

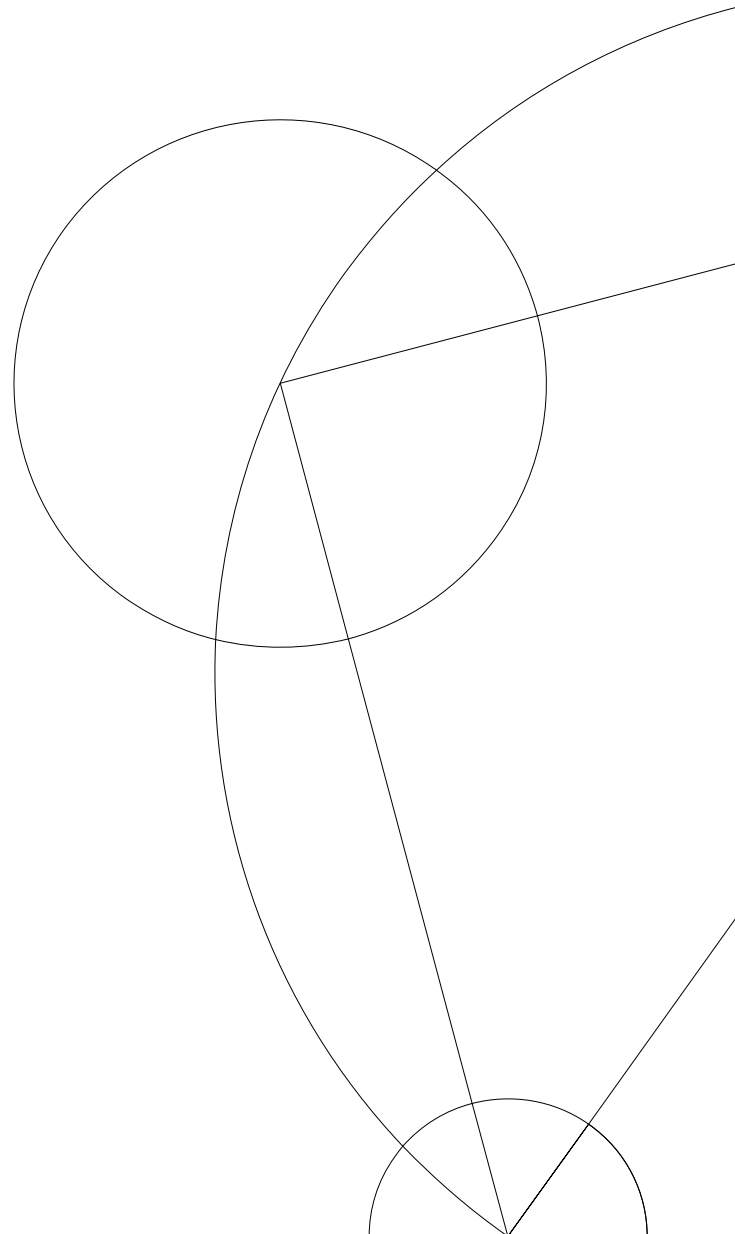


Becoming a Geologist - Identity negotiations among first year geology students

Rie Hjørnegaard Malm
Kandidatspeciale

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Abstract

This thesis explores how first year students in geology negotiate and make sense of the subject matter and develop a geological identity. The stories of 6 students who have entered the study program in Geology at the University of Copenhagen create the dataset for this research. The students' development has been documented in successive narrative interviews throughout their first study year. The series of interviews create individual stories of making sense of the subject matter, searching for belonging, and negotiating identity. This research use identity as an analytical lens that provides a framework to understand why the students struggle while making sense of the subject matter. The analysis shows that the process of making sense of the subject matter is closely linked to negotiations of identity. The students experience a subject matter that point in two directions and the students identify different types of geologist. The students create a divide where one part of the science is perceived to be more scientific, as it builds on calculations. The other part use imagination and interpretation and then perceived to be less scientific. The students negotiate their own position in this divide; hence they negotiate themselves in relation to the subject matter. The students' negotiations result in different ways of making sense of the subject matter and create personal stories of becoming a geologist.

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Becoming a Geologist

Identity negotiations among first year geology students

Master thesis

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Submitted
29th of November 2013

Abstract

This thesis explores how first year students in geology negotiate and make sense of the subject matter and develop a geological identity. The stories of 6 students who have entered the study program in Geology at the University of Copenhagen create the dataset for this research. The students' development has been documented in successive narrative interviews throughout their first study year. The series of interviews create individual stories of making sense of the subject matter, searching for belonging, and negotiating identity. This research use *identity* as an analytical lens that provides a framework to understand *why* the students struggle while making sense of the subject matter. The analysis shows that the process of making sense of the subject matter is closely linked to negotiations of identity. The students experience a subject matter that point in two directions and the students identify different types of geologist. The students create a *divide* where one part of the science is perceived to be more *scientific*, as it builds on *calculations*. The other part use *imagination* and *interpretation* and then perceived to be *less scientific*. The students negotiate their own position in this divide; hence they negotiate themselves in relation to the subject matter. The students' negotiations result in different ways of making sense of the subject matter and create personal stories of *becoming a geologist*.

Summary

The first year geology students have been followed throughout their first study year as they meet the subject matter and develop a geological identity. The identity framework provides a view into the students' processes when they struggle to make sense of the subject matter and continually negotiate their identity in relation to what they meet during the first study year.

This research builds on 6 students and their stories from the first year at a university science program. Their stories have been collected in successive narrative interviews. The narrative interviews create personal stories that give different views into understanding and making sense of the subject matter and how the individual student develops identity. The students' perception of geology changes throughout the academic year and especially their view of the scientific method is adjusted. The students enter the program with expectations of meeting a *science program* and the geological method surprise the students when they experience a method that builds on *interpretations*. The students struggle to make sense of the scientific method in geology and this becomes the starting point of creating a divide of the subject matter. The one part of geology is named by the students the *soft rock* geology, where the geology of sediments and fossils are researched. In this part of the science the geologist use *imagination* and *interpretation*. The other part is named *hard rock* geology, where geology is about mineralogy, the development of magma, and metamorphism and the geologist use *measurements* and *calculations* and thus perceived to be more *scientific*. The divide creates two different ways of understanding the subject matter and then different ways of *becoming a geologist*. In the framework of this divide the student identify different types of *geologist*; hence they identify different kinds of *geological identities*. The students negotiate their identity in this framework and search to aligning their perception of themselves into the different geological identities they identify. The students' journeys take different turns and they develop a geological identity in different ways, as they meet different challenges on the way. This thesis presents the students stories and shows what affects the students in their process of making sense of the subject matter and their possibilities of constructing a geological identity.

This thesis shows how *identity negotiations* is a central part of making sense of the subject matter and confirms the notion that negotiating identity plays a role in many steps on the way of *becoming a geologist*. Even before entering a study program this type of negotiations influence the choice of study program and the students continually negotiate their identity in the first study year. The negotiations create different paths for the students on their journey of *becoming geologist*.

Contents

1	Introduction	5
2	Navigating the thesis	7
3	Paper: Exploring first year geology students' stories of negotiations and identity-work	8
4	Theoretical framework	29
4.1	A model of science identity	29
4.2	Communities of practice	31
4.3	Narrative identity	32
4.4	Creating a framework	33
4.5	Literature overview	35
4.6	Choosing the method	35
5	Methodology	37
5.1	Using a narrative approach	37
5.1.1	Ethical considerations	39
5.2	Around the interviews	40
5.2.1	Informants	40
5.2.2	Planning the interviews	40
5.2.3	Locations	42
5.2.4	Exercises during interviews	42
5.2.5	The interviewer role	45
5.3	Transcribing the interviews	49
5.4	Validity and reliability	50
5.5	Limitations	52
5.6	Analytical approach	52
6	Extended analysis	54
6.1	Students expectations to the study program	54
6.2	Academic culture: Geology and the geologist	60
7	Discussion	65
7.1	Making sense of geology	65
7.2	Using identity as a lens	67
7.3	Methodological discussion	68
8	Conclusions	69

9 Implications	70
10 References	72
11 Acknowledgments	75

1 Introduction

In this thesis I present my work on first year geology students and their negotiations of geology and identity. The thesis is the final product of 15 months of work where I have been able to dwell into the complex world of developing identity. The thesis have brought me through the landscape of identity literature, shown me how students can be persistent and determined when trying to make sense of the subject matter, opened the world of stories and personal narratives the students have shared with me, and now I am able to communicate this great journey, which too is a product of identity development in me.

In this research I follow 6 students' way through their first study year at university and explore how they develop and negotiate their identity, when entering a higher education science program. The identity perspective gives access to explore the students' different ways of making sense of and negotiating geology. In the science education research the concept of *identity* and *science identity* has been explored in general for some time producing numerous of studies (e.g. Brickhouse et al., 2000; Brickhouse & Potter, 2001; Carlone, 2004; Tonso, 2006; Carlone & Johnson, 2007; Tan & Barton, 2007; Shanahan, 2009; Ulriksen, Madsen and Holmegaard, 2010; Johnson, Brown, Carlone and Cuevas, 2011; Holmegaard, 2012; Krogh & Andersen, 2012; Carlone, 2012; Holmegaard, Madsen and Ulriksen, 2013). The early research has had a focus on minorities in science e.g. girls and ethnic minorities and their special difficulties associated with developing a science identity (e.g. Brickhouse et al., 2000; Brickhouse & Potter, 2001; Carlone, 2004). From this starting point identity has been used to explore different challenges in the science education research. In more recent research identity has been used as a lens for exploring students' paths in the educational system in relation to retention and dropout (Ulriksen et al., 2010). Which is a topic much debated in the policy level and too has been a focus in numerous of studies to explain the high dropout rate in the university science programs (Tinto, 1993; Seymour & Hewitt, 1997; Palmera, O'Kaneb and Owensc, 2009; Holmegaard et al., 2010). The vast amount of research identify problems at different levels and the suggestions and analysis of the generally high dropout rate are many. In this Norwegian research the analysis points at *identity* as an explanation; creating a *science identity* is not perceived as an desirable identity for young people, as the rigid frames of science cannot include achieving one's personal potential and include personal development (Schreiner, Henriksen, Sjaastad, Jensen and Løken, 2010). This notion has also been brought up when the recruitment strategies for science programs are discussed (Holmegaard, 2012). Identity can also be used to understand *learning* from the learners perspective, this can help us understand learning deeper and explore the different paths students can take to succeed in science (Varelas, 2012).

The focus in most of the international science education studies has been on science identity *in general*. The studies explore the scientific *science* setting and research the students that *strive* and the students that *struggle* in this setting. The studies focus on the students' identity development in a *science* culture, perhaps evident in one or two specific disciplines but mainly the conclusions are made on science in broad terms and in some studies this also include engineering students (e.g. Tonso, 2006; Holmegaard et al., 2013).

The aim with this thesis is to build on the foundation of research on *science identities* and explore students' identity development in one specific field of science, in geology. When zooming in on one discipline it is possible to explore how the students make sense of the subject matter and explore how the students make sense of geology affects their way of constructing *a geological identity*. Two research questions guide this exploration: 1.) Explore how first year students negotiate and make sense of the subject matter during the first study year *and* 2.) Explore how the concept of *science identity* can be used to understand the students' development in a specific scientific context.

To explore the research questions a *narrative* framework has been chosen to research the individual student's way of *making sense* and *constructing identity*. The longitudinal approach makes it possible to see how the students make sense of the subject matter across time. The students' narratives or stories give a peak into the students' processes of making sense of the subject matter and their identity negotiations throughout the first year. The method takes the students viewpoint and this create a possibility to explore these processes through the students' experiences in the study program. This research provides a view into the complex processes of learning and developing identity during the first study year in a university science program.

2 Navigating the thesis

The thesis is build up with a paper presenting the main conclusions of my work, titled *Exploring first year geology students' stories of negotiations and identity-work*. The main intention with the paper has been to communicate my work in the *scientific paper format* and accept the challenges of writing in this specific format. The paper has been aimed at the journal: Nordic Studies in Science Education (NorDiNa). The second aim has been to explore the learning process accompanied with writing a scientific paper as a part of my work with this thesis. The paper is followed by a more detailed presentation of the theoretical framework, the literature, and the methodology. In an *extended analysis* I add aspects to the analysis conducted in the paper. I use a several pages to discuss and conclude my work and finally I provide suggestions for implications of my work.

The paper represents the main result of my work, where the thesis unfolds the aspects from the paper in greater detail in the attempt to secure transparency of my work. The final discussion and conclusion will include both results from the paper and the thesis.

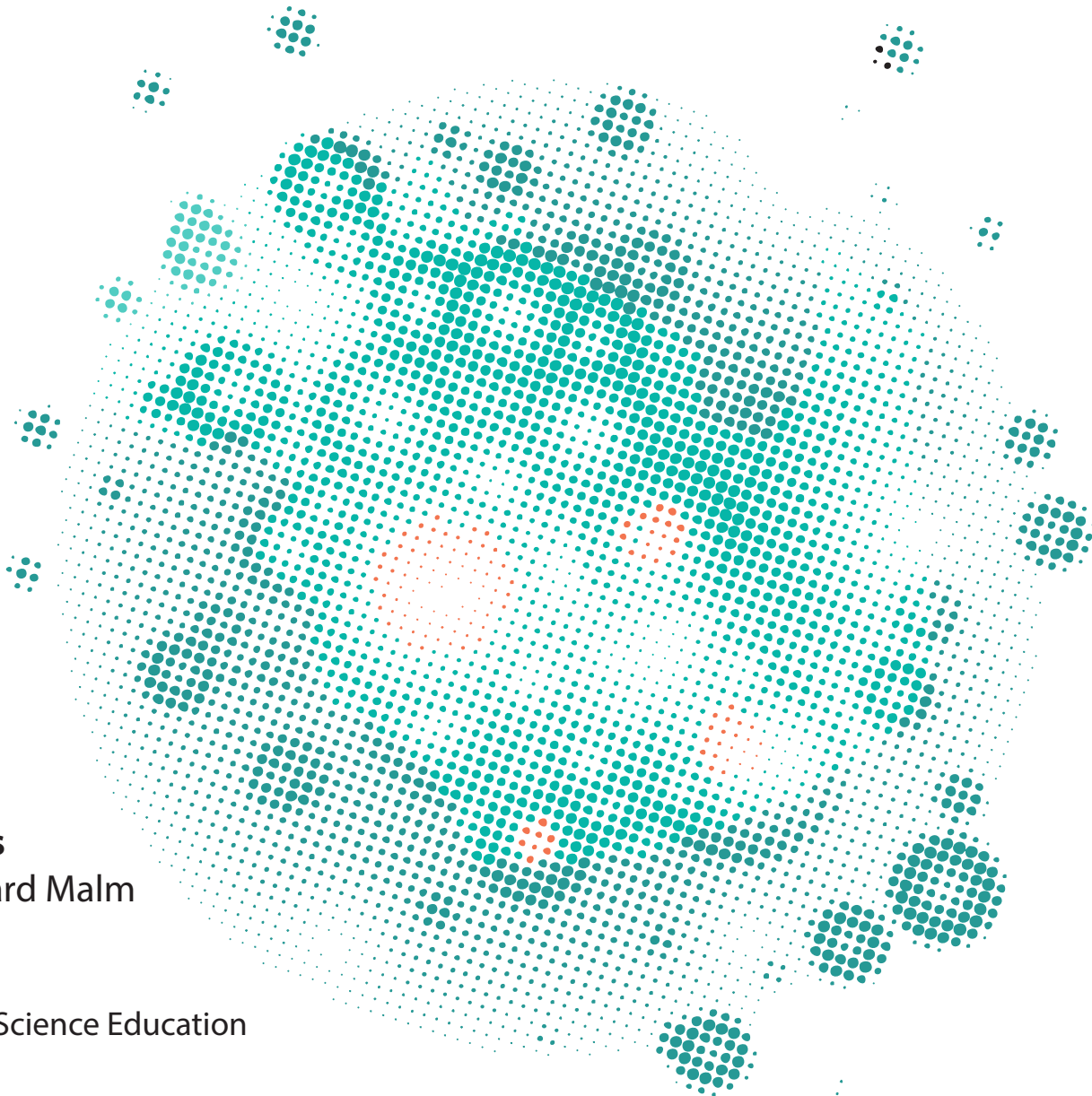
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Rie Hjørnegaard Malm, Copenhagen, November 2013.

In this thesis I use the color palette 'summer hues' developed by design-seeds.com



Paper: Exploring first year geology students' stories of negotiations and identity-work



Master thesis

Rie Hjørnegaard Malm

Department of Science Education

Submitted
29th of November 2013

Exploring first year geology students' stories of negotiations and identity-work

Abstract

The paper explores how first year students in geology negotiate and make sense of the subject matter, through the stories of 6 students who have entered a study program in Geology at the University of Copenhagen. The students' stories are documented in successive narrative interviews throughout their first study year. By applying *identity* as a framework it is possible to understand why the students struggle while making sense of the subject matter. The students are challenged by the scientific method in geology, which seems quite different from their perception of *science*. When the students attempt to make sense of this, they develop a division of the subject matter, where one part of the science is perceived more *scientific*, as it builds on *calculations*. The other part use *imagination* and *interpretation* to reach results and is perceived to be *less scientific*. The students negotiate their own position in this *divide*, hence they negotiate themselves in relation to the subject matter. This creates strong identities in either part of the science. The negotiations result in quite different ways of making sense of the subject matter and create personal stories of developing identity. This study also shows that being *recognized* is crucial, both in relation to learning and in the construction of a scientific identity.

