. I would have divided eight by four.

This again would point us in the direction of thinking that the teacher may have suspected, based on her knowledge of her pupils, that Espen might not be the expert on this subject. This aligns with knowing your classroom and your pupils as Grossman et al. (2009) states, and here the teacher question (81) can be viewed like she was unsure of the pupil's expertise and that is why he was given a way out of answering.

#### 4.4 Presumed anticipated pupils' answers

The following excerpt (Table 17), is from the first day of observations, Monday week 7, and it is chosen to depict what can be assumed is from the teachers viewpoint, an anticipated response from the pupils, (Transcript 4). When this does not materialize we see how honing and narrowing of the question is used to get the wanted and correct answer. This time, in contrast to what we saw earlier, (Table 15), this honing is not done by the use of more mathematical language or word use, but rather it is rephrased and later narrowed.

As has been the case in the previous analysis it should be kept in mind that this excerpt is from right after a repetition of tables and frequency tables has already been given by the teacher. The teacher also has informed the pupils on which page in the textbook this topic is written, and that they could and should look at these pages, (pp 154 and 155 enclosed as Attachment 9). We are also informed before this excerpt takes place



that the pupils have already, or at least have been told to, write down information about this topic in their rule-books the previous week. The discourse that is taking place is about the example, five point one on page 155 in their textbook, where both the example and the subsequent answer is listed.

We can see, (Table 17), that the word use has already covered the phrase frequency (28) and the explanation of this phrase. The teacher revoices (29) and acknowledges the correct answer with the initial yes. There are a couple of points that maybe should be taken into consideration when discussing this excerpt and also the reason for revoicing what in this case would be labeled a ritual answer. This is the first lesson with observers in the classroom, three in number. We see (28) that we are not yet thirteen minutes into the lesson and more than eight of those were spent on introducing the observers. For this reason the ritual questions and the revoicing here may serve a more important than normal role in the strengthening and improving of social relations (Sfard, 2008). Ritual routines and ritual questions are important (Sfard, 2008), and it would most likely be more difficult to engage the pupils in exploratory routines right off the bat with so many unknown adults in the classroom.

The first sentence in the second part of the teacher's utterances (29) can be viewed as a new idea (Rp). Insofar as a "system" could be regarded both as a way to connect the parts of tables to observations and graphs, and tables being the proleptic object, or as a new way to regard the process of making the transition from observations to numbers. The teacher then paraphrases in colloquial language from the example (29) leading up to a ritual question; "what is it natural for us to make?" After the explanation of the phrase "frequency" and the example it is clear that there is but one correct proleptic answer (Forman & Ansell, 2001), to this question. The pupil's answer (30) is interesting, as it is the object (Sfard, 2008), graph. It could suggest that she reads the question in a more exploratory direction, in so far as on the next pages in the textbook and what frequency tables often are used for is to produce graphs and column graphs. To further substantiate this claim we only need to remind ourselves that since this is repetition most of the pupils have already begun with the graphs. This would then indicate that she may think that the teacher wanted them to see that connection before this topic was properly addressed in this lesson.

Table 17 Ritual questions

Line	Time	Par.	Discourse	Gest	Comments	Coding
28	12.43	Linda	Frequency is the number of times a similar observation occurs.			P/S P/S, Ma
29	12.45	Tea	<p>Yes. The number of times a similar observation occurs. We count. So if you have to count how many were given a ride and ask them. You count the number. Or yes write down the number with counting streaks, and you write down those that were not given a ride.</p> <p>And then we have to make a system. <b>And what is a natural way to do this now that we have this research and have been observing and asking some (people)? What is natural for us to make? Dorthé?</b></p>	<p>Writes on the blackboard. Frames what she has written.</p> <p>Shakes a finger in the air. Making a circle and waves with the finger. Open her arms.</p>	<p>Revoicing</p> <p>Ritual</p>	NM, Ma Sc, Rp, Ep, Ap,
30	13.33	Dorthé	A column graph.			P/S
31	13.35	Tea	Eeh yes, eventually. But before that, to make a system. <b>What is it wise to make, Dagny?</b>	<p>Making a new circle i the air with a finger, and opens arms.</p> <p>Dagny, Asta and Liv raise a hand in the air.</p>	<p>Like she is holding a box.</p> <p>Ritual</p>	NM, Sc, Ap,
32	13.41	Dagny	A table		Y/N	Y/N
33	13.42	Tea	A table. <b>And what do we call this table? Liv?</b>		<p>Revoicing</p> <p>Ritual</p>	NM, Sc, Ap,
34	13.44	Liv	Frequency table.			P/S
35	13.45	Tea	Frequency table. <b>Can everybody see if I write this here?</b> I think I will write this here. Frequency table. That's an overview. Table.	Writes on blackboard.	<p>Revoicing</p> <p>Rhetorical</p>	NM, Sc,

If that was the case then the question could well have been labeled exploratory and in the continuation of this it would count as an exploratory routine.

It is also noteworthy that the teacher asks for this exact object, column graph, only three lines of discourse in the transcripts later and then gets the proleptic object as an answer. We on the other hand realize the proleptic answer was not given (31) as the teacher though acknowledging that this will indeed be the case later on, still makes it abundantly clear that she wants another answer. The teacher also repeats the gestures with her finger and hands to hint as to what she wants. The proleptic answer is the object “frequency table” so the next question posed is still ritual. The response (32) is the object table which is endorsed (33) by the revoicing from the teacher. Still this is not the proleptic object and with the additional ritual question as to the naming of this particular kind of table (33) the teacher has narrowed the line of questioning enough for the pupils to understand what the correct answer is, as it seems. Liv’s answer (34) is approved by revoicing again and the teacher makes a point in the following to repeat it yet another time and connect it to the phrase table as if to marry these two phrases for later use. The rhetorical question (35) also adheres to this claim as it seems to be used to focus the attention of the pupils to the instruction, (Viirman, 2015), and for them to focus on the object, this particular table.

#### 4.5 Short summary

The interview of the teacher was included to give what was a valuable insight into the teachers’ expressed thoughts. Especially thoughts regarding questions in teaching that was helpful when coding and analyzing chosen excerpts from the lessons that was observed. The transcript excerpts from the lessons displayed different ways of how instructional questions were used in teaching. Questions have been presented as rhetorical, ritual and exploratory and shown how they are used in different ways and with different aims. The transcripts also have shown how questions were used to instigate as well as continue both discussions and discourses. In addition some remarks have been suggested as to probable reasons for some of the choices made.

## 5 Discussion

The goal of this study was to explore and have a conceptual look at;

### **The nature of instructional questioning and its use in teaching.**

To do this there has been an analysis of a teachers' plenary instruction and questions used in mathematics lessons. Then we collected these findings and the analysis and discuss them in this chapter.

This chapter will start with a discussion on MDI levels in regard to the coding done in the excerpts. Then there will follow a discussion of what has been analyzed and coded according to the chosen Mathematical tasks of teaching. This is done to explicitly show the relationship found between the instructional uses of questions and how this was connected to core tasks of teaching. This will in the end be viewed in light of the research question, which is repeated there. It is however important to keep in mind the analysis done and the following discussions both lead up to and contain suggested answers to the research question.

### 5.1 Summative grouping in MDI levels

In total there are eighteen distinct segments of teacher talk in the chosen segments of analyses. Counting and adding the number of times each of the different categories, under the label Naming, occur show us that whilst colloquial talk (NM), show up almost three times as often as does Math words used as name only (Ms). The indicated level from Adler and Ronda (2015) would then suggest level 2. We will return to why this could be pertinent and in this case also a correct grading. To recap, the Learner participation categories, Y/N for when the pupils answer yes or no, or if they respond with single words and the P/S, which was when they responded in sentences to "what" or "how" questions. The number of times each of these was coded was almost the same and also resulting in a level 2. The coding of (D), as to learners answering why questions, were limited to one so it had no bearing on the placement of the level. It may seem unproductive to count, add and label the categories in levels but this proved to be a great advantage. If either one of these categories had been in level 1, it would

constrain what was possible to achieve regarding routines as it would have been difficult to analyze and talk about mathematical discourse (Sfard, 2008). It would have been more of an analysis and research about discussion with a less than obvious OL (Adler & Ronda, 2015; Marton & Tsui, 2004). If both had been in level 1 then most, if not all, of the talk from the teacher would have been colloquial and this would over time make it very hard to differentiate mathematical discourses from any other discourse and as all the responses would have been Y/N it would be hard to label it a discussion at all. It might even be hard for the pupils to recognize any OL or understand what kind of discourse was being offered by the teacher. Finding that both are level 2 was still somewhat of a surprise. As stated in the beginning of the chapter this was on the first two days of observation and as (Sfard, 2008; Thagaard, 2013) note, researchers have bearing on those observed and the impact of the observers was expected to generate a higher number of single word answers from the pupils. The number of ritual questions posted by the teacher should ease the way for both single word and as time progressed, more and more multiple word responses and hopefully ending in pupils' proposal of new endorsable narratives. It could also be that as a lot of what was the topic of the different discourses had already been taught the previous week and as such was familiar to the pupils.

As implied and as seen in the last paragraph, level 2 of Learner participation is thus here regarded a prerequisite for the exploratory routine (Sfard, 2008), in that it cannot, by definitions given, be an exploratory routine without an endorsable answer from the pupils, as the Y/N category cannot be endorsed in that it cannot be labeled a narrative (Sfard, 2008).

## **5.2 The analysis seen in the light of the Mathematical tasks of teaching**

As can be seen in the segments analyzed and coded it is only the teacher's dialog that has been coded on the grounds of the Mathematical tasks of teaching. It should be noted that this was done as of course the MDI of Adler and Ronda (2015) contain many of the Mathematical tasks of teaching. For example it could be argued that the MDI sub-category of Naming mirror the task of "Using mathematical notation and language and critiquing its use" (Lu). The sub-category of Learner participation

mirrors among others “Evaluating the plausibility of student claims” (Sc) and “Responding to students “why” questions” (Wq). The teachers questions and responses are a couple of times thus coded in both Naming and the Mathematical tasks of teaching.

When coding according to these tasks it was not arbitrary what for example counts as a productive question (Ap). Ritual questions (Sfard, 2008), are indeed productive depending on the proleptic answer (Forman & Ansell, 2001). It all comes down to what and if there was a conscious thought behind the reason for choosing those particular questions. It could also almost unconsciously be used essentially like a rhetorical questions (Viirman, 2015), to direct pupils attention to the instructional talk. I argue that if ritual questions are being used excessively then this could be a case where ritual questions are being used as and have the effect that a rhetorical question could encompass, as drawing attention more towards the instructional work being done. This was arguably the case in some instances in this classroom, for instance when the pupils had the textbooks open in front of them. They were told to look at an example and the teacher asked ritual questions pertaining to that example, asking them to just read and offer that as answers.

It was not for instance deemed productive if following other questions and then expecting a single word, correct answer response (Boaler, 2015). Keep in mind that productive does not equate to exploratory. That being said, of the eighteen times at turn of instructional speaking and asking, twelve of those times yielded a productive question. As mentioned, the level 2 of Naming can play a part in the explanations of the reasons behind the initial formulation of questions and the later actual formulations of questions and productive questions. Enright and Ball (2013) wrote that if you use learners’ names when posing a question, it is or can be used to strengthen bonds and relations and to confirm belonging. It seems like colloquial language is used the same way here. By using non-mathematical language you can be reinforcing the togetherness that comes from not excluding members of the mathematical discourse, as Sfard (2008) defines mathematical discourse to include some and by the same token exclude others. A discourse with only colloquial language would therefore exclude fewer pupils but would not necessarily be counted as a mathematical discourse, and hence lose sight of the OL. The teacher answered (255 in attachment 8.8) in the interview that she uses both mathematical and colloquial language as often as possible,

since some of the pupils cannot easily relate to more formal mathematical language. This means that especially in the lessons from which there are examples, it should be safe to assume that the teacher tries to ensure that she does not “lose” some participants in current and later discourses by using a too formal mathematical language in the questions and explanations.

As explained earlier, Sfard (2008) values the ritual questions and routines as ways to connect to learners and build relations. Again, the first lessons with observers would presumably lay the foundation for how the later discourses could evolve, that is it would most likely create precedence for how later lessons would unfold in this class with the observers present. It could be that too much of a focus on “easy” questions, as ritual questions to ensure that as many of the pupils as possible are available as later participants of mathematical discourses could have unpredicted consequences. For one, regarding the mathematical task of; “Responding to students “why” questions”, there are not a single why (Wq) question at all from any pupil in any of the recorded lessons in plenary discussions. All the observed questions from pupils in group work were in connection to the textbook-tasks they were working on, thus not coded nor having any bearing on the explanations given by the teacher in plenary discussion. It should also be noted in this respect that if the pupils are unsure of what is expected of them in a situation like this, they would most likely just follow the lead of the expert, the teacher (Sfard, 2008) and not ask or question anything, merely wait for instruction. This could additionally be seen in connection with the teacher’s statement (116) (Table 9) “at least they are quiet and calm”. Does the teacher use this amount of ritual questions and routines (Sfard, 2008) to ensure their good behavior as well? From own experiences you tend to “lose” the attention from your learners quicker if you attempt to engage them in a more challenging narrative routine if they are not already accustomed to it. Especially if the more challenging routines or questions necessarily would need for the pupils to be scaffolded (Bakker et al., 2015). If you “lose” their attention their interest will often follow that same trajectory and they would be more likely to engage in unrelated discourse with their peers and thus the noise-level could increase.

In this case, we could propose that the ritual routines and questions are used not only as a way to strengthen the social relations (Sfard, 2008), but also as an instrument to obtain a quiet classroom, for herself and for the observers presumably. Most teachers

and people in general, like to be perceived as competent in their field of work. Keeping control over the learners coupled with quiet and calm learners in classrooms are skills that for many are enviable. Many teachers would probably like to have a good reputation and be viewed as competent in the art of having a quiet and calm classroom like this.

This may come across as a negative feature, but that is not intended. It would be negative if that was the aim of the lesson or that questions were used for that sole purpose. On the other hand having a quiet and calm classroom opens up for learners to hear what is being said and of course they would not easily be distracted or disturbed when trying either to get work done or to concentrate on understanding the ongoing instruction. It is also easier to engage in or to be a participant in an ongoing discourse if you do not have to struggle to be heard or to hear or other disciplinary issues are at stake.

The teacher states (118 in Table 9) that she likes to use questions a lot and that discussions are important. It is understood by definitions given and the interpretation of the teacher that she also finds questions to be the key entry point into discussions and mathematical discourse (Sfard, 2008). An overall assumption based on the meager observations from two weeks seems to indicate that the majority of the pupils in this class are reluctant to engage and participate in in-depth mathematical discourses. A relatively small number of them showed by gestures, including the raising of a hand, or by speaking out of turn, a willingness to participate. Keeping in mind the presence of the observers, most likely for the first time for many of them, and that we are still dealing with an eight grade class with new textbooks as well. This could mean that already set routines in regard to discourse in this class, was in a state of change. This would not have been made easier with the observers present.

