An Investigation on the Role of Identity in Students' Representational Discourse

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Abstract

This thesis investigates how students negotiate identity in school science discourse when working with representations. This thesis is written as part of the REDE-project, which conducts research on the use of representations in school science, in order to create resources for teaching. In this thesis, the aim is to investigate how students in upper secondary school negotiate identity in the subject of natural science. I achieved this through investigating different performances of student identity, as well as a number of states that detail the nature of students' discourse. In this thesis, I considered identity something that can be performed in social interaction, rather than something a person possesses. I used data from video observation and student interviews from a Natural Science class in Norwegian upper secondary school for analysis. I have analyzed four groups of Natural Science students and how they perform identity in a group drawing project centered around the greenhouse effect and global warming. I constructed a framework for analyzing three different student identity performances, *Assessment Performance, Behavioral Compliance and Muscular intellect*. In tandem with these, I also used another framework for analyzing the students' discursive identity status, ordered into four states of increasing incorporation of science in discourse. The results show that the students focused on making a representation where everyone in the group contributed and where the representation was easy to understand for other students, however the students did not associate their drawings or methods with representations in "real" science. Their negotiation in making the representations was closer to a school science approach that valued comprehension before scientific complexity. The results also show that students could negotiate to gain power and recognition within the group. The findings from this thesis show that students are possibly more connected to the school version of science culture, and that they incorporate everyday and "real" science identity elements only to a small degree in their representations. The identity performances and states I present only demonstrate a few of the characteristics of students' identity negotiation, but nevertheless contribute to the students' discourse. The findings can be used to further research in student discourse and in the interplay of everyday, school and science culture.

Preface

I wish to thank my supervisors, Tobias Fredlund and Mai Lill Suhr Lunde, for helping me reach my goal, as well as providing the necessary goalposts. You have been a great help. I also thank Erik Knain and the rest of the REDE group for providing additional insight and a "home" for my thesis. I thank my fellow students Marthe, Silje and Camilla, for the support they provided, as well as everyone keeping me company during late evenings of writing. Finally, I thank my parents, Mary Ann and Rolf for all the patience and emotional support I have been given in my most hectic periods.

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1 Introduction

In a report on the natural science subjects from 2015, the Norwegian Directorate for Education and Training argued for the need for more scientific competence in a world increasingly dependent on technology (The Norwegian Directorate for Education and Training, 2015). An issue is that the school subject of natural science is not prioritized by students enough to meet the demands of today's science and technology-rich society, meaning more students should pursue a career in science (The Norwegian Directorate for Education and Training, 2015). However, even if a career in science appears favorable, being labeled and identified as a student that focuses on science may not (Francis, Skelton, & Read, 2010). Students turn away from science as they progress through school, often because of the simple but nondescript reason that "it's not for me." (DeWitt, Archer, & Osborne, 2012). It may seem like students do not pursue a science education simply because they "don't feel like it." However, Schreiner and Sjøberg (2007) argue that it is not students' interest in science that is the problem. Students want to be interested in science, but the science presented to them in school becomes a separate "world" that many of them find it hard to relate to (Kozoll & Osborne, 2004). In short, not all students identify with the culture of school science. One cause for this may be the impression of science as a difficult subject (Archer et al., 2010; Osborne, Simon, & Collins, 2003). While difficult or complex concepts within science may be challenging to students, the learning process can be facilitated by the use of representations (Ainsworth, 2008; Tytler, Prain, Hubber, & Waldrip, 2013). Working with representations is just one way students can learn science concepts (Knain, 2015). In this thesis, I will investigate what role identity could play in students' use of representations.

1.1 Thesis Statement

In support of the REDE-project's focus on representations, and the multifaceted process that students undergo in argumentation related to issues such as global warming, I focus on the communication of self that students deliver through their negotiation. The purpose of this thesis is given by the following statement: I will investigate how students in upper secondary school negotiate identity when creating visual representations in the natural sciences topic of climate change. I present two research questions to help answer the thesis statement:

- What identity performances did the students exhibit during their work with representations?
- What discourse states were demonstrated by students when working with representations?

