Scientific literacy is approached on the premise that language is key to understand the nature of both learning and participation, in scientists' practices as well as in liberal education for citizenship. Some of the questions that are addressed in the book are:

- What does it take to be able to participate in different arenas in society involving science?
- How does everyday language relate to scientific language?
- How can students' texts be analyzed to gain insights into their learning?
- How can images be analyzed alongside verbal language?

This book offers a thorough introduction to key ideas in M. A. K. Halliday's systemic functional grammar through examples and practical analysis. Detailed analysis is offered of science textbooks and curriculum documents, classroom talk, experimental work, and students' discussions of complex environmental issues. Further, an analytical model guiding the design and analysis of science learning discourses is introduced.

The book starts with introducing excerpts from whole-class discussions, group work, experimental reports and textbooks as text-in-context. From this starting point, key aspects of language are carefully explained. The role of grammatical metaphor in the development of science knowledge is an important topic throughout the book. Tools for analyzing multimodal representations, intertextuality and multiple voices are also among the topics covered for understanding and analyzing school science discourses.
Scientific Literacy for Participation
Scientific Literacy for Participation

A Systemic Functional Approach to Analysis of School Science Discourses

Erik Knain
Norwegian University of Life Sciences, Ås, Norway
To my wife Anneli, love of my life
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WHY THIS BOOK

The ambition of this book is to offer an in-depth understanding of language, meaning and text in school science. Like many academic books, this book is written because I experienced a need for it. When supervising students at master and PhD levels I found that students needed an account that offer an in-depth understanding of the workings of language while addressing some key issues in science education. This book attempts to fulfill this need.

There are many approaches to analyzing discourse. The main focus in this book is a perspective on language and communication that is established by M. A. K. Halliday. Myself, I first met Halliday’s theoretical framework as a PhD student in the mid-nineties. Having a background in the natural sciences, I looked for a framework for undertaking a discourse analysis of school science textbooks. Halliday’s systemic functional grammar (SFG) became the cornerstone of my approach. I found it to be the tool I needed for the task. It was a distinct theory with some key ideas of language that I found very useful in my work, for instance it enabled the individual, the social and the content of communication to be handled in a comprehensive model as different aspects of communication. A few powerful ideas of language and eventually learning could in principle be applied to any discourse. However, in my experience, these ideas are difficult for students and also researchers in science education to get hold of. The reason I suggest is that the specialized discourse of linguistics is, understandably, difficult for a non-specialist. Furthermore, at the heart of SFG is the powerful notion of ‘functional grammar’, and in Halliday’s standard work it is presented over hundreds of pages in great detail. Even when applied to science texts, detailed grammatical analysis in technical language tends to be at the forefront. I suspect that even if essential to the theory and in practical analysis, the complexity of the grammar may be overwhelming and make it difficult to get a hold on the powerful ideas of language that is at the heart of SFG.

This book intends to serve a need for students by explaining carefully a perspective on language use that is also illustrated in practical analysis in a specific type of discourses, that of school science. In my approach, I foreground the key ideas and use grammar for illustrating the perspective on meaning making. Thus, this book aims to fill a gap in terms of this intersection of focus and accessibility. Still, functional grammar is put to work in specific example as it connects what we mean with how we mean.

I develop through the chapters an analytical model of discourse based on ideas from not only Halliday, but also on ideas from Günther Kress, Carolyn S. Wallace,
PREFACE

Carolyn Miller, James Paul Gee and others. The model will be used in both critical discourse analysis (analysing what-is; text as product) and discourses designed for learning (connecting what-is with what-should-be; text as process). During subsequent chapters, the model is developed in different domains: subject matter (content), inquiry (process) and in socio-scientific issues (SSI). Along the way, key aspects of SFG is introduced, and the model is put to work on examples of growing complexity, from the ready-made science to contested contemporary socio-scientific issues, from analyzing the values and ideologies in discourses, to designing context that support learning perceived as change in discourse.

The text examples and the analysis of them are based on studies that I have participated in during the later years, published in peer reviewed literature. The examples are not chosen necessarily because they are particularly illustrative. Most analysis is done on data that is not “easy” in terms of for instance identifying hidden assumptions in critical discourse analysis, and I want to show that the approaches in this book can be useful on any material. On the other hand, the theory of SFG is quite comprehensive, and some aspects need to be focused in analysis. This selection should be guided by the research question and what kind of data that are focused in analysis, as will be illustrated in the chapters to follow.

OVERVIEW OF THE BOOK

Chapter 1

Chapter 1 introduces the key concepts and ideas of the book. The question “What is a discourse” is answered and marks the starting point for our adventure into discourses in school science. The simple (but powerfull) answer to the question is “Text-in-context”. This notion will be inquired into by a few examples. Then the SFG model of interaction between text and context is discussed, and concepts like context of situation and context of culture are introduced.

There are two primary aims for discourse analysis. One is broadly labeled “critical discourse analysis” which attempt to infer meaning on the cultural level – the level of ideology - from analysis of actual text. The goal of critical discourse analysis is to describe values and norms regulating the discourse (another way to express the text-context interrelation). The other looks at discourses from a learning perspective. In this perspective, learning is taken to be change in discourse as evidence of students learning. That is; by designing appropriate contexts for students meaning making, students offer texts that can be taken as evidence that they are progressing towards competent participation in the specialized practices in society.

Chapter 2

After the main ideas of language in SFG are introduced in Chapter 1, Chapter 2 describes and exemplify the grammar, or rather lexicogrammar as words and
grammatical patterns are not sharply distinct in the semantics of SFG. Examples of the main categories are given. This chapter is perhaps the most technical one and focuses on various aspects of SFG. The emphasis is on understanding the principles of this language perspective, and a researcher wanting to do analysis by SFG will find examples of this in the chapters that follow, but even after these chapters, the researcher wanting to do detailed analysis is likely to experience a need to consult more technical resources such as Halliday’s own Introduction (2013). However, this chapter should provide a good background for doing so. The notion of genre is important in connecting acts of meaning in the situation and a broader cultural meaning reservoir. Furthermore, an analytical model is developed in Chapter 2, the Transformation model. At the heart of this model is the notion of “authenticity”. Authenticity is considered as multifaceted concept. Learning takes place in fruitful tension between what is personally meaningful to the student and what is authentic in future discourses outside school.

Chapter 3

This chapter extends the linguistic approach of SFG into the visual. For instance the notion of metafunction has a parallel in the visual. The grammatical processes in the visual are, as in verbal language, construals of experience into meaning. Forms of representation such as images, graphs, tables and diagrams are tools for understanding and sense making in science as well as means for presenting science as a body of knowledge. Representations are furthermore multimodal. Different modes and representations have different affordances. “Affordance” refer to what can be conveniently and conventionally expressed by a given resource. For instance there are some significant differences between the affordance of verbal language and a photograph. As science discourses are fundamentally multimodal, understanding how multimodal representations work is helpful in designing both teaching and research.