“Evaluating student claims (often quickly)” (Sc) was coded and counted sixteen times overall in the analyzed excerpts and “Giving and evaluating mathematical explanations” (Ge) a total of four times. This indicates that there are both responses and answers to be evaluated and that there were pupils willing to respond. It was however a lot of the same pupils that on their own behalf chose to engage. This was more often than not the same pupils that the teacher had chosen for the groups to be recorded and followed for their mathematical competency. When we account for the



prevalent use of ritual and rhetorical questions juxtaposed to exploratory questions we can propose different reasons for this. Ritual questions (Sfard, 2008), do nothing to promote any profound plunging into new narratives or lengthy explanations. An unsubstantiated claim offered could be that if this line of questioning is the norm, and if, is stressed, then the ritual of answering these then common questions would maybe seem a bit like a waste of energy when taking into account personal experiences as a student and teacher. Another way to regard this could be that they fear, as has been shown that the teacher, by this line of questioning, often is in search of correct answers, as ritual questions often imply, to be wrong. In tables (Table 13, Table 16, Table 11) we find that the pupils do not offer the proleptic or correct answer to the teacher's questions, (104, 82 and 30) respectively. What was referred to from (Boaler, 2015) about the fear most people have from making mistakes can be transferred to a classroom situation as well. The society we live in worships the bright and clever that excels and it subsequently puts more pressure on those who struggle to always be right. The documented incidents of question-use to elicit the anticipated or correct answers could be enhancing that particular fear even more. The teacher gave one of them the opportunity to decline to answer, presumably so that he did not make a mistake. Boaler (2015) went to an area where they are renowned for great results in mathematics (Shanghai), and found that they in many cases support mistakes and wrong answers. They continually exalt that mistakes are excellent for engaging in discourse and sharing for the purpose of a deeper understanding. There the learners were proud to share their mistakes. We as a community and in our classrooms are not there by any stretch of the imagination. With increased knowledge and preparation of questions we could and should move forward in this regard.

If we look at the incident (Table 11) (line 30 and 31) with this in mind it is noteworthy that the teacher does not say it is wrong but still wants a different and more correct answer, presumably to repeat all the necessary steps that need to be taken to get at the enviable column graph she is shown to want in the end. What would happen if the teacher for example had asked the pupil: "Yes; and how would you proceed to make a column graph?", or "What steps would you have to go through to be able to make the column graph?" Could it have been that the pupil would have entered into that discourse, explaining which steps needed be taken before being able to plot that graph? Additionally that explanation might also include the object (Sfard, 2008),

frequency table. Not saying that this is the solution, the teacher may have had adequate and compelling reasons for the choices made. This was just an attempt to question our fear, as teachers as Boaler (2015) writes, for dealing with and calling out learners that on the surface offers what we often conceive at the time as a wrong answer or a mistake. It might on the other hand provide us as teachers with invaluable opportunities to expand and elaborate on present topics and OL.

When looking at and for instances where the teacher was presenting ideas (Pi), this did not occur one time in the coding. The overall idea was that (Pi) needed to be in close connection to the posing and designing of questions and then that the teacher presented an idea that was in conjunction with the current discourse but still in a totally new direction it would seem. Rather than coding and viewing the teachers' explanations and introduction to questions by (Pi) there was one instance where it was coded as a "Representation for a particular purpose" (Rp). It could still be argued that this can be used as an integral part of scaffolding through and by the use of questions (Enright & Ball, 2013), as the teacher uses these new ideas or sometimes examples to further scaffold the learners or students to either reach a new narrative or to better understand what the teacher is asking for. If we conceive of the (Rp) in these terms, then it will always be as a way to prepare and lay the foundation for the following discourses, which by extension of already given definitions are instigated by the teacher's questions. "Presenting ideas" (Pi), "Representations for particular purposes" (Rp) and "Finding an example to make a point" (Ep) are very closely related. Indeed all the mathematical tasks of teaching are connected, that is the idea, and they are an integral part of this work of teaching. The three mentioned have in this case all to do with being a preparatory tool to and for the ensuing questions. As for (Pi) and (Rp), the way they are viewed juxtaposed to (Ep) is that the former two are seen as evolving in the ongoing discourse, in some cases as a result of (Sc) or just as being part of the instruction prior to the questions. (Ep) is found and labelled four times in the excerpts. The teacher used in all the observed lessons examples from the textbook (Hjardar et al., 2014), when repeating topics and when presenting and instructing new material. This means that the four occurrences correspond to the examples used.

It was helpful to code in this way as it highlights and gives room for discussion about the preliminary work behind questions. Note that preliminary work here includes prepared questions but does not exclude ad hoc questions. All the questions in any

given discourse have a form of preliminary work ahead of it being spoken out aloud I propose. The meaning here is that there always is something in the classroom situation that instigates makes a question the natural way to progress. Evaluation, honing, refining, rephrasing, repeating or as a way into a new discourse are all different ways that this work of preparing can be labelled. This is not an exhaustive list though. It is difficult to propose any notion of to what extent the questions analyzed were being prepared beforehand and how many were ad hoc. I would still propose that it is more likely that prepared questions would be given a more prominent place and role in the ensuing instruction. It would seem even more likely that questions were prepared ahead of time, if given prior to instruction in a lesson. Especially if, as is my experience, the examples chosen for instruction were not in any textbook, but as a supplement to the textbook, then you would more likely pay more attention to preparing eventual questions. By finding different examples (Rp) from the textbook you, already by finding and choosing them, presumably invest more thought into it. That should make the proposed increased work of preparing the questions even smaller. It seems obvious that most follow-up questions are ad hoc and the refining of questions would more than likely also fall into the same category of, in the spur of the moment questions.

### 5.3 Findings in regard to the research question.

The research question that has been attempted answered by analyzing a teacher's questions in teaching and instruction were;

**How can the Mathematical tasks of teaching be connected to ritual and exploratory questions in plenary mathematical discourse and what can be achieved by making these connections?**

In the attempt to answer this research question there has been identified and shown a close and irrefutable connection between the Mathematical tasks of teaching and questions in the preceding chapter. No matter what type of question was being asked, ritual, rhetorical or exploratory, they were all asked for a possible intended purpose. That is not to say that all questions were or are successful, not ad hoc nor prepared questions are guaranteed to be successful. All the questions analyzed here could be

and were connected to multiple Mathematical tasks of teaching. All of the mathematical tasks that were chosen were connected to specific use of questions except one, and that was “Responding to students “why” questions” (Wq). It is interesting that this category (Wq), the only one not coded, is one of the Mathematical tasks that in its own right is connected to questions as implied by the name given by Ball et al. (2008). This should suggest that questions are important in discourses and class-discussions, regardless of who is asking. It also suggests that the prevalence of questions in classrooms is valued.

Finding and documenting this close connection is advantageous for a number of important reasons. It seems that there is consent that there are core practices that are specific to the work of teaching (Ball et al., 2008; Chapman, 2013; Mosvold, 2016; Shulman, 1987). By implication that should entail that these core practices are important to the work of teaching in general and to mathematics teaching in particular. Following this line of thought, by the close relation that is established here between questions and these tasks, then questions have to be regarded very important (Boaler, 2015). To repeat, we have established this close connection between questions and the Mathematical tasks of teaching and shown that questions beyond doubt are important. The implication of this would be that we need a still deeper, understanding of questions in instruction. This hopefully would lead to a greater focus on questions and question-asking by teachers and teacher-educators alike. We can then infer that more attention on asking the right questions would also improve students’ willingness to engage in mathematical discourses (Sfard, 2008; Sleep, 2012).

In the analysis it has been shown that what type of questions are being asked has a direct bearing on the proleptic (Forman & Ansell, 2001), responses and the possible discourses that follows. It has also shown that it has a direct impact on how different discourses evolve. Preliminary and preparatory work on questions by teachers should help in getting the proleptic responses. Not in the sense of correct answers, but in the sense that the more work is put into which questions to ask, the more likely all possible responses have been thought about beforehand. This would mean that we as teachers are more likely to get the wanted discourses. We have to be careful not to encourage and reinforce the notion that correct answers are what we seek (Boaler, 2015). Neither should we reinforce nor applaud the idea that the faster learners answer, presumably correct again, the better they are at mathematics, as Boaler (2015)

points out. This means that refining and honing of questions maybe should have other purposes, which can only be improved by the increased work on instructional questions.

Building on Sfard (2008)'s notion that by engaging in mathematical discourse is how we learn mathematics, mathematical discourses with the intended OL in mind need to increase in number. Thus an increased knowledge and awareness about questions and question-asking in mathematics classrooms might provide one way to improve mathematics education and learning as questions are shown to have a direct bearing on the ensuing discourses.

## 6 Conclusion

As we have seen, it can be argued that questions are directly and substantially linked and connected to the Mathematical tasks of teaching (Ball et al., 2008). Questions permeate many of the core practices in teaching, as shown here. Some of these core practices, the mathematical tasks, are quite distinct and on the surface they seem unrelated and remote from one another. Like for instance the Mathematical tasks of; “Evaluating the plausibility of students’ claims (often quickly)” (Sc) and “Selecting representations for particular purposes” (Rp). By connecting instructional questions so closely to the core mathematical tasks we can quite clearly see that these core tasks are related and have a bearing on each other. In this case we could envision one representation (Rp) for a specific OL. From this representation (Rp), follows instructional questions in regard to the topic with consequent learner responses (Sc). As we have seen this would follow the IRE/IRF pattern (Mehan, 1979; Sinclair & Coulthard, 1975). This is just an example that shows how clearly questions are connected to Mathematical tasks of teaching. We have also seen that they are invaluable as discourse accelerators and for the continuation of the discourse or even discussion. By the same token we find and are reminded of the fact that instructional questions are an integral part of teaching and instruction. This would also indicate that continued work on questions asking in regard to teaching and instruction needs to be taken seriously. If taken this seriously and by showing the close connection to core teaching practices, we might get more teachers to actively work on their use, formulation and volume of questions in connection with the OL. This would aid

teachers in the use and exploitation of the up until now, not yet fully explored and unexhausted resources of questioning that Tienken et al. (2009) was rhetorically scouring for. Professor Savas Dimopulos of Stanford is famously referred to with the quote “If you formulate your question properly, mathematics gives you the answer”, from the preceding findings this study proposes a different quote; “if you formulate your questions properly, it gives you mathematical answers”.

## **6.1 The road ahead pedagogical implications for teaching and research**

Many of the questions, if not most, that are being asked by teachers during discourse and in particular explanatory talk are unplanned I claim. Expanding on the idea from Zodik and Zaslavsky (2008) which is also referred to by Adler and Ronda (2015) when they found that the selection of examples were not a planned and conscious act by the teachers studied, the claim here is that this most likely is the case with questions as well. The findings here regarding the observed teacher’s questions and drawing upon my own experience as teacher, a pre service teacher and co-teaching in colleagues’ classrooms would strongly indicate this claim. Should this be the case, this could imply that teachers are fully aware of the importance of instructional questioning, but they lack sufficient tools to apply in their approach to questions. It would also suggest that proper routines for concentrating on instructional question-asking in teaching from school-owners perspective is also lacking. Otherwise it might already have been implemented as a specific goal in the preparation time administered in different schools.

One road ahead that might prove useful is to conduct more research on what type of questions prevail in the context of Norwegian mathematics classrooms. Then to use this information to identify what would be a fruitful path to put more focus on how to ask good ritual and rewarding exploratory questions in the education of teachers. Another aspect that should be researched is how we can work out how to ensure that proper steps are taken to master the art of questioning that Enright and Ball (2013) state is necessary to do. One way that could help in this regard would be to find out the extent of prepared versus ad hoc questions in mathematics classes, the same way that Adler and Ronda (2015) did with examples. As we have seen, research on questions in instruction and teaching has revealed interesting results, e.g. (Di Teodoro et al., 2011;

Enright & Ball, 2013; Tienken et al., 2009) . Thus increased research will help put more focus on one aspect of teaching that should be an area that would greatly benefit from this heightened interest. It might be the one thing all teachers regularly do that would improve teaching quickest? More work and focus on and with instructional questioning in teacher education for instance is something that should not be hard to incorporate at all. Expanded research on the use of instructional questions could prove double advantageous. If we accept what Tienken et al. (2009) wrote, they became more attentive to the questions they used and also what they wanted with their questions. They in addition focused more on the sheer amount of questions. It is therefore conceivable that this could happen again. Hopefully that would spill over into the education of future teachers. As this study only looks at the questions from one teacher in one Norwegian classroom it would be difficult to generalize about the phrasing of questions or the word use within them from these findings. On the other hand the questions that have been scrutinized here are not atypical in any way nor are the topics in which they occur in any way exceptional. For this reason the questions analyzed are deemed suitable for the purpose of having a conceptual look at question use in mathematical teaching and instruction. This Master's thesis is on these grounds a contribution to the ongoing research regarding instructional questioning in teaching.

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## 8 Attachments and transcripts

### 8.1 Attachment 1

#### Meldeskjema NSD



#### MELDESKJEMA

Meldeskjema (versjon 1.6) for forsknings- og studentprosjekt som medfører meldeplikt eller konsesjonsplikt (jf. personopplysningsloven og helseregisterloven med forskrifter).

1. Intro		
Samles det inn direkte personidentifiserende opplysninger?	Ja <input type="radio"/> Nei <input checked="" type="radio"/>	En person vil være direkte identifiserbar via navn, personnummer, eller andre personentydige kjennetegn.
Hvis ja, hvilke?	<input type="checkbox"/> Navn <input type="checkbox"/> 11-sifret fødselsnummer <input type="checkbox"/> Adresse <input type="checkbox"/> E-post <input type="checkbox"/> Telefonnummer <input type="checkbox"/> Annet	Les mer om hva <a href="#">personopplysninger</a> er.  NB! Selv om opplysningene skal anonymiseres i oppgave/rapport, må det krysses av dersom det skal innhentes/registreres personidentifiserende opplysninger i forbindelse med prosjektet.
Annet, spesifiser hvilke		Les mer om hva <a href="#">behandling av personopplysninger</a> innebærer.
Samles det inn bakgrunnsopplysning er som kan identifisere enkeltpersoner (indirekte personidentifiserende opplysninger)?	Ja <input type="radio"/> Nei <input checked="" type="radio"/>	En person vil være <a href="#">indirekte identifiserbar</a> dersom det er mulig å identifisere vedkommende gjennom bakgrunnsopplysninger som for eksempel bostedskommune eller arbeidsplass/skole kombinert med opplysninger som alder, kjønn, yrke, diagnose, etc.
Hvis ja, hvilke		NB! For at stemme skal regnes som personidentifiserende, må denne bli registrert i kombinasjon med andre opplysninger, slik at personer kan gjenkjennes.
Skal det registreres personopplysninger (direkte/indirekte/via IP-/epost adresse, etc) ved hjelp av nettbaserte spørreskjema?	Ja <input type="radio"/> Nei <input checked="" type="radio"/>	Les mer om <a href="#">nettbaserte spørreskjema</a> .