To my knowledge, there is little existing research in the field of the thesis statement. Identity is a popular topic within research focusing on the sociocultural dimension of science and students' impression of the nature of science (e.g. Archer et al., 2010; Brickhouse, Lowery, & Schultz, 2000; DeWitt et al., 2012; Kozoll & Osborne, 2004). Representations, and how students work with constructing them are also relevant topics in research focused on learning school science (Ainsworth, Prain, & Tytler, 2011). I argue that students form an identity as they construct their representations. Representations exist as concrete, visually distinct entities that make science concepts explicit to the reader, such as diagrams, photos and experimental models (Evagorou, Erduran, & Mäntylä, 2015). Identity, on the other hand, is dynamic, changing from one social situation to the next, created in moments of social interaction (Oyserman, Elmore, & Smith, 2012; Pozzer & Jackson, 2015). I have limited the scope of my thesis to the upper secondary school level and the topic of climate change, as it accommodates the context of research in the REDE-project, which I will present in the next subchapter.

1.2 The REDE project

This thesis is part of the REDE-project, REDE meaning "Representing to learn in science education" (Knain, Fredlund, et al., 2017). It is presented in short as:

> [The] design-based research project Representations and Participation in School Science (REDE), which aims to investigate new aspects of how representations create learning and teaching opportunities in school science in lower and [upper] secondary school. (Knain, Fredlund, et al., 2017, p. 1)

The project aims to support scientific literacy, and how it leads to participation in scientific discourse, but first and foremost learning through the use of representations. Its objective is to develop web resources that focus on representations in Natural sciences in Norwegian secondary school, with guides and recommendations for teachers, as well as for teacher students. REDE focuses on representations in three "modules": Content knowledge, Socio-scientific Issues (SSI) and the Nature of Science (NOS). REDE is partnered with three schools that provide an arena for collecting data on students' and teachers' experiences in working with representations and representation-based teaching design. The data is collected through video observation and interviews. In this thesis, I used the two latter methods to collect data, and while my thesis statement does not directly belong to a certain REDE-module, it is related to students' discourse and their relation to science as a culture.

1.3 The context and relevance of the theme of climate change

The Norwegian national curriculum demands that students consider the topic of climate change (The Norwegian Directorate for Education and Training, 2013). The focus on climate change is a product of the central competence aim of sustainable development, where students should recognize phenomena that lead to global climate changes, such as the greenhouse effect. They should also be able to consider challenges tied to the consequences of climate changes, such as increased temperature, and investigate global and personal environmental issues and solutions (The Norwegian Directorate for Education and Training, 2013). Notably, this topic is grounded in society and culture due to related themes such as sustainable development and greenhouse gases (The Norwegian Directorate for Education and Training, 2015). This makes global climate change straddle the line between social and natural sciences, and the cross-compatibility of natural and social sciences in this subject area is emphasized in the Norwegian curriculum (The Norwegian Directorate for Education and Training, 2013).

Global climate change and the REDE project is also related to how students learn science concepts and theories, as well as socio-scientific issues (SSI) An SSI is a science topic particularly angled towards a societal approach and conflicts of interest that are meant to be discussed, having no concrete, definable answer (Knain, Fredlund, et al., 2017). SSI have also been shown, by Sadler, Klosterman, and Topcu (2011), to have positive results on students' science content knowledge within the topic of global climate change. In contrast to the previously mentioned objectivist image of science, SSI like global warming require students to be able to make decisions and discuss contemporary controversies (Kolstø, 2001). This means that students' identity negotiations may incorporate elements from outside science culture, in an effort to connect the topic with experiences outside the classroom. Consequently, students may negotiate climate change using a blend of everyday and scientific identity markers. Knain, Remmen, and Fredlund (2017) demonstrates that representations tied to SSI help students evolve their discourse and use the representations to build their arguments in the SSI debate. Conversely, through inquiry, students may develop their own representations to become closer to a theoretical model, and thus a more accurate depiction of the scientific phenomenon (Fredlund, Knain, & Furberg, 2017).