Chapter 4

This chapter focuses on discourses focusing on science as product and science as process. The product aspect is illustrated by an analysis of a science textbook’s authoritative account of energy transfer. The analysis makes use of SFG concepts with the aim of showing how the textbook develops a thematic movement from everyday experience into a scientific account emphasizing abstraction and generalization. This movement is significantly taking place by grammatical metaphor, which enables things that happen (processes) to become realized as things (nominals). To understand the textbook example would be to be able to see the everyday phenomena against a background of the scientific account. This is also to be able to reconstrue everyday phenomena into scientific ones grammatically.
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The other example is a transcription of students’ interaction around a scientific instrument and a PC. It will be shown how verbal language is one form of representation when they interact with a physical representation (a Van de Graaff generator) and that gestures are important in mediating between talk and machine.

Chapter 5

In this chapter, we focus on participating in issues that are not easily confined to the cathedrals of science. The first case example will be the “wicked” problems of environmental issues; our focus will now be participation where students are struggling to cope with complexity rather than technicality. Competencies that are needed for participating in complex issues in society are now our focus. To illustrate, a case from an interdisciplinary project with 15-year old students will be analyzed.

Negotiation of identity in discourse will be looked into again, and so will the Transformation model.

Chapter 6

This chapter is devoted to critical discourse analysis (CDA): analyzing the values and norms of school science. Key ideas are that social norms are manifested in what is said, how it is said, and what is omitted. The text-context relation renders communication possible by enabling participants to establish shared understanding, a common ground by making some interpretations of signs more plausible than others. Our tool for analyzing how something is said will be SFG, with grammatical metaphor as an important notion. Examples on analysis of curriculum documents and textbook will be given.

Why does it matter which norms or ideologies that are part of discourses? They are important in shaping identities and regulate who are enabled to take part, and who is left out. Power is closely allied with inclusion and exclusion.

Chapter 7

In this concluding chapter, the themes of the preceding chapters are brought together, and I will take the Transformation model one step further. Some further reflections on language use in school science are offered, and guiding questions for analyzing learning situations as well as critical discourse analysis are offered.
ACKNOWLEDGEMENTS

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I also like to thank my relatives in Trondheim, who have been an important part of my life during the years I have studied the language of science. Thank you for being there for me and my family, and for being you.
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CHAPTER 1

AN ANATOMY OF DISCOURSES

INTRODUCTION

This book intends to offer a targeted perspective on language, and tools for analysis of language. The questions and issues that I will address in the following chapters are all related to science, language and learning.

- How does everyday language relate to scientific language? In what sense is everyday and scientific language similar? In what sense are they different?
- How do teaching and learning relate to the context in which they unfold?
- How do values become part of communication?
- How can language be analyzed in learning context, and in critical discourse analysis?

The discourses of school science are varied. Any particular text may be familiar or surprising to a student, and may be verbal or visual, talk or writing, paper or screen. Some examples of this variety are offered below:

1. A transcription of classroom talk:

   P1–: It is, it is, what is most important to hold on to, is that what is common to the three ways clouds are formed by, is – Tom?
   P2–: That it raises into the air
   P1–: That – that what raises into the air?
   P2–: Eh, the water vapour
   P1–: Air, air with water vapour with a certain amount of water as gas, water vapour rises into the air. And, what happens when it rises into the air?
   P2–: It cools
   P1–: It cools

2. A transcription of students’ discussions:

   G4–: We should include such things…when are we going to include the ethical stuff, then?
   G1–: When it comes
   G4–: But that’s it – The ethical stuff doesn’t mean that hunting is! all! wrong. A lot of people have different opinions about it
   G2–: [animals should not suffer unnecessarily]
CHAPTER 1

((READING FROM THE SCREEN))

G4: I don’t believe (SHAKING HER HEAD) that hunting is completely wrong. I believe that it is worse to let animals die from starvation.

G3: Ok, on the ethical correctness thing we need to include –

3. An excerpt from a textbook:

ENERGY SOURCES AND ENERGY CHAINS

From everyday life you are familiar with several energy sources. You can for instance heat water in a kettle in at least three different ways: Either by using an electric plate, a camp fire or a gas burner. In the first example the electric plate is the energy source, in the second example it is the camp fire, and in the third it is the gas burner.

In all the examples above the kettle is energy receiver. During the heating, an energy transfer takes place from the energy source to the energy receiver. This energy transfer is manifested by an increased temperature in the water.

The hot kettle then becomes the energy source for the water, and the water is energy receiver. During the heating, energy goes from the kettle to the water. This energy transfer makes the temperature increase in the water.

(Brandt, Brandt, & Fonstad, 2000, p. 102). Translated by author.

4. And an excerpt from an experimental report:

The first thing we could observe was that once we supplied the dichromate solution in one of the tubes, the colour changed. It split first in three nuances: black at bottom, brown in the middle, and yellow-brown at the top. After it had been like that for a minute, we could feel that the test tube had become hot where the solution was. The colour had by now become one, which we believed was brown. When we poured water into it in order to see this better, we saw that the liquid’s colour was green. The colour in the other test tube had not changed at all, it was just like from the start: orange.

5. The following diagram was included in this report:

![Chemical structures](image-url)
These texts are all different, and yet in some sense similar. They are all about some science concepts. Some of these texts (1-2) are transcripts of talk; meaning is interpreted and offered from instance to instance between participants that have eye contact. Other are in writing on paper (3 and 4), made for readers that are not present in the situation here and now. The experimental report (4) is written for the teacher to review well after the experiment is finished in the science room, and the textbook excerpt (3) is written for any student in first year, upper secondary education. The textbook is written by experts and represents authoritative knowledge. The experimental report is written by students in a learning situation in school science. The diagram (5) is a visual representation.

Most of these texts are rather easily recognized as school science in many parts of the world. They are recognized as specimens of kinds of text that have some significance or function in common, in situations that are similar. The experimental report is a significant type of text for conducting experiments in school science. It is part of a practice of doing experiments, making it a recognizable activity in school.

How does this work? What does it mean to be familiar with these kinds of texts? Why is this familiarity (or lack of it) important to students’ learning, and as outcome of schooling? Further, what is the relationship between students’ everyday language at home or leisure and the language they engage in the excerpts above? How does students’ use of language relate to the authoritative textbook language as found in excerpt 3?

In this chapter I will develop some key aspects of language as resource for meaning making in science. I will start with defining discourse as text in context. This relationship can be entwined from two angles. The first angle is to focus on why a particular text does what it does in the situation, for the learner of science as an act of meaning. How does a given text made by a learner in science relate to his or her learning? How does it compare to texts that are valued and for which the students are expected to strive for?