Blir det registrert personopplysning er på digitale bilde- eller videoopptak?	Ja ● Nei ○	Bilde/videoopptak av ansikter vil regnes som personidentifiserende.
Søkes det vurdering fra REK om hvorvidt prosjektet er omfattet av helseforskningsloven?	Ja ○ Nei ●	NB! Dersom REK (Regional Komité for medisinsk og helsefaglig forskningsetikk) har vurdert prosjektet som helseforskning, er det ikke nødvendig å sende inn meldeskjema til personvernombudet (NB! Gjelder ikke prosjekter som skal benytte data fra pseudonyme helseregistre).  <a href="#">Les mer.</a>  Dersom tilbakemelding fra REK ikke foreligger, anbefaler vi at du avventer videre utfylling til svar fra REK foreligger.
<b>2. Prosjekttittel</b>		
Prosjekttittel	Matematisk undervisningskurs	Oppgi prosjektets tittel. NB! Dette kan ikke være «Masteroppgave» eller liknende, navnet må beskrive prosjektets innhold.
<b>3. Behandlingsansvarlig institusjon</b>		
Institusjon	Universitetet i Stavanger	Velg den institusjonen du er tilknyttet. Alle nivå må oppgis. Ved studentprosjekt er det studentens tilknytning som er avgjørende. Dersom institusjonen ikke finnes på listen, har den ikke avtale med NSD som personvernombud. Vennligst ta kontakt med institusjonen.  <a href="#">Les mer om behandlingsansvarlig institusjon.</a>
Avdeling/Fakultet	Fakultet for utdanningsvitenskap og humaniora	
Institutt	Institutt for grunnskolelærerutdanning, idrett og spesialpedagogikk	
<b>4. Daglig ansvarlig (forsker, veileder, stipendiat)</b>		
Fornavn	Tone	Før opp navnet på den som har det daglige ansvaret for prosjektet. Veileder er vanligvis daglig ansvarlig ved studentprosjekt. <a href="#">Les mer om daglig ansvarlig.</a>  Daglig ansvarlig og student må i utgangspunktet være tilknyttet samme institusjon. Dersom studenten har ekstern veileder, kan biveileder eller fagansvarlig ved studiestedet stå som daglig ansvarlig.  Arbeidssted må være tilknyttet behandlingsansvarlig institusjon, f.eks. underavdeling, institutt etc.  NB! Det er viktig at du oppgir en e-postadresse som brukes aktivt. Vennligst gi oss beskjed dersom den endres.
Etternavn	Bulien	
Stilling	Førsteamanuensis i matematikdidaktikk	
Telefon	51831427	
Mobil	91521909	
E-post	tone.bulien@uis.no	
Alternativ e-post	matematikktone@gmail.com	

Arbeidssted	Stavanger	
Adresse (arb.)	Universitetet i Stavanger	
Postnr./sted (arb.sted)	4036 Stavanger	
5. Student (master, bachelor)		
Studentprosjekt	Ja <input type="radio"/> Nei <input checked="" type="radio"/>	Dersom det er flere studenter som samarbeider om et prosjekt, skal det velges en kontaktperson som føres opp her. Øvrige studenter kan føres opp under pkt 10.
6. Formålet med prosjektet		
Formål	Formålet med prosjektet er å undersøke matematisk klasseromdiskurs i matematikkundervisning på barnetrinnet. I prosjektet retter vi fokuset mot selve den matematiske diskursen til lærere og elever, og vi ser etter observerbare endringer i elevenes matematiske diskurs.	Redegjør kort for prosjektets formål, problemstilling, forskningsspørsmål e.l.
7. Hvilke personer skal det innhentes personopplysninger om (utvalg)?		
Kryss av for utvalg	<input type="checkbox"/> Barnehagebarn <input checked="" type="checkbox"/> Skoleelever <input type="checkbox"/> Pasienter <input type="checkbox"/> Brukere/klienter/kunder <input type="checkbox"/> Ansatte <input type="checkbox"/> Barnevernsbarn <input checked="" type="checkbox"/> Lærere <input type="checkbox"/> Helsepersonell <input type="checkbox"/> Asylsøkere <input type="checkbox"/> Andre	Les mer om forskjellige <a href="#">forskningstematikker og utvalg</a> .
Beskriv utvalg/deltakere	En matematikklærer og hans/hennes klasse	Med utvalg menes dem som deltar i undersøkelsen eller dem det innhentes opplysninger om.
Rekruttering/trekking	Vi ønsker å rekrutere en erfaren lærer med høy utdanninge/fordypning i matematikk	Beskriv hvordan utvalget trekkes eller rekrutteres og oppgi hvem som foretar den. Et utvalg kan rekrutteres gjennom f.eks. en bedrift, skole, idrettsmiljø eller eget nettverk, eller trekkes fra registre som f.eks. Folkeregisteret, SSB-registre, pasientregistre.
Førstegangskontakt	Prosjektleder tar direkte kontakt med lærer	Beskriv hvordan førstegangskontakten opprettes og oppgi hvem som foretar den.  Les mer om førstegagskontakt og forskjellige utvalg på våre <a href="#">temasider</a> .
Alder på utvalget	<input checked="" type="checkbox"/> Barn (0-15 år) <input type="checkbox"/> Ungdom (16-17 år) <input type="checkbox"/> Voksne (over 18 år)	Les om forskning som involverer <a href="#">barn</a> på våre nettsider.
Omtrentlig antall personer som inngår i utvalget	30	
Samles det inn sensitive personopplysninger?	Ja <input type="radio"/> Nei <input checked="" type="radio"/>	Les mer om <a href="#">sensitive opplysninger</a> .
Hvis ja, hvilke?	<input type="checkbox"/> Rasemessig eller etnisk bakgrunn, eller politisk, filosofisk eller religiøs oppfatning <input type="checkbox"/> At en person har vært mistenkt, siktet, tiltalt eller dømt for en straffbar handling <input type="checkbox"/> Helseforhold <input type="checkbox"/> Seksuelle forhold <input type="checkbox"/> Medlemskap i fagforeninger	

Inkluderes det myndige personer med redusert eller manglende samtykkekompetanse?	Ja ○ Nei ●	Les mer om <a href="#">pasienter, brukere og personer med redusert eller manglende samtykkekompetanse</a> .
Samles det inn personopplysninger om personer som selv ikke deltar (tredjepersoner)?	Ja ○ Nei ●	Med opplysninger om tredjeperson menes opplysninger som kan identifisere personer (direkte eller indirekte) som ikke inngår i utvalget. Eksempler på tredjeperson er kollega, elev, klient, familiemedlem, som identifiseres i datamaterialet. <a href="#">Les mer</a> .
<b>8. Metode for innsamling av personopplysninger</b>		
Kryss av for hvilke datainnsamlingsmetoder og datakilder som vil benyttes	<input type="checkbox"/> Papirbasert spørreskjema <input type="checkbox"/> Elektronisk spørreskjema <input checked="" type="checkbox"/> Personlig intervju <input checked="" type="checkbox"/> Gruppeintervju <input checked="" type="checkbox"/> Observasjon <input type="checkbox"/> Deltakende observasjon <input type="checkbox"/> Blogg/sosiale medier/internett <input type="checkbox"/> Psykologiske/pedagogiske tester <input type="checkbox"/> Medisinske undersøkelser/tester <input type="checkbox"/> Journaldata (medisinske journaler)	<p>Personopplysninger kan innhentes direkte fra den registrerte f.eks. gjennom spørreskjema, intervju, tester, og/eller ulike journaler (f.eks. elevmapper, NAV, PPT, sykehus) og/eller registre (f.eks. Statistisk sentralbyrå, sentrale helseregistre).</p> <p>NB! Dersom personopplysninger innhentes fra forskjellige personer (utvalg) og med forskjellige metoder, må dette spesifiseres i kommentar-boksen. Husk også å legge ved relevante vedlegg til alle utvalgs-gruppene og metodene som skal benyttes.</p> <p>Les mer om <a href="#">registerstudier</a>. Dersom du skal anvende registerdata, må variabeliste lastes opp under pkt. 15</p> <p>Les mer om <a href="#">forskningsmetoder</a>.</p>
	<input type="checkbox"/> Registerdata	
	<input type="checkbox"/> Annen innsamlingsmetode	
Tilleggsopplysninger		
<b>9. Informasjon og samtykke</b>		
Oppgi hvordan utvalget/deltakerne informeres	<input checked="" type="checkbox"/> Skriftlig <input checked="" type="checkbox"/> Muntlig <input type="checkbox"/> Informeres ikke	<p>Dersom utvalget ikke skal informeres om behandlingen av personopplysninger må det begrunnes.</p> <p><a href="#">Les mer</a>. Vennligst send inn mal for skriftlig eller muntlig informasjon til deltakerne sammen med meldeskjema.</p> <p>Last ned en veiledende mal <a href="#">her</a>.</p> <p>Les om <a href="#">krav til informasjon og samtykke</a>.</p> <p>NB! Vedlegg lastes opp til sist i meldeskjemaet, se punkt 15 Vedlegg.</p>
Samtykker utvalget til deltakelse?	<input checked="" type="radio"/> Ja <input type="radio"/> Nei <input type="radio"/> Flere utvalg, ikke samtykke fra alle	<p>For at et samtykke til deltakelse i forskning skal være gyldig, må det være frivillig, uttrykkelig og <a href="#">informert</a>.</p> <p>Samtykke kan gis skriftlig, muntlig eller gjennom en aktiv handling. For eksempel vil et besvart spørreskjema være å regne som et aktivt samtykke.</p> <p>Dersom det ikke skal innhentes</p>



Overføres personopplysninger ved hjelp av e-post/Internett?	Ja <input type="radio"/> Nei <input checked="" type="radio"/>	F.eks. ved overføring av data til samarbeidspartner, databehandler mm. Dersom personopplysninger skal sendes
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		Samtykke, må det begrunnes. <a href="#">Les mer.</a>
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Innhentes det samtykke fra foreldre for barn under 15 år?	Ja <input checked="" type="radio"/> Nei <input type="radio"/>	Les mer om <a href="#">forskning som involverer barn</a> og <a href="#">samtykke fra unge</a> .
Hvis nei, begrunn		

#### 10. Informasjonssikkerhet

Hvordan registreres og oppbevares personopplysningene?	<input type="checkbox"/> På server i virksomhetens nettverk <input type="checkbox"/> Fysisk isolert PC tilhørende virksomheten (dvs. ingen tilknytning til andre datamaskiner eller nettverk, interne eller eksterne) <input checked="" type="checkbox"/> Datamaskin i nettverkssystem tilknyttet Internett tilhørende virksomheten <input checked="" type="checkbox"/> Privat datamaskin <input checked="" type="checkbox"/> Videoopptak/fotografi <input checked="" type="checkbox"/> Lydopptak <input checked="" type="checkbox"/> Notater/papir <input checked="" type="checkbox"/> Mobile lagringsenheter (bærbar datamaskin, minnepenn, minnekort, cd, ekstern harddisk, mobiltelefon) <input type="checkbox"/> Annen registreringsmetode	Merk av for hvilke hjelpemidler som benyttes for registrering og analyse av opplysninger.  Sett flere kryss dersom opplysningene registreres på flere måter.  Med «virksomhet» menes her behandlingsansvarlig institusjon.  NB! Som hovedregel bør data som inneholder personopplysninger lagres på behandlingsansvarlig sin forskningsserver.
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Annen registreringsmetode beskriv		Lagring på andre medier - som privat pc, mobiltelefon, minnepinne, server på annet arbeidssted - er mindre sikkert, og må derfor begrunnes. Slik lagring må avklares med behandlingsansvarlig institusjon, og personopplysningene bør krypteres.
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Hvordan er datamaterialet beskyttet mot at uvedkommende får innsyn?	Lyd og video--opptak lagres på passordbeskyttet datamaskin og ekstern harddisk som oppbevares i et låsbart rom	Er f.eks. datamaskintilgangen beskyttet med brukernavn og passord, står datamaskinen i et låsbart rom, og hvordan sikres bærbare enheter, utskrifter og opptak?
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Samles opplysningene inn/behandles av en databehandler (ekstern aktør)?	Ja <input type="radio"/> Nei <input checked="" type="radio"/>	Dersom det benyttes eksterne til helt eller delvis å behandle personopplysninger, f.eks. Questback, transkriberingsassistent eller tolk, er dette å betrakte som en <a href="#">databehandler</a> . Slike oppdrag må kontraksreguleres.
Hvis ja, hvilken		

Hvis ja, beskriv?		via internett, bør de krypteres tilstrekkelig.  Vi anbefaler ikke lagring av personopplysninger på nettskytjenester. Bruk av nettskytjenester må avklares med behandlingsansvarlig institusjon.  Dersom nettskytjeneste benyttes, skal det inngås skriftlig databehandleravtale med leverandøren av tjenesten. <a href="#">Les mer.</a>
Skal andre personer enn daglig ansvarlig/student ha tilgang til datamaterialet med personopplysninger?	Ja ● Nei ○	
Hvis ja, hvem (oppgi navn og arbeidssted)?	Ytterligere en forsker og en gruppe med 15 forskningsassistenter vil ha tilgang til materialet	
Utleveres/deles personopplysninger med andre institusjoner eller land?	● Nei ○ Andre institusjoner ○ Institusjoner i andre land	F.eks. ved nasjonale samarbeidsprosjekter der personopplysninger utveksles eller ved internasjonale samarbeidsprosjekter der personopplysninger utveksles.
<b>11. Vurdering/godkjenning fra andre instanser</b>		
Søkes det om dispensasjon fra taushetsplikten for å få tilgang til data?	Ja ○ Nei ●	For å få tilgang til taushetsbelagte opplysninger fra f.eks. NAV, PPT, sykehus, må det søkes om <a href="#">dispensasjon fra taushetsplikten</a> . Dispensasjon søkes vanligvis fra aktuelt departement.
Hvis ja, hvilke		
Søkes det godkjenning fra andre instanser?	Ja ○ Nei ●	I noen forskningsprosjekter kan det være nødvendig å søke flere tillatelser. Søkes det f.eks. om tilgang til data fra en registreier? Søkes det om tillatelse til forskning i en virksomhet eller en skole? Les mer om <a href="#">andre godkjenninger</a> .
Hvis ja, hvilken		
<b>12. Periode for behandling av personopplysninger</b>		
Prosjektstart	02.01.2018	Prosjektstart Vennligst oppgi tidspunktet for når kontakt med utvalget skal gjøres/datainnsamlingen starter.
Planlagt dato for prosjektslutt	30.06.2019	Prosjektslutt: Vennligst oppgi tidspunktet for når datamaterialet enten skal anonymiseres/slettes, eller arkiveres i påvente av oppfølgingsstudier eller annet.
Skal personopplysninger publiseres (direkte eller indirekte)?	<input type="checkbox"/> Ja, direkte (navn e.l.) <input type="checkbox"/> Ja, indirekte (identifiserende bakgrunnsopplysninger) <input checked="" type="checkbox"/> Nei, publiseres anonymt	Les mer om <a href="#">direkte</a> og <a href="#">indirekte</a> personidentifiserende opplysninger.  NB! Dersom personopplysninger skal publiseres, må det vanligvis innhentes eksplisitt samtykke til dette fra den enkelte, og deltakere bør gis anledning til å lese gjennom og godkjenne sitater.
Hva skal skje med datamaterialet ved prosjektslutt?	<input checked="" type="checkbox"/> Datamaterialet anonymiseres <input type="checkbox"/> Datamaterialet oppbevares med personidentifikasjon	NB! Her menes datamaterialet, ikke publikasjon. Selv om data publiseres med personidentifikasjon skal som regel øvrig data anonymiseres. Med anonymisering menes at datamaterialet bearbeides slik at det ikke lenger er mulig å føre opplysningene tilbake til enkeltpersoner.  Les mer om <a href="#">anonymisering av data</a> .

