

Systemic functional linguistics as a methodological tool in mathematics education research

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The aim of this article is to illustrate how *Systemic functional linguistics* (SFL) can be used as methodological tool for analysing the meaning of texts from two different studies. An analysis using SFL provides insights into how different concepts of mathematical literacy operate in the text. SFL considers language to be a resource used for expressing meaning in specific contexts that accomplishes specific communication purposes. Therefore, SFL contains opportunities for highlighting different aspects of mathematics education which are of interest to researchers. In Sweden, the SFL approach has been used in other research areas but references to it in mathematics education research have been limited.

In this article, we are concerned with the relationship between a context and a text produced within it, in regard to mathematics education research. The context of an event or idea is the general situation that surrounds it. The interpretation of the context is constructed by individuals as they participate in practices which contribute to the production of texts (Halliday & Hasan, 1989).

The relationship between text and context has been studied using *Systemic functional linguistics* (SFL) by researchers in Sweden (Holmberg, 2012) but not in mathematics education. For example, af Geijerstam (2006) and Larsson (2011) have used SFL when conducting educational research about natural science. Also, Olvegård (2011) has used it in the field of history and Bergh Nestlog (2012) in Swedish language education. However, there are few examples in Swedish mathematics educational research that highlight what Lerman (2000, 2009) calls the "linguistic turn" and none which have used SFL. The linguistic turn addresses the

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relationship between the linguistic interaction and the kinds of meaning which can be realized within the texts (Veel, 1999). In discussing the linguistic turn, Lerman (2009) refers to a variety of texts in different contexts that are mediated through language.

Among the research that has been conducted internationally in mathematics education, Morgan's (2006) use of SFL to visualize processes in school mathematical assessments is the most well-known. However, others such as Meaney, Trinick and Fairhall (2012) have also used it to identify different genres in written mathematics texts, produced by students. In this article, the aim is to illustrate how SFL can be used as a methodological tool in different kinds of mathematics education research in Sweden.

To illustrate SFL's flexibility, we use it to explore the notion of mathematical literacy in data from two ongoing Ph.D. studies. Mathematical literacy is referenced extensively within the field of mathematics education research but different researchers define it in different ways (Jablonka, 2003). By using SFL, contextual aspects such as what goes on inside and outside the educational setting can be highlighted by examining the linguistic choices in the texts.

The first study (Segerby) is about year 4 students' strategies in reading mathematics textbooks. In order to predict the potential problems that students may have in reading a widely used Swedish year 4 mathematics textbook, one page of this textbook is examined. The second study (Ebbelind) concerns how a student teacher perceives becoming a mathematics teacher of children ten to twelve years old. An extract from an interview transcript with the student teacher is analyzed.

In this article, the main focus is not the page or the transcript, but rather how SFL can be used to unfold the different texts to reveal traces of context which have contributed to the formation of those texts. These traces of context are then interpreted through different notions of mathematical literacy.

In the following sections, we discuss mathematical literacy and SFL before providing a description of the methods used to generate the data. The article ends with a discussion about the usefulness of SFL in mathematics education research or, to be more specific, how SFL can lead to relevant interpretations of how the concepts of mathematical literacy operate in these texts.

Mathematical literacy

Mathematical literacy is used as a vehicle to unpack the meaning, the traces of context by using SFL in the two different texts. Mathematical

literacy, according to Wedege (2010), refers to the mathematical requirements and competences that are needed and developed in everyday life. The mathematics wanted or needed in everyday life can be defined as:

[...] an individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgements and to use and engage with mathematics in ways that meet the needs of that individual's life as a constructive, concerned and reflective citizen. (OECD, 2006, p.72)

This is a broad definition of mathematical literacy, but others have tried to narrow its focus for different reasons such as Kilpatrick (2001) who conducted a study in the United States to provide research-based recommendations for "successful mathematics learning" (p. 105). In this study, successful mathematics learning was defined as *mathematical proficiency*. "Mathematical proficiency can be used to define learning goals for all students; at any age or grade students can be judged proficient or not according to those goals" (Kilpatrick, 2001, p. 106). This has a clear resemblance to the mathematical requirement and competences that are wanted and needed in everyday life (Wedege, 2010).