Keywords

First year experiences; Identity; Geology; Recognition; Making sense of subject matter.

Introduction

The paper analyzes 6 students' way through their first year at university and explores how they develop and negotiate their identity, when entering a higher education science program. Applying a identity perspective give access to explore the various ways the students make sense of the subject matter, in this case geology. For some time science education has explored the concept of *identity* and *science identity* in general (e.g. Tonso, 2006; Carlone & Johnson, 2007; Shanahan, 2009). There has been a focus on minorities in science and their difficulties associated with developing a science identity (e.g. Brickhouse et al., 2000; Brickhouse & Potter, 2001; Carlone 2004). Identity has been used as a frame to explain the minority students' difficulties with engaging in a science community and construct a science identity (e.g. Carlone & Johnson, 2007; Johnson, Brown, Carlone and Cuevas, 2011). Identity has in recent research been used as a lens for exploring students'

paths in the educational system in relation to retention and dropout (Ulriksen, Madsen and Holmegaard, 2010). Maria Varelas (2012) approach identity as a construct that has perspectives when we try to understand learning:

Education researchers may benefit from developing a feeling for the learner in order to deeply understand how learning of, engagement with, involvement in, and relation with science successfully takes place in and out of school classrooms. Identity may be a construct that could get us closer to such a goal. (Varelas, 2012, p. 3.)

In this way we can expand the identity construct to help us understand learning and the paths for students to succeed in science. The studies just mentioned, as well as most of the international science education studies conducted, focus on science identity in general. The studies focus on the scientific *science* context and how this context affects the students' identity development.

This paper uses the identity construct to explore the scientific context as it is viewed by students, who has entered a study program in *geology*. When zooming in on a discipline it is possible to explore the students' identity-work when they negotiate and make sense of the subject matter, and to explore how their understanding of geology affects their way of constructing a *geological identity*. By focusing on the subject matter in relation to the development of identity we can gain some new perspectives on the use of identity as a construct. This research follows a great number of other identity studies, though adding a detailed picture of how identity can be used in the context of geology as a way of understanding the students' challenges when making sense of geology as a science.

Aim

The research aims at exploring how first year students experience and make sense of what they meet in the first study year. The main objective is to analyze the study program from the students' viewpoint, not to give a full description of the academic discipline or culture but to take the perspective of students' experiences into account.

Research questions

- Explore how first year students negotiate and make sense of the subject matter during the first study year
- Explore how the concept of *science identity* can be used to understand the students' development in a specific scientific context

Theoretical framework

One of the obvious challenges associated with using *identity* is the difficulties that occur when trying to operationalize. The view of *identity* and *identity development* depend on the theoretical approach to the constructs. One way of dealing with identity is to define an overall framework in which, the identity construction take place. Marie-Claire Shanahan (2009) argues that a considerable part of the research on *science identity* has its origin in the communities of practice approach (Lave & Wenger, 1991). Heidi Carlone (2012) summarizes the theoretical assumptions that emerge from the overall theory of *social practice theory*: "*First, identities are formed in practice. Second, people have a say in who they become (agency), but that agency is often limited by historical, social, institutional, and local structures (Holland et al., 1998)*" (Carlone, 2012, p. 4). From this viewpoint identity must be studied in the different *practices* the individual is placed in e.g. the different institutional and social settings. The aim of this paper is to zoom in on the *individual student* and her process of developing a geological identity, therefore moving the focus from *the practice* to *the individual*. The *narrative framework* offers a gateway to explore the individual student's *story* or *narrative*: "*Narrative is a form of meaning making*", where the individual make sense of their lives across time (Polkinghorne, 1988, p. 36), thus making identity a fluent and dynamic construct that we constantly narrate and negotiated in the cultural setting. However, the individual person experiences a coherency and feels a core personality, as Holmegaard et al. (2013) highlight. In this way creating a complex situation where we continually construct our identity in the different social setting in our lives and at the same time we experience a sense of selves. This means that when we study the identity development of a first year students, we need to acknowledge that: "*students need to construct new coherent narratives about how they belong at this particular study program and how it fits with their perceptions of themselves*" (Holmegaard et al., 2013, p. 5). When constructing this *coherent narrative* the students negotiate their sense of selves in relation to the subject matter they meet. These negotiations are here defined as signs of *identity-work*. In this process of constructing identity *recognizing oneself* and *getting recognized by others* is found to be main factors (Carlone & Johnson, 2007). In a longitudinal study Jonhson et al. (2011) explores how women of color create a *science identity* and how the identities they themselves and others ascribe to them affects their identity-work. The study underlines the concept of *identity-work* as a ongoing process, that "*was especially visible at each new stage in their career. Every time they entered a new setting, they had to return to making careful orchestrations and tentative bids for recognition*" (Johnson et al., 2011, p. 361), thus emphasizes how identity-work becomes important when entering a new setting and how *recognition* influences the development of identity.

Building on these previous studies this paper explores how first year students enter the new setting of a university science program, where they need to construct a science identity that fits with their view of themselves. The students journey can be viewed as a *transition* when entering the study program and in the process they reconstruct their narrative in the new setting (Holmegaard et al., 2013). The narrative constitutes different *events* or *turning points* that influence how the students make sense through time: "From a post-structuralist viewpoint these turning points are constantly taking place as the students constantly work on and negotiate their identities and their strategies for belonging." (Holmegaard et al., 2013, p. 12).

This paper use the narrative method and the *turning points* in the students' stories to explores how the students make sense of the subject matter and how they construct a *geological identity*.

Methodology

The data were collected in the academic year 2012/2013 at the study program Geology-geoscience at the University of Copenhagen.

The study program

The study program is placed at the Faculty of Science; here the academic year is divided in 4 blocks with two courses in each block. The first year comprises 8 different courses in geology with one introduction course in block 1, five basic courses in block 1, block 2 and 3, a course in the geology of Denmark and a field course in block 4 (see table 7).

Table 1: First year courses at Geology-geoscience in the academic year 2012/2013. *From the course database: sis.ku.dk*

Block 1	Block 2	Block 3	Block 4
Introduction: Geological processes and products	Basic paleontology	Basic sedimentology	Geology of Denmark
Basic Geophysics and Hydrogeology	Basic mineralogy and metamorphic petrology	Basic magmatic petrology	Field course 1

Informants

53¹ students applied and got accepted at the study program in August 2012 and they were invited to participate in a survey. The survey included 11 questions with background information, interest in geology, and considerations about choosing geology. The students could also choose to participate in the interview study. 6 students chose to engage in the following interview study, four girls and two boys. One student leaves the interview study between the second and third interview, though he stays in the study program. The survey data is not included in this paper.

Interviews

The first interviews took place in August 2012 two weeks before the academic year started. Thereafter one interview was conducted with each informant one time during each block. The interviews, in one round, were preferably held in the same week due to the fast progress in the courses.

The qualitative interviews took a narrative form where the students' personal stories were explored (Webster & Mertova, 2007). Each interview would begin with the question: "*what has happened since the last time we talked?*" as an encouragement to make the students tell their story. Follow-up questions were asked to explore the stories in greater detail and support the students in creating a meaningful story. The interviews were held at different locations, though mainly at the Department of Science Education. The interviews would last between 40 minutes and 2,5 hours. The interviews were transcribed verbatim and afterwards anonymized.

Analytic approach

The 27 interviews were analyzed in two steps. Each interview has been through a thematic analysis (Braun & Clarke, 2006) finding the main themes for the student at each point in time. In total a collection of 5 thematic analysis for each student and 2 for the one student who left the interview study. Each interview was afterwards approached with the analytical questions: *what influence the students understanding of the subject matter?* and *how do the students negotiate and make sense of the subject matter?* In this way the narratives were explored on two levels; first by identifying what factors in the study program that proved to be significant when developing an understanding of the subject matter and secondly focusing on their negotiations in relation to creating a geological identity. The themes for each interview round have been compiled in *meta-themes*, see tabel 2. The thematic analysis, with all 6 students, forms the basis of the first part of the results. The second part treats the students' stories individually by using *turning points* to analyze their narrative.

¹<http://studier.ku.dk/bachelor/ansoegning-og-optagelse/optagelsesstatistik/2012/antal-optagne/>

Table 2: Compiled meta-themes from thematic analysis, all students.

1st interview	<p>Interest</p> <p>The future</p> <p>The other students</p> <p>Becoming a student</p> <p>Geology</p>	<p>In nature in general. Earthquakes, volcanoes, hydrogeology.</p> <p>Interesting work. Traveling.</p> <p>Geeks. Worried about social life.</p> <p>Expectations of work pressure and worries about academic level.</p> <p>Ideas about the study program and the subject matter.</p>
2nd interview	<p>Feeling welcome</p> <p>The students</p> <p>Geek term</p> <p>Fieldwork</p> <p>Relaxed mentality</p>	<p>Feeling at 'home'. Getting help from older students.</p> <p>Positive surprise, they are not too geeky. Meeting someone with similar interest.</p> <p>Transformed from the <i>stereotype</i> to a geology-geek, a passionate storyteller.</p> <p>Interesting and social.</p> <p>Great interaction with teachers.</p>
3rd interview	<p>Teacher relation</p> <p>Exam</p> <p>Teaching language</p> <p>Student life</p> <p>Learning strategies</p>	<p>Getting feedback and being seen.</p> <p>Good atmosphere.</p> <p>Challenged by the teachers accent.</p> <p>About planning, prioritizing.</p> <p>Testing different strategies. Learning to read and prepare for lectures.</p>
4th interview	<p>Disciplines</p> <p>Exams</p> <p>Motivation</p> <p>Scientific method</p>	<p>Choose between <i>hard</i> or <i>soft</i> rock.</p> <p>Feeling confident, learned the oral format.</p> <p>Undulates during the block.</p> <p>Questioning the scientific method in sedimentology.</p>
5th interview	<p>Feeling confident</p> <p>Block 4 courses</p> <p>Fieldwork</p>	<p>The study program was the right decision. Getting through the first year.</p> <p>Poor planning. Unnecessary stress.</p> <p>Experience the subject matter in the field, changing view about the scientific method.</p>

Using turning points

The second part of the analysis explores the students' narratives *across time*. The stories of the 5 students were constructed by searching for *turning points*, often evident by negotiations of either subject matter or identity. Turning points can be *significant events* when the students reconstruct their narrative (Holmegaard et al., 2013). These *events* or turning points occur when the student experience something new or develop her identity and in this way receive a new perspective. In the analysis *turning points* have been used in relation to the students making sense of subject matter, e.g. when they experience a new scientific approach in geology. The turning points have also been used to show developments in identity, e.g. when a student expresses a new attitude towards becoming a geologist.

Results

Part 1: The students' experiences with the study program

The study program is described by the students as coherent with courses that build on top of each other. The students feel that each course is logically succeeding another and trust that they learn what they need to progress into the next course. They experience that the courses explore the concepts of geology in a continually greater detail. During most of the courses the students are on field trips to different locations in Denmark and Sweden, thus making a link between theory and practice.

The students describe an open, relaxed, and engaging study environment, where students help each other, form study groups, and discuss geology with older peers. The relationship with the teachers is characterized as personal and open, with great possibilities to ask questions both in class, in the field, and when dropping by at the teachers office.

The students' perception of geology

The students define geology as a discipline that constructs models of Nature and a geologist is one who is able to check the models by observing Nature. Nature is the object, which is explored, and the model is a way of explaining the observations.

Interviewer: So you can check the models you have set up?

Inge: Yes, and it's models of reality, it is not? You do not attempt to illustrate, "this is how it fairly works", you say, "how does it roughly work and then we can go out and look at it properly". *Inge, 5th interview p. 7.*

The students' understanding of the subject matter is closely linked to the collection of data e.g. observations. The construction of a plausible model, on the basis of the data, is

one of the challenges the students meet. The students learn to conduct observations by looking at rocks in class and during fieldwork. They learn to identify minerals, structures, fossils, and how to use the geological principles. In this way the students learn how to construct a geological history.

Interviewer: Okay in this way you can read the story [the geological story]?

Frida: Yes, and you can read all the processes that is going on, and you can see what's going on in a volcano and everything. At the same time it is incredibly simple, it's very few rules you should be able to understand to derive all these things. *Frida, 3rd interview p. 8.*

Through observations, interpretations, and the geological principles the geologist is able to explore rock genesis and ultimately she will be able to tell a story about past environments, past climate, and the evolution of earth (Marshak, 2005).

Questioning the scientific method

One of the main challenges the students experience is how geology should be approached scientifically. The students find it difficult to figure out how the geological research is carried out. During the first year the students meet different scientific approaches in each geological discipline and they continually develop their perception of the scientific method. The students mainly discuss how the geologists create interpretations and conclusions on the basis of the observed data. Some students begin to reflect upon the scientific method quite early in the academic year and express concerns such as:

Frida: It seems like they know very little and then they make a huge story out of it, without really having the evidence, that bothers me (...) it seems like this is how it's done, to make a hypothesis and then I would think, that one should disprove it, but it doesn't really happen here, they just prove the hypothesis. *Frida, 2nd interview p. 12.*

Frida experiences a clash with the idea of the science method that she has learned earlier. Other students also discuss this theme and they find it difficult to be convinced that what they see is actually *science*. Geology seems like storytelling based on a few scattered data. The process of turning data into interpretations is not clear to the students and the doubts of the scientific method occur. These questions occur in the students' stories during the introduction course where they talk in general terms about the scientific method in geology.

Later in block 3 during early spring the students attend a theoretical sedimentology course. At this time most of the students articulates real frustrations with the scientific method, now exemplified in sedimentology. In the course they experience teachers who

seem to make interpretations and conclusions on the basis of single observations. The students struggle to make sense of the scientific method in sedimentology and general concerns about the scientific method reappear. The frustrations are, however, transformed during block 4 where the students are engaged in a great deal of fieldwork.

Frida: Sedimentology, I found out, is such a profession that works when you are out in the field, it does not work to sit and stare into some boring dry textbook, the discipline is simply not for that, (...) but when you're out and look at the outcrops, then it's pretty exciting actually, so I'm starting to like it a little better. *Frida, 5th interview p. 2.*

The last field course in block 4 is very intensive and the students get to work with their own locality. The field course changes the students' perception of the scientific method because they experience themselves what it takes to collect data in the field and make interpretations on the basis of the data. This helps the students to understand the scientific approach in geology. They turn the frustration into a new understanding of the subject matter.

Sigrid: It was actually quite fun to go out and not just see it [geology] in pictures and drawings, but also see how it looks in reality because the drawings may be right, and the figures can be really good, but it is seldom that it is so perfect as on them [the pictures in the text book], so we could evaluate the things yourself. *Sigrid, 5th interview p. 4.*

Through the experiences in the field the students are able to create a more complete picture of the scientific method and they accept, to some extent, the premise of data collection geology dictates. For one student the fieldwork starts reflections on the scientific method the geology:

Anna: It's very much about getting your own ideas and look at what others have thought, but to make your own interpretation from some descriptions. *Anna, 5th interview p. 18.*

In this way the student acknowledges that the subject matter cannot give absolute answers but builds on interpretations. The interpretations are made on the basis of the observations and descriptions made in the field. In the interview Anna highlights the importance of making plain descriptions in the field and conduct the interpretations afterward. Then you are able to go back to your descriptions and make a new interpretation on the basis of e.g. new knowledge created within the field. This reflection shows how the fieldwork gives the students a clearer idea of the scientific method in geology.

Dividing the subject matter

As the academic year progresses the students continually question the scientific method, the data collection, and in general the academic approach they experience in geology. This evolves into an understanding of geology as being divided in two main categories that have different ways of approaching the data. The two categories emerge during block 2 and the start of block 3. In block 3 and 4 the students clearly divide the science and negotiates themselves in relation to the different approaches.

The students clearly define one part of geology as descriptive, where you observe and interpret structures in sediments. The other part is dealing with mineralogy, the development of magma, and metamorphism and this part put emphasis on measurements and calculating the results. The two parts are for the students clearly divided by the content, the methods used, and the different mind-sets you need to succeed in each category.

Interviewer: So it's really two different things, you have to, be able to do?

Sigrid: Yes, it's two different mindsets, I think it's also the reason why it divides us so much now. *Sigrid, 4th interview p. 4.*

The categories are by the students named the *hard rock* geology and the *soft rock* geology, giving the nature of sediments being more *soft*. The students recognize that the disciplines have different ways of processing the data. Sigrid also observes a difference between her and two of the boys in her study group.

Interviewer: What do you think is the difference between you?

Sigrid: I just think they are very logical people, when they see a formula, they can understand it just by looking at it. *Sigrid, 4th interview p. 2.*

This way of being *logical* or *mathematical* is linked to the *hard rock* geology in opposition to using *imagination*, *interpretation*, and *discussion* in the *soft rock* geology. As the *hard rock* geology uses calculations it is perceived to be more *scientific*. When entering the study program it is clear that the students also expect to meet the *hard rock* geology. They talk about interest in volcanoes, earthquakes, and in general the great powers of Nature in the first interview. When they meet the *soft rock* geology with interpretations and approximations they are surprised by the content and the scientific approach. To some of the students this approach is too far from what they expected and they cannot make it fit with their understanding of *science*. This enhances the divide and it becomes very defining for the students to either choose the *hard* or the *soft* part of geology. The divide becomes clear in the students negotiations of the subject matter and it plays a major role in the negotiation of their identity, which will be elaborated subsequent.