13. Finansiering		
Hvordan finansieres prosjektet?	egen forskningstid	Fylles ut ved eventuell ekstern finansiering (oppdragsforskning, annet).
14. Tilleggsopplysninger		
Tilleggsopplysninger		Dersom prosjektet er del av et prosjekt (eller skal ha data fra et prosjekt) som allerede har tilrådning fra personvernombudet og/eller konsesjon fra Datatilsynet, beskriv dette her og oppgi navn på prosjektleder, prosjektittel og/eller prosjektnummer.
15. Vedlegg		
Vedlegg	Antall vedlegg: 2. <ul style="list-style-type: none"> <li>• informasjonsskriv laerere.pdf</li> <li>• informasjonsskriv foreldre.pdf</li> </ul>	

## 8.2 Attachment 2

Kvittering NSD



Tone Bulien

4036 STAVANGER

Vår dato: 14.12.2017

Vår ref: 57328 / 3 / LAR

Deres dato:

Deres ref:

### **Vurdering fra NSD Personvernombudet for forskning § 31**

Personvernombudet for forskning viser til meldeskjema mottatt 21.11.2017 for prosjektet:

57328

*Matematisk undervisningskurs*

*Behandlingsansvarlig      Universitetet i Stavanger, ved  
institusjonens øverste leder Daglig ansvarlig Tone Bulien*

### **Vurdering**

Etter gjennomgang av opplysningene i meldeskjemaet og øvrig dokumentasjon finner vi at prosjektet er meldepliktig og at personopplysningene som blir samlet inn i dette prosjektet er regulert av personopplysningsloven § 31. På den neste siden er vår vurdering av prosjektopplegget slik det er meldt til oss. Du kan nå gå i gang med å behandle personopplysninger.

### **Vilkår for vår anbefaling**

Vår anbefaling forutsetter at du gjennomfører prosjektet i tråd med:

- opplysningene gitt i meldeskjemaet og øvrig dokumentasjon
- vår prosjektvurdering, se side 2
- eventuell korrespondanse med oss

Vi forutsetter at du ikke innhenter sensitive personopplysninger.

### **Meld fra hvis du gjør vesentlige endringer i prosjektet**

Dersom prosjektet endrer seg, kan det være nødvendig å sende inn endringsmelding. På våre nettsider finner du svar på hvilke [endringer](#) du må melde, samt endringsskjema.

### **Opplysninger om prosjektet blir lagt ut på våre nettsider og i Meldingsarkivet**

Vi har lagt ut opplysninger om prosjektet på nettsidene våre. Alle våre institusjoner har også tilgang til egne prosjekter i [Meldingsarkivet](#).

**Vi tar kontakt om status for behandling av personopplysninger ved prosjektslutt** Ved prosjektslutt 30.06.2019 vil vi ta kontakt for å avklare status for behandlingen av personopplysninger.

*Dokumentet er elektronisk produsert og godkjent ved NSDs rutiner for elektronisk godkjenning.*

NSD – Norsk senter for forskningsdata AS    Harald Hårfagres gate 29    Tel: +47-55 58 21 17    [nsd@nsd.no](mailto:nsd@nsd.no)    Org.nr. 985 321 884  
NSD – Norwegian Centre for Research Data    NO-5007 Bergen, NORWAY    Faks: +47-55 58 96 50    [www.nsd.no](http://www.nsd.no)

Se våre nettsider eller ta kontakt dersom du har spørsmål. Vi ønsker lykke til med prosjektet!

Dag Kiberg

Kontaktperson: Lasse André Raa tlf: 55 58 20 59 /

[Lasse.Raa@nsd.no](mailto:Lasse.Raa@nsd.no) Vedlegg: Prosjektvurdering

**Personvernombudet for forskning**



Prosjektvurdering –

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Kommentar

Prosjektnr:  
57328

## DATAINNSAMLING

Det vil gjennomføres personlige intervjuer og gruppeintervjuer med henholdsvis lærere og elever. I tillegg vil det gjennomføres observasjon av undervisning, der det også vil gjøres videoopptak.

Personvernombudet legger til grunn at alle personer som kan fanges opp på videoopptak (lyd eller bilde), samtykker til dette i forkant. Vi legger videre til grunn at det legges opp til et alternativt opplegg for elever som ikke ønsker å delta i prosjektet, jf. informasjonsskriv av 13.12.2017.

## INFORMASJON OG SAMTYKKE

Du/dere har opplyst i meldeskjema at utvalget vil motta skriftlig og muntlig informasjon om prosjektet, og samtykke skriftlig til å delta. Det innhentes også samtykke fra elevenes foreldre. Vår vurdering er at informasjonsskrivene, slik de foreligger i revidert versjon av 13.12.2017, hovedsakelig er godt utformet. Vi ber imidlertid om at følgende presiseres:

- Det bør komme klarere frem dersom hele forskningsgruppen skal ha tilgang på personopplysninger.
- Det foreligger et avvik mellom meldeskjema og informasjonsskriv med hensyn til dato for prosjektslutt. Vi legger til grunn at førstnevnte stemmer, og at prosjektet avsluttes 30.06.2019. Informasjonsskrivet må revideres for å gjenspeile dette.
- Etersom foreldre og elever samtykker til både observasjon, intervju og oppgaveanalyse, bør dette komme klarere frem. Vi anbefaler at det legges opp til avkrysning for hva man samtykker til.

## LÆRERS TAUSHETSPLIKT

Personvernombudet bemerker at taushetsplikten vil være til hinder for at læreren kan kommentere identifiserbare enkeltelever. Læreren bør minnes i forkant av intervjuene om å omtale elever på en måte som ikke gjør dem identifiserbare.

## BARN I FORSKNING

Selv om barnets foresatte samtykker til barnets deltakelse i prosjektet, må også barnet gi sin aksept til å delta. Vi anbefaler at barnet mottar tilpasset informasjon om hva deltakelse i prosjektet innebærer. Du/dere må sørge for at barnet forstår at deltakelse er frivillig, og at det kan trekke seg om det ønsker det.

## DATASIKKERHET

Personvernombudet forutsetter at du/dere behandler alle data i tråd med Universitetet i Stavanger sine retningslinjer for datahåndtering og informasjonssikkerhet. Vi legger til grunn at bruk av privat pc/mobil lagringsenhet er i samsvar med institusjonens retningslinjer.

## PROSJEKTLUTT

Prosjektlutt er oppgitt til 30.06.2019. Det fremgår av meldeskjema/informasjonskriv at du/dere vil anonymisere datamaterialet ved prosjektlutt.

Anonymisering innebærer vanligvis å:

- slette direkte identifiserbare opplysninger som navn, fødselsnummer, koblingsnøkkel
- slette eller omskrive/gruppere indirekte identifiserbare opplysninger som bosted/arbeidssted, alder, kjønn
- slette lydopptak
- slette eller sladde bilde- og videoopptak

For en utdypende beskrivelse av anonymisering av personopplysninger, se Datatilsynets veileder: <https://www.datatilsynet.no/globalassets/global/regelverk-skjema/veiledere/anonymisering-veileder-041115.pdf>

### 8.3 Attachment 3

Informasjonsskriv vedrørende forskningsprosjekt i skolen

Jeg vil her informere deg/dere som foreldre til barn i (NAVN PÅ KLASSE) på xxxxx skole om forskningsprosjektet som vi ønsker å gjøre i klassen. Prosjektet er en del av et kurs på Masterstudiet i matematikdidaktikk ved Universitetet i Stavanger (UiS), hvor to forskere og åtte masterstudenter deltar. Målet med prosjektet er å studere klasseromdiskurs i matematikk. Arbeidet vil dreie seg om sammenhenger mellom lærers og elevers diskurs omkring sentrale matematiske begreper.

Det er derfor ønskelig at vi får anledning til å observere klassen (3–10 skoletimer) og samle inn data som feltnotater, intervju og oppgaveanalyse. Det vil bli gjort video- og lydopptak fra undervisningen og intervjuene. Alle observasjoner og kommentarer fra lærer og elever vil bli behandlet konfidensielt, og datamaterialet vil bli anonymisert ved prosjektslutt slik at det ikke vil kunne spores tilbake til elevene, klassen eller skolen.

All medvirkning i dette prosjektet er basert på frivillighet, og dere står selvsagt helt fritt til å velge om deres barn skal være med eller avstå fra å delta i prosjektet eller ikke. Dersom dere ikke ønsker at deres barn skal delta i prosjektet, vil de få følge tilsvarende undervisningsopplegg i en parallellklasse mens dette prosjektet pågår.

Observasjonene vil fortrinnsvis foregå i løpet av februar/mars, etter nærmere avtale med klassens matematikklærer. Video- og lydopptak vil bli oppbevart på en sikker måte. Prosjektet er meldt til Personvernombudet for forskning ved NSD. Alle involverte parter fra UiS er underlagt taushetsplikt, og data vil bli behandlet deretter. Alle opptak vil bli slettet/destruert når prosjektet er avsluttet. (Dato for prosjektets slutt er satt til 30. juni 2018)

Det ferdige arbeidet vil bli presentert i en skriftlig rapport som senere kan videreutvikles til en publiserbar artikkel. Hverken skolen, læreren eller elevene vil kunne gjenkjennes i eventuelle publikasjoner.

Nærmere informasjon om prosjektet kan fås ved henvendelse til Reidar Mosvold (tlf. 51 83 23 42 og e-post: reidar.mosvold@uis.no) som er ansvarlig for dette prosjektet. Vi håper på positiv tilbakemelding fra deg/dere.

Vennlig hilsen



Reidar Mosvold

Professor i matematikdidaktikk, UiSSvarslipp:

Jeg tillater at deltakere i forskningsprosjektet fra UiS observerer (og eventuelt intervjuer) vårt barn.

Underskrift av foresatt(e): .....

Jeg godtar også at det blir samlet inn data som beskrevet ovenfor.

Ja

Nei (sett ring rundt valg)

## 8.4 Attachment 4

Informasjonsskriv til lærer vedrørende forskningsprosjekt i skolen

Jeg vil her informere om forskningsprosjektet som vi ønsker å gjøre i klassen din. Prosjektet er en del av et kurs på Masterstudiet i matematikdidaktikk ved Universitetet i Stavanger (UiS).

Målet med prosjektet er å studere klasseromsdiskurs i matematikk. Arbeidet vil dreie seg om sammenhenger mellom lærer og elevers diskurs omkring sentrale matematiske begreper.

Det er derfor ønskelig at vi får anledning til å observere klassen (3–10 skoletimer) og samle inn data som feltnotater, intervju og oppgaveanalyse. Det vil bli gjort video- og lydopptak fra undervisningen og intervjuene. Alle observasjoner og kommentarer fra lærer og elever vil bli behandlet konfidensielt og anonymisert slik at de ikke vil kunne spores tilbake til elevene. Gjennom hele prosessen (innsamling, bearbeidelse, analyse og presentasjon av data) vil vi være bevisste på å anonymisere datamaterialet. Det vil derfor ikke være mulig å vite hvem som har gjort eller sagt hva eller hvilken klasse og skole forskningen har foregått ved.

All medvirkning i dette prosjektet er basert på frivillighet, og deltakerne har mulighet til å trekke seg fra prosjektet når som helst. Dersom noen av elevene ikke ønsker å delta, ber vi om at de får anledning til å delta i tilsvarende undervisning i en parallellklasse mens prosjektet varer.

Observasjonene vil fortrinnsvis foregå i løpet av februar/mars – etter nærmere avtale med deg som lærer. Video- og lydopptak vil bli oppbevart på en sikker måte. Prosjektet er meldt til Personvernombudet for forskning ved NSD. Alle involverte parter fra UiS er underlagt taushetsplikt, og data vil bli behandlet deretter. Alle opptak vil bli slettet/destruert når prosjektet er avsluttet. (Dato for prosjektets slutt er satt til 30. juni 2018.)

Det ferdige arbeidet vil bli presentert i en skriftlig rapport som senere kan videreutvikles til en publisierbar artikkel. Hverken skolen, læreren eller elevene vil kunne gjenkjennes i eventuelle publikasjoner.

Nærmere informasjon om prosjektet kan fås ved henvendelse til Reidar Mosvold (tlf. 51 83 23 42 og e-post: reidar.mosvold@uis.no) som er ansvarlig for dette prosjektet. Vi håper på positiv tilbakemelding fra deg/dere.

Vennlig hilsen<sup>[1]</sup><sub>[SEP]</sub>

Reidar Mosvold<sup>[1]</sup><sub>[SEP]</sub>

Professor i matematikdidaktikk, UiS

## 8.5 Attachment 5

### Lærerintervju

#### Introduksjon

XX: Intervjuer 1 (den som leder samtalen med lærer; noterer og stiller ev. oppfølgingsspørsmål)

YY: Ansvarlig for filming / audio

Mitt navn er XX, og dette er YY. Vi er begge masterstudenter i matematikdidaktikk ved Universitetet i Stavanger. Vi er med i et prosjekt der vi ønsker å lære mer om elevenes læring i matematikk og lærerens undervisning. Det har derfor vært veldig spennende for oss å observere arbeidet med statistikk i klassen din.

I denne samtalen har vi lyst til å snakke med deg om undervisningen om statistikk. Vi takker for at du har sagt deg villig til å være med, og vi håper det er greit for deg at vi tar opp denne samtalen med lyd og filmopptak. Din deltakelse er basert på frivillighet, og du har derfor full rett til å trekke deg dersom du ønsker det. Men vi håper selvsagt at du er villig til å være med på denne intervjusamtalen også! Når prosjektet vårt er over, så vil alle opptakene slettes, og du kan være trygg på at alt datamaterialet blir brukt på en slik måte at identiteten til deg, elevene eller skolen ikke blir offentliggjort.

Da er vi klar til å begynne!

#### Spørsmål om bakgrunnsinformasjon (5 minutter)

- Kan du fortelle litt om din utdanning og erfaring som matematikklærer?
  - Hvilke trinn har du arbeidet med?
  - Hvor mange års erfaring har du?
  - Hvilken utdanning har du?
    - Når?
    - Hvilke fag?
- Kan du si litt om hvorfor du valgte å bli med på dette prosjektet? (Hvorfor valgte du å være med en gang til?)
  - Kan du fortelle om hvordan du utvikler deg som lærer? (Kurs, erfaring, erfaringsdeling, ...)
    - Hvordan legger skolen til rette for dette?
  - Hvordan samarbeider dere på skolen?
    - Utvikler dere undervisningsopplegg i fellesskap?
    -

#### Spørsmål om undervisningen (15-20 minutter)

- Hvordan vil du beskrive din rolle som matematikklærer i denne 8. klassen?
- Kan du si litt om plasseringen av statistikk i forhold til de andre matematiske emnene?
- Hvordan har du planlagt emnet statistikk som helhet?

- Kan du si litt om valget av undervisningsmåter/metoder (plenum. smågruppe osv. si litt om valg – arbeide i par)?
- Kan du si noe om hvordan du har planlagt introduksjonen av emnet?
- Hvordan tenker du om tilpasning av matematikkundervisningen til ulike elever?
  - Når du planlegger matematikkundervisning?
  - I selve undervisningen?
- **Hvordan bruker du læreboka?**
  - Hvor ofte bruker du denne?
  - Hvordan bruker du andre verktøy? (videoer)
  - Synes du læreboka er tilfredsstillende i forhold til det elevene skal lære av begrep?
  - (Hvordan) bruker du lærebokas nivådeling?
- Opplevs statistikk som et lett/vanskelig emne for elevene? Hvorfor?
- Hva er det du ønsker elevene skal sitte igjen med etter en periode med undervisning i statistikk?
  - Er du opptatt av elever selv skal forklare begreper, eller vektlegges anvendelse?
- Hva mener du skal til for at elever på 8. trinn forstår statistikk?
  - Hvilke begreper ønsker du at elevene skal få med seg i dette emnet?
  - Kan du si litt om hvordan du har brukt/kommer til å bruke disse begrepene i løpet av disse to ukene? (Hvorfor? Er det andre begreper? Noen du har utelatt – eventuelt hvorfor?)
  - Kan du si litt om hvordan elevene bruker/har brukt de nevnte statistikkrelaterte begrepene i undervisning?
  - Legger du spesielt til rette for at elevene skal snakke sammen om statistikk? (Kan du gi noen eksempler på hvordan du har gjort dette?)
  - Hvordan legger du til rette for samtaler mellom deg og elevene i fellesundervisning og når elevene arbeider med oppgaver i smågrupper?
- Har du noen ytterligere kommentarer helt til slutt? Noe du vil utdype? Noe du synes er viktig når du underviser i statistikk?
- Da må vi bare si tusen takk for at du stilte opp – både i intervjuet her og i prosjektet som helhet.