However, other researchers wanted to go beyond these abstract goals and concentrate on social and/or cultural issues. For example, Kanen (2002) uses the concept of numeracy as something that is created and constituted while engaging with others. It is situated within a specific context and involves the individual or group having a purpose for using mathematical knowledge. This perspective does not set out to describe the necessary skills, such as proficiency; instead, it tries to understand in a broader perspective what knowledge is developed within society (Wedege, 2010). By considering that knowledge is developed in society, it becomes evident that the context of culture is important. *Context of culture* refers to the conditions and events in the world and the social processes which make a difference to mathematical understanding (Halliday, 1978) and is influenced from both outside and inside the educational setting (Meaney, 2007; Morgan, 1998).

The context of culture then includes assumptions about how individuals learn. There are two broad perspectives about how students learn in mathematics education research. One perspective focuses on individuals' learning and has had a strong tradition in mathematics education research (Sfard, 2007). This perspective implies that mathematical literacy is an individual skill that can be developed, examined or judged. Thus, it refers to that which is internal to the individual; for example, understandings, skills, and capabilities, but which can be represented externally through performance on tasks and problem solving.

Alternatively, in the last two decades, there has been an increased focus on social settings (Morgan, 2006). According to Morgan, social perspectives can provide specific insights about mathematics education. This perspective does not set out to describe the skills acquired; instead, it tries to understand in a broader perspective what knowledge is developed within society (Wedge, 2010).

Another important aspect that affects the development of knowledge connected to general literacy, is raised by PISA: "Reading literacy is understanding, using and reflecting on written texts, in order to achieve one's goals, to develop one's knowledge and potential and to participate in society" (OECD, 2006, p.46). This definition goes beyond considering reading literacy as mere decoding and comprehension, and implies that reading literacy involves understanding, reflecting and using written information for a variety of purposes. It takes into account the active role of the reader in gaining meaning from written texts. Brown (2009) builds this reflecting and active role into *critical mathematical literacy practices*, which gives students opportunities to reflect upon, modify, compare, and expand their ideas, enabling them to place themselves in the position of mathematicians. In the Swedish curriculum (Skolverket, 2011), critical mathematical literacy practices are included as one of the five abilities that the students should develop during their mathematics education. To support the development of this ability, it has been suggested that teachers should provide students with instructions about structuring mathematical arguments, such as justifications and explanations, and constructing narratives which can support their mathematical thinking (Meaney, 2007).

Following Lerman's linguistic turn in mathematics education, it seems relevant to seek for traces of these perspectives in our studies as we do not simply examine texts, but also what occurs beyond the text. Therefore, we consider SFL appropriate to use as methodological tool to examine traces of notions of mathematical literacy in our texts.

Systemic functional linguistics

Halliday's *Systemic functional linguistics* (SFL) views language as a resource that people use to accomplish specific purposes through expressing meaning in context (Halliday, 1978; Halliday & Hasan, 1989; Halliday & Matthiessen, 2004). Meaning can be analyzed at the clause level to understand how contexts (such as classrooms) are reflected in the linguistic choices that participants make in their text production. According to Halliday and Matthiessen (2004), a text is any instance of language used as part of a context of situation. Therefore, every text reflects that it is

about something, is addressed to someone, and uses a particular mode – spoken or written language, for example – to express its meanings.

Texts are developed through the context of situation which, in itself, is surrounded by the context of culture (Halliday & Hasan, 1989). As discussed earlier, the *context of culture* is what occurs outside language, such as the events and conditions of the world and the social processes that are involved in those (Halliday & Matthiessen, 2004). The *context of situation* is the "environment in which meanings are being exchanged" (Halliday & Hasan, 1989, p. 12) and includes the field, the tenor and the mode (Halliday & Hasan, 1989). *Field* refers to what is going on, *tenor* refers to who is taking part, and *mode* refers to the role assigned by language.

When texts share the same context of situation, they will have similar ideational, interpersonal, and textual meanings. Then, it is said that the meta-functions belong to the same register. *Ideational-metafunction* describes how people use language to express experience. *Interpersonal-metafunction* describes the relationship between participants, and *textual-metafunction* describes the process of structuring the way that the information is conveyed. Halliday (1978) refers to register as "a set of meanings that is appropriate to a particular function of language, together with the words and structures which express these meanings" (p. 195). For example, the mathematics register is made up of specific uses of language, such as mathematical terms (like *hypotenuse*) and expressions (like *relational clauses*) for mathematical purposes. Consequently, a register can be recognized by the linguistic choices in the text, such as the structures and vocabulary in mathematics, and contributes to the mathematical meanings being expressed.

The meta-functions (ideational, interpersonal and textual) are groups of grammatical systems that produce meanings which can be seen as being mapped onto the structure of the clause. For this reason, SFL analyzes clauses from the three meta-function perspectives. Halliday and Hasan (1989) argues that the concept of meta-function is one of a small set of principles that are necessary to explain how language works; in this case, it explains how meanings are expressed through language.