Part 2: Stories

The first year experience is different for all students, as some engage in study groups, some interacts with the teachers, some negotiates their experiences, some do not. All these factors combined with the social and academic background the students carry with them shape their way through the first year (Holmegaard, 2012). The students in this study have been followed closely, which makes it is possible to create a detailed picture of how they make sense and negotiate as the academic year progresses. The *identity perspective* makes it possible to see the stories of *negotiating the subject matter* and also become *stories of identity construction*. The analysis finds that the students in varying degrees negotiate how they see themselves in the subject matter when trying to make sense, which will be demonstrated in following section. First Frida's story will be described in detail with the focus on how she continually develop her perception of the subject matter and the scientific method, what difference it makes when she recives recognition, and how she negotiates her geological identity.

Frida's story

Frida is a student who negotiates a great deal and her story illustrates one way of making sense. Her story is summed up in figure 1 where the top part shows, how her understanding of the subject matter develops and the lower part, how this affects her way of making sense (figure 1). Frida's story illustrates how recognition can play a major role in the process of making sense of the subject matter. One of Frida's fundamental questions is why the teachers seem so sure about themselves when explaining the geological interpretations of observations. She realizes quite early in the academic year that the data behind the interpretations are few but never the less full interpretations are concluded upon them. She also find it difficult that the students are expected to learn details e.g. minerals or specific characteristic of ancient animals before learning the complete picture. She strives to understand the complete picture and struggles to get an overview. The third interview was placed in the middle of the paleontology course in block 2 and during this time her frustration peaks the first time. She struggles with figuring out what the intended learning outcome is, how to read the complex textbook, and getting her questions answered by the teacher. This frustration makes her question the scientific method, the teachers' knowledge, and the validity of the subject matter in general. At the time of the fourth interview in March, she recalls the frustration and explains:

Frida: I was often really frustrated [during the paleontology course], but he [the exercise teacher] understood it, he did not get mad at me, he was just trying to answer my questions (...) he understood the frustration and said "*I understand, it's not very smart, but you know there are a lot of other animals, which are also stupid*". Frida, 4th interview pp. 20-21.

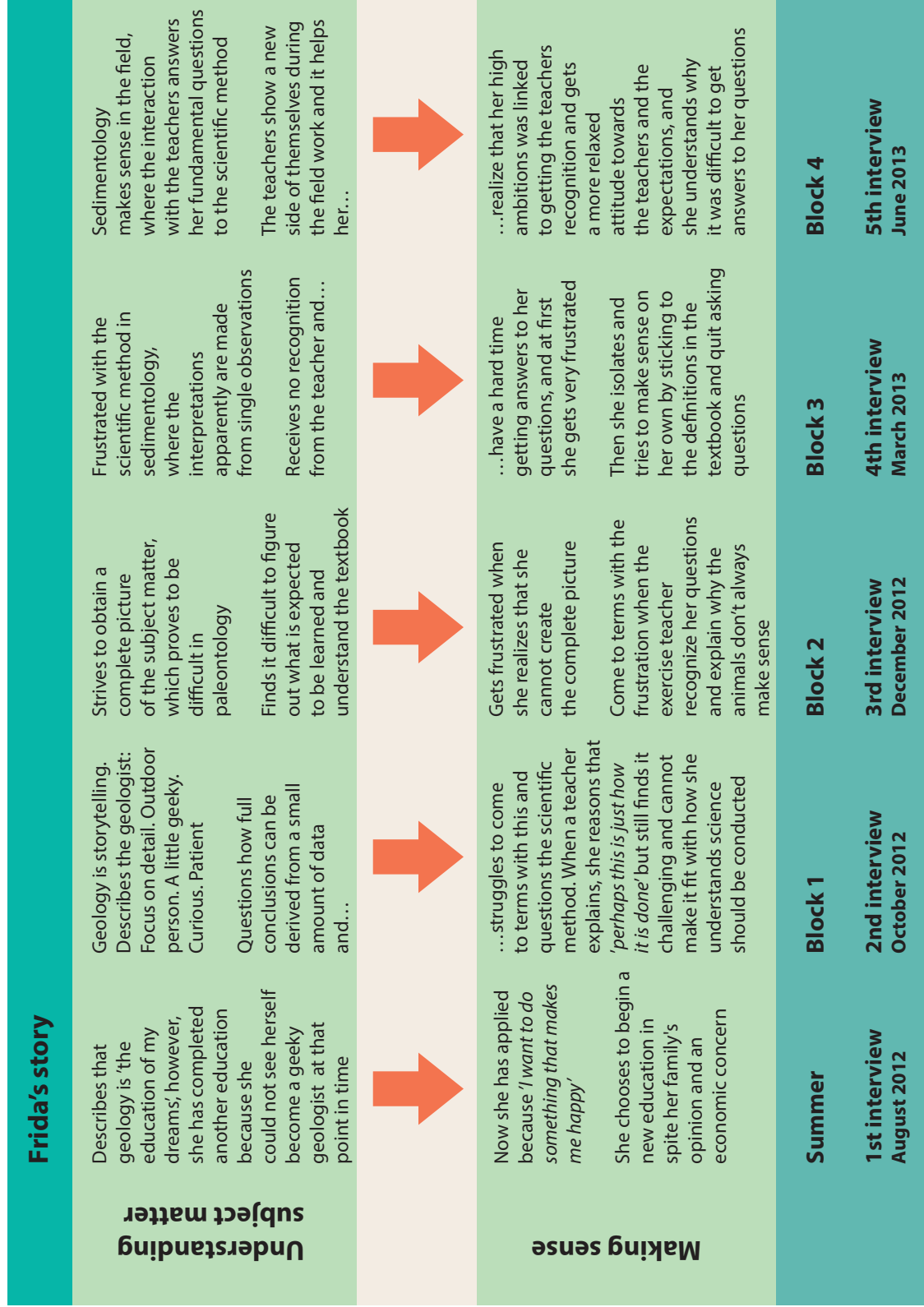


Figure 1: Frida's story. 1st to 5th interview.

She experiences that the exercise teacher recognizes her questions and it helps her deal with the frustration; this is the first *turning point* in Frida's story. She declares that paleontology will not become her favorite discipline but the teachers recognition helps her come to terms with learning it and works as an example of *letting go*. She realizes that she cannot learn everything about the animals and she needs to let go of the big picture sometimes. Letting go is a huge step for her as a high-achieving student with huge expectations to herself.

During the fourth interview she has started a new course in theoretical sedimentology and experience some of the same frustrations. Here she receives no recognition from the teachers and actually experience getting into confrontations with the exercise teacher. She feels that he won't answer her questions and when he answers it differs from what the textbook defines. Here she describes a scene where she asks for help during class:

Frida: Now I've found a proper definition from the book and then I brought it [to the exercises] the other day and the exercise teacher was not entirely happy with me (smiles). He said: "Now, I have to be careful with what I say, when I come over here". *Frida, 4th interview p. 8.*

She interprets this reaction from the teacher as her being annoying when asking questions and in the interview she reasons: "[...] well, now I've gone over the limit in terms of questioning" (*Frida, 4th interview p. 8*). After this incident, she concludes, during the interview, she will quit asking questions and read the definitions in the textbook instead. The lack of recognition from the teacher forces her to change her study strategy and makes her trust the teachers' knowledge less. It goes without saying that she is quite frustrated at this time but chooses to focus on the course in magmatic petrology, which has caught her interest. However, her perception of sedimentology and the teachers *do* change when another *turning point* occurs. It takes place when the students return to the field during the last months of the academic year. The fieldwork is placed in Denmark and consists mostly of sedimentology and paleontology. In the field she realize why the teachers cannot answer the questions she asked. She finds that it is difficult to gather data and the interpretations are not easily made. She experiences that the same data *can* give different interpretations and this answers one of her fundamental questions. The data cannot give straight answers and you have to discuss the findings and consider alternative interpretations. The experience in the field also changes her view of the teachers. In the last interview she explains the difference:

Frida: I think this is very dull [sedimentology], and I have had an idea that it's kind of dull people, but I can see now that it's not true (...) but I have thought it until now (...) but then we were on the field trip and they [the teachers] were not dull and boring, they were fun and cozy. *Frida, 5th interview p. 19.*

The new view of the teachers changes both her perception of the subject matter they teach and makes her realize why she has struggled throughout the year. She realizes that all the hard work and pressure of achieving, she has placed on herself, has been a matter of getting the teachers recognition.

Frida: I have found that it's possible *not* to make an A-grade and the teachers still like you (...) the largest part of getting good grades, was that I had the idea, that I must not disappoint the teachers. *Frida, 5th interview pp. 8-9.*

Realizing this creates a different calmness around learning and achieving. She experiences a new side of the teachers when they act in the field. She is able to ask questions and the teachers have time to explain properly on the basis of the observations they make together. The interaction with the teachers in the field gives her the recognition she has been missing.

In Frida's story of negotiating identity, it becomes clear that she negotiated the subject matter at the same time as negotiating her identity. Making the negotiations tough as they included here sense of selves and her view of *science* at the same time. The *hard rock* geology has caught her interest and she finds that this part of geology fit her idea about science the best. The measurements and calculations appeal to her view of science as being more precise. This explains her struggles with making sense of the *interpretations* in paleontology and sedimentology. It is clear that she does not see herself becoming *any* geologist, she see herself becoming a *hard rock geologist*.

Frida's story is the most extreme of the 5 stories, in terms of negotiations. She negotiates a great deal, gets really frustrated, and struggles a lot. She questions the subject matter, she strives to get answers and to create the complete picture, she engages in discussions, talks to teachers, has high expectations to her studies, and study a great deal. Her story underlines the importance of being recognized when learning and constructing a scientific identity. The recognition she receives makes all her efforts worthwhile.

Students' stories

Frida's story shows how important recognition becomes when a student struggles to make sense of the subject matter and constructing a coherent narrative. This section all students' stories are described shortly and analyzed in terms of making sense of the subject matter and their individual identity construction. The outline of the stories is presented on a timeline in figure 2. The text in the figure unfolds the students' stories by pointing out the *turning points* in orange and explaining the ups and downs in the curve.

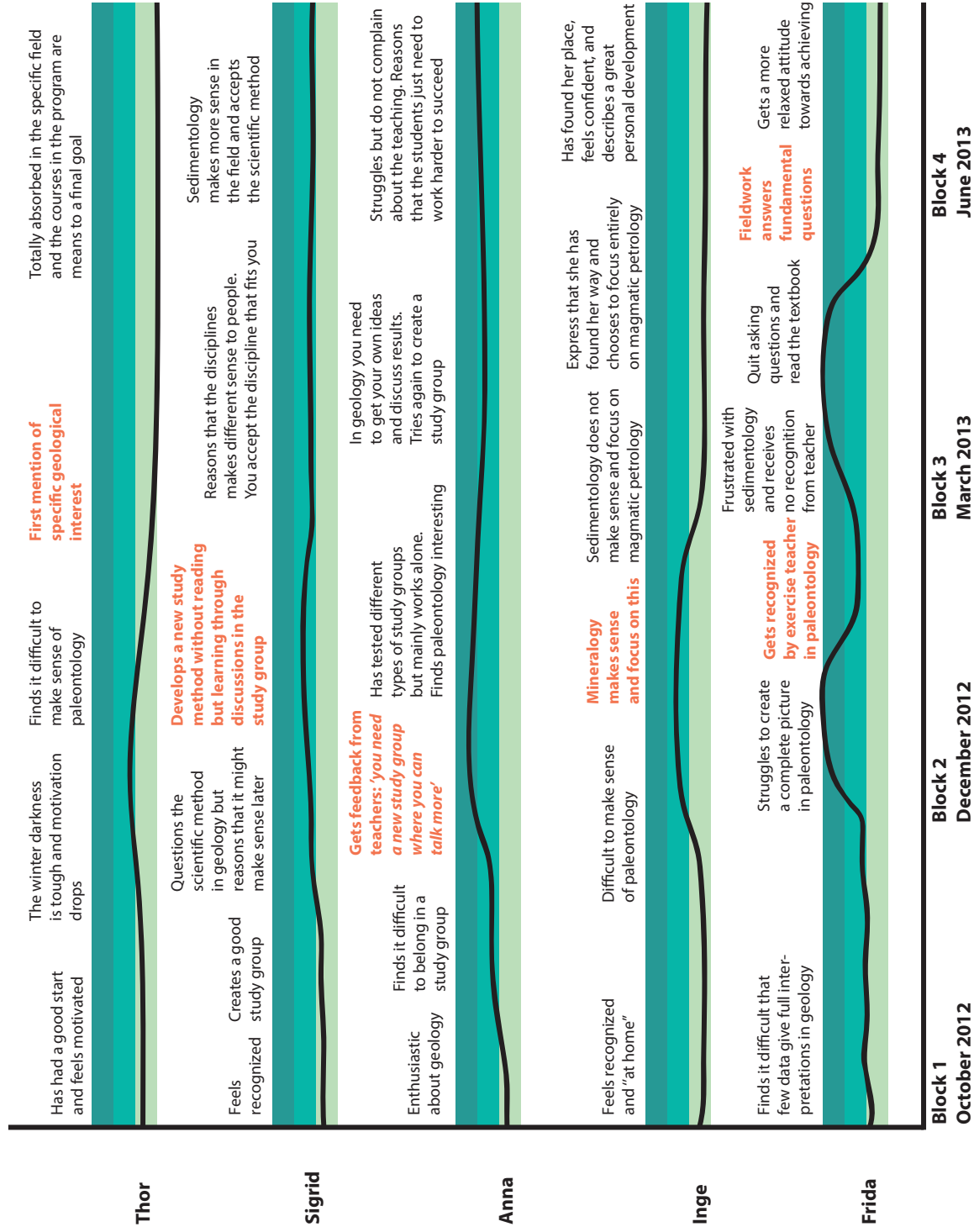


Figure 2: Students' stories - Timeline. The interviews were held in the months shown. The curve is placed on a scale representing to what extent the students negotiate. The negotiations are limited in the light green area and more pronounced in the dark green. Interpreted turning points in orange.

Thor's story shows how choosing *a specific goal for the education* can give strong motivation for studying. Thor does not question or negotiate the subject matter as the other students do. He accepts the scientific methods in geology and to him the courses represent knowledge to be learned as a means to get a job. During the first year he becomes absorbed in one specific field of interest and makes a career path towards that the goal. Thor's story shows how determination and a clear goal limit the negotiations. At the end of the first year he has developed an identity in the specific field and visualize himself becoming this specialized geologist.

Sigrid's story is an example of how *a good social integration* can strengthen the learning. Already during the first week she puts together a study group that will follow her throughout the academic year. In the study group they develop a study strategy where they don't read the textbook but discuss the lectures and exercises, in this way creating an open social learning environment. Her possibility to discuss in the study group helps her make sense and her negotiations never become too frustrating like some of the other students in the material. She learns everything through the study group and in this safe environment she develops and even has the energy to help other students that don't have a study group. Her story underscores how powerful the social environment can be for students in the process of making sense.

During the year she develops an interest in paleontology and sedimentology because she likes to discuss the results and do, what she calls, 'the detective work' in sedimentology. She describes how she always has been interested in both social sciences and natural sciences and had difficulties with choosing between the two. Her general interest in nature made her choose geology and now she reckons that the *soft rock* geology suits her interest in discussing and interpreting. In this way she aligns how she sees herself with her interest in the subject matter.

Anna's story is about creating a *belonging at the study program* and how this affects her learning. During the first course Anna engage in a unsuccessful study group. At the first exam in November the teachers express concerns for her role in the study group and encourage her to find a new group where she is able to talk more. The oral exams emphasize the importance of an active geology vocabulary and the teachers address this. She follows the teachers' advice and leave the group. Throughout the year she engage in different study groups but never finds a steady group. During the last interview she realizes that her lack of continuous discussions in a group has led to a great deal of struggle. She persists to engage in a group because she sees that it has an impact on her ability to learn. She never succeeds during the first year, however, due to the open social environment it is possible for her to ask questions and get most of the help she needs. Though she would prefer to become a member of a group she fights her way through the

academic year and finds motivation in her great interest in geology. Her story emphasizes that belonging and being a part of the social environment becomes important when learning. Her identity negotiations are not in the foreground during the interviews. The main part of her negotiations is concerning learning, belonging, and becoming a student in general. Her interest lies in the *soft rock* geology area but a clear connection to her sense of self is not found in the data.

Inge's story includes *a great personal development*, where in the process of making sense of the subject matter, she evolves as a person. From the start she expresses a great interest in geology, though she struggles with making sense of paleontology in block 2. She gets by in the block by focusing on mineralogy, which takes all her focus. In spring she gradually decides to focus entirely on the *hard rock* geology and talk about the calmness that occurs when finding something that interests her. Her negotiations of the subject matter disappear during spring explained by her confidence in geology being the perfect choice for her. In the fifth and final interview she tells the story about going through a great personal development and becoming more confident as a person. For the first time she makes plans for the future and clearly sees herself becoming a geologist.

Conclusions

The students' stories show a variety of ways for students to make sense of the subject matter. The stories show that the students' perception of geology develops, especially their view of the scientific method changes during the academic year. The divide the students create becomes the starting point of understanding the subject matter and defining different geologists. The *identity perspective* adds a dimension to the stories and shows how the students at the same time make sense of themselves in relation to the disciplines they experience in geology. The students try to align the disciplines of geology with their view of themselves and negotiate their identity. The use of *identity* makes it possible to understand the students' negotiations of the subject matter from the students' perspective. It makes it possible to see through the frustrations and see that they are linked to the students' understanding of *science* and their development of a geological identity. It also makes it possible to see the students' struggles as *negotiations of identity* and acknowledge that these negotiations are a tough process, regardless of the context. As a second conclusion, this study underlines the importance of *recognition*, not only in the identity construction, but also when students make sense of the subject matter.