The second focus considers texts as means for finding out something about a broader social system in which the texts derive their meaning and significance. What can be inferred about school science in general by analyzing the language of school science textbooks, or recordings of communicative events from school science classrooms such as the examples 1-5 above? These two concerns are of course related. For instance, a given utterance can be considered as an attempt to master the kind of text valued in school science. Such attempts involve working with language, and learning is the result of such work. Each individual learns to grasp reality through language. First as common sense, everyday reality through mother tongue, and later, perhaps the specialized languages of subject disciplines.

I start by defining the term “discourse”.

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AN ANATOMY OF DISCOURSES
CHAPTER 1

‘DISCOURSE’ IS TEXT IN CONTEXT

The headline of this section considers discourse to be ‘text in context’. This begs the questions of what ‘text’ and ‘context’ means, and what is meant by the ‘in’. In a sense, “text in context” is a reiteration as con-text means what is “with” the text, “the total environment in which a text unfolds” (Halliday & Hasan, 1989, p. 5). For now, we follow Halliday in that “Language is, in the first instance, a resource for meaning making; so text is a process of making meaning in context” (Halliday, 2013, p. 3).

I will introduce the concept of ‘discourse’ by an example that is neither school nor science. I do this to illustrate that the approach that is outlined in this book is a general theory on text and meaning making. (But also I believe that recognizing some key principles in different examples supports learning. This is actually an important part of the analytical model that is to be developed later).

Take a look at the following picture. You see to persons interacting in the social act of bying a ticket on a bus. Presumably, some talking is involved. Take a guess at what the exchange would be like before reading further.

![Figure 1. Bying a bus ticket.](image)

My guess would be something like:

- One ticket to the city center, please.
- That would be 2 pounds please
- Here you are
- Thank you. Your change.
- Thanks.
Was your guess very different? To people who have experiences with bus travel, this is a familiar situation. And by being familiar, we know from experience what is a typically thing to say in order to conduct the social act of obtaining a ticket for the bus ride, and the material actions that we must do during the exchange to complete it. Of course, there could be other possibilities than my suggestion, such as:

- Excuse me; does this bus stop at the railway station?
- Yes, here is a bus table showing when.

Some would be possible although perhaps not the first to think about:

- Will you attend the school meeting tonight?
- Yes, but I will arrive a bit late, perhaps about 7.30.

In this case, from familiarity with the context (a situation of buying bus ticket) we were able to have some expectations to what a text would be like. In the next example, consider the following exchange involving participants P1 and P2:

P1: It is, it is, what is most important to hold on to, is that what is common to the three ways clouds are formed by, is – Tom?

P2: That it raises into the air

P1: That – that what raises into the air?

P2: Eh, the water vapour

P1: Air, air with water vapour with a certain amount of water as gas, water vapour rises into the air. And, what happens when it rises into the air?

P2: It cools

P1: It cools

From this pattern of exchange, are you able to guess what the situation is? What is going on here, what are the participants engaged in?

If you guessed that this is an exchange from a school science classroom, then you are correct. And I suspect that most readers would guess correctly. The reason is that it is not really about guessing, but about expectations from prior experiences. From the talk, it is possible to guess what the situation is like, not exactly, but close enough if the exchange is familiar and known. This would presuppose that you have experiences of similar situations where such talk was prevalent, either first hand, or from other texts. Perhaps some image of a physical situation comes to mind when you read. But it is not only the physical situation that you recognize, it is a cluster of content, social relations and physical setting that comes to mind.

The participants are discussing cloud formation, and in doing so, they establish contact with each other through social relations. They need to do both in order to make it into a communicative event: talk about something to someone. And in this particular situation, this is done by verbal talk. The physical and material
aspects of the situation are what make this social event possible. The students sit in rows in front of the teacher, looking forward to the teacher. The teacher can have eye contact with all students, and all students can have eye contact with the teacher.

This example is the IRE (Initiation-Response-Evaluation) pattern of exchange familiar to many students of science (Lemke, 1990; Mehan, 1979). It is teacher controlled in that the teacher initiates for instance by asking a question to the class, after which a student is nominated and answers, and the teacher evaluates the answer. The teacher decides who is allowed to contribute, and decides if the response is appropriate.

What makes this type of exchange recognizable is that it is a frequently found pattern in science classroom, frequent enough that it is given its own name by educational researchers, IRE. Even if each particular instance is different from any other instance, we recognize its social purpose and the typical relations between the participants. The social relations are more stable than the thematic content in question, which of course could be any issue that could legitimately count as “school science”. This kind of exchanges is an important part of students’ learning, even if not intended to be so. During many years in school, subject matter come and go, but the stable genres like the IRE pattern is repeated over and over again. These patterns are functional by being shared social norms and thus expectations among students and teacher in school. More on this aspect in Chapter 6.

Familiarity means that little effort in interpretation is required. When the situation is familiar in terms of what goes on, who takes part and means of communication we draw on shared contextual knowledge. Familiarity is however always a matter of degree and can change from one moment to the next in face to face communication. Consider the next example, later in the same session as the previous example:

Teacher: … but then I ask, why isn’t it just as hot in the night, when the ground is warmed by the sun during the day? Why isn’t it hot in the night too?

Tom: Because the energy in the sunlight disappears and become reshaped into other forms of energy.

Teacher: Yes…

Tom: Than heatenergi.

Teacher: Eh- it may not be correct to say that it is reshaped into other…

Tom (interrupts): Yes, but if you got, if you have greenhouse effect, and…then of course some of the energy disappears out, but it need to be reshaped….must it not? All energy is reshaped again…

(A few seconds silence)

Teacher: But what is…what it is most important here, is that…. You said, what does shortwave radiation look like…
If not energy is reshaped here, the pattern of dialogue certainly is, as the student challenges the IRE pattern and engages the teacher in a more leveled discussion, having an agenda of his own. What would be expected in a IRE sequence is that the teacher completes his evaluation of Tom’s answer, and then makes a new initiative. However, Tom interrupts this move to rephrase his understanding, and requests the teacher to respond to this (“must it not?”). However, the teacher does not follow up this invitation. After a few seconds silence and a fumbling start, he says “You said, what does shortwave radiation look like…” but actually “what does shortwave radiation look like” is not the voice of Tom, but his own scientific story. By this mild use of authority, the teacher again takes control of the pattern of dialogue.

Neither Tom’s interruption nor the teacher’s restoration of the pattern of dialogue were startling or incomprehensible. Both teacher and student in this case were likely to have several experiences of similar situations.

Later, a more startling episode occurred, when Tom raises from his desk and walks to the teacher in front of the class while he is lecturing, and engages the teacher in a discussion. The teacher looks at the recording camera looking both puzzled and amused. A few seconds later the bell rings, and the other students leave the class, the teacher and Tom still discussing.