Table 1 illustrates the relationship between the context of situation and the meta-function and is adapted from Halliday and Hasan (1989, p. 26). However, the process of analysis is not hierarchical as suggested in table 1; rather the process of analysis can begin at any point.

The first function, ideational meta-function, addresses experience as a type of process and is realized through the field (Meaney, 2005; Morgan, 2006). According to Halleson (2011), this function relates to the clauses that describe the world and how people use language to express experience. The field concerns what the participants are engaged in; it is

Table 1. *The methodological tool*

Situation	Realised by	Meta-function
Field ✓ What is going on? ✓ What is happening? ✓ What are the participants engaged in?	<u>Ideational Function</u> Transitivity Naming	Material processes: There is an actor that does something. Mental processes: The senser is addressing a phenomenon. Relational processes: Emphasise relations between objects. Verbal processes: Express something that has been said. Concerns the naming of objects that is evident in the linguistic choices made by participants.
Tenor ✓ Who are taking part? ✓ What entities are visible? ✓ What choice according to power/status/role?	<u>Interpersonal Function</u> Tense Polarity Modality Voice	Present, past or future time. Positive or negative validity. To what extent the proposition is valid. Imperative, personal pronouns and modal verbs.
Mode ✓ What role are assigned to discourse/language?	<u>Textual Function</u> Cohesiveness Lexical chain	Relation to the Context of Culture Being cohesive to the subject.

derived from past experience and present situations that merge into new meaning. Further, it is concerned with how actions are expressed through the process of 'meaning' and uses the verb transitivity system to illustrate how actors are connected to the actions. Different kinds of actions are described as material, existential, relational, verbal, mental or behavioural processes (Halliday & Matthiessen, 2004). In most research in Sweden, the material, relational, verbal and mental processes are identified in the analysis (Halleson, 2011; Holmberg & Karlsson, 2006). According to Karlsson (2011), these processes are sufficient to characterize a register or disentangle an image of the world in the text. Material processes involve physical actions (an actor, or doer, doing something); relational processes emphasize relations between objects; verbal processes express something that has been said; and finally, there are mental processes, wherein the senser addresses a phenomenon. The ideational meta-function also involves the naming of objects relevant for the context (Halliday & Hasan, 1989). For example, in a lesson on Pythagoras' theorem, it would be expected that terms such as *triangle*, *right angle* and *hypotenuse* would be used.

The interpersonal meta-function is realised through the tenor (Meaney, 2005; Morgan, 2006) and highlights the roles of participants and the choices that they have in the situation, from the perspective of power and status. The relationship between participants, highlighted through the interpersonal meta-function, can be revealed by examining the "voice" of the text through identifying the use of personal pronouns,

imperative and modal verbs in texts (Herbel-Eisenmann, 2007). Personal pronouns, such as *you* and *we*, identify the participants who are considered to be the main and secondary actors in the text. Imperative verbs command listeners or readers to do something, and modality indicates the level of certainty associated with particular actions.

This meta-function concerns past and present participation expressed through, for example, the modal verb, and it focuses on the interaction between the subjects. The time of the interaction is indicated through the choice of the verb tense and can be categorized according to present, past or future. This kind of interaction is described as the *tense* (Holmberg, 2011). The interpersonal meta-function is more complex than the ideational meta-function because the interpersonal meta-function is set up to analyze the participants in relation to the process.

Finally, the context and language structures used to carry the meanings of the text are components of the *textual meta-function*. This function is realised through the mode (Meaney, 2005; Morgan, 2006), and it concerns the process of structuring the way the information is conveyed; an analysis of this meta-function would include locating the theme and rheme and how cohesiveness is achieved. The theme serves as the point of departure (Halliday & Matthiessen, 2004) and the remainder of the clause is called the rheme which is "the part in which the theme is developed" (Halliday & Matthiessen, 2004, p. 64), such as "Multiplication in arithmetic (theme) is considered as repeated addition (rheme)". Multiplication in arithmetic is the point of departure because what follows provides information about it. Often, the theme will provide information which has already been given, thus providing links between sentences and paragraphs.

The focus in this article is to unpack different texts to reveal traces of context which contribute to the formation of these texts. Depending on the studies theoretical underpinning, methodological considerations and type of generated data, the focus on the meta-functions can be different in different studies (Herbel-Eisenmann & Otten, 2011).