This research leaves us with more detailed descriptions of how students negotiate and make sense of the subject matter during the first study year and emphasizes that understanding of the subject matter is linked to the construction of identity.

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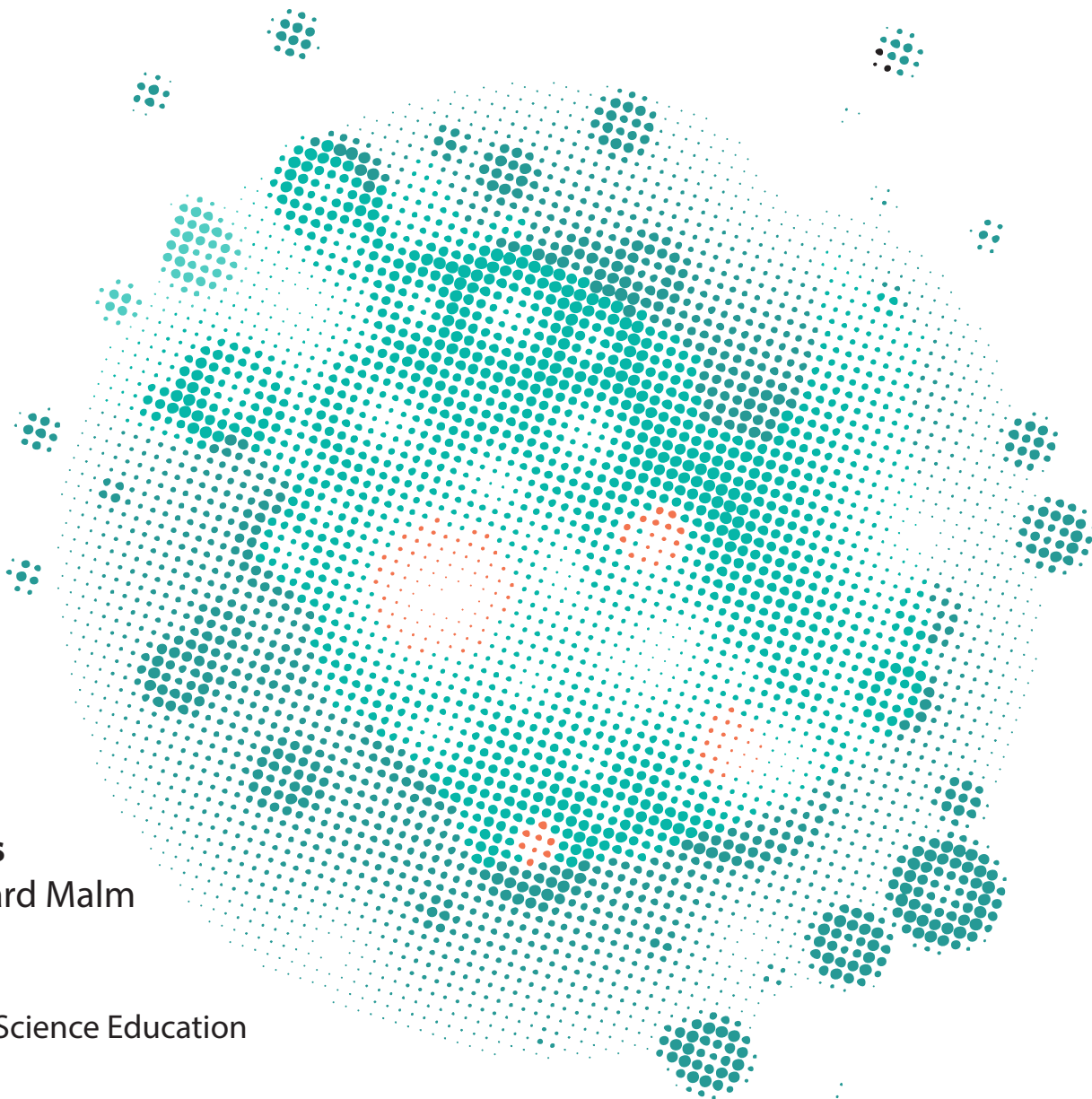
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Becoming a Geologist

Identity negotiations among first year geology students



Master thesis
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4 Theoretical framework

A literature review has brought me through different theoretical frameworks to understand *identity* and *identity construction*, without finding a framework that perfectly fitted my aim with this thesis. Through the search for a suitable framework I found different *terms* or *pieces* of framework that I could see fitted with the approach I wanted to create. The first term I picked up was *recognition*, then *negotiation*, then *identity-work*, then *turning points* and finally the *narrative approach*. In this section I will reconstruct my journey through the literature and on the way show how I constructed my final framework.

When I realized that I was about to create a *new* framework I searched for guidelines to do this in a scientifically correct way. I found inspiration in the work done by Henriette T. Holmegaard (2012) where *the landscape of strategies for connecting theoretical approaches* from Prediger, Bikner-Ahsbahs and Arzarello (2008) has been used. The landscape includes a spectrum that illustrates to what degree a theory has been used when constructing the new framework (Prediger et al., 2008). The authors stress that: "(...) *it is important not to synthesize different parts of incompatible theories into arbitrary patchwork-theories. Especially when the cores of theories contradict, there is a danger of building inconsistent theoretical parts without a coherent philosophical base.*" (Prediger et al., 2008 p. 12). The choice of theoretical frameworks must have *compatible cores* hence, the combination of the theories must make sense and have similar theoretical foundation. To secure transparency in the construction of my theoretical framework I here provide the story of my way through the jungle of identity literature.

4.1 A model of science identity

In the first phase of searching for literature on *identity* and especially *science identity* one paper turned up describing, how young women of color constructed a science identity (Carlone & Johnson, 2007). In the paper the researchers had constructed a *model* for science identity and the article became the starting point for researching literature on *science identity*. Heidi Carlone and Angela Johnson (2007) developed the model on basis of the work done by James Paul Gee (2000-1) and with the approach that:

One cannot pull off being a particular kind of person (enacting a particular identity) unless one makes visible to (*performs for*) others one's *competence* in relevant practices, and, in response, others *recognize* one's performance as credible. (p. 1190)

On the basis of this they created a model that contained three areas that together described science identity; *performance*, *competence* and *recognition* (Carlone & Johnson,

2007). The model was applied on a longitudinal study and during their research they found *recognition* to be the strongest factor when developing a science identity and they developed the model further and went into more detail with *recognizing oneself* and *getting recognized by others* that proved to be important factors in the identity construction (Carlone & Johnson, 2007).

The two essential concepts in the model *recognition* and *performance* can both be traced back to the *post structuralism* literature. Judith Butler (1990) uses the terms of '*performing gender*' and '*to become one's gender*' in the construction a *gendered* identity, thus suggest that we *perform* identity. The scope of this thesis is not to go into depth with the concepts, though recognizing the influence of post structuralism framework and the notion of *performing identity* in a cultural setting as a way of viewing identity construction.

In my paper, presented above, Johnson et al. (2011) is used as an example of a longitudinal study that explores identity-work and recognition in depths. The paper underlines how the construction of identity is continuous *work*, which can be compared with the notion of *performance* as the black women in the study by Johnson et al. (2011) continually need to perform the appropriate science identity to be recognized.

Johnson et al. (2011) also highlight the obstacles there still exist for women of color to succeed in the field of science in the United States. My final framework is heavily inspired by the thorough work on *science identity* that Heidi Carlone, Angela Johnson, and their colleagues has done throughout the years, see figure 6 (overview of the literature background). I take the importance of *recognition* and the notion of *continuously identity-work* with me as main factors in the construction of a science identity, figure 3.

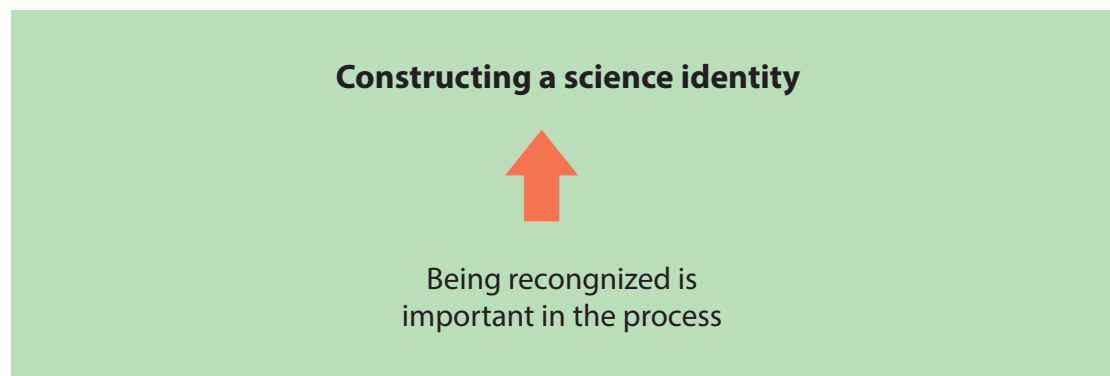


Figure 3: Recognition in identity construction process

My next clue is a review paper by Marie-Claire Shanahan from 2009 introducing the *social practice theory* in the identity research.

4.2 Communities of practice

In a review paper Marie-Claire Shanahan (2009) argues that a considerable part of the research on science identity has its origin in the communities of practice framework (Lave & Wenger, 1991). This approach has been used in numerous studies including some of the widely cited studies on science identity e.g. Brickhouse et al. (2000) and Brickhouse & Potter (2001). Especially Brickhouse & Potter from 2001, which use two cases to show identity development in a science classroom and the communities of practice framework to show how the notion of 'legitimate peripheral participation' can be used to explore the students' way into science (Shanahan, 2009). Shanahan (2009) argues that when using this approach the *macro levels* is ignored and suggests that future research include the norms, social roles, and overall structures of society when exploring students' identity construction. The communities of practice are based on the understanding that *learning* takes place in a social setting, which was new in the prevailing cognitive learning paradigm. The main focus of the communities of practices approach was not an attempt to describe *identity construction*, though the framework recognizes that learning plays a part in the identity construction.

Learning thus implies becoming a different person with respect to the possibilities enabled these systems of relations [relation to a social community]. To ignore this aspect of learning is to overlook the fact that learning involves the construction of identities. (Lave & Wenger, 1991, p. 53)

Learning then becomes a matter of who the learner want to become, also noted by Brickhouse & Potter (2001). The close relationship between learning and identity can be viewed as 'transformation' of the learner's identity when learning and "*learning can be viewed as an outcome of identity transformation*" (Shanahan, 2009, p. 57). Taking this specific approach to the communities of practices it makes sense that some researchers have found it beneficial to use when exploring identity in relation to learning. The present study aims at exploring the *individual's* construction of specific science identity and I argue that the communities of practice framework cannot capture this. Though, the communities of practice framework can be meaningful when trying to explore identity in a social setting or in relation to the changes in spaces for learning e.g. when researching classroom structures. At this point I searched for a framework that included a focus on the *individual* person's identity construction. I found inspiration in the work done by Henriette T. Holmegaard (2012) and the use of *narrative identity*.

4.3 Narrative identity

As humans we create *meaning* of our lives and actions through our *narrative*. We narrate our *story* and create meaning *across time*. Donald Polkinghorne stresses the *temporality* of the meaning making process.

Narrative is always controlled by the concept of time and by the recognition that temporality is the primary dimension of human existence. (Polkinghorne, 1988, p. 20).

Temporality is defined as *the state of existing within or having some relationship with time*.² In this case understood as the narrative we construct is bound in time. When we narrate we make sense across time and the events in our lives make sense in the sequence they occur. Our individual experiences then become a series of experiences that together is a part of a whole (Polkinghorne, 1988, p. 36). The effect is that we constantly develop our narrative as time passes and we construct *meaning* of our lives in the process.

Narrative is a form of "meaning making". It is a complex form which expresses itself by drawing together descriptions of state of affairs contained in individual sentences into a particular type of discourse. (Polkinghorne, 1988, p. 36)

When we narrate our story we make sense of our experiences in *a particular type of discourse* or in the social setting or culture we belong to. This create a link between the individual and *culture*, meaning that we cannot narrate our story without surroundings, also noted above by Carlone & Johnson (2007). So we narrate our story in the cultural setting and entering into a higher education science program the new students need to reconstruct their narrative in this setting. In a study of first year students in physics, Cathrine Hasse (2002) uses the notion of culture as *social practices* that the new physics students need to adapt into and be recognized within. In this *socio-cultural* framework the identity negotiations are embedded in a culture where the students need to align their sense of selves and the academic and social culture they meet. In this process, *negotiations* are one way of identifying the changes in narratives. When exploring negotiations it is possible to see how a person make sense of the surrounding culture in relation to their already constructed narrative. The negotiations can be views into the *identity-work* the student does when constructing his or her personal narrative. Summing up, we have narrated stories of identity that develop through time; we construct our narrative in a cultural setting, and negotiate ourselves in relation to the culture we meet, shown in figure 4.

²<http://www.oxforddictionaries.com/definition/americanenglish/temporality>

Constructing a science identity



Figure 4: Simplified model of constructing identity in cultural setting

The next stop on my journey through the identity landscape is the concept of *turning points* in our narratives. The notion is that the students' entry into a higher education program can be characterized as a *transition process* (Holmegaard et al., 2013). In the transition process into a new cultural setting the students need to reconstruct their narrative. The narrative constitutes different *events* or *turning points* that influence how the students make sense through time (Holmegaard et al., 2013). The turning points become signs of identity-work evident by negotiations of the events. This fits well with the narrative approach, which emphasize *time* and the *connection of events through time*. The *turning points* in the students' stories can be specific experiences with the subject matter or development in identity, evident in a new type of negotiation or realization. Searching for *turning points* in the students' stories is one way of recognizing *identity-work* and the turning points are mainly used as an analytical tool in this thesis (see section 3.5 *Analytical approach*).

4.4 Creating a framework

The journey through the identity literature results in a framework that recognizes four main aspects when developing a science identity, illustrated in figure 5.

1. Identity is narrated and constructed continually through time.
2. The identity construction is embedded in a cultural setting.
3. Identity is negotiated.
4. Receiving recognition influences the process.

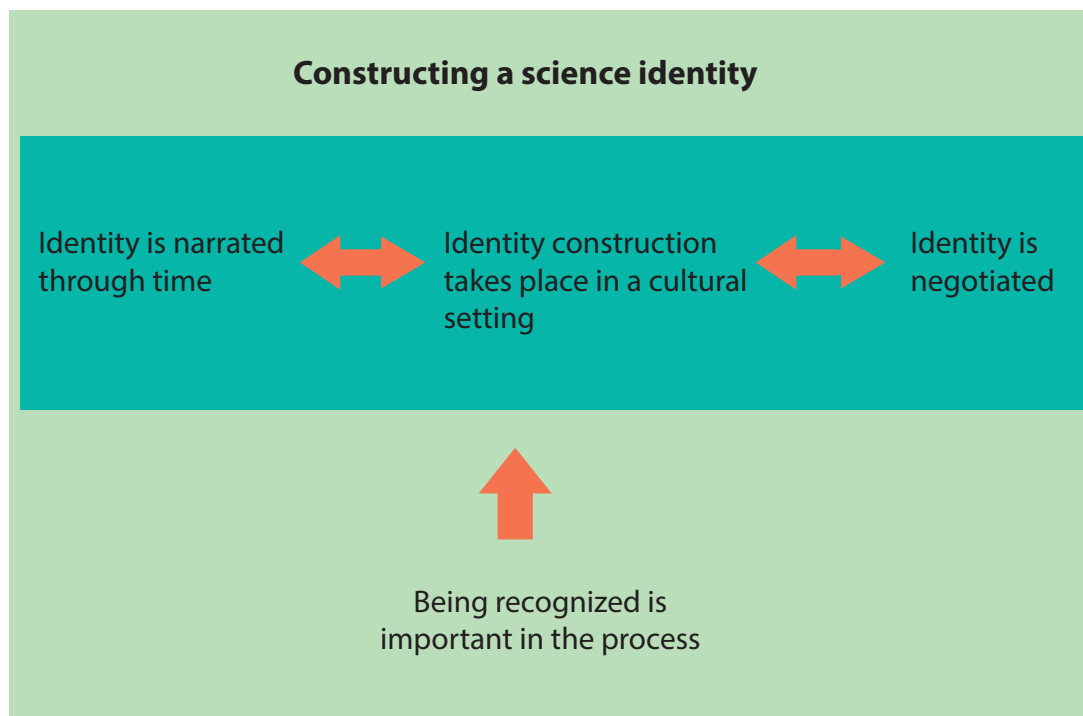


Figure 5: Compiled simplified model of constructing a science identity

The framework suggests that identity is narrated and constructed through negotiations of oneself in a cultural setting. The used constructs all take the position that identity is *fluent* and thus constructed in a narrative that develops through time and in a cultural setting. This is the *compatible core* of this framework, to use the term of Prediger et al. (2008).

However, as pointed out in the presented paper above, I also recognize that the individual person feels a *coherency* or a *core personality*. Holmegaard et al. (2013) use the work of Donald Polkinghorne (1988) to explain this apparent contradiction of *negotiating identity* and having a *core identity* and explain it through a *cultural narrative*.