## 8.6 Attachment 6

### Aktivitets oversikt

<b>Aktivitet, Observasjon</b>	<b>Tema, fokus</b>	<b>Lærerstyrt tidsbruk</b>
1. time	Observasjon, frekvens, gjennomsnitt	31 min
2. time	Kalkulatorbruk, gjennomsnitt	22 min
3. time	Sentralmål, median	31 min
4. time	Diagram, linjediagram	23 min
5. time	Diagram, linjediagram	18 min
6. time	Datarom: jobbet med oppgaver i grupper, diagram	15 min
7. time	Arbeidstimer, gruppearbeid	
8. time	Arbeidstimer, gruppearbeid	
Elev intervju 1	Læring, arbeidsmåter, statistikk, forståelse for tema	
Elev intervju 2	Læring, arbeidsmåter, statistikk, forståelse for tema	
Lærer intervju	Bakgrunn, litt SCK, statistikk, undervisning, flipped classroom	

## 8.7 Attachment 7

### CURRICULUM FOR THE COMMON CORE SUBJECT OF MATHEMATICS

Dette er ei omsetjing av den fastsette læreplankteksten. Læreplanen er fastsett på Nynorsk

Established as a Regulation by the Ministry of Education and Research on 21 June 2013

Valid from 01.08.2013

#### **Statistics, probability and combinatorics**

Statistics covers planning, collecting, organizing, analyzing and presenting data. Part of data analysis is describing general characteristics of the data material. Assessing and critically considering conclusions and presentations of data are key elements in statistics. Probability focuses on expressing in numbers the likelihood that an event will occur. Combinatorics involves systematic ways of determining numbers, and is often required for calculating probability.

#### **Basic skills**

Basic skills are integrated in the competence aims where they contribute to development of the competence in the subject, while also being part of this competence. In the subject of Mathematics the basic skills are understood as follows:

*Oral skills* in Mathematics involves creating meaning by listening, speaking and conversing about mathematics. It involves forming opinions, asking questions and using argumentation with help from informal language, precise terminology and the use of concepts. This also means participating in discussions, communicating ideas and elaborating on problems, solutions and strategies with other pupils. The development of oral skills in Mathematics begins with conversations about mathematics and leads to presenting, discussing and elaborating on more and more complex themes related to the subject matter. Furthermore, this development starts with a basic mathematics vocabulary that leads to precise professional terminology, the use of specific concepts and other modes of mathematical expression.

*Being able to express oneself in writing* in Mathematics involves describing and explaining a process of thought and putting words to discoveries and ideas. It involves the use of mathematical symbols and formal mathematical language to solve problems and present solutions. It also means making drawings, sketches, figures, graphs, tables and diagrams suited to the situation. Writing in Mathematics is a tool for developing one's own thoughts and own learning. The development of writing related to mathematics begins with simple forms of expression and gradually moves toward more formal symbolic language and a precise terminology. The development also begins by describing and systematizing simple

situations with content from the subject matter to building up comprehensive argumentation concerning complex relationships.

*Being able to read* in Mathematics involves understanding and using symbolic language and forms of expression to create meaning from texts in day-to-day life, working life and from mathematics texts. The subject matter of Mathematics is characterised by complex texts that may include mathematical expressions, graphs, tables, symbols, formulas and logical reasoning. Reading in Mathematics involves sorting through information, analysing and evaluating form and content, and summarising information from different elements in the texts. The development of reading in Mathematics begins with finding and using information in the texts by means of simple symbolic language and moves toward finding meaning and reflecting on complex professional and technical literature with advanced symbolic language and concepts.

*Numeracy* in Mathematics involves the use of symbolic language, mathematical concepts, methods of approach and varied strategies to solve problems and explore mathematics by taking a point of departure in practical day-to-day situations and mathematical problems. This involves learning to pinpoint and describe situations where mathematics is involved and using mathematical methods to deal with problems. The pupil must also communicate and evaluate the validity of his or her solutions. The development of numeracy in Mathematics begins with a basic understanding of numbers, pinpointing and solving problems in simple situations and gradually leads to analysing and solving a wide range of complex problems using a varied selection of strategies and methods. It also involves an increasing use of different tools for calculations, modelling and communication.

*Digital skills* in Mathematics involves using digital tools to learn through play, exploration, visualisation and presentation. It also involves learning how to use and assess digital aids and tools for calculating, problem solving, simulation and modelling. It also means it is important to find information, analyse, process and present data using appropriate tools, and being critical of sources, analyses and results. The development of digital skills involves working with complex digital texts with an increasing degree of complexity. It also involves developing an increasing awareness of the new digital tools that exist for learning in the subject of Mathematics.

## **Competence aims**

### **8.7.1 Competence aims after Year 2**

#### Statistics

*The aims of the studies are to enable pupils to*

- collect, sort, note and illustrate data using tally marks, tables and bar graphs, converse about the process and what the illustrations tell us about the data

## 8.7.2 Competence aims after Year 4

### Statistics

*The aims of the studies are to enable pupils to*

- collect, sort, note and illustrate data using tally marks, tables and bar graphs, with and without the use of digital tools, and converse about the process and what the illustrations tell us about the data

## 8.7.3 Competence aims after Year 7

### Statistics

*The aims of the studies are to enable pupils to*

- plan and collect data in connection with observations, questionnaires and experiments
- represent data in tables and graphs that are produced digitally and manually, with and without using digital tools, and read, interpret and assess their usefulness
- find median, mode and averages for simple data sets and assess them in relation to each other

## 8.7.4 Competence aims after Year 10

### Statistics

*The aims of the studies are to enable pupils to*

- carry out investigations and use databases to search for and analyse statistical data and critically assess sources
- order and group data, find and discuss and elaborate on the median, mode, average and spread, and present data with and without digital tools, and discuss and elaborate on different ways of presenting data and what impressions these can give



## 8.8 Teacher interview

### Lærer intervju

Nr.	Tid	Hvem	Diskurs	Gestikulering	Kommentar
1	0.06	Int 1	Ja. Mitt navn er Geir Erik Øvrebø, og dette er Tron.		
2	0.11	Int 2	Trodal		
3	0.12	Int 1	Vi er jeg masterstudenter i matematikdidaktikk ved Universitetet i Stavanger. Vi er med i et prosjekt der vi ønsker å lære mer om elevenes læring i matematikk og lærerens undervisning. Det er derfor det er veldig spennende for oss å observere arbeidet med statistikk i klassen din. Ehh Vi har lyst til å snakke med deg om undervisningen i statistikk, og vi takker deg for at du har sagt deg villig til å være med, og vi håper det er greit for deg at vi tar opp denne samtalen		
4	0.41	Lærer	Ja		
5			med lyd og bilde. Du har lov å trekke deg fra prosjektet når du vil siden du er her frivillig. Men vi håper selvsagt at du er med veien ut. Når prosjektet vårt er over, så vil vi slette alle opptak, så du kan føle deg trygg på at alt datamaterialet blir brukt på en måte som gjør at vi ikke kan identifisere deg, elevene eller skolen. Da er vi klar til å begynne. Om du kan fortelle oss litt om utdanning og erfaring som matematikklærer?		
6	1.19	Lærer	Ja. Nå er det det tiende året jeg jobber i ungdomsskolen som mattelærer. Eh jeg er utdannet faglærer i matematikk og naturfag.		
7	1.33	Int 1	MmmMmm		
8	1.34	Lærer	Så så den var tre årig den la de ned i nittini. Så jeg var det nest siste kullet der da. Ehh Så da har jeg hatt naturfag og matematikk og da mattedidaktikk og pedagogikk og praksis og alt det der.		
9	1.49	Int 1	MmmMmm		
10	1.50	Lærer	MmmMmm		
11	1.53	Int 1	Hva tid var det du ble ferdig med undervisning [med...]		
12	1.56	Lærer	Jeg ble ferdig med eksamen i nittini også jobbet jeg ett år som lærervikar på ****skole		

13	2.03	Int 1	MmmMmm		
14	2.04	Lærer	Også startet jeg et renholdsfirma sammen med mannen min slo det sammen med andre servicer og tjenester. Så da holdt jeg på der i seks år så i totusen og sju gikk jeg tilbake til skolen.		
15	2.17	Int 1	MmmMmm		
16	2.18	Lærer	MmmMmm		
17	2.19	Int 1	Eh så de trinnene du har arbeidet med det er helst ungdomsskole og [(ukjent tekst)]		
18	2.21	Lærer	[Ja] I hovedsak ungdomsskole. Det var kun det ene året jeg var vikarlærer på **** barneskole.		
19	2.29	Int 1	MmmMmm [Har du da...]		
20	2.30	Lærer	Det var fra første til sjuende.		
21	2.33	Int 1	Ja og da har du jobbet med alle trinnene åttende til tiende?		
22	2.34	Lærer	Ja åttende, niende og tiende, så jeg har fulgt tre grupper og holder på med den fjerde nå.		
23	2.38	Int 1	MmmMmm		
24	2.39	Lærer	NnnNnn		
25	2.41	Int 1	Kan du si litt hvorfor du valgte å bli med på dette porsje.. prosjektet?		
26	2.45	Lærer	Jo		
27	2.46	Int 1	Eller hvorfor du valgte å bli med en gang til.		
28	2.47	Lærer	Ja (ler) Jeg syntes det er veldig spennende og jeg ser at det og er skjerpende for meg som lærer. eh for det at da må jo. Altså etter ti år s f... Da var det jo åtte år jeg hadde jobbet når jeg sa ja til dette sist. Da begynte jeg på det niende året og mange ganger så tror man at man kan snu bunken også undervise i det samme som man har gjort før, men det går ikke for alle klasser er forskjellige.		
29	3.12	Int 1	MmmMmm		
30	3.13	Lærer	Alle lærer.. alle elevene har med seg forskjellig basiskunnskap om de grunnleggende elementene fra barneskolen og de kommer fra to forskjellige barneskoler.		

31	3.22	Int 1	MmmMmm		
32	3.22	Lærer	Og det merker jeg. Noen har hatt tid og har blitt flinke for eksempel i Excel mens andre har ikke gjort det. Noen har begynt litt på likninger, mens andre har ikke. Så så hver gang jeg begynner på et nytt emne så må jeg ta det ganske fra begynnelsen av. Det som jeg synes er kjekt da når jeg får studenter inn, det er det at jeg jeg må spørre meg selv altså hva vil jeg undervise i, hvordan vil jeg gjøre det, og eh hvordan skal jeg få elevene til å jobbe videre med. ja.		
33	3.52	Int 1	MmmMmm. Er det noen andre måter du utvikler deg som lærer? Er det noen sånn kurs eller noe sånn som du har?		
34	3.59	Lærer	Vi har noen får kurs. Eh nå har jeg ikke satset videre på videreutdanning eh nå i matte fordi jeg har begynt med ledelse.		
35	4.09	Int 1	MmmMmm		
36	4.09	Lærer	Har begynt å studere det.		
37	4.10	Int 1	MmmMmm		
38	4.11	Lærer	Ellers hadde jeg gått vidre og studert matte.		
39	4.13	Int 1	MmmMmm		
40	4.14	Lærer	Så. Så de nye reglene er jo egentlig. Det er bra.		
41	4.20	Int 1	MmmMmm		
42	4.20	Lærer	For du må ha flere vekttall da så du må lære mer. Og på ungdomsskolen så merker jeg at vi må ha mer faglig tyngde. Det er ikke bare det å være flink å undervise du må ha mer faglig tyngde for nettopp å kunne eh sette seg litt mer inn i de spontane situasjonene og kunne gi bedre eksempler, bedre vinklinger og forklaringer til elevene.		
43	4.43	Int 1	MmmMmm		
44	4.43	Lærer	Du kan ikke bare si en ting på en måte du må si det på tre måter. Ellers får du ikke alle med deg.		
45	4.48	Int 1	Legger skolen opp til at til at du får utvikle deg videre?		
46	4.53	Lærer	Ja.		
47	4.54	Int	Ja.		

48	4.54	Lærer	MmmMmm		
49	4.56	Int 1	Eh Hvordan samarbeider dere på trinnet? Dere var tre lærere som hadde matematikk?		
50	5.00	Lærer	Vi er tre lærere ja.		
51	5.01	Int 1	MmmMmm Eh og hvordan utvikler dere undervisningsopplegget i fellesskap eller?		
52	5.08	Lærer	Nnei Vi har de samme planene . Eh vi hadde vel nå et samarbeid nå rett før jul der vi skulle velge ny fag bok. altså nye fagbøker.		
53	5.19	Int 1	MmMmm		
54	5.20	Lærer	Eh Vi går felles på geogebra kurs. Excel kurs. eh har noen felles møter med eh med bare sånne rettningslinjer hva skal vi ta denne måneden og neste måned når vi lager halvårspålaner og forskjellig men det er ikke så veldig mye møter og planlegging.		
55	5.37	Int 1	Nei		
56	5.38	Lærer	Det er det ikke .		
57	5.40	Int 1	Eh da går vi over til spørsmål om undervisningen.		
58	5.43	Lærer	MmmMmm		
59	5.44	Int 1	Hvordan vil du beskrive din rolle som matematikklærer i denne åttendeklassen.		
60	5.49	Lærer	Ja. Beskrive min rolle. Eeeh Ja da tenker du På undervisning altså jeg ser jo at det er viktig for meg og ut i fra bøkene så er det viktig for meg at jeg hjelper dem også få på plass det grunnleggende og bygge videre på det.		
61	6.10	Int 1	HmmMmm		
62	6.11	Lærer	Sant så bøkene er fulle av gode eksempler vi bruke nettsider til det og der det blir lest opp og forklart med masse eksempler. Eh men jeg føler det er viktig det at jeg som lærer bruker mye av tiden i begynnelsen av et emne til å gjennomgå ting og få vist eksempler. Eh og at de får jobbet med det sånn at det vet hva de skal gjøre hjemme i lekse.		
63	6.36	Int 1	MmmMmm		
64	6.37	Lærer	Eh så jeg prøver også styre så jeg har kontroll på hva de skal lære og at de og ser stukturen i det hvordan de skal		

			jobbe.		
65	6.49	Int 1	MmmMmm. Så du ser deg som den som skal formidle og sette dem i gang da eller [er det] slik du tenker?		
66	6.54	Lærer	[Eh Ja] Også få dem selv til å jobbe med det.		
67	6.56	Int 1	MmmMmm		
68	6.58	Lærer	Og lære det sånn at det lærer det. En ting er hva jeg forteller men de lærer ikke det sånn umiddelbart.		
69	7.04	Int 1	Nei		
70	7.05	Lærer	Så jeg prøver å bruke veldig mye samtale men det er gjerne ikke innenfor den rollebeskrivelsen.		
71	7.12	Int 1	Nei		
72	7.12	Lærer	Nei		
73	7.13	Int 1	Men det kommer sikkert.		
74	7.13	Lærer	Det kommer på metode. (ler)		
75	7.15	Int 1	Ehh har du tenkt litt på plasseringen av det temaet statistikk i forhold til andre matematiske emner?		
76	7.22	Lærer	Det går vel mye på grunnleggende matematikk. At dette med de fire regnearter.		
77	7.27	Int 1	MmmMmm		
78	7.28	Lærer	Senere når det er sektordiagram, nå er ikke det i åttende da, så er det jo prosentregning.		
79	7.33	Int 1	MmmMmm		
80	7.34	Lærer	Når de skal øve seg der.		
81	7.36	Int 1	Ja		
82	7.38	Lærer	Så det er jo den grunnleggende matematikken og det å kunne lære å tolke diagrammer.		
83	7.42	Int 1	MmmMmm		
84	7.43	Lærer	Så for det får de jo over alt.		
85	7.46	Int 1	Ja		