Data collection of the empirical material

This article uses empirical data from two studies with different aims. The first study concerns the analysis of a page in a widely used, Swedish mathematics textbook for year 4 students (age 10). This study focuses on the relationship between the reader and the textbook and how that relationship affects the reader in a participatory way (Remillard, 2005). By using SFL, an understanding of potential issues the reader might face when reading the textbook page can be revealed. These are related to how the textbook design features influence the reader to learn and apply mathematical concepts (Bryant et al., 2008).

The second study aims to disentangle/unravel student teachers' past, present or future participation in different contexts of situations; for example, in lectures, seminars, working groups and internships (Ebbelind, 2013). Past participation may include earlier school experience, present participation may be contemporary experience, and future participation may be the intended classroom as an educated teacher. The focus is on understanding one student teacher's linguistic choices in a short interview transcript. These linguistic choices are made in relation to internal and external influences; internal influences may be different aspects of teacher education, and possible external influences may include family, media, social structures or relationships. This short episode is then interpreted in relation to different understandings of mathematical literacy.

Result and analysis

In this section, the results from using SFL and their analysis, using mathematical literacy, will be presented separately.

The first study – interpreting the textbook

Page 13 from a number sense chapter in *Matte Direkt Borgen* (Andersson, Picetti & Sundin, 2003) is analyzed. This is a commonly used Swedish year 4 textbook. This is the only page in the textbook that discusses odd and even numbers. The heading on this page is "Even and odd numbers" [Jämna och udda tal] and it is followed by an information box. Under the information box, there are six exercises, 36–41, for the students to perform.

This analysis uses SFL to show how the linguistic choices made in producing a page in a mathematics textbook for year 4 students illustrate connections to a specific perception of mathematical literacy. SFL, with a focus on tenor, has previously been used by Herbel-Eisenmann (2007) to analyze the voice of a mathematics textbook, and serves to illuminate the construction of the roles of the authors and readers, as well as the expected relationship between them.

The ideational function (field)

In the analysis of the textbook page, the ideational function operates primarily through naming objects of interest, with the use of mathematics vocabulary and relational processes. The objects named on this particular page are the mathematical concepts "odd and even numbers" [udda och

jämna tal]. The naming occurs in the main heading and both terms are repeated regularly in the information box and in the exercises.

However, these two words have different meanings in everyday conversational language compared with the meaning in mathematics in both Swedish and English, so there is a possibility that they could be misunderstood by students. "Odd" [udda] can be used as an alternative word for peculiar (something that stands out) in both Swedish and English. The word "even" [jämna] can also be used to describe flat surfaces in both of the languages.

In one of the exercises on the page, the adjective "jämnt" [even], is used to describe a number [tal] in the expression "ett jämnt tal" [an even number]. In a different Swedish context, the word "jämnt" can also mean barely, such as in the expression "nätt och jämnt". Another issue that can lead to confusion is that the Swedish words "jämt" and "jämnt" are pronounced in the same way and so can become confused. The word "jämt" expresses something which happens continuously, as in "det regnar jämt" [it is raining all the time]. Thus, if readers bring their everyday knowledge when trying to comprehend what is written on the page, confusion or misinterpretation can arise because of the differences in possible meanings.

The relational process emphasizes relations between objects. In the text, the relationship between even and odd numbers is in focus because of the use of the conjunction "and" [och] in the heading. The heading has a significant role because it is considered to summarise the content and present the main ideas on the page. This can help students to activate their prior knowledge (Carter & Dean, 2006).

According to Palinscar and Brown (1984), summarization involves the activation of relevant background knowledge, which might help students to connect their previous knowledge to the new material being learned (Carter & Dean, 2006). As the relationship between odd and even numbers is not clarified, the confusion with alternative meanings may not be resolved by the students when reading the text.

In the information box, the first examples of even numbers less than ten are presented, followed by examples of even numbers greater than ten. The same process is then done with odd numbers. The even and odd numbers are presented separately, and exactly how the two types of numbers are related is not shown; therefore, it is up to the students to infer the relationship. This suggests that the textbook page does not provide students with an understanding of relationships, structures and tools (Meaney, 2007). It is up to the students to discover the meaning of the words "odd and even" and to understand the connection between them. This suggests that the textbook writers view this understanding

as internal to the individual and supports the students' own learning as no collaboration is suggested and it is up to the students to find out about the relation between odd and even number by themselves.