(...) through culturally embedded narrative configurations - we understand our existence as an expression of a single progressive story and achieve a sense of self and identity. One of these culturally shared storylines is how identity is seen as a core of self carried within each of us. Therefore individuals perceive themselves as possessing a coherent self. (Holmegaard et al., 2013 p. 5)

In this way explaining that the *core identity* we feel is too a *story* created by the social and cultural structures around us. On this philosophical note I end my journey through the identity literature. In the next section I provide a graphical overview of the papers that form the background for this thesis and argument for my choice of method in this thesis.

4.5 Literature overview

The literature has been selected in the narrow frame of *science identity* and mainly includes studies that have been done on identity in relation to science. A larger more thoroughly literature search on *identity* could have been done, however, the scope of this thesis is to focus on the development of *geological identity* and therefore creating this limit in my literature search. The overview provided in figure 6 show the main papers that have influenced this thesis.

The literature overview cannot ever be complete as the literature on identity is huge. The goal here is to provide some of the background for the theoretical framework presented in the paper and above. The literature overview mainly includes papers (and one book) as it is through the papers I have been taking the identity journey and on the basis of this developed my theoretical framework.

The overview is build up with the most recent papers on the left and the earlier work on the right. The lines between the papers represent citations and they all point to the right, as the more recent work cites the earlier work. The light green papers are by Heidi Carlone and colleagues. The orange and dark green papers are not connected. The color of the lines is created with the attempt to give an overview of the citations.

4.6 Choosing the method

Based on the theoretical framework and the literature review a *narrative* methodology has been chosen to explore the research questions. In the narrative framework it is possible to explore the individual's way of making sense and explore the personal negotiations. The student have been followed with successive narrative interviews through the academic year and this longitudinal approach makes it possible to see how the student make sense of the subject matter *across time*. In this way exploring how the students *narratives* or *stories* develop throughout the first study year and what internal and external factors that influence the students stories. The narrative method is a way into exploring the complex construct of *identity* and makes it possible get a view into the process of constructing identity. The students stories give small peaks into their development at different points in time and with the complete dataset it is possible to reconstruct the students development.

In the following section the method is presented in detail and the limitations discussed. I add some methodological reflections on how I used the narrative method and my role as an interviewer.

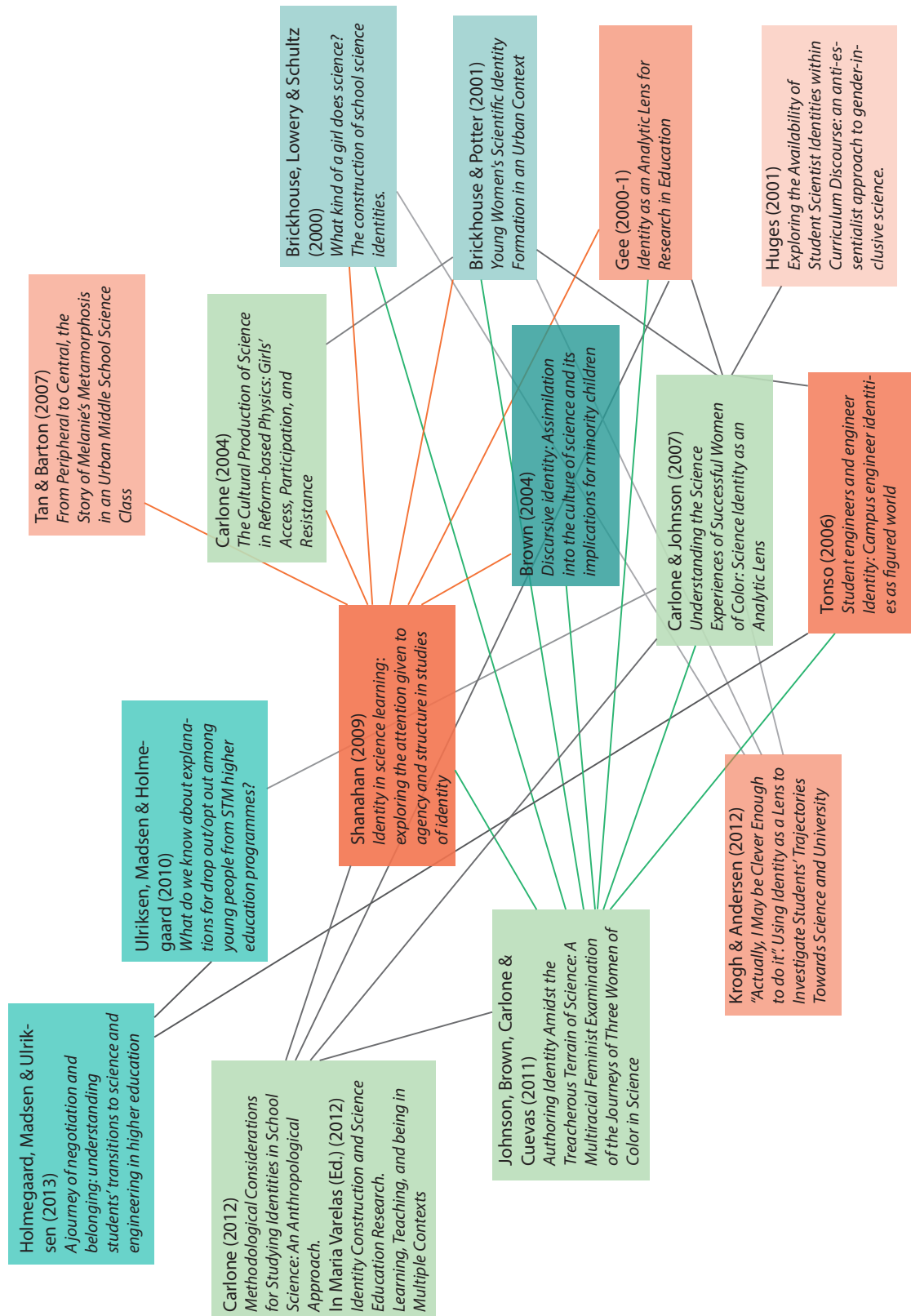


Figure 6: Literature overview of *science identity* papers. Most recent papers to left, citations go to the right.

5 Methodology

In this section I present the used method in greater detail and add some methodological reflections. The main goal is to explore *the students' process of making sense*, hence, this research searches for *understanding* and not concrete *explanations* in line with the hermeneutic paradigm (Bryman, 2012). By using the qualitative method we can gain an understanding of the *meanings* in human actions and experiences (Bryman, 2012). One way of eliciting the *meanings* is through listening to the *stories* a person constructs. We can gain access to these stories through *interviews*. In the qualitative interview we can obtain qualitative descriptions from the person being interviewed (Kvale, 1996). Using interviews is a way of collecting these personal descriptions of how a person understands and sees the world. The interviews in this study are conducted as *narrative interviews* where the students' *stories* are explored.

5.1 Using a narrative approach

The narrative method builds on a position where *stories* are considered an important means through which we communicate and make sense of the world around us (Mishler, 1986). Therefore focuses the narrative interview on a person's story and explores how the person make sense of the story. This creates some challenges when using narrative interviews as the main data source. The stories in the data material must be approached accordingly, as exactly *stories* the students construct at one point in time. The narrative interview will perhaps show how the student makes sense across time, if this is elaborated. The narrative interview can also be viewed as a story constructed in the context without connection to time. In this way the narrative interview only explores a small part of the student's story. In the attempt to capturing some of the students narratives *across time* the successive interviews were conducted. It is, however, still difficult to apprehend the narratives because the interview cannot uncover all details and some things might be implicit, also to the student.

Since we live in storied worlds, we can draw upon more established social narratives to explain an event or to complete a particular story. This is not a process of which we are always conscious. (Murray, 2003, p.114)

However, when trying to establish the complete story, follow-up questions can be used to explore the untold implicit story in the story. These questions can be used to explore the students' story further, though it will never be possible to capture the context of the story completely, regardless of pronounced attempts to do so. Taking this into account I also see the narrative interviews having advantages because it is possible to capture the exact *meaning making process* as it happens during the interview. A nice example is when Frida realizes what her expectations to the study program were before entering

the study program. This occurs after a post-it exercise during the fifth interview, where the student writes the different disciplines they see in geology (see section 5.2.4 and all the students' words can be found in the Appendix).

Frida: I thought it was probably a little more travel, a travel study in which I came out and looked at cool places and that was it, I never ever thought that *petrology* existed.

Interviewer: Cool.

Frida: Yeah, it's pretty good ... I thought it was geophysics, I think.

Interviewer: Yes, if one were to examine what you looked at.

Frida: Yes, and now that look at these yellow ones (post-it), what I have written under *geophysics*, is how I pictured it, before I started. *Frida, 5th interview, p. 26.*

Here Frida links back to the exercise and the descriptions of the disciplines while realizing that her picture of geology has changed. It was clear in the interview that she was surprised and she reflects further: "*but, now petrology, I think, is the cool part of it [of geology], so it was really quite a large part of the subject, I did not know anything about*" (*Frida, 5th interview, p. 26*). Frida makes sense during the interview and it is clearly constructed in the situation due to the exercise. During all the interviews the students would make sense while talking and explaining their story. The influence of the interviewer becomes crucial for both the students' possibility to construct a meaningful story and the data quality of the interview. Therefore being aware of ones' role as an interviewer becomes extremely important. The narrative is constructed in an unusual setting where the power relations naturally are asymmetric (Kvale, 2006). The interviewer will become a co-constructor of the narrative and influence the students in countless ways. To establish some transparency I will here give some examples of how I approached different situations the interviews.

First of all, it was important for me to be explicit about my aim with the interviews. I would formulate very directly at the first interview that I aimed at collecting their *story* and that all they wanted to share was embraced. Inspired by Henriette T. Holmegaard (2012) I begun each interview with the question: "*what has happened since the last time we talked?*" attempting to create an open atmosphere where the students were able to tell their story, whatever it included. Sometimes during the interviews a student would ask: '*is this what you want?*' and I would in every instance reply: '*yes, just tell me*'. My approach to these questions was always to embrace them and I categorize them as an ongoing check of expectations between the student and me. The result was sometimes quite long interviews going down winding roads into different stories. The interviews would go on until the student had nothing more to add. Though sometimes when the

interviews went beyond 2 hours and I felt that we were getting tired I would articulate that: *'I think we have talked for a long time now and about some interesting things, so if you don't have anything to add we might stop here, what do you think?'* Usually the student would have nothing to add, naturally, when I closed the conversation like this but sometimes new stories emerged at this point in time. This open way of interviewing created some quite unique stories and the follow-up questions helped explore the stories in greater detail. A nice example of an effective follow-up question is when I asked Inge during the last interview what her own analysis of her story were. At this point in time she has told the story about her becoming more confident and feeling a great positive development during the first year.

Interviewer: What do you think this is about, what is your analysis of it?

Inge: I think it's about I have found something that I actually think is so exciting that I want to devote my life to it and I never had that before. *Inge, 5th interview, p. 14.*

Here I prompt Inge to expand her story and let her create the meaning herself. It was obvious in the interview that she felt a great need to tell this story and asking this question was one way of motivating her to explore the story further.

5.1.1 Ethical considerations

When working so intensely with other persons' stories some ethical considerations are in place. There are some issues to be discussed in relation to both conducting and treating the data from the interviews. During the first interview the students were informed about what kind of research they participated in and how the data would be exposed later. When a student occasionally asked: *'will you use what I just told you?'* I answered as generally as the question allowed and typically explaining that all the interviews would be transcribed and then I would look for *general tendencies* in the material and in that way limit the exposure of the single stories. Once a student asked if the recorder could be turned off while talking about a sensitive theme and of course this request was fulfilled. A considerable amount of time was used in the last interview to make sure that the students felt safe leaving me with their stories. I explained my plans on writing a paper that might be more exposed than the thesis itself and I promised to send the manuscript to the students before sending it for review.

Of course everything has been done to secure anonymity of the students' identities in the thesis. The full transcriptions of interviews will only be available for the evaluation of the thesis.

5.2 Around the interviews

In this section I will extend some of the methodological considerations around the main data source in this research, the interviews. I will dwell on the selection of informants, planning the interviews, conducting the interviews at different locations, and the use of exercises. I discuss the interviewer role and the validity and reliability of the research. The final section creates a transition to the *Extended analysis*, section 6, with descriptions of the analytical approach.

5.2.1 Informants

The data collection started with a survey with the new students just after they had accepted their enrollment at the study program of Geology. 53³ students accepted and the survey were sent to these students in the beginning of August 2012. The survey included 11 questions with background information, exploring the new students' interest in geology, their initial understanding of the subject matter, and considerations about choosing this study program. The survey data is not included in the paper and was mainly used to find students for the following interview study. The questionnaire and the data from the survey can be found in the Appendix. 6 students initially choose to participate. One student left the interview study between the second and third interview, when the student stopped answering mails or texts. Speculations on whether the student had left the study program begun but not answered during the following months. In the last interview with one of the other informants it appears that the student had stayed in the study program. The reason for leaving the interview study was never solved.

5 students stayed in the interview study and participated in all 5 interviews, which constitute the main data material.

5.2.2 Planning the interviews

The first interviews took place in August 2012 two weeks before the academic year started (for a description of the academic year, see table 7). The interview concerned the students' choice narrative about choosing to apply for geology. The interview also explored what the students expected of the study program and their perception of the subject matter.

The second interview took place 5 weeks into the academic year. Then the students had had some weeks of teaching and been on the first field trip. The interview focused on the students first meeting with geology and the other students. The interview had an exercise where the student was asked to write five words on how he or she understood *geology*. The student explained the words and why they were chosen. Secondly, the student was asked to describe a *geologist*. These five words were unfolded by the student and gave

³<http://studier.ku.dk/bachelor/ansoegning-og-optagelse/optagelsesstatistik/2012/antal-optagne/>

a characteristic of the geologist the student saw at this point in time. The use of the exercises is explored in depth in section 5.2.4.

The third interview was held at the Geological Museum in Copenhagen during December 2012, 4 months into the academic year and 3-4 weeks into the second block. Focus was how the transition from block 1 to block 2 had been, the subject matter of the new courses, and how the students experienced the exam and the expectations from the study program. The effect of having the Geological Museum as a frame for the interviews is discussed in section 5.2.3.

The fourth interview was held in March 2013 and at this point the students had met the four main themes in geology in block 2 and 3 (see table 7). At this point in time the students had passed the exam of block 2, held in the end of January 2013 and most of block 3 had passed and then placing the interviews quite close to the next exam period in April 2013. These interviews were, due to their placement, able to capture how the students understood the different disciplines in geology and how they experienced the intense period close to the exam. The interview included an exercise where the students drew a curve of their motivation from block 1 to block 3, see section 5.2.4.

The fifth interview was held in June 2013 and being the final interview it had a summing-up atmosphere, where the students were asked to evaluate the past year and how they felt about the choice they had made in studying geology. The interview had a post-it exercise where the students wrote all the different disciplines they identified in geology (see section 5.2.4).

Table 3: Timeline and locations of the interviews

1st interview	2nd interview	3rd interview	4th interview	5th interview
August 2012	October 2012	December 2012	March 2013	June 2013
Before the academic year	Block 1	Block 2	Block 3	Block 4
Department of Science Education (one in student hometown)	Department of Geosciences and Natural Resource Management	The Geological Museum	Department of Science Education	Department of Science Education

5.2.3 Locations

The interviews were held at different locations (table 3) though mainly at the Department of Science Education, which were found to be the most neutral place to conduct the interviews. When the students were invited to participate in the first interview they were given the opportunity to choose the location for this first interview. One interview was held in the student's hometown and the rest were held at the Department of Science Education. The second interview was held at the Department of Geosciences and Natural Resource Management in a meeting room making it easy for the students to fit with the teaching. It proved to be difficult to get access here so the next round of interviews was held at the Geological Museum and the last two interview rounds were held at the Department of Science Education. The two departments and the Museum are situated close to each other making it easy for the students to walk between the locations.

I will use a few words on describing the interviews held at the Geological Museum. In the first two interview rounds in the autumn, I generally had difficulties getting descriptions of how the students worked with geology. Therefore the idea occurred to take them closer to the geological materials and catch the reasoning directly in the interviews. Using the Geological Museum as a frame for the interviews had both a positive effect and proved to be quite difficult. To start with the challenges, which occurred during the first couple of interviews where I had the intention to make the students describe some of the rocks or minerals in the museum. The aim were to make the student use the terms they had learned and explore more about their scientifically reasoning. However, the students were not ready to get a task like this at this point in time and my attempt to catch their reasoning didn't succeed. What the interviews in the museum did create was a window to see *interest* and *fascination*. Walking around minerals and rocks in the museum generated sudden outburst of joy and happy associations when the students saw the materials. So quite unexpected the interviews could explore *interest*, which must be conceived as a difficult construct to examine.

5.2.4 Exercises during interviews

Small exercises were carried out during the interviews. The exercises contributed in different ways to the interview situation and the data gaining process. The exercises would focus on getting the students to describe aspects of the subject matter or their experiences during the first year in greater detail, see table 4. The post-it exercise in the fifth interview was shortly presented above in section 5.1 and the exercise in the museum in section 5.2.3. Here I will discuss the exercises conducted in the second and fourth interview.