Text and Context as Mutually Construed

Text and context are interpreted mutually through expectation. From experiences with similar situations, we have expectations to what would be appropriate to say in a present situation. This makes us select meanings from the vast meaning potential of language when interpreting what is actually said. Sharing such expectations with other participants present makes discourse possible by limiting the space for interpretation. Expectations of what is going to be said are background for interpreting what is actually said. Put another way, text and context construe each other. We infer text from context, and context from text.

In the interdependency of text and context, language becomes tied to the physical and social world. Language use thus becomes acts of meaning. Text and context construe each other mutually. This puts SFG in a constructivist tradition:

Work of this kind would not easily derive from, or reconcile with, a correspondence notion of language, the view that language is doing no more than reproducing a cognitive model of experience. Rather, it assumes a constructivist interpretation, whereby language actively construes human experience, from the “commonsense” constructions of the everyday mother tongue to the highly elaborate edifices of the disciplines as they are taught and researched in schools and universities. (Halliday, 1992/2003, p. 379)

However, of all that can be possible recalled and drawn upon as context, what makes something become foregrounded as significant? The most important cue is that of
the situation. The situation ties together expectations into larger interrelated patterns, tentative or stable, that signify what social action is going on.

What we have seen in the introductory examples is that it is possible to have expectations on what is (likely) to be said when we recognize the situation. In the bus example (Figure 1), part of the context is the immediate verbal text prior to the exchange shown, for instance “Good morning”. There is also a material aspect of the situation, the location of the driver in the bus and space designed for the passenger to stand, the ticket system, that money in terms of coins and bills are actually exchanged instead of a card being validated, and so on. But around this immediate environment, there are many experiences with previous exchanges of buying a ticket, which enable the passenger to predict how to use language to get a ticket. And buying a bus ticket is within a family of exchanges that very often occur in most parts of the world, “buying something”. Children learn to do this kind of exchanges quite early when visiting stores with their parents. I will later introduce the notion of “context of culture” to signify this broader meaning reservoir.

**Conclusion**

To conclude this far, there is a covariance between text and situation so that the one tends to be predictable from the other. This is made possible because situations that are similar become indexed with similar texts in our consciousness. And it is as text that language become chunks of meaning that can fulfill some interest of the speaker, a social purpose. In the bus example, the situation is defined by the passenger’s need for a ticket (and the transport company’s need for money), and the exchange has the social purpose of fulfilling these goals. Similar situations have similar goals and are realized by similar types of exchange.

By “realization” I mean, for now, that the bus driver and the passenger make it into a ticket exchange by their selection of words and pattern of interaction from a shared reservoir of meaning at a cultural level. It is made possible by a shared sense of purpose and how this purpose can be carried out by language as social interaction. Thus similar texts group with similar purposes.

We always have a good idea of what is coming next, so that we are seldom totally surprised; but the surprise will always be within the framework of something that we knew were going to happen. And this is the most important phenomenon in human communication. We make predictions – not consciously of course; in general, the process is below the level of awareness – about what the other person is going to say next; and that’s how we understand what he or she does say. (Halliday & Hasan, 1989, p. 9)

Even Tom’s interruption in the IRE exchange would likely happen from time to time in Norwegian classrooms, and is familiar to many teachers. However, when Tom
walks up to the teacher and starts a face-to-face conversation with him during his whole class lecture, that was truly startling to the teacher, judging by his reactions. That was clearly unfamiliar. In that case, it was not only the pattern of exchanges that was challenged, but the physical situation in that the position of teacher talking to an audience in the IRE pattern, was disrupted when the student walked up to him and engaged him in a face-to-face conversation.

In the above subchapter we have investigated how text and context are interrelated, not in a mechanical way as cause-and-effect of independent phenomena, rather text and context construe each other, the one is needed to interpret the other. Later I will show how the interdependence is rooted in the very fabric of language in SFG. First I will consider how meaning making in the situation relate to higher levels of context and higher levels of meaning, how meaning making is *stratified*.

**LEVELS OF MEANING: SITUATION, GENRE AND CULTURE**

Referring to the bus example, I argued that the passenger and the bus driver could predict from experiences in similar situations what the exchange would roughly look like. From this general, shared script the woman and the driver can make the minor adjustments necessary to complete this particular exchange. These resources of shared experiences constitute a broader contextual background beyond the immediate situation. We can associate meanings that belong to a “culture of public transport” so that the word “bus” can take a connotative meaning, a kind of associative meaning above “this particular bus”.

These are meanings at a cultural level, “the culture of public transportation”: frequency, the cost during a month, regularity, and public discourses on transportation. In this broader context beyond the actual situation we enter the realm of values and politics of public transport, themselves textual practices.

The theoretical point is that the broader patterns of experiences constitute a higher-level semiotic, a higher level meaning potential where any one particular situation is a realization of this potential, a selection and transformation from a broader reservoir of meanings.

*Text Norm, Genre and Culture*

Actually there is an intermediate level between the act of meaning in the situation and a cultural level, in this case public transportation. This level is *genre*. A genre is, as I will outline below, standardized ways of doing things by language in similar situations. The experimental report, the IRE and the bus ticket purchase are all genres for achieving some standardized social purposes. We thus get three levels of meaning: context of culture, genre, and context of situation (Halliday, 2013, p. 28). These concepts I will elaborate in this section.
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Seen from the text-side, one could in principle collect all sort of texts somehow related to public transportation, and find that some of them had similar structure, thus they were of a particular text category. From the contextual point of view, one could see that if mapping out all kinds of situations in the public transportation system, there were some situations that were similar to each other. Situations can be grouped. In one group of situations, the activity nearly always happened in front of the bus after the passenger entered the bus, and before the bus started to drive. These two approaches would match in the sense that one could find a match between situation type and text group. In these kinds of situations, these kinds of texts occur. It would seem, that this kind of text fulfilled some goal or intention. If this mapping was done across a representative variety of situations of public transportation, then a description of the culture of public transportation would result. Berge (2007, 2012) holds texts and what people do with them as constitutive of culture: “A culture may be understood as the collection of text created in the culture and/or texts that are used daily in the culture” (Berge, 2012, p. 94). In this sense, texts are not only products of culture, they are also constitutive to culture; texts facilitate the activities that make up a culture. Text and culture are interdependent as texts need some shared, standardized way of interpreting them when made in acts of meaning. A text is a realization of a meaning potential at the cultural level by shaping participants expectations so that some materialized item can be recognized as a text, and as having some cultural

Figure 2. The ticket purchase as an act of meaning is an example of a situation type that takes place in bus transportation (left image), so that each instance is a realization of a more general pattern of interaction that serve this general purpose (illustrated in middle image). This pattern is part of a “culture of transportation” (illustrated at right).
value. These expectations are labeled text norms by Berge. The text norm helps us recognize an utterance as a social phenomenon of text in the first place, and the text norm furthermore attributes it some value.