1.4 Thesis structure

Now that I have presented the thesis question in brief, I will elaborate on existing theory to form a context and attempt to define the different terms of the thesis statement, notably “Identity,” “Negotiation” and “Representations”. Next, I will use identity theory to construct a framework for analyzing students’ identity negotiation. I will bring the framework into the method chapter, where I present the classroom setting and method for data collection and analysis. I will then attempt to operationalize the analysis framework. Finally, I will present results, along with discussion of relevant cases, before presenting a general discussion and implications for further research.

2 Theory

In this section, I will first attempt to define and elaborate upon the characteristics of representations and the constructions of representations, scientific literacy, identity, negotiation, and discourse within a science context. Lastly, I will present theory to support a framework for analyzing the different characteristics of students' identity negotiation.

2.1 Defining representations

In school science, representations are necessary tools to help students learn science. The effects of representations on students learning has been repeatedly shown to be positive, or rather they have the potential to be positive, as there are a lot of prerequisites before learning can be optimized (Ainsworth, 2008; Cook, 2006).

The term "representation" is often likened to mean an object. Conversely, representation is also a process and a medium for cultural and semiotic communication (Lemke, 2010). In general, representation as a term blurs the line between a concrete tool and a phenomenon depending on how it is defined. This does not mean that "representation" is necessarily difficult to define without being applied to a specific context, as I will argue is the case for identity. Representations are described by Tang, Delgado, and Moje (2014) as:

> artifacts that symbolize an idea or concept in science (e.g., force, energy, chemical bonding) and can take the form of analogies, verbal explanations, written texts, diagrams, graphs, and simulations. (p. 306)

As I show in the method section, the data and analysis, as well as the REDE project as a whole, focus on a more narrow set of representations, in the form of concrete images. I will consider the subgroup of visual representations as the focus of this thesis. This aids in lessening ambiguity about what a representation is, as entities of text and words, such as student talk, are defined by some to mean representations as well (e.g. Tang et al., 2014). In that sense, what I mean by representations is a certain subgroup of representations. Examples in this subgroup of visual representations include photos and drawings. In short, an image or figure in visually perceived space.

I will also consider the word "representations" interchangeably with terms that serve a similar purpose from a theoretical perspective, such as "models" (Gilbert, 2005). In Gilbert's context however, “model” is treated as a cognitive construct (2005). Instead, I choose to focus on a more sociocultural approach to representations. The reasons for this are mostly tied to the nature of representations in the context of science in the classroom, and by extension, the REDE project’s focus. The REDE project is concerned with scientific literacy, for which representations are a central part (Knain, Fredlund, et al., 2017). “Visualization” is likewise treated by Gilbert as more of a cognitive processing of representations that, regardless of how concrete they are, have yet to be presented “on paper” (Gilbert, 2005). I abandon any deeper theoretical explanation on representations not tied to interaction or expression; Even if mental representations and visualization may contribute to scientific literacy (Gilbert, 2005), I consider it more of a preliminary stage to the concrete representations we are working with in practice. Indeed, Evagorou et al. (2015) argue with a theoretical analysis of a case study focused on scientific practices, that purely cognitive processing of representations should be linked more to context and communication. In their conclusion, they argue that: “the emphasis in visualization should shift from cognitive understanding […] to engaging in the process of visualization.” (p. 11). This stands in contrast to Gilbert’s cognitive view of visualization. Common to both however, is the argument that visualization should be defined as more than simply presenting an image for the sake of information. In that regard, “visualization” would be closer to a process, and the verb form of representation, rather than concrete images.

2.1.1 Representations as semiotic resources

Research on representations has been shown to have shifted its consideration to include learning *with* representations, rather than *from* representations, in later years (Tippett, 2016). This entails a more outwards application of representations, in that they can be used as tools in reasoning and communication, both in the construction process and as a medium. Overall, it allows for a flow of information and understanding that does not only flow between the representation and the reader, but also between people (Evagorou et al., 2015). In a social context, representations could thus be seen as semiotic resources, as I will argue here.