86	7.47	Lærer	MmmMmm		
87	7.48	Int 1	Eem Hvordan har du planlagt emnet statistikk som helhet?		
88	7.54	Lærer	Da har jeg tatt for meg hele kapittelet, sett på mål.		
89	7.58	Int 1	MmmMmm		
90	7.59	Lærer	Også er boken veldig godt inndelt med hensyn på da begrepene. Og oppgaver til de ulike begrepene.		
91	8.07	Int 1	MmmMmm		
92	8.08	Lærer	Og så da har jeg laget et målark for hele kapittelet med alle begrepene, med sidetall i boken, sidetall i de forskjellige vanskelighetsgradene i oppgaveboken.		
93	8.21	Int 1	MmmMmm		
94	8.22	Lærer	Sånn at de kan velge kategori om de vil jobbe på det mest grunnleggende som er en og videre som er kategori to og det vanskeligste som er kategori tre.		
95	8.32	Int 1	MmmMmm. Velger de det helt selv?		
96	8.33	Lærer	Det gjør de selv ja.		
97	8.34	Int 1	MmmMmm		
98	8.35	Lærer	Så men jeg må jo passe på litt der hvis det er noen jeg ser gjør leksene på fem minutter men de jobber på gult så prøver jeg å utfordre dem å se på de rød altså kategori tre.		
99	8.44	Int 1	MmmMmm		
100	8.45	Lærer	Før jul hadde vi den andre boken der var det fargedeling. her bruker de ordet kategori en, kategori to, kategori tre. Så vi bruker litt tid på å omstille oss der og.		
101	8.53	Int 1	Ja.		
102	8.54	Lærer	Men jeg bruker målark ut i fra målarkene så klipper jeg og limer jeg da to ukers planer.		
103	9.00	Int 1	MmmMmm		
104	9.01	Lærer	Eehh og så har vi da fire timer i uken så at jeg føler at begynnelsen av uken så får jeg gått igjennom to kanskje tre av de begrepene så de får jobbet hjemme med det og.		

105	9.12	Int 1	MmmMmm		
106	9.13	Lærer	Og bruker da den siste timen på å siste timen i uken på å nøste opp hvor langt de har kommet, hva de trenger hjelp med av lekseoppgaver og sånne ting.		
107	9.24	Int 1	MmmMmm Ehh Du hva.. Kan du si litt om valget av undervisningsmetoder? Det i forhold til å bruke grupper og plenum og ehhh og sånn hvordan du har satt i sammen elevene sånn har du tenkt noe i forhold til det?		
108	9.40	Lærer	Nå var det litt strategisk da med hensyn på situasjonen når dere skulle komme og hvem som skulle intervjues.		
109	9.46	Int 1	MmmMmm		
110	9.47	Lærer	Ehh Ehh det har vært litt forskjell der. Noen ganger har vi satt dem enkeltvis hvis de er i en periode der de er veldig snakkesalig. Ehh Men det er fordeler å sette dem litt parvis.		
111	10.01	Int 1	MmmMmm		
112	10.02	Lærer	Ehh Noen ganger sitter de gjerne tre etter hverandre og. Ehh og da prøver jeg og se alt etter ønsker fra elevene, noen elever ønsker å jobbe, men så blir de veldig fort distraheret. Så da må jeg passe på at jeg setter de med elever som jobber. Så da er det litt strategisk med hensyn på hvem som klarer å jobbe sammen hvem som er flinke å hjelpe hverandre og hvem som er trygge på hverandre.		
113	10.26	Int 1	MmmMmm		
114	10.27	Lærer	For at de kan jobbe godt sammen.		
115	10.30	Int 1	MmmMmm Hvordan tenker du om den plenumssituasjonen hvordan er de å ha i fellesundervisningen?		
116	10.35	Lærer	Det fungerer som regel veldig bra syntes jeg da er de alltid rolige de følger med Ehh det er selvfølgelig lett for at noen detter ut og og kanskje ikke er med i det hele tatt men bare er, men de er i alle fall stille og rolig.		
117	10.52	Int 1	MmmMmm		
118	10.53	Lærer	Jeg prøver å bruke veldig mye spørsmål svar i undervisningen. Bruker veldig mye tavleundervisning. jeg liker veldig godt den.		
119	10.58	Int 1	MmmMmm		
120	10.58	Lærer	Liker at de bruker regelbøker og skriver ned. Liker å ha		

			litt system der.		
121	11.04	Int 1	Ja		
122	11.05	Lærer	Og med tanke på at de får bruke regelbøkene på del 2 på matteprøver.		
123	11.10	Int 1	MmmMmm		
124	11.11	Lærer	Så de har akkurat nå blitt kjent med den, vi har begynt med halvdagsprøver. Der det er del en der de skal bruke det de har lært utenatt, der er ingen hjelpemidler. Og del to, der frå de bruke bøker og regelboken sin og alt det de har skrevet ned.		
125	11.24	Int 1	MmmMmm. eh Vi var jo ikke og så introduksjonen av dette		
126	11.29	Lærer	Nei		
127	11.29	Int 1	emnet. Hvordan.. kan du si noe om hvordan du planla det?		
128	11.32	Lærer	Ja. Ehh da måtte jeg gjøre det samtidig som jeg repeterte kapittelet med likninger.		
129	11.40	Int 1	MmmMmm		
130	11.41	Lærer	Så da tok jeg først og gav dem en liten test i likninger.		
131	11.46	Int 1	MmmMmm		
132	11.47	Lærer	Med addisjon og multiplikasjon ehh og subtraksjon og divisjon for å finne $X$ . Og det å sette prøver på det, så det måtte jeg bruke halve timen på slik at jeg da første timen kunne kartlegge hvem som hadde fått med seg dette. For jeg hadde vært på kurs uken før. Ehh Gjerne for å ha kontroll på hva de har gått igjennom. Hva faglærer altså vikarlærer har vist dem. Ehh og ut i fra det da så de tre endre timene de hadde forrige uke, så visste jeg da hvem vi kunne sette ut på grupperom som var selvstendige nok til å jobbe sammen Ehh å kunne jobbe sammen på ulike nivå også sørget jeg for at den største gruppen som var cirka halvparten av klassen. Det var de som ikke hadde fått med seg emnet med algebra og likninger. Så da måtte jeg repetere med dem.		
133	12.39	Int 1	MmmMmm		
134	12.40	Lærer	Så jeg hadde litt sånn delte timer samtidig som jeg da følte at ehh statistikk, der begynte vi ganske enkelt. Kun med å definere hva vi mener med statistikk, hva vi mener med frekvens, frekvenstabell også et enkelt		



			stolpediagram.		
135	12.55	Int 1	MmmMmm		
136	12.55	Lærer	Det følte jeg at de fikk litt oversikt på, men det var litt frem og tilbake og, det ble mest likninger det ble ikke så mye statistikk. Derfor følte jeg denne uken at vi kunne lande ganske bra med å bare begynne fra begynnelsen av i statistikk.		
137	13.03	Int 1	Ja.		
138	13.03	Lærer	Med de grunnleggende elementene der og ta det litt fra begynnelsen.		
139	13.14	Int 1	MmmMmm		
140	13.15	Lærer	Så kunne de da sjekke regelbøkene at de hadde fått med seg det som vi hadde tatt forrige uke med statistikk.		
141	13.23	Int 1	Ja		
142	13.25	Lærer	Så det var litt kanskje litt bråkete noen elever vil kanskje oppleve det som ganske uryddig begynnelse på et nytt kapittel.		
143	13.34	Int 1	MmmMmm		
144	13.35	Lærer	Vi var liksom ikke ferdig det andre også skulle vi begynne med noe nytt.		
145	13.37	Int 1	Ja		
146	13.38	Lærer	Så.. så hadde jeg valgt på ny hvis det nå ikke var sånn at dere var kommet nå og hvis vi var kommet så og så langt og skulle blitt ferdig med dette prosjektet på to uker så hadde jeg nok gjort meg ferdig med alg..likninger og algebra forrige uke, også hadde jeg tatt det da denne uken og begynt på det denne uken.		
147	13.56	Int 1	MmmMmm		
148	13.57	Lærer	Så ja.		
149	13.58	Int 1	Ja. Jeg aner jo litt hvordan du har tenkt men kan du si litt mer om det å tilpasse undervisningsopplegget i forhold til ulike elever. Går det..		
150	14.08	Lærer	Ja.		
151	14.09	Int 1	Gjør du det når du planlegge og..		

152	14.13	Lærer	Ja.		
152	14.14	Int 1	Gjennomfører undervisningen.		
153	14.14	Lærer	Ja. De som har IOP der har vi den greie ordingen nå i år. Vi vet ikke helt hvordan det vil bli til neste år med hensyn på økonomi, men i år så har vi en veldig god ordning. Så de blir veldig godt ivaretatt. av IOP lærer		
154	14.31	Int1	MmmMmm		
155	14.31	Lærer	Tre timer i uken av de fire og den fjerde timen så har jeg en ekstra styrkelærer inne i klassen.		
156	14.37	Int 1	MmMmm		
157	14.37	Lærer	Så i år, så føler jeg at den kall det den svakeste, men de som jobber mest mest grunnleggende i matematikk, de blir godt ivaretatt der.		
158	14.45	int 1	MmmMmm		
159	14.46	Lærer	Sånn at når jeg begynner å gå igjennom et nytt emne , så ser jeg for meg jeg har en todeling igjen.		
160	14.53	Int 1	MmmMmm		
161	14.54	Lærer	Og da når jeg har gått igjennom et emne så ser jeg at jeg kan sette noen sammen som kan hjelpe hverandre og de aller flinkeste har jeg rett og slett gitt lærebøker i niende og tiende og satt dem ut på grupperom.		
162	15.09	Int 1	MmmMmm		
163	15.10	Lærer	Så går jeg litt inn og hjelper dem og kommer de litt inn og spør meg om hjelp og.		
164	15.13	Int 1	MmmMmm		
165	15.14	Lærer	Så vi har vi har hatt litt sånn todeling.		
166	15.15	Int 1	Ja.		
167	15.16	Lærer	Men som regel så har jeg en fast gjennomgang av et emne for sånn at jeg vet at alle får med seg det grunnleggende de får skrevet ned i reglbøkene selv om de føler at dette kan de.		
168	15.25	Int 1	MmmMmm		
169	15.26	Lærer	Emm Så jeg prøver å tilpasse det der. Og så har jeg han ene styrkelæreren inne den fjerde timen i uken.		

170	15.31	Int 1	MmmMmm		
171	15.32	Lærer	Så da kan vi utfylle hverandre litt. Da kan han og gå litt rundt å hjelpe i grupper.		
172	15.39	Int 1	MmmMmm Supert emmm Hvordan emm bruker du ehk læreboken. Hvor ofte bruker du den?		
173	15.46	Lærer	Jeg prøver å bruke den ganske ofte. For å lære elevene hvor de kan finne om de forskjellige emnene. Så der kanskje jeg gjør dem en bjørnetjeneste men arbeidsplanene så står jo sidetallene og begrepene og det står sidetall med oppgaver det står sidetall med i oppgaveboken der de skal gjøre leksene.		
174	16.07	Int 1	Ja		
175	16.09	Lærer	Ehh og de begrepene er helt lik hvis de da går inn på CampusIncrement.no. Der han De kaller ham for lektor Thue, han heter det. Der han har filmsnutter, altså videosnutter til hvert av de eh begrepene.		
176	16.26	Int 1	MmmMm		
177	16.26	Lærer	Eller overskriftene da. Så de også ligger inne på arbeidsplanen.		
178	16.30	Int 1	MmmMmm		
179	16.31	Lærer	Så da blir det de kan.. Nå har ikke vi helt fått gjennomført det for vi har ikke chromebook til alle elevene, så det er ikke alle som har PC hjemme. Ehh men av og til så har jeg PC rom så tar de med headset også går de gjennom de CampusIncrement videoene. Også jobber de videre etterpå.		
180	16.52	Int 1	Ja		
181	16.52	Lærer	Og da kan de ta det i sitt eget tempo.		
182	16.54	Int 1	MmmMmm		
183	16.55	Lærer	Så jeg har ikke helt sånn omvendt undervisning enda. Og jeg kommer aldri til å slippe taket på undervisningen selv. (ler)		
184	17.01	Int 1	Nei		
185	17.02	Lærer	Men jeg ser at jeg bruker mindre tid på undervisning.		
186	17.05	Int 1	MmmMmm		

187	17.05	Lærer	For det at da føler jeg at jeg kan forklare en ting den ene dagen dagen etter kan jeg repetere litt og ingen bruke litt andre ord, litt andre spørsmål for å se om de har forstått det. Og hvis de da hører på lektor Thue i tillegg så får de ting forklart tre ganger.		
188	17.21	Int 1	MmmMmm		
189	17.21	Lærer	Så det er liksom målet mitt.		
190	17.22	Int 1	MmmMmm		
191	17.23	Lærer	At de får repetert det litt. Svarte jeg på spørsmålet ditt?		
192	17.27	Int 1	Deet haar du gjort ja. eh Da bruker du da han lektor Thue på video		
193	17.34	Lærer	MmmMmm		
194	17.34	Int 1	Er det andre ting enn læreboken og videoene av ham som du bruker i undervisningen [Har...]?		
195	17.39	Lærer	[Ja] i likninger da har jeg hentet den gode gamle vektstangen.		
196	17.44	Int 1	HmmMmm		
197	17.45	Lærer	Og hentet slike esker med lodd.		
198	17.47	Int 1	Ja.		
199	17.47	Lærer	Eh det morsommer var jo da at de elevene som har nå i dag (he) de vet jo ikke omtrent ikke hva en vektstang er. De vet ikke hvordan det fungerer. Så vi brukte en time på å leke med vektstang. Hva er en vektstang? Hva viser det når pilen går ned og står på null og altså hva betyr det da. Og hva har d. Hva har du da i hver av de vektskålene. Er det likt? Eller er det ulikt?		
200	18.06	Int 1	MmmMmm		
201	18.07	Lærer	Også tok vi da og overførte det til likninger at vektstangen det er likhetstegnet også kan du da finne ting i penalet ditt på den ene siden. Også kan finne lodd på den andre siden, også kan du finne ut hvor mye det veier.		
202	18.22	Int 1	MmmMmm		
203	18.23	Lærer	Også så kan du finne ut hvor mye det veier. Også kan du tømme penalet ditt også kan du en ukjent ting inni. Hvordan kan du finne ut vekten til den? Sant så måtte de gruble litt på det. Så ja.Så jeg bruker litt konkreter der jeg kan. Dette med å bruke praktiske ting, vise. Det er jeg		

			veldig opptatt av. Ikke bare snakke om alt mulig.		
204	18.43	Int 1	Ja		
205	18.45	Lærer	men vise praktisk e ting.		
206	18.46	Int 1	Synes du at læreboken er tilfredsstillende i forhold til til elevenes læring av begreper.		
207	18.52	Lærer	Jjja der gjenstår det å få det bevist. (ler)		
208	18.56	Int 1	Ja		
209	18.56	Lærer	Etter at vi begynte med de bøkene nå i januar. Vi fikk dem i første uke i januar. Så har har vi da gått igjennom kapittelet med likninger og nå statistikk.		
210	19.07	Int 1	MmmMmm		
211	19.08	Lærer	Så så den neste prøven vi har før påsken den vil jo da vise trenden sant. Om det er de samme karakterene som jeg hadde før jul med det andre læreverket, eller om det har gått litt ned eller kanskje litt opp.		
212	19.20	Int 1	HmmMmm		
213	19.21	Lærer	Og da håper jo jeg at jeg vil se en endring hos den svake gruppen.		
214	19.28	Int 1	MmmMmm		
215	19.29	Lærer	Hvis de har klart å heve seg litt så kan det jo være det at dette med å høre på lektor Thue har vært litt utslagsgivende. Kanskje.		
216	19.36	Int 1	MmmMmm. Ja eh Opplevs statistikk som lett eller vanskelig emne for elevene?		
217	19.45	Lærer	Det virker som de elevene jeg har nå som er generelt sterke. De syntes det var for lett. De var litt bekymret i timen nå og de har jo hatt det forrige uke og. Så de spurte, blir det ikke vanskeligere enn dette?		
218	19.57	Int 1	MmmMmm		
219	19.58	Lærer	Men det er jo de fire fem elevene som dere også intervjuer. de de er blant de sterke.		
220	20.06	Int 1	MmmMmm		
221	20.07	Lærer	Eh men ja. Det virker som det er lett samtidig som det er lett å snuble i de begrepene.		