Interpersonal function (tenor)

As discussed earlier, the interpersonal function refers to who is taking part, the kind of roles that they fill, and the relationships between participants. This is constituted by the *tenor* (Halliday & Hasan, 1989). Following the work of Herbel-Eisenmann (2007), questions, personal pronouns and modality are examined to visualize the relationships the textbook sets up between it and the reader. Herbel-Eisenmann has investigated the use of imperative verbs in textbook tasks, but these were not present in the Swedish textbook page. Instead, it seemed relevant to consider the use of the interrogative tense in questions.

In addressing the reader, personal pronouns can be used, such as "you" [du] and "we" [vi], to indicate who is taking part in the interaction. Modality signals uncertainty within a message and indicates a position between a definitive yes and a definitive no. Often, the use of modal verbs provides an indication of how much choice students have in a teaching and learning context (Butt et al., 2000).

All of the exercises on this page are in the form of questions and there are no imperatives telling students directly what they must do. The most common interrogative is "which" [vilka] and it appears in four of the six exercises. In all of the exercises, the questions act as instructions, telling by implication what the students should do, such as in exercise 36 where the question is: "Which of these numbers are even? 52, 365, 881, 138, 996 and 520". Usually, interrogatives have the function of requesting unknown information; therefore, using them to ask for information already known to the textbook authors, the relationship between experts (the writers) and novices (the students) is reinforced.

The factual information requested by "which" [vilka] is different from requests for students to explain, describe, or reflect on their thinking, which the Swedish curriculum sees as developing students' ability to "use mathematical forms of expression to discuss, reason and give an account of questions, calculations and conclusions" (Skolverket, 2011, pp.59–60). None of the exercises require students to do this. However, supporting students to reflect on, describe and explain their thinking can help them to become active participants in mathematics, and place themselves in the position of mathematicians (Brown, 2009).

Pronouns can be used to indicate the relationship between participants, such as the textbook authors and the students and teachers. In

exercise 38, "you" [du] is used to address the reader directly; otherwise, no other personal pronouns are used in any other exercise. Exercise 38 stated "All of the buses with even numbers go to the beach. Which buses can you choose between?". The "you" indicates that it is the students who must choose between 4 different busses, 14, 25, 67 and 922, indicated on a sign. However, there is a picture of a boy wearing a swimming ring and a snorkel connected to this exercise so it seems like the authors intention with the bus ride is to go to the beach, but this is not explicitly expressed in the text of the exercise.

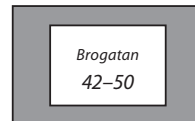
In the same exercise, there is the only example of the use of a modal verb, "can" [kan]. Modal verbs generally indicate how much choice the students have. However, in this task, there is only one correct answer which was determined by the writers when they wrote the exercise. Thus, students have no choice and so the use of "can" could confuse them about whether or not they have to answer.

Textual function (mode)

The third function, the *textual function*, is analyzed according to what role language plays and it concerns cohesiveness and theme of the texts. It is constituted by the mode. A page in a mathematics textbook often contains several different forms of representations, or modes, such as written language, symbols, diagrams and pictures. In order for the textbook page to be comprehensible to readers, these modes must work together to produce the writer's anticipated meaning and to be cohesive. Often, the sentences and questions in the exercises provide the context of the problems, the symbolic mathematics describes patterns or relationships, and drawings make connections to the physical world (Schleppegrell, 2007).

The written language in two of the exercises (exercises 40 and 41) is dense, with much information provided in only a few sentences. Translated versions of the exercises are given below with a reproduction of the picture connected to task 40:

40. Sarah is going to visit Hanna who lives on Brogatan 43.
- Does Hanna live at an even or odd number?
 - Does Sarah stand on the appropriate side of the street if she is standing at this sign?



41. Between two crossroads on one of Storgatan's sides are five doors.
The first door has the number 91. Which numbers do the other doors have?

In exercise 40, the students need to have prior knowledge of how house numbers are distributed, with odd numbers on one side of the street and even numbers on the other. In the next exercise (41), the students also need to have the same prior knowledge. Connected to exercise 41 is a picture of a street sign and to solve the problem, the students need to connect the information from the picture with the information in the written text. To understand how to read the information in the picture demands prior knowledge that not all students may have. This exercise potentially has two different answers as 91 can be the largest as well as the smallest number on the doors.

Specific knowledge is also required in exercise 38, described in the previous section. In this exercise, there is also a picture connected to the text. The students need to know what a bus sign looks like and how to read it in order to solve the problem.