Table 4: Timeline and exercises in the interviews

1st interview	2nd interview	3rd interview	4th interview	5th interview
Before the academic year	Block 1	Block 2	Block 3	Block 4
Department of Science Education (one in student hometown)	Department of Geosciences and Natural Resource Management	The Geological Museum	Department of Science Education	Department of Science Education
No exercise	Exercise with post-it. Write 5 words describing <i>geology</i> and five characterizing the <i>geologist</i> .	Exercise. Describe a rock or mineral in the Geological Museum. Use the terms learned.	Exercise. Draw a motivation curve over the first three blocks.	Exercise with post-it. Write 5 words on <i>geology</i> or the <i>disciplines in geology</i> .

During the second interview, two months into the academic year, the students were asked to describe *geology* with five words. In the explanation of the words they would sometimes change the words or add some in extension to their explanation. The exercise caught the reflections about the words and the connections between them. The students were afterwards asked to write five words describing a *geologist*. The nuanced picture of the scientist that emerged was used to explore the student's image of themselves in relation to becoming geologists. The characteristic of the geologist the student had just made guided their story.

Frida's words describing the geologist: Focus on detail. Outdoor person. A little geeky. Curious. Patient (detail oriented).

After Frida had explained the words I ask:

Interviewer: (...) and you can see yourself in that way?

Frida: Uh...yes, I think so, to some extent ... I'm not patient, but I am very detail oriented and I'm very stubborn, I think, I think it's okay then. *Frida, 2nd interview, p. 16.*

The exercise starts the *reflection* and the follow-up questions catch the *negotiation*. Examples like this were used to explore the students' identity-work.

In the fourth interview in March 2013 the students drew a motivation curve for the past six months. The student would draw the curve while explaining and talking in depth about the ups and downs in motivation across time (see the curves in the Appendix). When follow-up questions were asked to the different parts of the curve more detailed stories emerged. The stories were expanded with personal events that helped explain the story e.g. this twist with the housing conditions.

Interviewer: So there are several things that makes the curve go downwards?

Inge: Yes, it was because I moved here (points at the curve) in November, into an apartment that had to be renovated a lot (...) so it's been a little tough but now that it has gone well, yes, both socially and academically and in terms of housing, so now it's going really well.

The extra loops the stories get highlight the reasons behind the downward movement on the curve. The students are able to tell a more detailed story and give a fairer picture of the situation. The exercise also involves *time* both making it possible for the students to construct their story across time and for the interview to capture the meaning of events. When analyzing the data it is possible in greater detail to determine when e.g. a downward movement in motivation is related to the courses, the subject matter or personal events not related to the study program. In addition the students would in later interviews use terms, like 'going down the curve' or 'I think I'm on my way up now' and referring back to the exercises when narrating their story.

The different exercises can be characterized as multimodal (Tucker-Raymond et al., 2007; Moje et al., 2007; Lemke, 1998) where the students' narrative is supported by the extra dimension of drawing and writing. In this case the extra dimension was created in collaboration between the student and the interviewer. In the *motivation curve* exercise the student would take the lead in the exercise and the interviewer would follow-up and support as a co-constructor, in that way creating a more balanced conversation between the two participants. The multimodal approach created different shifts during the interviews. First of all the exercises would take the pace out of the conversation, creating a break for both interviewer and student to reflect. Giving the student the main responsibility in the exercise would also create a shift of power towards the student in the asymmetric power relations described by Kvale (2006) enhancing the intention of making the student the expert in the construction of the narrative.

When the interview moved away from the classic question-answer construction, to the student constructing alone (when writing), a more detailed narrative occurred. The students would explain about the post-its or the drawing and unfold their stories in the new format. New and more detailed stories would naturally emerge.

Setting up an exercise with a specific purpose will inevitably change the topic of the

conversation. The shift in topic would also influence the rest of the conversation and give a new direction after the exercise. The way that the exercise zoomed in on one topic gave the students possibility to explore ideas and attitudes in more depths and this 'deep' approach would set a new mood in the conversation. The effects were a more detailed and reflective part of the interview, an effect not foreseen or intended but naturally embraced. In addition, it is worth mentioning that the students enjoyed the exercises, enhancing the positive effect they had on the interview situation.

5.2.5 The interviewer role

Following the students closely created some challenges in the relationship between me as the interviewer and student as the interviewee. As the interviewer I felt a great responsibility for the students and meeting with them again and again created some kind of connection. In some situations the connection meant that I had access to very personal stories and in some situations would my person, being a geologist, complicate the relationship. Figuring out what was happening in the different relationships took some time, as in every relationship we engage in with other people. Though in this special situation I used a lot of energy to find a way to be friendly and have a good connection to the students and the same time keep my distance and observe them in their development. Creating this balance proved to be more difficult than expected.

The first challenge I experienced was communicating with one student in the material. Generally I felt that the student would not answer my questions and we would talk past each other making the conversation difficult at times. Sometimes a quite tens atmosphere would build up during the interview. I found out that it usually occurred when I asked the student to describe the subject matter, when we talked about how the student worked, or asked the student to describe rocks during the interviews. The student would say something like, '*you know all this*', referring to the geological knowledge the student thought I had and then answering shortly or denying answering. During the first interviews I tried to say: '*I can't really remember, just try to explain to me what you think*', but the student denied. At first I analyzed the situation as a sign that the student felt that I tested or in some way evaluated the student's knowledge. I never succeed in getting good descriptions of the subject matter from this student but I learned that the role the interviewee assigns me, as the interviewer, means everything in the relation. In this relation I didn't succeed in letting the student become the expert and the student made me the expert on geology, perhaps caused by failing to align our expectation from the start. However, during the last interview my perception of the student changed. I realized that I have been searching for *explanations* and *negotiations* in the student's story without much result because the student just did not negotiate. The student's view of life is to just see what happens, not expecting much, and accepting the things that

show up. This made all my questions seem a bit silly and it makes sense that our communication had gone wrong. In the very end of the fifth interview I tried to understand his point of view.

Interviewer: Is there anything else, now we have talked many times, is there something between interviews, or something [you would like to add], it just seems like you're thinking: "I'm here, I just did this" or something like that?

Thor: Yes, it has been like that.

Interviewer: So that's why my questions do not quite work (smiling).

Thor: I have not been thinking so much of the time, it's just gone, so when you stop and look up, then there's suddenly gone two months, bang bang, now I'm almost finished, that's great and a little sad. *Thor, 5th interview, p. 11.*

When all the pieces fell into place for me, I realized that my own perception of the world and life had affected my questions to all the students, my perception of them as persons, and how I understood their stories. This realization was a huge *turning point* for my further work with the interviews and afterwords treating them with even more care. With the goal to minimize my own impact on the stories and being aware how I communicated them.

Returning to the issues with not being able to discuss the subject matter. This would occasionally occur in the other interviews too and here I will explore, in more depths, the reason for this. Hanne Kirstine Adriansen and Lene Møller Madsen (2009) discuss being a researcher researching your own field by interviewing colleagues and how it can create some challenges, they describe becoming a *double insider*.

In addition to being insiders by interviewing our colleagues, we were also insiders in the sense that we as geographers were studying the making of geography, or in other words studying discourses we were part of ourselves. Hence, we had a double insider role. (Adriansen & Madsen, 2009)

The article touches upon some of the issues I met during the interviews. Being a student of geology interviewing other students about geology would at different points in time create complex situations. In some situations, when talking about the subject matter, the students would presume that I already knew the answers and making it a bit silly for them to answer. In general the students presumed that I knew more than them but in fact they quickly became quite confident in the field of geology. With four of students in the material I managed to get great descriptions of the subject matter after some rounds of aligning expectations and encouraging them to talk more about the subject matter.

I also experienced being an *insider* as an advantage. When the students e.g. formulated questions to the scientific method in geology I was quickly able to follow their rationales. This made it possible for me to ask follow-up questions that would explore their rationales even further. I also experienced that the students could be *geeky* with me as they knew I was one of them. Being geeky about rocks is just not recognized in all social settings. The disadvantages is of course the questions I *did not* ask because I thought I knew what the students meant. I was very aware of this when interviewing keeping in mind to ask more questions than I usually would when talking about geology.

The second challenge I want to discuss is the *roles* that played out during the interviews. Being assigned a special role by the students is a recurring theme when discussing the relationship to the students. Some students in the material use the interviews to discuss difficult issues and talk about challenges they experienced while studying. Especially some of the girls talked about how they enjoyed our 'talks' and that they always walked from the interviews with new energy and determination to work on the issues they had brought up, thus assigning me a counselor's role. A role much familiar to me (as former Student counselor for students in Geography and Geology at the University of Copenhagen) but totally not intended to become in this situation. Based on my previous experience with conduction interviews and my role as a counselor, I approached the interviews with great care. Focusing on not asking counselor type of questions and stay in the interview format, which I experienced in earlier occasions to be a challenge when changing from being an councillor to becoming an interviewer. I very actively tried *not* to paraphrase the students stories but to use their own words and expressions to avoid interfering the story being narrated. So in spite of my efforts to create an interview situation the students sometimes took the interviews as a counselor session. Making my role as an interviewer difficult but at the same time giving access to intimate feelings and stories. When analyzing my questions and reactions to the students during the interviews I conclude that the narrative approach just involves recognition and follow-up questions that *do* sound a great deal like a counselor's questions. Though the great difference is that I never suggest new options or create an action plan, as the counselor would have. This is again a challenge *not* to do when the students begin to sneak into my life and I begin to care for them. Then the interviewer role becomes difficult to obtain, like in this example:

Interviewer: So you get 10 (B-grade), does it mean something, does it really matter?

Frida: (nods and smiles).

Interviewer: It does (surprised).

Frida: I didn't think it did.

Interviewer: A proper interviewer asks, "*what does it mean?*" (Breathe in).

Frida: It means, I was just so disappointed. *Frida, 4th interview, p. 23.*

In this case I literally felt like falling out of the interviewer role and into a normal conversation, where you respond instinctively. Here the shift of role was so pronounced that I felt the need to redeem the situation and articulate that I was out of place and actually wanted to know the meaning of her previous statement. By doing so the student was able to continue the story in her own pace. Though adding to the story, this is from the 4th interview with Frida, where she is very frustrated, so honestly, at this point in time (1 hour and 14 minutes into the interview), I felt the frustration too and really felt sympathy for her. All this made it difficult to stay in the interviewer role and not acknowledge her struggles by words. In situations like this it was tough just to listen and not be able to act and help. As I would have done in both a professional and a personal conversation, when sensitive, frustrating, and challenging themes are brought up. In the interview situation I tried to recognize the students by being an active listener and with my body language indicate sympathy in difficult situations. I recognize that my body language of course is a way of influencing the situation but I tried to limit the *verbal* influence because I experienced that the power of words were great in the narratives. In these situations single words could turn the conversation and I tried to limit my influence especially in these vulnerable situations.

A third challenge occurred when the students asked questions. Some questions concerned the interview, like: *'Is this what we are supposed to talk about?'* or *'what was the question again?'* and these type of questions was quite easy to answer as everything was interesting to me, as described above. The other category of questions would be about me and my geological knowledge and more difficult to answer. In the whole interview I would be a co-constructor and active participant in the development of the interview. But when we talked about the subject matter I would be very cautious not to participate with my own knowledge and influence the students too much. It became difficult when they asked questions about the subject matter and forcing me to participate. I usually tried to turn the question around and avoid answering. Both the students questions and my way of answering would change the roles in the interview, shortly until the 'correct order was restored' moments later.

The fourth challenge I experienced was keeping to the narrative interview format. Asking follow-up question can keep the interview going for some time but at one point questions need to be put forward to continue the interview. When I asked question I instantly felt that I was changing their story or interrupting them in their way of telling a story. I would never ask unmotivated questions and would try to keep in line of the talk. This proved to be quite difficult because I would use my own understanding to ask the question. For example a student talked about learning or difficulties when trying to

learn. Then I would ask follow-up questions directly to the story but at some point the story seemed 'told' and the student would stop talking. At this point I might ask if the student participated in a study group. This would sometime be perfect in line with the students story and they would continue in this new track. In other cases this question would be quite irrelevant or the student might need to expose that they actually failed at participating in a study group. This way of asking about study groups in relation to learning is based on my own experiences with participating in a good study group where I learned everything. In this way would my preconceptions become evident in the interview situation.

Another, more directly interfering I must claim guilty of is eagerness. Occasionally my enthusiasm would take over and I impatiently would suggest words to the students, when they searched or felt lost from words, every time regretting it. It might seem like a detail but in the situation the choice of words become quite important when explaining a feeling or situation.

So I was quite challenged at many points in time but generally I believe, I succeed in giving the students a safe and minimally disturbed place, in where they could narrate their story.

5.3 Transcribing the interviews

The interviews were recorded and transcribed verbatim. The transcriptions were created by listening carefully through the interview and write every word said. Expressions like *uhh*, *hmm*, and *aha* have only been recorded when they were significant in the narrative e.g. when the students reflect and say: '*uhh...I think, yes, hmm, maybe*'. Commas have been used abundantly in the attempt of creating a readable document. The full transcriptions are available in *Appendix Interviews* (in Danish).

Table 5: Transcribing the interviews

Code	Description
,	Comma, break in the talk or placed due to grammar rules
..	Short break
...	Longer break, usually connected to reflecting
/	The person is interrupted or interrupt herself when talking
[insertion]	Text in the brackets have been added to understand the statement
CAPITAL	Press a particular word in the phrase, " <i>it was just SO exciting</i> "
Then I thought: "... " or then he said: "... "	The students say exactly what they were thinking or reproduce what someone else has said

5.4 Validity and reliability

A theme in qualitative research is discussing the *validity* and *reliability* of the research when evaluating the quality of the research (Østerud, 1998). In the influential work done by Guba and Lincoln in the 1980s (Guba & Lincoln, 1981; Guba & Lincoln, 1982; Lincoln & Guba, 1985) they translate the terms from quantitative to qualitative research and introduce the term *trustworthiness* of research. They recommend to apply different strategies to improve the *credibility* and *transferability* e.g. triangulation (to use different methods to collect data and involve a wide range of informants), frequent debriefing sessions, and peer scrutiny or review (Guba & Lincoln, 1981). The scope of this thesis is not to discuss the terms and meanings in depth and in table 6 the terms are defined shortly.

Though it is an important theme to discuss when conducting qualitative research and some of the suggested elements to secure *trustworthiness* is discussed here.

Table 6: Terms in connection to validity and reliability. Compiled from Bryman, 2012; Østerud, 1998; Guba & Lincoln, 1981.

Quantitative Research	Qualitative Research	Description
Internal validity	Credibility	The <i>internal validity</i> evaluate if the research findings describes the phenomena the research seeks to describe. <i>Credibility</i> assess if the results are congruent with reality.
External Validity	Transferability	<i>External validity</i> is in the positivistic research paradigm also termed <i>generalizability</i> . <i>Transferability</i> apply to how well the results can be applied in other contexts.
Reliability	Dependability	<i>Reliability</i> concerns if the results from a research are repeatable, where <i>dependability</i> emphasizes the <i>stability</i> of the data over time.
Objectivity	Confirmability	<i>Objectivity</i> seeks to eliminate the researcher from the process. <i>Confirmability</i> also seeks to limit the personal bias though the method is to make the analyzing process <i>transparent</i> . Showing that the outcomes are not products of the researchers' imagination but emerged through the empirical data and treated according to the chosen theory.

Triangulation is in this study limited in the case of using different methods to explore the concepts. The survey give some additional data and create some kind of triangulation but only to first round of interviews. The students turned out to be quite diverse and their stories can be verified against each others and in that way create a more nuanced picture.

Frequent debriefing sessions was held during the data collection with my academic adviser, Lene Møller Madsen. After another round of interviews we would meet and put the interviews into perspective. This was very helpful in the initial phase, where interview experience still was filled with the students emotions. Right after the interviews I would be so absorbed in their story that it was difficult to see the story from other angles than the student. Straight after the interviews I would write the questions and concerns that came out of the interview. The following discussion of the stories started the first

interpretations and helped me create a more complete picture of the stories.

Peer scrutiny or review was conducted after the all the interviews were collected, and some of the initial interpretations were made, during a meeting with two Postdoc researchers, Henriette T. Holmegaard and Bjørn Friis Johannsen, at the Department of Science Education. The preliminary results was also presented at the 10th Conference of the European Science Education Research Association (ESERA) in Nicosia, Cyprus⁴. In both cases feedback was given and taking into account in the later phases of the research.

In this thesis I attempt to make every step of the research transparent to secure trustworthiness. In the next section I highlight some of the limitations of this research followed by the analytical approach both sections that aims a creating transparency.

5.5 Limitations

This type of qualitative research cannot be conducted without limitations. The main limitations in this research are the choice of *only* focusing on the students' narratives and then limiting the research to not include the surrounding *culture*. Some of the cultural aspects have been included in the *extended analysis* but again only from the students' viewpoint. It could be valuable to research how the academic culture and the teachers affects the students' narratives in the way the students' make sense of the subject matter and the identity negotiations.

The research quality in this type of research is dependent on the researcher and influenced by the researcher's personal biases and background. In this case my position as a student in geology created some limitations and some advantages, as described above.

5.6 Analytical approach

The aim in all research is to create data that are valuable to the academic community. It is important that the community are able to evaluate if the data is approached correctly according to the theory and method selected for the research. In this section I go into detail with the analytical approach of both the paper and the extended analysis. The aim is to make the analytical process more transparent.