222	20.14	Int 1	MmmMmm		
223	20.15	Lærer	Sant dette hva er observasjon, hva er frekvens og hvordan lager vi en tabell og hvordan skal vi lese en tabell.		
224	20.22	Int 1	HmmMmm		
225	20.23	Lærer	Jeg tror nok det er lett for dem det også lage et spørreskjema. Sant. Det vil nok være lett. Eh så målet neste uke blir jo at de skal, i de doble timene vi har på tirsdag så de da lage en undersøkelse også skal de fremstille det selv.		
226	20.38	Int 1	MmmMmm		
227	20.38	Lærer	Lage plakat		
228	20.39	Int 1	Ja. Hva du ønsker at elever skal sitte igjen med etter en periode med undervisning i statistikk?		
229	20.46	Lærer	Jeg ønsker de skal lære seg at det som har med presentasjon. Altså hvordan de skal presentere data.		
230	20.54	Int 1	MmmMmm		
231	20.55	Lærer	Sant hvordan de skal lage en undersøkelse sel og hvordan de skal jobbe med det materialet og lage en presentasjon.		
232	21.04	Int 1	MmmMmm		
233	21.05	Lærer	Så det blir det de jobber med på slutten da. De siste timene neste uke.		
234	21.08	Int 1	MmmMmm		
235	21.09	Lærer	Da sitter de i grupper.		
236	21.10	Int 1	Ja Syntes du det viktigste skal forklare begrepene eller bruke dem i anvendt.. Kunne bruke dem i		
237	21.19	Lærer	Ja		
238	21.20	Int 1	Praksis.Hva tenker du det viktigste er?		
239	21.22	Lærer	Ja. Ja nå glemte jeg det forrige spørsmålet. det er viktig at de og lærer dette med kildekritikk.		
240	21.27	Int 1	Ja		
241	21.27	Lærer	Ja at de lærer, for det er noen som prøver å jukse med statistikk sant. Og krymper gjerne en stolpe hvis noe skal se mindre dramatisk ut. Eller får den til å bli større hvis		

			det skal se veldig dramatisk ut.		
242	21.38	Int 1	MmmMmm		
243	21.39	Lærer	Så det skal jeg snakke litt om og. Men hvis du kan gjenta det siste spørsmålet.		
244	21.44	Int 1	Er du Eh er du opptatt av at elevene selv skal forklare begreper eller vektlegges anvendelse?		
245	21.51	Lærer	Ja		
246	21.52	Int 1	Praktisk bruk.		
247	21.54	Lærere	Det som er viktigst er er jo hvordan de skal bruke det.		
248	21.57	Int 1	MmmMmm		
249	21.58	Lærer	Men for at de skal kunne bruke vise kunnskapen på prøver så må de bli kjent med begrepene. Sant så det blir.. de må kunne begge deler.		
250	22.05	Int 1	MmmMmm		
251	22.06	Lærer	Eh. så er utfordringen da at helt fra barneskolen så er de vant til å bruke ordet pluss, minus, gange og deling.		
252	22.13	Int 1	Ja		
253	22.14	Lærer	Også eh føler jeg fremdeles at det er vanskelig å gi slipp på de fire ordene.		
254	22.18	Int 1	MmmMmm		
255	22.18	Lærer	Sant når jeg har prøvd fra første dag addisjon, subtraksjon. divisjon og multiplikasjon sant. Men jeg føler ikke at alle er på den på det nivået at de vet med en gang sånn intuitivt hva addisjon betyr og hva subtraksjon betyr.		
256	22.35	Int 1	MmmMmm		
257	22.35	Lærer	Så derfor må jeg bruke det litt om en annen så det virker som om det er veldig sleiving med bruk av begreper. Begrepene mine og det irriterer meg litt men jeg prøver liksom å gjenta begge deler hver gang jeg snakker om det.		
258	22.46	Int 1	MmmMmm		
259	22.47	Lærer	Brake begge als..f.. de foreklede begrepene og de korrekte begrepene.		

260	22.52	Int 1	Ja		
261	22.53	Lærer	For det jo det de må svare på når det er prøver. Det er jo de ordene som brukes i teksten.		
262	22.58	Int 1	Ja		
263	22.59	Lærer	Sant. Så. men det viktigste er jo at de skal lære hvordan de bruker de begrepene i boken. Hvordan de skal jobbe hvordan de skal lære.		
264	23.07	Int 1	MmmMmm. Eh Hva mener du skal til for at elever på åttende trinn skal forstå statistikk?		
265	23.16	Lærer	Ja da må jeg ta utgangspunkt i noen kjente ting. Det er veldig mange som liker sport, så der er det alltid tabeller. for eksempel i fotball. Oog og ut i fra dem da forklare de at det er det de bruker når de prøver å finne ut hvor stor sjanse for eksempel Liverpool har til å slå det neste laget. Sant. Da må de jo se hvem de spiller mot og hvordan statistikken har vært før. Sant. Det er jo et eksempel. Også er det veldig mange som ikke liker fotball, så da må jeg finne noen andre eksempler.		
266	23.45	Int 1	MmmMmm		
267	23.46	Lærer	Så og da det er jo mye. Nå er jeg naturfagslærer og så da kan jeg trekke inn CO <sup>2</sup> nivå og, Ja bruke litt statistikk i fra hverdagen. Ting som de møter i alle slags diskusjoner på nyheter og sånn. Prøve å få det sånn virkelighetsnært sant at de ser at statistikk det er ikke bare noe vi lærer på skolen, men det er noe vi eh vi lærer å bruke i livet.		
268	24.08	Int 1	MmmMmm		
269	24.08	Lærer	Sant. Ikke la oss lure eller villedde men ja. Så igjen dette med kildekritikk.		
270	24.16	Int 1	Ja		
271	24.17	Lærer	Og sta.. og og liksom eh se hvordan en statistikk og hvordan tall og diagrammer framstilt.		
272	24.27	Int 1	Ja. Hvilke begreper ønsker du at elevene skal sitte igjen med etter dette emnet?		
273	24.34	Lærer	Ja. Det er kildekritikk at de lærer hva det er.		
274	24.38	Int 1	MmmMmm		
275	24.39	Lærer	Og eh. Eh. Står det litt stille. Eh. det som jeg snakket om i sted. Dette med å tolke disse her tabellene riktig.		



276	24.53	Int 1	MmmMmm		
277	24.53	Lærer	Sant at det ikke noen prøver å lage en forferdet forferdelig bilde av virkeligheten men at de kan se hva er det som egentlig er her.		
278	25.01	Int 1	At de lærer seg hva er den liggende aksene hva er den egentlig prøver å.. Hva er den viser av alternativ og den stående aksene. Hva er det den egentlig forteller oss.		
279	25.12	Int 1	MmmMmm. Så de er ikke så opptatt av at de husker hva de heter X og Y akse eller først og andre akse eller.		
280	25.19	Lærer	Nei det kommer i andre rekke.		
281	25.21	Int 1	MmmMmm		
282	25.22	Lærer	MmmMmm så er det å måle hvis de bruker de ordene mange nok ganger at det sitter (Ler) Så Ja så det er jo litt krevende og i min rolle da når jeg skal undervise dette så må jeg passe på at jeg har de begrepene stødige. (Ler)		
283	25.40	Int 1	Ehh Hvordan har du brukt de begrepene da i statistikk.		
284	25.46	Lærer	Ja. Nå når jeg har undervist sant.		
285	25.48	Int 1	Ja		
286	25.48	Lærer	Når jeg har vist på tavlen den liggende aksene så viste jeg at den kan hete mye forskjellig.		
287	25.54	Int 1	MmmMmm		
289	25.54	Lærer	Men hva er det egentlig den viser oss? Sant. Jo den viser oss de forskjellige observasjonene.		
290	25.58	Int 1	MmmMmm		
291	25.59	Lærer	Og Og den stående, han ene eleven sa venstre sant. Så sa jeg ja det er den til venstre hvordan ser den ut, men hvordan ser den ut? Altså hvordan ser du for deg at den ser ut. er den stående eller er den liggende?		
292	26.28	Int 1	MmmMmm		
293	26.29	Lærer	For jeg visste jo at han tenkte på den stående men jeg måtte bare få ham til å si si det selv.		
294	26.13	Int 1	HmmMmm		
295	26.14	Lærer	Så Ja.		

296	26.17	Int 1	Ja. Eh		
297	26.19	Lærer	Svarte jeg på spørsmålet?		
298	26.21	Int 1	Ja du har vel eh gjort det. Eh Har du Eh Kan du si litt hvordan elevene har brukt de nevnte statistikk relaterte begrepene i undervisningen eh Eh hvordan bruker de dem? Eh vi har jo snakket litt om addisjon og slik men det det		
299	26.43	Lærer	Ja		
300	26.43	Int 1	er jo ikke ikke akkurat statistikk, men andre		
301	26.47	Lærer	Nei [de]		
302	26.47	Int 1	[Begreper]slik som gjennomsnitt. [eller]		
303	26.48	Lærer	[ja] gjennomsnitt der hadde de kun brukt ordet gjennomsnitt. De hadde ikke brukt middelvei.		
304	26.55	Int 1	MmmMmm		
305	26.56	Lærer	Så så derfor så trakk jeg det og frem at det betyr det samme. Det er som regel det som dukker opp i spørsmålene Nå.. Som de får på prøver sant.		
306	27.04	Int 1	MmmMmm		
307	27.06	Lærer	Så ja prøver å lære dem eh det. Men jeg merker det at de er fort tilbake på dette med der skal vi gange der skal vi plusse der er det minus så.		
308	27.15	Int 1	MmmMmm		
309	27.15	Lærer	Så de faller lett tilbake så slike Eh de enkleste begrepene. Som de gjerne har lært først på barneskolen.		
310	27.22	Int 1	MmmMmm		
311	27.23	Lærer	Så det spørs. Det kommer jo ann på hva den matte læreren eller de mattelærerne har tenkt når de undervis altså hvor lang frem de har tenkt. Hvor lenge de har tenkt at begrepene de skal vare. (ler) Tenker jeg.		
312	27.35	Int 1	Ja		
313	27.36	Lærer	For. Men vi har jo hatt mye samarbeid med de lærerne på barneskolen der.		
314	27.40	Int 1	[Ja]		

315	27.41	Lærer	[med] hvordan vi underviser, men vi har ikke noe møte der på et par år så vi har ikke vært så nøye på begreps biten der.		
316	27.50	Int 1	Nei		
317	27.53	Lærer	Men det er jo igjen dette her med metoder og strategier som de lærer. De har gjerne ikke fullt så opptatt av de begrepene.		
318	28.01	Int 1	Nei		
319	28.02	Lærer	og nå har vi ikke hatt statistikk så lenge, men når jeg gikk rundt og de skulle regne gjennomsnittet så var de fort tilbake på det å ja da skal vi plusse p ja da der var det minus og. Så og de har ikke brukt.. Jeg hørte ingen som brukte ordet frekvens nå da.		
320	28.17	Int 1	Nei		
321	28.17	Lærer	Så så det blir spennende også se i løpet av uken hvor mye de bruker de ordene.		
322	28.24	Int 1	Ja		
323	28.24	Lærer	Men der tror jeg bare jeg må minne dem på det. Når de har sagt det med enkle ord, så kan jeg spørre dem hvordan ville du sagt det på den korrekte måten.		
324	28.34	Int 1	MmmMmm		
225	28.34	Lærer	Så jeg tror bare jeg må speile dem litt.		
326	28.37	Int 1	Ja. Eh Legger du spesielt til rette for at elevene skal kunne snakke om statistikk?		
327	28.43	Lærer	Eh ja. De skal nå få jobbe med en oppgave.		
328	28.48	Int 1	MmmMmm		
329	28.49	Lærer	Så oppgaven i det kapittelet handler om at de skal selv lage en undersøkelse.		
330	28.54	Int 1	MmmMmm		
331	28.54	Lærer	og videreføre det med at de da skal, de får plakater. Så må de da finne ut hvordan de skal presentere resultatene.		
332	29.03	Int 1	HmmMmm. Har du.. er det lett for deg å få snakket med elevene når de jobber selvstendig eller i grupper?		
334	29.03	Lærer	Ja det er det.		