Summary

In regard to identifying potential problems for readers of this textbook page, the analysis using SFL was valuable in identifying issues in all three meta-functions. The vocabulary is connected to the ideational meta-function and focuses on the words "odd and even". Both words have different meanings in other Swedish and English contexts which may cause confusion for students (Adams, 2003). The ideational meta-function analysis also highlighted that the relational process was not made clear to the reader. In the headline, the conjunction "and" sets up the relation between odd and even. However, in the information box, the relationship is not clarified; so students need to determine the connection themselves.

An investigation of the interpersonal meaning shows how the authors position themselves as the authority. The teacher is not invited to participate in any of the exercises. The questions position the students as doers that perform actions and not thinkers that reflect, describe or explain their thinking. The pronoun "you" is used in one of the exercises which suggests that the student can become an active, thinking participant, but the question is not open as it has only one correct answer, thus indicating that students do not need to reflect after all.

In regard to mathematical literacy, it seems that the authors of the textbook do not take into account that knowledge, such as numeracy, is created and constituted while engaging with others (Kanes, 2002). All of the exercises on the page require the students to perform actions individually and no social activities are requested.

Textual meaning is about the cohesiveness of the text. In two of the exercises, the students need to connect information in pictures to written sentences so that they are able to solve the problem. However, these two

exercises require prior knowledge, such as how street numbers are distributed and how to read a bus sign. It may be that not all students have this knowledge and that will hinder their possibilities for completing the exercises. The teacher could have a role in supporting the students to gain this knowledge, but there is no direct suggestion that they could ask their teachers.

Using SFL as a methodological tool allows information about how the linguistic choices connect to the context of situation which, in this case, is framed within the Swedish classroom where children are expected to work silently with their textbooks (Johansson, 2006). The textbook writers are placed in the role of the experts, whilst the students are expected to know background information about the exercises (such as how street numbers are distributed) but be unknowledgeable in regard to mathematical concepts of odd and even numbers. However, SFL does not provide any deeper analysis of the pictures connected to the tasks since SFL focuses on linguistic choices and not on analysing illustrations. To analyze illustrations, other frameworks need to be adopted such as Kress and van Leeuwen's (2001) which draws on understandings of SFL.

The second study – student teachers

The transcript selected in this article comes from a semi-structured interview with a student teacher one week before entering a 30 credit course (20 weeks) in mathematics education. As mentioned previously, the main focus in this paper is not on the content of the transcript, but rather how SFL can be used for unpacking the meanings in it.

The student teacher had completed one and a half years (out of a total of four years) of her teacher education. In several interviews, the student refers to her mother and her mother's teaching practices in particular (Ebbelind, 2013). Her mother works as a year 4–6 mathematics teacher and the student teacher's goal is to follow the same career path. During interviews, the student teacher often engages and re-engages in past discussions with her mother and speaks of the mother's practices as a teacher. Before this short transcript, the interview addressed the experience she may have gained through a program of internship. The student teacher brought her mother's practice into the conversation from the beginning as a way of contrasting her experience. The conversation in the transcript below is about the usefulness of mathematics and why it is an important subject.

First, the short transcript is presented and then followed by the ideational, interpersonal and textual meta-function analysis. Finally, a summary is given, which uses the meta-functions when interpreting the data.

- Researcher: What would you say that mathematics is today?
[Vad skulle du säga att matematik är idag?]
- Student: A part of the society and basic knowledge so that one can cope. Above all, when you shop and when something is needed in everyday life, not just something that one should do.
[En del av samhället och en grundläggande kunskap så att man ska klara sig. Framförallt när man handlar och det är nått man behöver i vardagen, inte bara något som man ska göra.]
- Researcher: Once again you return to usefulness. Have you always thought of it in this way?
[Du återkommer med nyttan igen, har du alltid tyckt så?]
- Student: It derives from my own schooling and that we talk a lot about it at home.
[Det kommer från när jag själv gick i skolan och att vi talar mycket om det hemma.]
- Researcher: Your mother, does she think she is successful in communicating usefulness?
[Din mamma, tycker hon att hon lyckas förmedla nyttan?]
- Student: Yes I think so; she says that many students ask questions about if this is reasonable. She has driven it into them.
[Ja det tror jag, hon berättar att det är många elever som ställer frågan är det här rimligt. Hon har kört in det i dem.]

The ideational function (field)

In the interview between two people, the researcher guides the conversation. The student teacher makes linguistic choices when discussing her engagement in past, present and future contexts of situations. In the following sections, the notion re-engagement, renewed or repeated engagement, is used. Re-engagement is used in symbolic interactionism, or frameworks linked to symbolic interactionism, to highlight that participants in immediate happening interact symbolically with past and present contexts (Skott, 2013).