Consider the example of the experimental report genre. A particular report is written by a student in a particular situational context. This situational context would include the physical situation (perhaps sitting at a desk in the classroom, the equipment perhaps still on a table nearby, notes from the conduct of the experiment and the textbook available, the teacher’s handwriting and illustrations on the blackboard, other students doing the same writing assignment, prior knowledge about the subject matter, and so on). If one collected a number of such reports from a range of classrooms, one would infer that there are some similarity between these reports, and that they are likely part of some standardized practice. If one did a cultural study of school science, one would indeed find experimental work as a practice, more or less varied, and that the experimental report genre was key to realize these practices. At the individual level, this meaning potential at the genre and cultural levels are (more or less) shared textual competence and expectations to solve this particular assignments in school science. The experimental report genre then, mediates between individual intentions and skills on the one hand, and the culture of school experiments on the other. Students struggle with creating texts that can pass as some realization of a culturally valued pattern of empirical science. As the student struggle with writing up an experiment, the individual experiences and intentions meet the text norm of the experimental report, and the student appropriate the text norm (Berge, 2012). The relationship between text, context of situation, genre and culture is often illustrated by onion layer models in SFG. In Figure 3 this model is illustrated with the experimental report.

How do the different levels relate to each other? What does the arrow in Figure 3 mean? The “down” arrow means that the context of culture and genre levels are
meaning potential for acts of meaning in the situation. School science consists of several genres that enable school science purposes to be fulfilled. One genre, the experimental report, is a standardized way of writing up experiments in school science. This genre is likely learned explicitly by being modeled by a recipe, and then this recipe is practiced in many experiments. In each particular instance, the genre is a resource for writing a new report.

The “up” arrow means that the higher levels are realized by the lower level. The experimental report genre is, as tacit knowledge and social norm, the sum of all these previous instances that have become part of students’ expectations to what an experimental report should look like. There would be no functional experimental report genre without the individual reports.

What comes first, language or culture? The individual texts, or the genre? In a sense, neither.

Language neither drives culture nor is driven by it: the old questions about which determines which can be set aside as irrelevant, because the relation is not one of cause and effect but rather […] one of realization: that is, culture and language co-evolve in the same relationship as that in which, within language, meaning and expression co-evolve. (Halliday, 1992/2003, p. 380)

Halliday compares the relationship between the meaning potential of language at the level of culture and a particular act of meaning to the relationship between climate and weather. Climate and weather are not different phenomena as climate is realized by weather; rather they are the same phenomenon seen at different time scales. Climate makes weather possible. This of course does not imply that you from a model of climate can predict precisely the weather at a given location at a given time. Rather, climate says something about what would be familiar weather and what would be peculiar. In a summer day in July in Norway, I might expect sunny or rainy weather, but snowfall would be a total surprise. And I may hope for 20C temperature, it might become 27 and this would be a warm summer day, whereas 45 degrees would be worrying. You see that we are discussing familiar and unfamiliar experiences and expectancies again.

It should be noted that in SFG, there is another meaning of “realization”. The notion of “realization” above is referring to how a meaning potential at one strata or level is realized by the strata below; i.e. how school as institution is a meaning potential where the experimental report genre has some significant function, and the specific reports is a realization of the genre. The other meaning of “realization” is how language as a grammatical system is realized into a particular text, how the grammar as a vast meaning potential is realized by some specific wording in a text and its context (cf next chapter). This is called “instantiation” in SFG. I will however largely use “realization” in both of these two meanings in this book.

Now, let us return to the examples of IRE sequences from the science classrooms. We have already seen that “IRE sequences” are typified situations; they are genre
patterns that are repeated frequently in classrooms. Even though a particular exchange has some unique characteristics and cannot be predicted in detail, there are still similarities across situation that has made it a phenomenon in the educational literature. When looking into a multitude of classroom, these patterns of communication are found.

Schooling is a particular good example of how a context of culture is a meaning potential that realizes a genre into a particular text. For the IRE sequence to take place, we have seen that there are certain physical aspects of the situation that enable it; that a teacher can have eye contact with several students. And certain power relations between the teacher and students enable the teacher to have a controlling role, and the students to have a more passive one, only contributing when nominated by the teacher. The teacher has the power to evaluate the answer, whether it fits into the explanation being developed by the teacher or not. This power comes from someone being positioned as knowledgeable, and others having the role of learners. This of course is legitimized by the school as institution in society. The institutions of science have a stake in school by both legitimizing the uneven relationship between those who knows and those who don’t, and (relatedly) secure future recruitment of scientists. To achieve these purposes, the school constitutes a set of practices that can be recognized as genres.

After our excursions into the functional relationship between the context of situation and context of culture, it is appropriate to define genre more precisely. In agreement with a functional perspective on language, Veel defines genres as ‘staged, goal-oriented social processes’:

‘Staged’ refers to the fact that genres usually consist of a number of distinct parts which work together to build the meaning of a text. ‘Goal-oriented’ refers to the fact that genres usually function to achieve some purpose – they get something done (e.g. action, learning, persuasion, entertaining, etc). ‘Social’ refers to the fact that genres are dialogic, they evolve from social interaction.
(VEel, 1997, p. 191)

Conferring to the bus example, the exchange is “staged” in the sense that it contains some actions construed by language:

- Initiation: approaching the driver
- Telling the driver the destination
- The driver tells how much to pay
- Paying
- Closure, finding a seat.

It is “goal oriented” as these actions have the purpose of obtaining a ticket for the ride. And it is “social” because the woman and the bus driver have to cooperate in order for the transaction to reach completion. Similarly the IRE examples can be interpreted in terms of Veel’s definition, where Initiation, Response and Evaluation comprises the stages.
Perhaps the most easily distinguishable school genre of all is the experimental report genre. A recipe offered to students typically have the following sections:

- Aim
- Equipment
- Methods
- Results
- Conclusion

This recipe has roots in scientific communities emerging in the 17th century, where efforts to overturn classical authority by documenting singular experience textually resulted in novel ways of using language for scientific argumentation and theory development (Knain & Flyum, 2003). Grasping the goals and the stages of this recipe for students in a particular experiment doesn’t come easy for many students. In Knain (2005) I show how a student that had not experienced the recipe before upper secondary school had difficulties in appropriating the genre in her work. Her difficulties seemed to be about staging the experiment according to the recipes sections and in terms of who the addressee was, and her identity as a science student:

Erik: Would you say that these headings: purpose, observations, carrying out and so on is linked to, or reflect a bit how you do experiments, would you say that?

Sophie: Yes, uhh….