335	29.11	Int 1	Hvordan løser du det?		
336	29.14	Lærer	Eh De er veldig opptatt av å spørre om hjelp da. Så da går jeg rundt til de og hjelper.		
337	29.20	Int 1	MmmMmm		
338	29.21	Lærer	Eh så i matematikken spesielt så har jeg ikke så mye ledig tid til å gå rundt og høre.		
339	29.26	Int 1	Nei		
340	29.27	Lærer	Men når de spør meg så hører jeg jo hva de kan og hva de trenger hjelp med. Når de spør meg og viser dette har jeg fått til og emm og så spør jeg dem da. Stiller dem spørsmål hvis de har en oppgave de lurer på så prøver jeg å stille spørsmålet. Hvordan tenker du der. Hvis.. Prøver å finne ut sammen med dem svaret. At jeg ikke bare at ikke jeg bare serverer hvordan de skal gjøre det.		
341	29.50	Int 1	HmmMmm		
342	29.51	Lærer	MmmMmm		
343	29.52	Int 1	Har du noen ytterligere kommentarer helt til slutt, som du syntes vi burde ha spurt deg om, men som vi ikke har spurt deg om?		
344	30.01	Lærer	Nei Kommer ikke på noe. (Ler)		
345	30.04	Int 2	Det er greit stopp.		
346	30.06	Int 1	Da får vi si tusen takk for at du stilte opp. Og i intervju her og i prosjektet som helhet. Så er våre spørsmål ferdige men så har kanskje du noen eh.		
347	30.15	Int 3	Jeg har et lite et som jeg tenkte for du du ble spurt om når du ble spurt om du brukte andre ting, og du fortalte om vekta og konkreter og sånn. Så tenkte jeg plutselig på IKT hva med, bruker du, bruker du noe, ikke bare lektor Thue altså, Nå tenker jeg mer som et hjelpemiddel i, bruker du det i undervisningen?		
348	30.35	Lærer	Ja at jeg		
349	30.36	Int 3	Mye? Eller sa altså Nå sa du at dere måtte på datarom, du har ikke data tilgjengelig i klasserommet.		
350	30.42	Lærer	Neida men jeg, av og til så tar jeg opp PCén også viser		
351	30.46	Int 3	Ja		

352	30.37	Lærer	Også viser jeg felles i klassen, og så løser vi oppgavene felles.		
353	30.50	Int 3	Ja.		
354	30.50	Lærer	Så hvert sånn emne tar jo alt fra to tre minutter kanskje til fem seks minutter.		
355	30.56	Int 3	MmmMmm		
356	30.56	Lærer	Så det har jeg gjort noen ganger. Så jeg supplerer litt.		
357	31.02	Int 1	Du hadde jo en prosjektor i klasserommet. Som du kan bruke.		
358	31.03	Lærer	Ja da så den bruker vi mye.		
359	31.05	Int 1	Men du liker å bruke tavlen?		
360	31.07	Lærer	Ja jeg fordi at ellers så tar det plutselig mye tid hvis hvis jeg skal gå igjennom for mye av lektor Thue . Så tar han hele timen. (Ler)		
361	31.14	Int 1	Ja		
362	31.14	Int 3	Men nå tenkte jeg [ikke lektor Thue men du snakka om] Excel og [Geogebra]		
363	31.15	Lærer	[Da får de ikke sjanse til å jobbe. Ja] [Geogebra] Ja		
364	31.21	Int 3	Kurs som dere har		
365	31.23	Lærer	Ja. Så det det bruker vi sammen med elevene.		
366	31.26	Int 3	MmmMmm		
367	31.26	Lærer	Så før jul så var vi hadde vi Excel.		
368	31.29	Int 3	MmmMmm		
369	31.30	Lærer	Da var vi litt inne på datarommet og jobbet med oppgaver. Og da var det forskjellige emner. Det var fire regnearter og litt sånn prosentoppgaver.		
370	31.39	Int 3	MmmMmm		
371	31.40	Lærer	Da var det sånn postordrekatalog, også skulle de lage et bestillingsskjema, så da lærte de å lage formler.		
372	31.47	Int 3	HmmMmm [Så da har du]		

373	31.47	Lærer	[Så da så jeg]		
374	31.48	Int 3	Ja nå har du statistikk. Kommer du til å bruke det i forbindelse		
375	31.51	Lærer	Ja		
376	31.51	Int 3	med statistikk?		
377	31.52	Lærer	Det gjør jeg. MmmMmm		
378	31.54	Int 1	Ja. Supert da takker vi for at du ville stille opp på intervju.		

## 8.9 Transcript 1

Line	Time	Par.	Discourse	Gest	Comments
60		Lær	≈Helt riktig. Så når det står frekvens her. <b>Hva var det Ane sa at det var? (.) Hva kan vi oversette ordet frekvens med? (3s) Dorte?</b>	Punkt peking i boken. Hermetegn til ordet oversetter.	<b>Refererer til Ane, for å inkludere</b>
61		Dorte	Antall.		
62		Lær	Antallet ja. Den samme observasjonen. Helt riktig. (.) Så oppgave fem seksten, så tar vi a sammen der (3s). Skriv den i regelbøkene, sant. Så har dere noen eksempeloppgaver og noen oppgaver som vi har der. Så nå tar vi for oss (2s) nå er det typetall.	Nikker.	<b>Revoicing</b>  Læreren går bort og skriver på tavlen.
63	09:15	Lær	Eksempelet har vi da lest igjennom her. (.) Nå tar vi å gjør oppgave fem seksten (.) Begynner med a og så se. Kanskje vi tar b sammen og. Og så (.) tenker jeg at vi ser litt videre på variasjonsbredde også. For jeg tror at ganske mange av dere har forstått mye her.	Peker i en bue.	Læreren blar i boken.
64	09:42	Lær	Så jeg tør å gå litt raskere frem enn det jeg hadde tenkt. <b>Hva tenker dere om det? (.) Er dere klar for å se variasjonsbredde også i dag?</b>	Peker i læreboken.	<b>Et retorisk og et som forventes svar på, rituert.</b>

## 8.10 Transcript 2

Line	Time	Par.	Discourse	Gest	Comments
28		Lær	Og det stemmer med fasiten. Nå er vi så heldige at bak i boken i disse nye bøkene er det en fasit. <b>Hvem har oppdaget det?</b> (1s) Ja det er bra. <b>Bruker dere den før dere regner ut, eller etter dere har regnet ut?</b>		De fleste elevene rekker opp hånden. <b>Rituelt</b>
29		Elever	Etter		
30	07:34	Lær	Ja, det er bra. Det er sånn dere må bruke den. (1s) Eeh, b, der er det fire målinger. Det er tretten, femten, femten, fjorten. <b>Hva gjorde dere der, for å finne gjennomsnittet?</b> (2s) Liv?		Ser på oppgaven i boken, leser. <b>Explorativt</b>
31		Liv	Jeg plusset dem sammen, og så tok jeg 57 og delte det på fire.		
32		Lær	Ja. <b>Da fikk du?</b>		<b>Rituelt</b>
33		Liv	Fjorten.		
34		Lær	Ja. Riktig (.) Så har vi.. Ja, Lars trenger en. Tusen hjertelig takk. (3s) <b>På oppgave b, nei c, hva fikk dere der? Der var det plutselig negative tall, så der er jeg spent på hvordan dere gjorde det (.) Linda?</b>		Gustav kommer tilbake med nye kladdebøker. Ser i lærebok. <b>Rituelt</b> <b>Explorativt</b>
35	08:19	Linda	Ehm, jeg tok fem pluss to pluss (.) liksom 0 da, minus tre minus to som ble to så delte jeg to på fem som ble null komma fire.		



## 8.11 Transcript 3

From Tuesday wk 7 lesson 1

99	18:58	Lær	Ja. <b>Så skal vi finne det midterste tallet (4s) Ja?</b>	Gnir seg i hendene	
100		Linda	Em, det er to midterste tall.		
101		Lær	Nå er det to midterste tall (2s) Det så du fordi at når du går fra den minste til den ytterste og så hopper vi da, <b>klarer dere å se?</b> (.) der, nå står hodet mitt i veien, hehe, <b>og der, ser dere nå?</b> Og der (.) vi har to midterste tall (2s) <b>Hva må vi gjøre da? (4s) Noen som ikke har svart enda, Lars?</b>	Peker på tavla mens hun «hopper» inn på rekka  Setter ring rundt de midterste tallene	
102	19:40	Lars	(ukjent tekst) ..kanskje du skal ta den som er mellom de to		
103		Lær	Du skal finne det om er imellom ja (.) <b>Hvordan kan vi gjøre det?</b>		
104		Lars	Du tar det største minus det minste (2s) eller..		
105		Lær	<b>Vil du trekke de fra hverandre?</b>		
106		Lars	°Ja, nei° (ukjent tekst)		
107		Lær	Da finner du forskjellen, altså differansen, det blir null komma to (2s) null komma to e jo mye, mye mindre enn.. enn det laveste tallet (.) så da må vi tenke nytt (1s) <b>Du vil finne noe mellom, men det går ikke å trekke de fra hverandre, så hva kan vi gjøre da?</b>		

108		Lars	Skal det ikke være en komma fem?		Ser ikke hvem som spør
109		Lær	Hæ?		
110		Lars	Skal det ikke være en komma fem?		
111		Lær	Du ser at det er en komma fem, hold den tanken (.) <b>hvordan kan vi gjøre det med regning? Pål</b>		
112		Pål	(2s) plusse det og dele det på to	Lær nikker	
113		Lær	<b>Er alle enig? (.) ja, ok hva er det vi i prinsippet har funnet da? Da har du funnet ?</b>	Noen elever nikker	
114		Pål	(2s) Da har jeg funnet (2s) medianen		
115		Lær	<b>Ja (.) og du har brukt utregningen for, eeh (1s) hvilken type utregning, metode har du brukt for å finne medianen? Ja?</b>	Peker på Dagny	
116		Pål	Gjennomsnittet		
117		Dagny	[Gjennomsnittet]		
118		Lær	Ja! Da ble dere enig på likt (1s) Altså en komma fire pluss en komma seks (.) deler det på to (.) <b>Hva får vi da?</b> En komma fire på en komma seks (.) så det blir tre, delt på to, Espen, eller Lars sa at dette ble en komma fem og det hadde du helt rett i. (2s) sant, du så at det ble det og her har du utregningen som viser det	Dunker på tavla	

## 8.12 Transcript 4

28	12.43	Linda	Frekvens er antall ganger en lik observasjon skjer.		
29	12.45	Lærer	Ja. Antallet ganger en lik observasjon skjer. Teller vi. Så Hvis du skal telle opp hvor mange som har blitt kjørt og spør de. Så teller du ned antall ja. Også eller skriver ned antall ja med tellestrek. og de som ikke blir kjørt teller du også skriver det ned et annet sted.  Og da må vi få et system på dette. <b>Og hva er det da naturlig å gjøre nå vi da lager en slik undersøke og observert litt og spurt noen. Hva er naturlig at vi da lager? Dorthe?</b>	Skriver på tavlen. Rammer inn det som hun skriver.  Rister fingeren i luften Lager sirkel og bølger i luften med fing. Tar ut hendene.	revoicing
30	13.33	Dorthe	Et stolpediagram.		
31	13.35	Lærer	Eeeeh ja tilslutt. Men før det for å lage litt system i dette her. <b>Hva er lurt å lage.Dagny?</b>	Lager sirkel i luften med fing. Og tar ut hendene.  Dagny, Asta og Liv rekker opp handa.	Som om hun holder en boks.
32	13.41	Dagny	En tabell		
33	13.42	Lærer	En tabell. <b>Og hva kaller vi den for?</b>		revoicing
34	13.44	Liv Lærer	[Frekvenstabell] [Liv]		
35	13.45	Lærer	Frekvenstabell. <b>Ser alle hvis jeg skriver det her?</b> Jeg tror jeg skriver det her jeg. Frekvenstabell. Det er en oversikt. Tabell.	Skriver på tavlen..	Revoicing retorisk

## 8.13 Attachment 8

Statistikk

**Regel:**  
Vi finner gjennomsnittet ved å summere alle observasjonene og dividere på antall observasjoner.

**Eksempel 5.9**  
Her ser du snødybden Hanna har målt på hytta fra 2008 til 2014:

2008	2,7 m
2009	1,4 m
2010	0,9 m
2011	1,2 m
2012	2,7 m
2013	3,2 m
2014	1,9 m

Regn ut gjennomsnittlig snødybde.

Løsning

$$\frac{2,7 + 1,4 + 0,9 + 1,2 + 2,7 + 3,2 + 1,9}{7} = \frac{14}{7} = 2,0$$

Den gjennomsnittlige snødybden er 2,0 m.


**Oppgaver**

5.10 Regn ut gjennomsnittet av tallene.

a)	2	5	5				
b)	13	15	15	14			
c)	5	2	0	-3	-2		
d)	4,3	-8,3	-6,5	-8,5	0	-4,0	5,5

5.11 Simen spiller bowling og får disse resultatene:  
172 134 150  
Regn ut gjennomsnittet.

5.12 Finn gjennomsnittet av 22 kr, 18 kr, 36 kr og 12 kr.



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Statistikk

**Median**  
En median sier oss hvilken verdi som er den midterste verdien i et tallmateriale. For å finne medianen, sorterer vi først tallene i stigende rekkefølge. Deretter finner vi den midterste tallverdien. Hvis det er to tall i midten, er det gjennomsnittsverdien av disse to tallene som er medianen.

**Regel:**  
Medianen er den midterste observasjonen når observasjonene er ordnet i stigende rekkefølge.

**Eksempel 5.10**  
Finn medianen til tallene.

a) 0,9 1,4 1,2 1,9 2,0      b) 1,6 0,9 1,4 1,2 1,9 2,0

Løsning

Vi sorterer tallene i stigende rekkefølge.

a) 0,9 1,2 **1,4** 1,9 2,0      b) 0,9 1,2 **1,4** **1,6** 1,9 2,0

Medianen er 1,4 m.      Medianen er  $\frac{1,4 + 1,6}{2} = 1,5$ .

**Oppgaver**

5.13 Bestem medianen til tallene.


a)	0	1	3	3	5				
b)	6	6	9	0	8	9	7		
c)	12	16	13	15	18	15	17	18	15

5.14 Finn medianen til tidene  
4 min, 2 min, 8 min og 6 min.

5.15 Bestem medianen til tallene.

a)	55	56	58	55	59				
b)	120	123	123	125	121	135			
c)	0,5	0,51	0,52	0,51	0,56	0,52			
d)	1,6	2,4	3,5	1,8	1,8	3,0	2,7	1,9	2,9
e)	0,12	0,13	0,15	0,18	0,22	0,23	0,17	0,20	

Hvis antall observasjoner er partall, finner vi gjennomsnittet av de to midterste observasjonene.



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## 8.14 Attachment 9

**Frekvens**

**Hva mener vi med frekvens?**

Når vi vil gjøre en statistisk undersøkelse, må vi først samle inn data. Å samle inn data kan være å

- lese av temperaturer
- registrere karakterer
- få svar på spørsmål
- måle nedbør

Dataene vi samler inn, kaller vi *observasjoner*.

Hvor mange ganger et bestemt svar, eller en lik observasjon forekommer, kaller vi *frekvens*. Vi presenterer frekvensene i en *frekvenstabell*.

Herman og Lotte så at 21 personbiler og 8 varebiler kjørte forbi skolen. Vi sier at frekvensen av personbiler er 21 og frekvensen av varebiler er 8. Vi viser dette i en frekvenstabell.

Biltype	Frekvens
Personbil	21
Varebil	8

**Regel**

Frekvens betyr hvor mange ganger et bestemt svar eller en observasjon forekommer.

**Eksempel 5.1**

Sara har undersøkt hvor mange elever som blir kjørt til skolen en dag. Her ser du resultatet av undersøkelsen:

Blir kjørt: |||||

Blir ikke kjørt: |||||

a) Hva er frekvensen til de ulike svaralternativene?  
b) Lag en frekvenstabell.

**Løsning**

a) Frekvensen av elever som blir kjørt til skolen, er 21. Frekvensen av elever som ikke blir kjørt til skolen, er 16.

b) Frekvenstabell:

Svaralternativ	Frekvens
Blir kjørt	21
Blir ikke kjørt	16

## 8.15 Transcript 5

Week 7, Thursday 1<sup>st</sup> lesson

49	08:47	Tea	Hvem her har lest Donald Duck? Ja, hvem her har lest, sett tegneserien av Onkel Skrue når han tjener masse penger og lager en tabell og en graf utav det? Hvordan ser den ut?	Snur seg mot tavlen. snur tilbake og ser rundt.  Noen elever rekker forsiktig opp	Retorisk
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