The main data source for this thesis is 27 narrative interviews with 6 students. The interviews were held during in the academic year 2012/2013 and thus making it possible to analyze the data in several steps throughout the year. After each round of interviews all the interviews would be transcribed, preferably in the same week and each analyzed with the thematic analysis as described by Braun & Clarke (2006) in six steps (see table 1 in the paper). When the interviews in each interview round had been analyzed the

⁴<http://www.esera2013.org.cy/>

themes would be collected into meta-themes for the whole interview round. Presented in the paper above, in table 2. The meta-themes were collected to get an overview of the student stories in an attempt to see what in general was important to the students at different points in time or *vertically*. In the most inductive way possible, just letting the interviews tell the students stories at that particular point in time. This created themes related to the subject matter and themes that concerned other parts of becoming a student e.g. study strategies, social, and personal themes. The themes associated with the subject matter and making sense of the subject matter was used in the first part of the analysis in the paper. The themes were the starting point to explore the students' stories about the subject matter. To research this in depths the data was secondly approached with the two analytical questions: *what influence the students understanding of the subject matter?* and *how do the students negotiate and make sense of the subject matter?* also presented in the paper.

In this part of the thesis I extend this analysis with the students *expectations* to the study program. In this extended analysis two additional questions were used to explore this particular theme: *What are the students' expectations to the study program before entering?* In this analysis the survey data (n=24) were used and adds some details to the analysis. The survey data included four questions, where the students were able to write small text, these results are used to support the thematic analysis:

- Question 1: Why did you choose to apply for Geology-geoscience?
- Question 2: What do you think is exciting about geology?
- Question 4: Are there other aspects that have been important to you in your choice of Geology-geoscience?
- Question 5: What expectations do you have for the study program in Geology-geoscience?

The responses to these question and a summary of the survey can be found in the Appendix.

The extended analysis is able to use the students' expectations when entering the study program to explore the students' way of making sense of the subject matter in greater detail.

In the paper the second part of the analysis is concerned the students *stories* as they develop *across time* this can be viewed as a *horizontal* analysis. After creating the overall outline for the stories the search for *turning points* became essential when trying to make sense of the students stories. The analysis of the turning points begun with searching

for *events* or *negotiations* related to the *subject matter* e.g. when the student experience a new scientific approach in geology or negotiations of *identity*, e.g. when a student expresses a new attitude towards becoming a geologist. All the students' stories inform the extended analyses where I also add the *academic culture* to the analysis to explore this part in more detail.

6 Extended analysis

In this extended analysis I am able to give more examples of what the data shows than the scope of the paper allowed. I add some of the *cultural aspects* in the study program to explore the research questions in greater detail. In the first part I go into depths with the students' *expectations* to the study program and show how the expectations the students enter the program with affect how they make sense of the subject matter. Then I analyze the academic progress in the first year in the attempt to show how the students continually develop the *divide* in the subject matter. Last I sum up by analyzing the *academic culture* the students meet during the first study year and explore how this affects their identity negotiations.

6.1 Students expectations to the study program

The aim with this part of the analysis is to show how the students' *expectations* to the study program influence their way of *making sense* of the study program and influence the students' *identity negotiations*.

The first answers the students gave when asked about expectations to the study program were the possibility to specialize and secondly that they expected the education to involve fieldwork. The students expressed an interest in science in general but wanted to receive a specialized degree. They saw strength in choosing one subject over a general profile e.g. a general science profile at Roskilde University or another science program that offers jobs in many different directions e.g. mathematics or physics. The students saw a clear career path with geology and they were able to mention different types of jobs. They expected that a job within geology would become challenging, interesting, and with varied work assignments. The main factor in the desirable job perspective were the possibilities to do fieldwork. The students linked studying Earth and doing fieldwork with being able to travel abroad. Traveling and exploring the world played a significant role in the students' *choice narrative*. They see geology as the perfect study program for exploring the world.

The data from the survey shows the diversity in the students' approaches to choosing geology. The first example shows how interest and knowledge guide the way.

Geology is the science that combines all of my interests. The combination of physics, chemistry, and biology that are needed to understand the Earth (and other planets), challenges traditional disciplinary boundaries, and the necessity of fieldwork makes geology an experience as well as a profession. In our search for answers to the universe's big questions - why life occurs, can it be found in other worlds - geology is also quite central. *From student in survey, August 2012.*

The second example shows how coincidence and chance brought the student to the study program.

It was a very spontaneous decision, but nature has always intrigued me. I went through all undergraduate programs in Denmark and eventually found Geology-geoscience and read all information about the program. The following day I was looking more forward to begin the study program than for my planned sabbatical year, so I applied. *From student in survey, August 2012.*

All the data from the survey is included in the Appendix (in Danish). The main reasons for applying were general interest in Nature and in science in general and with the hope of an interesting and good study environment. The students paths towards applying are quite diverse as the quotes above show and thus creates differentiated expectations and views of the subject matter from the beginning.

The first round of interviews explored the *choice narratives* of the students. Sigrid's story is an example of a student who has done extensive research before choosing the study program. She had read all the information material and the course descriptions for the courses in the first year. Still she felt unsure about the content of the study program because there were many words she could not understand and searching for more information did not help much. She concluded that perhaps she were not meant to understand it yet and she trusted that her interest in Nature and science were the necessary components for choosing the right study program. All the students in the interviews were not sure exactly what the study program included but they trusted that it were the right program based on their interest in Nature and science. So the students enter the study program with limited knowledge of geology but with a clear picture of what *science* is and expect to meet a *science program*. Holmegaard et al. (2013) show how students expectations to a science study program differs from what they actually meet in the program and thus create a *gap*. The students experience the gap to different extends and approach the gap with different strategies (Holmegaard et al., 2013). The

research shows that the students *expectations* to the study program is a part of the students *negotiations of belonging* in the study program and then become important in the retention and dropout research (Holmegaard et al., 2013). The students in this study have few expectations to studying *geology* but many different expectations to becoming a student, handling the work amount, and figuring out how to study at university level. The result is students that enter the program based on interest and fascination with nature and without specific knowledge in geology. Where students entering science programs in e.g. physics or biology know what the subject matter include and then form concrete expectations to the study programs before entering. The reason can be found in high school where geology is taught as a small part of geography and then not a separate subject matter. So the geology university program differs from other science programs when it comes to the students expectations and this explains why the students do not experience a huge gap as Holmegaard et al. (2013) describes. The students enter the program with expectations to meeting a *science program* and *this* is a factor when the students negotiate the subject matter and create the divide, as will be described subsequent.

The students get access the subject matter through the courses in the first year and it is here the students form their view of geology as a science. Here I go into depths with how the courses introduce geology in order to understand the how the students create the divide in the subject matter, as described in the paper.

The students are introduced to geology in two introduction courses (see figure 7) and it is these courses that create the foundation for the students understanding of the subject matter. In general the students experience that the courses build on top of each other as the academic year progresses. Sigrid explains in the fifth interview how she needed to re-learn what she had learned in the beginning of the year. She had learned about *glauconite* in simplified terms, that were not wrong but so simplified that she had to re-learn it again later. Aside this point, this next quotation is also an example of how I become a co-constructor in the interview, as discussed above. Here we discuss *glauconite* which is a mineral formed in marine deposits in predominantly oxidizing conditions. The mineral can also be formed locally in reducing micro environments where there is organic material e.g. in excrement balls or as Sigrid says, *worm's shit*.

Sigrid: For example, we learned in block 1 that *glauconite* was worm's shit and it's just a mineral found in the ocean, but it was what he [the teacher] said, that it was worm's shit, so everyone went around and said every time there was something a little green in a rock: "it's worms shit".

Interviewer: Ahh that's because the it is organic material that makes it [the chemical compound that can make rocks green].

Sigrid: Yes, and we all thought that it was worm's shit (...)

Interviewer: No, it's only later you find out that it is a chemical compound.

Sigrid: Yes, I think it were in block 3, or something, maybe even in block 4, it was a little funny.

Interviewer: But it is a very good example of the explanation: "there have been some animals in the sea floor, that is what you should be able know" like that.

Sigrid: Yes, it comes from animals in the sea bed, so it's something with some shit maybe, then we learn later, that it is something else. *Sigrid, 5th interview p. 20.*

Sigrid explains that when she found out that *glauconite* was a mineral and not worm's shit, she needed to re-learn the term again. We discussed if it were confusing or difficult to figure out but Sigrid explains that having the simple framework helped her remember the term and the details were then added. She explains that it was confusing at first but re-learning it made it stick for good. This is an example of how the course in the first block creates a foundation for the students learning. The course simply defines terms and the next courses build on top of this foundation. In this case, Sigrid were able to connect the terms and make sense of the simplified explanation and she figures out how to add more knowledge. This might not be the case for all students in all cases and something to be aware of in the study program. The point here is to show how the first courses create the framework for the students understanding of the subject matter on top of the expectations the students have to a science program.

In the second block the students meet two specialized courses, one in paleontology and one in mineralogy. These courses build on the framework from the first courses but differs in the way the students are expected to learn. It is during these two courses the students for the first time mention 'leaning by heart' and explains that the courses both have huge vocabulary they need to navigate in. The students find both paleontology and mineralogy difficult to make sense of, though the difference is that the scientific method in mineralogy fits the students view of *science* better and they negotiate this course less. Paleontology both has a large vocabulary that is difficult to navigate in and the students challenge the scientific method because it contradict what they expected from a science program, as described in the paper. So it is the combination of the students view of *science* and their expectations to a science program that creates the divide. This divide is confirmed in block 3 where sedimentology and magmatic petrology are taught. The students are again challenged when making sense of the subject matter but the magmatic petrology has the 'scientific' advantage. So the students have the divide or framework to understand the subject matter and the courses in block 3 confirmed this divide and it grows even stronger. The courses in block 3 fit into the framework of the subject matter the students have created and their need to negotiate the subject matter

decreases in general, as evident in figure 2. In the confirmed divide of the subject matter the students are able to place themselves more definitive. Inge, Thor, and Sigrid's stories show that finding your place in the subject matter limits the negotiation of the subject matter, as the one part just seems to fit the best and gradually moves the attention to this part. The other part of the subject matter then becomes something to overcome. This way of making sense of the subject matter and dividing it creates a simple framework to negotiate identity within.

So the framework or divide is formed in a combination of the students *expectation* to a *science program* and the courses or the subject matter in the first study year. The divide can then be linked to *identity negotiations*, as the paper go into detail with. To make another loop to the story, the students *expectations* can also be directly linked to *identity negotiations*. To explore this loop I return to the first interviews from August 2012, where the students also formulated clear expectations to the *other students* in the study program. The expectations were linked to the small number of students in the study program, which were perceived to be a positive thing. Inge interpreted the small number of students in the program as a way of being something *special*. The people that do apply must be quite dedicated and have this special interest, she interpreted. The general idea was that the people who apply must be *geeky* when interested in rocks. This notion of being geeky can be followed through the interviews and all the students mention it. This way of having expectations to the other students in a study program played a role in at least two of the choice narratives; Sigrid's and Frida's.

Sigrid explained that she were both interested in *science* and *social science* and did actually apply for a *social science* program but cancelled the application in the last minute. Her reason were her view of '*the social science girls*' that were not entirely positive and she could not see herself in this social setting. She concludes that the students in geology must be more like her in terms of being interested in Nature and she expect that the study program has a nice social environment because of the 'down to Earth' mentality she expects. In Frida's choice narrative the view of the students in geology makes her choose another study program to begin with. She perceived the students in geology be too geeky and she could not see herself in this social setting and becoming a part of this culture. She applied for another program and first after graduating from an engineering program she decided to confront her own perception of a geology student and applies. These type of reflections show how *identity* and the expectations of *becoming a certain kind person* influence the students choice of study program. This also shows that the reflections on *becoming a geologist* has begun even before the students enter the study program. In the next section I dive into the students understanding of the academic culture and how their picture of the geologist changes during the first year.

Table 7: First year in geology at the University of Copenhagen. Modified from the course database: *sis.ku.dk*

	Block 1	Block 2	Block 3	Block 4
Course	Basic Geological processes and products	Basic paleontology	Basic sedimentology	Geology of Denmark
Content	Materials, basic geological terminology, plate tectonics and the Earth's structure, sample collection in the field, the material description	Fossil Formation, species classification, fossils as time markers, paleo-ecology, climate, environments, fossil biology and life history	Sedimentology, sedimentary rocks and sedimentary processes; lakustrine sediments; lectures on current topics.	Denmark's regional and historical geology, introduction to the basic principles of stratigraphy and basin geology.
Fieldwork	3 days	None	1 day (canceled)	6 days
Exam	Oral exam	Oral exam	Oral exam with preparation	Oral exam
Course	Basic Geophysics and Hydrogeology	Basic mineralogy and metamorphic petrology	Basic magmatic petrology	Field course 1
Content	Introducing the disciplines of geophysics and hydrogeology; basic introduction to different geophysical methods and their application, methodological possibilities and limitations and aquifers	The basic physical and chemical properties of minerals, an introduction to petrographic description and identification in thin section, and an introduction to metamorphic rocks	Basic physical and chemical processes for the formation of rocks, igneous petrography and petrology; introduction to analytical methods and laboratories	The focus is on the self-collection of geological and geophysical observations and data in the field and their subsequent treatment with a view to illuminating the area / site geological history.
Fieldwork	2 days	None	None	7 days
Exam	Written assignment with associated oral examination	Oral exam	Oral exam	Written assignment with associated oral examination

6.2 Academic culture: Geology and the geologist

The students meet both the subject matter and the academic culture when they enter the study program. The analysis of the students attitude towards and understanding of the subject matter shows that the students combine their understanding of the subject matter with the academic culture. In the second interview the students have difficulties with dividing the *subject matter* from what can be conceived as the *academic culture*.

In the second interview the students are asked to *describe geology with five words*. When the students describe the subject matter they automatically includes what could be categorized as the *academic culture*. Inge's words on post-it give a nice example of this combination, see table 8. Here she explains why she has chosen the words and it becomes clear that her understanding the subject matter is linked to both the academic and the social culture. The words she has chosen is in *italic* in this quote.

Inge: *Fieldwork* because it's what we have done and it's also what I would like to do when I'm done, go out in the field, I think that could be great (...) *Nature*, after I started, there have been a lot outdoor life [with the other students e.g. climbing trips] (...) I think that after I started, I remembered how beautiful a place nature is (...) it has been really nice (...) something like the world has become a more beautiful place, in my eyes (laughs) ... and then I have written *Community* [fællesskab] because there is a lot more cooperation in the study program, than I had in high school, we have almost been forced to write those reports in groups. *Inge, 2nd interview, p. 4.*

Inge's words and the connection between them shows how she mixes her understanding of the subject matter and the social life. *Fieldwork* is linked to her experience with doing fieldwork at Bornholm and linked to a future job, where she sees herself working in the field. Inge's next word is *Nature* and it is not directly linked to geology but the social life she experiences with the other students during fieldwork or when they arrange climbing trips. *Nature* is also associated with a feeling of joy that arrives when she is in nature and she describes that her experience of nature has changed after entering the study program. This notion of experiencing nature in a new way is also mentioned by the other student at this point in time. The students receives a new way of being, observing, and enjoying Nature. Inge's last word in this quote is being in a *community* with others directly linked to the social and academic culture in the study program, where the students work together and learn in study groups.

Table 8: Characterize *geology* with five words, from 2nd interview in October 2012

Student	Words on post-it	
	Danish	English
Frida	Altomfattende	Comprehensive
	Stort	Big
	Enkelt	Simple
	Aktivt	Active
	Interessant	Interesting
Anna	"Jordens oprindelse"	"Earth's origin"
	"Jordens" fremtid	"Earth's future"
	Bæredygtighed	Sustainability
Thor	Nede på jorden mennesker	Down to earth people
	Lækker meget feltarbejde	Nice with lots of fieldwork
	Sjovt	Fun
	Socialt	Social
Sigrid	Nørde sten	Being geeky with rocks
	Genkende bjergarter og mineraler	Recognize rocks and minerals
	Feltture	Field trips
	Naturens enorme kræfter	Nature's immense power
	Fede oplevelser	Great experiences
Inge	Feltarbejde	Field work
	Natur	Nature
	Fællesskab	Community
	Se på sten	Looking at rocks
	Naturkræfter	Natural powers
Aske	Læren om jordens/ universets oprindelse	The doctrine of the earth/ universe origin
	Grundstenen for al viden/ teknologi	The foundation of all knowledge/ technology

The analysis of the academic culture across the data material is linked to this perception that learning takes place when the students engage in groups or in academic discussions with the teachers. This reflects an established 'talking' or 'discussion' culture in the study program, where the assumption is that the students learn when working together. This implied culture also explains the teachers' feedback to Anna at the first exam, where they encourage her to find a new study group where she is able to *learn more*. This reflects the culture where the creation of *study groups* or *learning communi-*

ties is a high priority to the teachers. This approach to learning resembles the view of the communities of practice (Lave & Wenger, 1991) and might origin from the tradition where trained geologists take young geologists into the field and through this learn how to collect data and create interpretations, as the field courses do in the education. There are some tendencies in the culture about learning through *doing* and through *experience* geology e.g. when conducting fieldwork. The students experience this culture when being in the field and when engaging in discussions or getting feedback from the teachers. The approach to learning becomes a way of including the students in the academic culture and create the strong belonging, as Sigrid's story shows. Though it also creates some challenges for the students that find it difficult to belong to a study group or creating a productive group, as in Anna's case. The effect is that the strong academic culture around learning in groups affects the students and create a pressure of belonging to a group to be able to succeed in the study program.