Erik: Or would you disagree…

Sophie: Yes, I can’t quite see the point of writing purpose and conclusion. I’m never quite sure what to write there. It’s sort of… I feel that it is unnecessary to write anything there. We always ask what the purpose is, and then he just tells… just writes it, really, it’s something that…

Erik: So he knows the purpose, really, so then you didn’t need to write it.

Sophie: No, when we write it, it becomes correct then too, but in a way it is nothing that…it isn’t any point in putting it in, when he [the teacher] realizes what the purpose is, when he reads the report.

In scientific research, one writes such reports for someone who really need to know the purpose of the experiment. When this purpose of the genre is recontextualized to school science, tension arises between the purpose of the report genre in science (writing about tentative claims to knowledge addressing someone who does not know) and a purpose of school science (writing about known knowledge to someone who already knows). Part of becoming a participant in the cultures of school science is to recognize or construe the scientific purpose in the school purpose. When a student has internalized the purposes and stages of the experimental report genre, she can talk about the recipe this way:
Erik: Have you considered the succession that you use, of Execution, Explanation, Sources of Error and Conclusion. Is that a succession that you always use?

Lucy: Yes, I always have that recipe on my computer, I have a template. It makes it easier for me and for the teacher who assesses it, too. I think it is important first to know the purpose, what you are going to do, and then the equipment you are going to use, and then what we did so that others that read the report are able to do the same as you did. It’s nice to have a description first, then they can do it, and then see what I found out, what I have observed and what I explain, what sources of error I found, and then I have a conclusion on what I learned from the experiment.

Note how ‘I’ is frequent in the interview transcript above.

In the experimental report genre, there are sections that constitute stages, reflecting the distinct combination of action, thinking and reflecting that are parts of the textually representation of the scientific experiment as well as certain relationships between writer and reader. When making a particular experimental report in science class, the students appropriate a cultural tool, and in the processes position herself or himself as members of a community of school scientists. The genre both constrain and offer opportunities in a process of socialization.

**Discourse and Practice**

I have used the notion of “practice” several times already. How does “practice” relate to “discourse”? One can infer from the literature that they are tightly connected, although there are nuances in how they are defined. Barton refers to research that have used “texts, participants, settings and artefacts” as components of practices (Barton, 2001, p. 97). Fairclough (2001a, p. 231) lists the following elements as constituting practices: activities, subjects and their relations, instruments, objects, time and place, forms of consciousness, values, and discourse. These usages of the term suggest that “practice” is a wider notion than “discourse” by being in a sense more than discourse, but Fairclough notes that they tend to internalize each other. The definition of discourse as “text in context” introduced in the beginning of this chapter emphasizes that discourse includes the surroundings of the text, namely its context. A practice then includes the text and the context that make it meaningful. Thus, in Fairclough’s use of “discourse” some of the discourse is actually in the other categories listed above if “discourse” is defined as “text in context”. I follow Berge (2012) and Barton (2013) in emphasizing that culture is significantly textually mediated, hence the term “text culture”. When I use the term “practice” in this book, practice is fundamentally textually mediated social activities at the level of genre. When I use “practice” rather than “discourse” I emphasize the kind of activities and purposes rather than the acts of meaning by language; but these are tightly interwoven.
From a cognitive perspective, Kahnemann (2011) describes how our consciousness draws on experiences to shape expectations. In his book on the psychology of decision making “Thinking, fast and slow”, he describes an interplay between intuitive thinking and a more effortful form of thinking. Kahneman describes System 1 and System 2 modes of thinking. System 1 operates in a more intuitive and effortless manner based on associations and coherent patterns represented by norms and prototypical responses in familiar situations and challenges. System 2 is a more effortful form of thinking, allowing for more complex deliberations, concentration, agency and choice. System 2 is “lazy” in the sense that our mind works by System 1 as long as things are going well, in a condition of cognitive ease. “Easy is a sign that things are going well – no threats, no major news, no need to redirect attention or mobilize effort” (Kahneman, 2011, p. 59). System 1 operates by a model of what a “normal” world is like. The model is constructed by associations that link ideas of circumstances, events, actions, and outcomes that co-occur with some regularity, either at the same time or within a relatively short interval (ibid, p. 71). At this point this cognitive perspective meets our semiotic one, “We are able to communicate with each other because our knowledge of the world and our use of words are largely shared” (ibid p. 74). Thus, students’ experiences with the IRE sequence in similar situations in terms of location, participants and goal make it familiar, normal and predictable. And by participating, they reinforce the norm of how to communicate and behave.

Bor (2012) emphasizes that the most salient feature of human consciousness emerging from neurobiological brain research is two systems that he describes along the same lines as that of Kahneman, static, automatic, unconscious processes, on the one hand, and highly dynamic, flexible conscious ones, […] This conscious machine is designed to kick in whenever the task cannot be achieved by our instincts or bank of unconscious automatic habits. (Bor, 2012, p. 177)

He furthermore describes a connection between consciousness and awareness. The gatekeeper of awareness is attention, which is related to working memory. The reason that awareness is a precious resource is that what can be processed in the mind, are only four items at a time. These we have in common with many other animals. However, what makes the human brain distinct is its extraordinary capacity for finding and manipulating patterns. The economy that the limited capacity of working memory infuses on our mind, is compensated for by an amazing capacity for finding patterns and relate patterns to each other into hierarchal layers, where the layer below is the foundation for the layer above, so that “by the time we reach adulthood, most seemingly novel items have some preexisting context” (ibid, p. 150). According to Bor, the significance of these patterns is that they allow for redundancy, by noting not
every single aspect but only the similar, repeating parts of the pattern. When called
for, then, the top of the pattern can be brought into attention, and information further
down in the hierarchies can be recalled, combined and refined extremely flexibly
according to the demands of the situation.

The purpose of awareness then is to regulate the interface between system 1 and 2
in Kahneman’s terms. This is a process of focusing and leaving things out:

The first, meager less interesting stage of attention, and indeed awareness,
is where we get a weak sense of everything around us, as if we are not
really attending to anything - or rather, we are attending to everything in the
same minimal way. This lasts for about 200 milliseconds. A short time later,
though, the second form of attention kicks in, which is goal driven. Our neural
landscape shapes itself according to the task at hand, and we start to hone in
on interesting details [...]. During this second stage, our brains then calculate
exactly what it is we want to focus on, what the few objects are that really
matters. This important subset of our world gets a generous attentional boost,
and we are far more aware of what matters. Everything else gets suppressed,
and our awareness of whatever is outside our working memory and focus of
attention may become invisible. (Bor, 2012, p. 144)

There is likely to be some important differences between a semiotic theory focusing
on meaning and a neurological approach focusing on patterns of neurons firing,
calculations and processing in the brain. However, one should expect these approaches
to be compatible, and even converge to some degree. Bor’s account of consciousness
shows evidence of this, even if he is largely silent about the role of language in
consciousness (but he acknowledges its importance, of course) and the role of social
interaction in the chunking of experience into patterns. It is nevertheless interesting
to note that Bor’s notion of chunking experience into patterns that are hierarchical
and goal driven are similar to the definition of genre offered by Veel. In the next
chapter you will meet a perspective where learning is about transforming patterns
according to the demands of the situation at hand. The accounts of Kahneman
and Bor point in this direction. Indeed, awareness and its relation to attention and
working memory seem from these accounts to be a prerequisite for framing as a
social selection of genre and mode (see Chapter 3) as discussed by Kress (2013). The
frame separates what is outside from what is left out, and what is inside the frame is
made into some unity.