The researcher confronts the student teacher through the processes "say, thought and think". The first one is a verbal process, and the second and third are mental processes. In the first answer the student teacher described mathematics using the relational process "cope", the material process "shop", the relational/existential process "needed" and the material process "do". The material process "do" is also considered a grammatical metaphor. A grammatical metaphor is a process that has become objectified and contributes to making the argumentation denser (Halleson, 2011). In the second question, the relational process "return"

is used. When describing the origin of the present understanding, the relational process "derives" and the verbal process "talk" are used. The last clause contains one mental process "think", one verbal process "tells" and one material process in "She has driven" [körte]. The metaphor in the phrase "She has driven it into them" [Hon har kört in det i dem] is used to summarize the mother's action in the classroom. The relational processes indicate that mathematics is integrated in society, while the first two material processes refer to activities that include mathematics. The last verbal process implies that they are someone else's experience.

As mentioned earlier, processes concern how actions are expressed through the transitivity system to produce meaning. Processes illustrate how actors are connected to the actions and indicate how experience is linked to context. An example of this is that the student teacher is connected to her mother's practice through the mental process "think" and not for example through the material process "visited" [besökte].

Interpersonal function (tenor)

The interpersonal meta-function answers the questions: Who is taking part (persons or entities)? What entities are visible? What choices do they have according to their power, status and role? There are two people present in the interview situation: The researcher who poses the questions with prompts such as "what would you say", "have you always thought" and "does she think" and the student, who answers the questions. The student teacher co-operates and follows the conversation by responding to the questions, interrogative sentences, asked by the interviewer.

The researcher demands personal answers by using the pronoun "you". The student teacher's prior school experience, mathematics experience, her mother and her mother's practice as a teacher appear in the interview as entities through the re-engagement of the past and present. The first question and answer in the transcript are presented as the student's current understanding. The pronoun used in the answer, "one" [man], is used and refers to people in general. This might suggest that everyone needs to know mathematics as an integrated part of society.

In the second question, the researcher uses the relational process "return" [återkommer]. When answering this question, the student teacher draws on her past experience, such as her own schooling through the word "my" and her mother's practice through "she" and "them". These different actors are all participants in the text. The story is centred around the student. "We" refers to the student teacher and her mother. An important actor, or entity, in this interview is the mother's practice as interpreted by the student.

The tense evaluates if the proposition/clause is valid for present, past or future. As already indicated, the transcript starts in the present; however, in the second answer, there are experiences from both past and present contexts of situation. The last answer is presented in the past tense when referring to the pronoun "she". With regard to modality the text has strong validity in the first two questions. In the last answer, the validity becomes weak when the student teacher uses the mental process "think".

Textual function (mode)

The textual meta-function is concerned with cohesive relations, how the text is organized and constituted by the mode. In this transcript, verbal language is used to pose questions that the student teacher can evaluate and then when phrasing her responses make choices about what is the appropriate verbal language to use.

The student teacher uses the conjunction "and" to merge different content to answer the same question. This conjunction is additive and indicates the relationship between the different clauses as being equal. The consecutive subjunction "so that" marks that the subordinate clause is added. A consecutive subjunction express a consequence or result. Looking at the theme and rheme in the transcript reveals that mathematics which is the rheme in the first question becomes the theme in the first answer. One can say that the researcher uses the last clause in the first answer to be the theme in the second question. In the second answer, the clause ends with "home". Once again, this rheme is used and made into the theme when introducing "your mother". Home is semantically close or related to your mother. This is a common way of creating coherence in texts, and thus the conversation can be interpreted easily by both the researcher and the student teacher. This transcript can be considered cohesive and coherent because the different sentences refer back to previously mentioned concepts or experiences. This is what Halliday and Hasan (1989) call a lexical chain. As the chain remains intact throughout the interview, there is no change of topic.

The story is centred around "I", the student teacher. The "I" is related to "we", which demonstrates that the ideas are not restricted to the student teacher's thoughts. In this transcript, "we" also refers to the mother and her proven practice.

Summary

The interview occurs between two persons, a researcher and a student teacher. The researcher guides the conversation and the student teacher

makes linguistic choices to indicate that she was engaging and re-engaging in prior, present or future contexts of situations.