When we return to look at all the students' words in the post-it exercise from the second interview round (table 8) it is clear that all the students shift between words describing the subject matter and the social and academic culture, as described in detail with Inge's words. When analyzing the second interviews it becomes clear that the students are absorbed in figuring out what the subject matter is about and finding a place in the social life, which offers the explanation that the students just cannot see the difference. This would also explain the challenges to get good descriptions of the subject matter from the students at this point in time.

The students are, however, able to give a detailed picture of how they see *the geologist*. They characterize the geologist on the basis of the teachers, the older students, the other new student, to some extend the *stereotype*, and themselves. In the first interview, in August 2012, some of the students express concern about the other students being geeky and not social, as the geeky stereotype implies. The first few weeks in the study program where the students engage in fieldwork and they meet others with similar interest the term of the *geeky geologist* is transformed into a *passionated storyteller*. The students meet engaged teachers and older students that help them during the first few weeks, that makes the students change their perception of the geologist. The geeky part is still present but now more positively expressed, being a geeky geologist means that you are so absorbed in the subject matter that you cannot stop talking about it and everywhere you go, you observe the surroundings and become eager to explain about it. In table 9 all the students words are listed and there is a theme around being *patient*, *curious*, and *relaxed*.

Table 9: Characterize a geologist with five words, from 2nd interview in October 2012

Student	Words on post-it	
	Danish	English
Frida	Fokus på detaljer Udendørsmenneske Lidt nørdet Nysgerrig Tålmodig	Focus on detail Outdoor person A little geeky Curious Patience
Anna	Opslugt Levende High on life Omrejst Åben	Being absorbed Alive High on life Traveled Open
Thor	Meget nørdet Lidt hippieagtig Down to earth Aldrig bleg for en fest Glade mennesker	Very nerdy Kind of hippie-like Down to earth Never afraid of a party Happy people
Sigrid	Analysere og fortolker data Fjällravs bukser (jordnær) Lidt meget nørdet (på den fede måde) Vigtig ressource for samfundet	Analyze and interpret data Fjällravs pants A little geeky (in a good way) Important resource for the society
Inge	Afslappet Rejsende ”Stolt nørd” Observere omgivelser Venlig, men måske lidt kynisk?	Relaxed Traveling ”Proud nerd” Observe the surroundings Friendly, but maybe a littel cynical
Aske	Afslappet Tålmodig God til at fordybe sig ”Nede på jorden”	Relaxed Patience Good at immerse themselves ”Down to earth”

Here Aske explains how he sees the connection:

Aske: I have written *Relaxed* and "*Down to earth*" it goes together because geologists are in no hurry, "what is there today, is most likely still there tomorrow", in the same context, I have written *Patience* because it takes a long time, again, with processes if you think about tectonics, plate tectonics and stuff like that, it moves two centimeters per year, as I said what is here today, it is probably there tomorrow too, and then you have to be *Good at immerse yourselves* [for dybe sig] as a geologist, you must be good at analyzing and say, "I want to figure it out, even if nobody else who knows the answer", that is how I'd say a geologist is. *Aske, 2nd interview, p. 7.*
Aske leaves the interview study after this second interview round.

Aske also describes that sometimes it can become a bit too relaxing and he becomes impatient when the teacher use too much time to explain different terms during class. Frida also experience becoming impatient, recall Frida's negotiations, when asked if she can see herself becoming a geologist, "*yes, to some extent ... I'm not patient, but I am very detail oriented and I'm very stubborn*". (*Frida, 2nd interview p. 16.*)

This shows that the students are able to connect the subject matter to a specific type of person or *a geological identity*. The students link their understanding of the subject matter e.g. *collecting data* in the field and the characteristic of a geologist e.g. the geologist need to be *detail oriented* and *patient* to be able to collect the data. Creating this image of the geologist is a way of making sense of the subject matter and the effect is the development of a scientific identity in geology, that the students are able to negotiate themselves in relation to.

The students also characterize a geologist as an open, traveled, happy, and friendly person, which can be seen as a reflection of a good atmosphere and social life at the study program. So the characterization of the geologist can both be seen as a way of making sense of the subject matter and the academic culture in the study program. This creates a strong link between the culture and the subject matter.

When applying this connection between the subject matter and the culture to the students identity negotiations, it becomes clear that the students negotiations is based on both the subject matter *and* the culture. This extends the conclusions in the paper when understanding that the students negotiations is not only linked to *the understanding of the subject matter* but also *the academic culture in the study program*. The paper focus on the students way of making sense of the *subject matter* and illustrate the *identity negotiations* linked to this. In this extended analysis it was possible to apply *culture* and then extend the conclusions already made.

With this I am able to show how *identity negotiations* take place before entering a study program, how the negotiations influence the choice of study program, how the students extract a geological identity from the culture, how the students continually negotiate their identity in the first study year, and how the negotiations create different paths through the first year.

7 Discussion

This research has provided a peak into first year students' negotiations of subject matter and identity. The discussion focuses on exploring the two research questions in greater detail based on the points from the paper and the extended analysis. This research has applied *identity as a methodological lens* to explore the students' stories and the effect of this approach is discussed too and finally I discuss the narrative method.

7.1 Making sense of geology

The analysis shows that the students make sense of the subject matter on the basis of their understanding of *science* that also influence the divide the students create of the subject matter. The divide between the *hard rock* and *soft rock* geology create a framework for the students' negotiations of the subject matter. All the students create the divide of the subject matter in their stories and when analyzing figure 2 (timeline of the students stories) from the paper, there are some clear tendencies in the stories. There is a significant increase in all the students negotiations when they enter block 2. The students negotiations are linked to making sense of the subject matter and the teaching. The students talk about difficulties with navigating the textbook and figuring out what the intended learning outcome should be, as Frida's story in the paper highlight. The students get quite frustrated and the interviews create a picture of students trying to understand *why* they need to learn all the chemical formulas and the fossils. The frustrations are in the foreground of the students' stories and of course not a pleasant feeling, though the frustrations can be signs of *learning*. Frida gets quite frustrated with the scientific method and the way the observations are transformed to interpretations. In the fifth interview she arrives in a place where she is able to see beyond the frustrations and look back at the frustrations in a new way. Here Frida reflects if the frustrations need to be a part of the learning process.

(...) I do not know if we would have been able to make the evaluation [of the interpretations] earlier, if they had given us the information about what [data], the conclusions was based on, I don't know if I could have used them before now, or whether there should be that period with frustrations, before

you know enough to be able to do it [make the interpretations] on your own.

Frida, 5th interview p. 26.

At this point in time Frida has realized why she became frustrated with the scientific method and reflects further that: "*it is probably also different, how you deal with it [the frustration] (deep breath), but yes, it had helped me a lot if there had been some a background information*". (*Frida, 5th interview p. 26*). Frida questions if the frustrations need to be there to learn but at the same time she sees that it could have helped her if the teaching had been more transparent in terms of showing *how* the interpretations were carried out. She experiences this during the fieldwork in the end of the academic year but perhaps she could have avoided some of the frustrations earlier. The analysis of the students stories show that the frustrations with the scientific method start negotiations of the subject matter and at the same time the students negotiate their geological identity. The link between frustrations, negotiations, and developing a scientific identity arrives from analyzing all the students' stories. The timeline of the students stories in figure 2 show the 'result' of the students stories by indicating to what degree the students negotiate in the fifth interview at the end of the academic year. The degree of negotiations can be interpreted as *degrees of geological identity* or to what extend the students see themselves *become a geologist*.

Thor and Inge's stories end with few negotiations and a clear image of becoming a geologist. They are both determined to become a special *type* of geologist and picture themselves in a future job. Frida's curve is placed a bit higher on the scale because she is not *as* determined as Thor and Inge but still she picture herself becoming a *hard rock* geologist. At the end of the academic year Sigrid has not found her place definitively but see herself become a geologist within sedimentology or paleontology. Anna is interested in the *soft rock* geology too but negotiate the subject matter still and her identity negotiations are not in the foreground in her story.

In spite of her frustrations Frida learn the subject matter and perhaps *because* of the frustrations that lead to *negotiations of identity* she develops a strong geological identity. So her frustrations and negotiations are intense, though transformed into a strong identity. In this way making all her struggles worthwhile. Anna's negotiations do not result in a strong geological identity and thus not transformed. The great difference between the stories is the *recognition* Frida receives and the struggle Anna experience when trying to create *belonging*. Both Anna and Frida negotiate more than the other students though Frida's negotiations are linked to the *subject matter* and Anna's are linked to *creating belonging*. So frustrations and negotiation *can* create strong identities *if* they are linked to the subject matter.

The students negotiations of the subject matter is linked to understanding the *scientific method* which must be conceived a valuable negotiation in any academic discipline

and perhaps the negotiations of exactly the *method* is the key to understand why the students develop strong geological identities. Anna's story shows how frustrations and negotiation linked to other aspects of becoming a student e.g. creating a good study environment in some way limit the negotiations of the subject matter and this affects the identity negotiations in relation to becoming *a geologist*.

Frida's story show that negotiations of the *subject matter* can result in a strong science identity and in the other end of the spectrum Thor's story show how a student with *few* negotiations *too* can develop a strong geological identity. What the two stories have in common is *recognition*. Thor's passion for the specific field has given him contacts among the teachers, that encourage him to pursue his goal and in this way Thor receives recognition. The recognition is not linked to making sense of the subject matter it is linked to the specific interest and goal, which turns out to be a recognized path for Thor to pursue. The students' stories show how it is possible to transform frustrations into strong identities when being recognized and in this way making the struggles worth it. In the next part of the discussion I go into depths with this when discussing how the *analytical identity lens* give a view into this process.

7.2 Using identity as a lens

Identity has been used in numerous of studies as an analytical tool (figure 6) and has proved to be able to show how students engage in science, why students choose science, what it takes to develop a scientific identity, how teachers and the academic culture influence students possibilities of constructing identity, as shown in section 4 where the theoretical framework is presented.

The paper zoomed in on the students' negotiations of subject matter and how this created a framework to negotiate identity. The extended analysis applied the cultural perspective and showed how the students continually negotiate identity before entering and during the first study year.

This give two different views into the students identity negotiations, where the paper is able to show how students *make sense* of the subject matter by negotiating identity and the extended analysis show how *choosing* a science program and continually *develop into an academic culture* is a identity negotiation. Both views arrive when applying the identity lens and give new answers to the research questions.

If another type of analysis, e.g. '*how first year students make sense of the subject matter*' had been conducted it would possibly have found the same divide of the subject matter in the students understanding. It would have been able to show how the students talk about the subject matter in different ways and show how their interest divide the students in different directions. Without the *identity lens* it might not have been possible to analyze *why* the students created the divide and understand *how* the students'

negotiations of themselves as becoming a science person conflict with a geological science that *interprets*.

When analyzing the students' struggles to make sense of the subject matter the identity lens offers an opportunity to understand the reasons behind. Without the identity lens the conclusion could point in the direction of the teaching, the students' knowledge, the students' background, and the teachers when attempting to analyze the students' struggles. Applying identity made it possible to see beyond the teaching and beyond the frustrations and explore *why* the frustrations with the subject matter occur.

Some of the frustrations do occur in direct relation to the teaching or planning of teaching e.g. when they students find it difficult to make sense in the first part of block 4 because they have few hours of teaching and the plan for the fieldwork were not communicated to them. Then frustrations occur directly linked to the planning of the teaching and here the identity lens again makes it possible to seek out these frustrations and categorize them as 'frustration with planning' and not 'struggles to make sense of subject matter'. In this way this thesis is able to see beyond frustrations with teaching and planning but to zoom in on the students *understanding* and *learning* of the subject matter, as suggested by Maria Varelas (2012). The use of identity *does* take us closer to understand students and their paths towards succeeding in science.

7.3 Methodological discussion

This research as all qualitative research has some limitations founded in the nature of the research method where the search for meaning in the data requires many decisions from the researcher. I have tried to make my methodological decisions transparent to secure *trustworthiness* in the process. Here I discuss the method used and highlight the advantages and the challenges with the narrative method.

When using a narrative approach to the interviews my data totally depended on what the students wanted to tell me. The stories represent snapshots into the students' lives and show pieces of identity and become examples of the identity development the students have started in geology. The use of narrative interviews, however, proved to be beneficial because it provided a space for the students to tell anything important to them at the different points in time. The successive interviews provided a window to explore how the stories *change* during the academic year. The five interviews with each student created thick descriptions and the analysis presented above only includes a small part of what could have been extracted from the stories. The specific research questions lead the way through the great amount of data, which must be perceived as the most important thing to be aware of when conducting this type of research.

The combination of *inductive* and *analytic* analysis created a foundation for the conclusions of this research. The *inductive analyses* of the interviews were conducted after each round of interviews throughout the academic year in the form of the thematic analysis.

These analyses provide insight *vertically in the dataset* at the different points in time. When the full dataset was collected the *analytic processes* could draw lines *horizontally across time* in the students stories. The combination of these approaches created a reasonable foundation to construct the conclusions presented.

The choices of taking the students view only create obvious limitations in the way that this research cannot show the surrounding academic culture in depths. The academic culture has been analyzed through the students' stories and not observed or explored with other views that might create a more complete picture of the academic culture in the study program. The stories the students tell about their experience with the culture is the only view into the culture this research provides. In this way the cultural aspects become interwoven in the students negotiations. One way of strengthen the conclusions would be to include a cultural aspect in the data collection e.g. through observations of teaching, interviews with teachers, or interviews with older students that have become a part of the academic culture.

8 Conclusions

This thesis has provided a peak into the complex processes of learning and developing identity during the first study year in a university science program. The aim with this research has been to 1.) Explore how the first year students negotiate and make sense of the subject matter during the first study year and 2.) Explore how the concept of *science identity* can be used to understand the students' development in a specific scientific context. The analysis of students' stories shows that the students understanding of geology begins by making sense of the *scientific method*. The students experience two different scientific methods in geology and thus create a divide of the subject matter. The divide of the subject matter becomes the starting point of understanding the subject matter and defining different types of geologists. The *identity perspective* adds a dimension to the stories and show how the students at the same time make sense of themselves in relation to the disciplines they experiences in geology. Thus creating a strong link between making sense of the subject matter and identity negotiations. With this perspective it becomes clear *why* the students struggle to make sense of the subject matter because they, at the same time try to negotiate themselves in the subject matter. This makes it possible to see through the frustrations and see that they are linked to their understanding of *science* and their development of *a geological identity*. Being *recognized* proves to be important when the students to make sense of the subject matter and when the students construct *a geological identity*. This research help us understand *why* the students struggle with the subject matter and it helps us to see the students as engaged persons that negotiate themselves into the subject matter. The negotiations create different paths for the students on their journey of *becoming geologist*.

9 Implications

The implications of this research could be many here I have chosen three dimensions. First I present some methodological considerations for future research and some ideas to the future use of *identity* in science education. In the last part I describe some implications for the study program at the University of Copenhagen.

The longitudinal narrative method used in this research gives access to detailed stories that develop through time. The successive interviews made it possible to analyze how the students' stories changed through the academic year, as they meet different courses and made sense of the subject matter. This research succeeded in getting detailed descriptions of the subject matter including the scientific method, which turned out to be a central theme in the students' stories. The aim with this research has been to zoom in on the specific field of geology and show how this approach creates new stories of developing identity in a specific field. This approach showed how *identity negotiations* are closely linked to *understanding the subject matter* and thus creating a framework to understand the students' struggles in the first study year in a specific study program.

This research adds to the research in *science education* by pointing out *how different* the science disciplines within the field of science are. The conclusions of this work applies to *geology at the University of Copenhagen* and not necessary to chemistry or biology, as pointed out in the discussion about the *gap* between students expectations and what they meet in a science study program. The disciplines in science have different histories, traditions, and different academic cultures even the *scientific method* can be understood differently, that is at least what the students in the first year of geology experience. A way of exploring this in more detail could be to research other geology departments and explore if the conclusions truly are linked to *the subject matter of geology* or the conclusion only apply of this specific study program at the University of Copenhagen with the specific conditions for teaching and the academic culture that can be found here.

The research can point at some implications for the geology study program at the University of Copenhagen. The students overall experience with the study program are *positive*. The students feel included in the academic culture where the close relationship with the teachers becomes important. All the students in this research create a sense of *belonging* and some even *strong geological identities*. This is possible in a social environment where the students are able to ask questions and feel that the study program wishes for them to thrive. The paper shows how important the *fieldwork* is when the students make sense of the subject matter. The obvious implication of this is to *maintain the focus on fieldwork* in the study program and in no way neglect the importance of this.

To take this point even further, the study program could put even more emphasis on the fieldwork and attempt to be more explicit about *how* the fieldwork is a part of *the scientific method in geology*. The students experience from the beginning that the fieldwork is a central part of the study program and the academic culture. The students recognize the importance of the fieldwork but finds it difficult to figure out *in what way* fieldwork is conducted and how the *interpretations* are made. The study program could benefit from explaining this in more detail as this might limit some of the students' struggles with making sense of geology and possibly prevent that e.g. sedimentology is perceived to be non-scientific. One aspect this study program really succeeds in is being able to *see* the students, giving them concrete feedback, and even *recognizing* the students. This research shows how important recognition becomes when the students struggle to make sense of the subject matter and this particular study program actually succeeds in doing this to some extent.

The research represents a *positive story* of creating belonging and scientific identities in a higher education science program. This study program provides the students with knowledge, great experiences, and the possibility to create a scientific identity. When exploring this study program in detail the positive stories emerge along with the challenges and this creates a framework for improving the study program and create an even more attractive education for young people to choose in the future.

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