Semiotically, the frame is essential to make meaning: without the frame we do
not know what is to be put into relation with what; what is to be put together
with what; and where the boundaries to interpretation are. […] We might say:
Without ‘frame’, no meaning. (Kress, 2013, p. 73)

At this point, I will return to the quote from Halliday and Hasan. The relationship
between consciousness, awareness and working memory may connect to their
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account of how language works in that focused awareness is about shaping a context as basis for prediction.

We always have a good idea of what of what is coming next, so that we are seldom totally surprised; but the surprise will always be within the framework of something that we knew were going to happen. And this is the most important phenomenon in human communication. We make predictions – not consciously of course; in general, the process is below the level of awareness – about what the other person is going to say next; and that’s how we understand what he or she does say. (Halliday & Hasan, 1989, p. 9)

As Bor does not address language in any detail, he does not consider chunking of pattern into meaning as a fundamental social interaction by language. This is however discussed by Halliday in his merging of Edelman’s account of the development of the human brain, where language is the result of an evolutionary path to bypass the limitation of the immediate context of here and now, accompanied by a significantly larger brain than most other animals (Halliday, 1995/2003). This large brain was necessary to handle not only a physical world, but also a social world of negotiation.

METAFUNTIONS OF LANGUAGE

So far I have mainly investigated the text – context relationship. The main ideas are: 1. that text and context realize each other in acts of meaning, and 2. in acts of meaning we draw on broader meaning potentials above the situation. In this section I will focus on a third aspect of acts of meaning: 3. We do fundamentally two things with language: act on the social environment and reflect on experience. These two functions are found in the fabric of language as metafunctions according to SFG.

When we communicate, we always do two things simultaneously: when we talk about something, we also establish contact with others. We construe human experience, and we enact. By “enact” is meant that we establish, shape and negotiate social relations through language. Obviously, the teacher and his students established contact with each other in the IRE exchange about cloud formation. The field (context) of cloud formation is construed as a particular thematic pattern, and teacher and student shape social relations – enact – through the IRE.

The textbook writer establishes contact with a reader. As the context of writing is different in terms of time and place from that of reading, this contact is very different from that of the IRE. The main point is though, that we both construe and enacts in acts of meaning:

[...] the full creative power of an act of meaning arises from the fact that language both construes and enacts. It is not only a way of thinking about the world; it is also, at one and the same time, a way of acting on the world – which means, of course, acting on the other people in it. (Halliday, 1992/2003, p. 384)
It is a central tenet of constructivism that our mental representation of the world is not passively given, represented in a passive, photographic sense, instead it is constructed by individuals from experiences in social settings. SFG is a theory on how this works, and we will start this exploration in this chapter. The short answer is that we make sense of the world, we construct it through our grammar, which is our theory of human experience. By grammar we shape the continuous flow of experiences into meaning. This is a fundamental function of language, it is one of the metafunction in SFG terms.

Construe experience into meaning and enacting is fundamental to language use, and is within the system of language metafunctions, the ideational and the interpersonal, respectively. The ideational metafunction construes experience into thematic meaning, whereas the interpersonal metafunction shapes social relations. And the interpersonal metafunction is no less significant than the ideational:

Systemically, in this interpersonal metafunction, the grammar continues both society and, through society, the individual self; instantially, the grammar enacts dialogic roles and the ongoing “personification” of “I” and “you”. (Halliday, 1995/2003, p. 414)

The notion of grammar as reconstrual of experience is paramount in SFG and will be returned to on many occasions during this book. It will be dealt with further in Chapter 2. For now I will emphasize the importance of considering both ideational and interpersonal meaning. In science discourses, it is tempting to focus on the content as primary, and the social as a kind of packaging of content after it has been decided on. Distinctions between “form” and “content” sometimes have such implicit meanings. However, in some respects, the social is more primary than experience and content. Children are born with a disposition to construe and enact, and “signs are created in the intersection of these two modes of activity” (Halliday, 1993b, p. 95). Children develop a protolanguage with a few distinctive motifs in language to act with and language to learn with, and it is these that develop into metafunctions. Acts of meaning become both acts of action and acts of reflection. In a sense, the interpersonal is the gate through which ideational meaning is made. And in my experience in analyzing science discourses, it is tempting to consider ideational meaning as more important or interesting, but I usually find the interpersonal meaning as more interesting to the research question focusing the analysis.

In the bus example, the content part of the meaning, “ticket”, “city centre”, “pounds” and “change” only makes sense through the interaction between the bus driver and the passenger. It becomes part of action as a social exchange. In the IRE sequences, the content of the talk – clouds, air, vapor and so on – have a meaning as exchanges between the teacher and the student, they are making sense together. Take their social interaction away, or take the content away, and there is no act of meaning.

Note that in the examples above, we would not recognize neither the ideational nor the interpersonal aspects of the meaning if they were not tied together as meaningful units – texts – that could serve a purpose. Somehow we are able to
recognize the exchanges as “buying a ticket” or “IRE in a science class”. This is done in the textual metafunction. This metafunction breathes life into the other two by combining them in textual events. In this metafunction we can study how utterances are tied together so that meaning can be developed. In the teacher-student interaction we can see how certain words and phrases are repeated from one utterance to the next, and how questions and answers create a pattern. Thereby the exchange could be recognized as a communicative event in a science classroom, of the IRE type. The experimental report is structured by paragraphs that tie together manipulation of artefacts and observations in relation to task and question, and possible theory. It ties together the activity as empirical inquiry in school science practices.

I will now introduce the idea in SFG that as “text” is differentiated into metafunction, there is a corresponding sectioning of context. In other words, there is a functional organization of language in metafunctions corresponding in a systematic way to context. The ideational metafunction corresponds to aspects of the context that is significant to the construal of content, labeled field in SFG (Halliday, 2013, pp. 33-34). The interpersonal metafunction corresponds to aspects of the context that is significant to the construal of relationships between those participating in the discourse, labeled tenor. The textual metafunction corresponds to aspects of the context that is significant to the construal of text as functional units, labeled mode.