The researcher requests the student teacher to talk about mathematics through the verbal process verb "say". The student teacher describes mathematics in relation to the entities "society, basic knowledge", and something that is "needed in everyday life" (relational process). Through using the relational process "cope", the student teacher indicates that she is re-engaging in two different contexts. With regard to mathematical literacy, the first relates to mathematics as part of society, and the second to basic knowledge as a tool that one needs to acquire. Basic knowledge concerns the kind of knowledge wanted or needed to function in society. Finally, if mathematics is both a part of the society as well as basic knowledge, then the need for mathematics is existential. Mathematics as "something [that] is needed in everyday life" can be interpreted as an existential process. The material process "do" is an ideational metaphor that relates to the common use of rote learning using textbooks.

The student teacher's responses can be interpreted as linked to the OECD definition of mathematics literacy. It highlights both the role mathematics plays in the world and a capacity that is used in everyday life. However, gaining the "basic knowledge" that is wanted in society is not completely considered to be an institutional endeavour. This suggests that Kanen's (2002) notion of numeracy is being used in the student teacher's interpretation. While using mathematics to operate within the society can mean that mathematics is recognized as not always visible but situated within the context. Mathematics, described through the material process "do", is not something that "one shall do". Instead, mathematics is used while participating in society, which suggests that Wedege's (2010) interpretation of mathematical literacy as something that can be related to the kind of knowledge that is wanted in society was in operation.

The concept of mathematics being useful is related to prior and present experience through the relational process "derives" and the verbal process "talk". The discussion "derives" from the student teacher's past engagement in school as a child and her re-engagement with her mother's practice. Once again, there are two different entities that are addressed in this clause; two different situations have merged through the conjunction "that" into the student teacher's present understanding of usefulness in relation to mathematics.

The last clause contains one mental process, "think", one verbal process, "tells", and one material process, "she has driven" [kört]. The re-engagement through the verbal process tells us something about internship or, in reality – the lack of internship – in this interview. Although it

focused on the internship experience, the student teacher only addresses the mother's teaching practice.

Regarding the ideational grammatical metaphor "She has driven it into them" [Hon har kört in det i dem], this suggests no co-operation in the sense that she, the mother, and the children have found out the usefulness of mathematics through mutual engagement; rather, it is the teacher that has explained the usefulness to the students. This does not give them the opportunity to, in Brown's (2009) sense, become active participants in the mathematics classroom. There are no signs of what knowledge is being developed in society in this transcript. When the student teacher re-engages in the mother's present practice, the student's critical behaviour in relation to usefulness is addressed, suggesting that there are traces of critical behaviour.

Discussion

In this article the aim is to illustrate how SFL can be used as a methodological tool in mathematics education research in Sweden. In particular, we discuss how SFL can be used to unfold different texts to reveal traces of context that contribute to the formation of these texts. This makes interpretations in mathematical literacy possible, such as revealing different actors' role in the texts.

Between the two texts in this paper there are similarities, such as both of them are developed through the linguistic choices of the contributors to the texts. SFL allows the context and choice of words in these two texts to be evaluated through the meta-functions; ideational, interpersonal and textual, which make processes visible (Morgan, 2006).

However, there are also differences between the texts, since the first study involved examining what a participant (the reader) might be engaged in while the second study involved what a participant (a student teacher) is engaged in. This affected which components of the three meta-functions were of more interest in the two studies (Herbel-Eisenmann & Otten, 2011). When investigating the ideational meta-function, in the first study naming and the relational process were important because the textbook page needed to be examined for the way the mathematical content was outlined. In the second study the ideational meta-function related to transitivity was in focus because it allowed the choices made by the student teacher in the interview to be highlighted. This concerns, as Morgan (2006) mentions, the different types of processes and how these processes are related to different kinds of actors.

When exploring the interpersonal meta-function the main focus in both texts involved examining the modality which indicates the level of certainty in the clause. The pronouns were also examined in both of the

texts, but for different reasons. In the first study, the pronouns illustrate how the text affects the reader's participation while in the second study the pronouns indicate how the entities and processes being expressed are related to the student teacher.

Regarding the textual meta-function in the texts, the cohesiveness in the texts was investigated differently. In the first study, the investigation was of how the written language and the illustrations, connected to different exercises, work together to support students to solve the problems. However, to analyze the role of the illustrations more deeply other frameworks need to be adopted since SFL focuses on linguistic choices. In the second study the cohesiveness was mainly examined by looking at the use of conjunctions and subjunctions that were used to merge different content but also on the thematic structure of the interplay between the researcher and the student teacher.

That the main focus in the meta-functions can have both similarities and differences, depending on the text, demonstrates the usefulness of using SFL as a methodological tool and we believe that this approach can, in different ways, contribute to illustrating the relationship between texts and contexts in mathematics education research.

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