I will denote the mutual construal by metafunction and the corresponding context as questions that can be asked to the context (Halliday, 2013; Macken-Horarik, 2002, pp. 33-34):

- WHAT’s going on in the situation: (i) the nature of the activity and (ii) the domain of experience in this activity
- WHO is taking part in the situation: (i) the roles in those taking part in the socio-semiotic activity, and (ii) the participants’ values
- HOW is language made into larger chunks of meaning – text – in the situation. Texts needs to be materially mediated, often by technological design. Important aspects: (i) language as constitutive of the situation or language as facilitating, (ii) division of labour between linguistic activities and other semiotic activities, (iii) orientation towards field or tenor, dialogic or monologue, written or spoken, phonic or graphic.

The interdependences that are described above are illustrated in Figure 4. The text in context model in this figure is illustrated by two examples below.

Example 1

What goes on in the bus example (WHAT) could be: the passenger negotiates with the driver who sells tickets for the ride. In order to pay the correct amount, the passenger needs to tell the driver where to go, and the driver completes the transaction. The domain of experience is public transportation by bus.

The tenor (WHO): it is a meeting between two people who may be stranger to each other, or they may know each other, but the situation is bound by a rather
restricted and formalized exchange that can’t take too much time. This restricts the leeway for creativity and nearly eliminates difference in status or power, as there is little room for negotiation whether the passenger has paid the correct amount or not (but one can think of several negotiations that can take place if the ticket is pre-paid, paid in a previous trip and so on).

Mode (HOW): it is a short dialogue, spoken language facilitates the ticket purchase but is dependent on certain physical gestures (handling of money and ticket). One could imagine the ticket transaction take place without any talk. Thus language has a facilitating role, not constitutive.

Example 2

A description of the situational context in these terms on the IRE sequence from the science classroom would be something along these lines:

The field (the WHAT aspect) is students’ learning about cloud formation in the domain of school science. It is part of a larger teaching unit on weather and climate.

In the tenor (WHO), the asymmetrical power relation between teacher and student is apparent in how the teacher nominates students to answer. Their answers are short phrases that the teacher has the authority to judge as appropriate or not. However, the students also have power to accept teacher authority or not to some extent. Teacher authority is partly formal, backed by school regulations, but students may respond by inattention and mild misbehavior or other disruptive behavior. Or,
they may, still focusing on cloud formation, challenge the pattern of exchanges, and thereby challenge the teacher’s power to regulate which ideas that count as valid contributions. This is what happened in the following example, where the IRE sequence was challenged but the teacher regained control. However, later, when the student actually approaches the teacher while he is lecturing in front of the class, the situational context cannot be restored to its prior state. In this sense, the field is the same (they are still talking about some aspect of cloud formation) but the tenor is changed: It is changed from a familiar teacher controlled teaching situation to a situation inside the situation; two persons talking face to face in front of the whole class who sits and listen. The tension that arises is resolved by the bell ringing.

The mode (HOW) is oral talk, oriented to the field (developing a shared understanding of cloud formation). Language, teacher talk and students’ responses are constitutive for the situation in the sense that without them, the situation would quickly dissolve. However, there are other semiotic resources for the participants meaning making, in particular a internet page shown on a screen in front of the class. The teacher shows students visual illustrations on the process of cloud formation on this screen. Still, language is constitutive of this situation.

DISCOURSE ANALYSIS AND ANALYSIS OF LEARNING DESIGNS

One of the benefits of the SFG model is that it provides a theory on social interaction as well as the key processes in which experiences become knowledge to the individual, in a broader contextual frame, the context of culture. In this way, critical discourse analysis and studies of students learning can be done within the same model of language, see Figure 5.

Figure 5. Students texts can be considered as evidence of their learning as well as evidence of the culture of science.
When focusing on students learning, the analysis focuses on the context of the situation and students’ texts. When focusing on the culture of school science, students texts are evidence of culture as creative realizations individuals make of a meaning potential at the level of genre and culture. Below I discuss both these approaches.

**Students’ Texts as Evidence of Learning**

A set of laboratory reports could be assessed in order to get a hold on students’ abilities to write explanations, for instance, in order to offer feedback to the students. In this case, we would be interested in texts as process, as evidence of their learning. We would be interested in designing a situational context so that students’ texts develop in a desired direction, as texts that count in domains and practices of science. This is what Chapter 4 and 5 will focus on. By considering learning from a language perspective, the individual, the communal and social connect; “language is the essential condition of knowing, the process by which experience becomes knowledge” (Halliday, 1993b, p. 94).

Student’s texts may then be considered in sequence, as evidence of their learning through time and shifting contextual frames. In every instance there is a field, tenor and mode, they are shifting based on some pedagogical principle; pedagogical principles that they into account, among other things, how students learn through language. More on this in Chapters 2 and 4. Students text can be taken to trace out an interaction trajectory (Furberg & Ludvigsen, 2008).

**Critical Discourse Analysis**

In critical discourse analysis (CDA), texts are considered as primarily products and as evidence of the values, belief structures and purposes that make meaning potential at the level of culture familiar and common sense. For instance, what images of science are regulating school science discourses? What kind of school science can pass as familiar and “right” for which stakeholders? By collecting experimental reports from several classrooms and several students by some specified method, one could analyze certain aspects of language and build an analysis into categories constituting an image of science for this practice, in a third person perspective. In the onion-model above in Figure 5, that would be a focus on the outermost level. Still the assumption made is that the cultural level realizes acts of meaning in the situation. By analyzing text in the situation, an interpretation is built on what kind of values and ideologies that were the meaning potential for the situation in the first place. Referring to the climate – weather metaphor used earlier, a CDA focuses on climate, and analyze samples of weather to say something about climate. Equivalently, the focus of analysis is language as a meaning potential at the cultural level, where each instance is a particular realization of the meaning potential available in the practice of practical work in science. By selecting reports from several classes at one school
CHAPTER 1

and analyzing them, one would get an idea of the meaning potential available to the students in practical work.

Note that this mapping of the meaning potential is indeterminate; there is of course not possible to accurately predict a particular experimental report from this analysis, and therefore the meaning potential needs to be inferred through analysis, through interpretation.

SUMMARY

Discourse is taken to text in context. Text and context construe each other in acts of meaning. In analyzing learning, students’ texts are evidence of their learning in some teaching design (context).

Science texts are always unique and reflect the intentions, interests and knowledge of the designer, but they are also realizations of a higher level meaning potential. Around acts of meaning there is a cultural reservoir at the level of genre, constituting a range of genres at the level of culture. Some are more stable and defined than others, in particular in institutionalized practices.

Science practices are significantly contextualized by phenomena in nature and empirical work. They are social practices and tools for thinking by way of language. In any act of meaning, we both construe experience and enact social relationships. This is realized by three metafunction of language: the ideational, the interpersonal, and the textual metafunction. These metafunctions correlate with contextual aspects of field (WHAT), tenor (WHO) and mode (HOW).