The foundation for the semiotic theory used for this thesis originates from Halliday (1978). While his theory on social semiotics is mostly focused on language, representations can be argued as related to language as semiotic tools. Halliday states that: “Social interaction typically takes a linguistic form, which we call *text*.” (Halliday, 1978, p. 125). Thus, text can be interpreted as just another form of representation. Furthermore, a representation can consist of several components of different modes, such as a picture with accompanying text, making it a multimodal representation (Tang et al., 2014).

Social semiotics in broad terms, aims to explain meaning making as a product of semiotic practice in a social context, as put by van Leeuwen (2005): “[…] social semiotics explores two closely related issues: the material resources of communication and the way their uses are socially regulated.” (p. 93). Thus, while it is obvious that a visual representation, such as a picture, does not itself communicate the same way people do towards each other in dialogue, it could be considered one such material resource. The communicative nature of semiotic practice consequently ties the representation resource to our use of language. The relevance of representations as semiotic resources comes to light when we consider language a component in discourse and interaction between students. Students’ language, words and talk are not the only ways the language of science can be used in discourse. The students’ discourse can translate their science argument from language to visual representations and actions as well (Lemke, 1998).

A semiotic perspective on representations and student discourse is useful for distinguishing between a negotiation in talk only and one using visual representations as a resource. In science proper, using and making representations is common and a natural tool for argumentation. The same cannot be taken for granted in school science, however. This is argued by Evagorou et al. (2015) as a need to bring the practices utilization of representations in “real” science to the science classroom. They do emphasize, however, the necessity of proper scaffolding and guidance to positively affect student learning, an argument shared with Tytler et al. (2013). Through a longitudinal study of teachers employing a model of representation construction focus, they found that teaching with this emphasis on representation construction helped students to familiarize themselves with the process of representation construction, and use it to attain deeper learning in central ideas in school science. In the same vein, Knain (2005) shows, through students’ experimental reports, that a student who has familiarized themselves with the characteristics of “being scientific” (p. 617), has an easier time writing in science as a genre.

2.2 The concept of Identity

2.2.1 Identity in science education research

The study of identity has been carried out in a number of ways, stemming from a need to define identity within a specific discipline or culture: Identity is formed by people as a result of cultural influence, and each culture has its own characteristics that help form this identity (Cote & Levine, 2002). When the phenomenon of student identity is applied to science education, students are often measured against a science culture (e.g. Aikenhead, 1996; Kozoll & Osborne, 2004; Taconis & Kessels, 2009). Like culture, identity in science education can be considered a subcategory of identity, rooted in, but still distinct from identity in general. Both teachers and students are members of the culture of science education, and are, unsurprisingly, the two main groups focused upon in identity research (Pozzer & Jackson, 2015). Within these two groups, a majority of research studies focus on the building and display of identities, which is highly relevant for student-student or teacher-student interactions (Pozzer & Jackson, 2015; Shanahan, 2009). Furthermore, when focusing on student identity, there is often an emphasis on how students encounter the cultural characteristics of school science. Challenges in research in this area of school science is typically the same issues students face when interacting with the culture of science and said cultural encounters (Aikenhead, 1996). Research shows that a challenge with the culture of science education is its alienation to other cultures, and consequently other identities (Aikenhead, 1996). Like students' everyday identity, which stems from an almost supremacist objectivity-based science culture, this alienation has become a trademark of the stereotyping of science (Aikenhead, 1996; Ziman, 1998). Other challenges posed by research studies include ones more focused on how science is applied to school culture, often focusing on students' personal issues that arise within the classroom. A common topic is the issue of "equity" – differences and struggles in groups with higher or lower positions of power (Barton, 1998; Brickhouse et al., 2000). For teacher-student relations, the power discrepancy is often apparent, as the teacher is automatically considered in a position of higher power. I will also elaborate on power as a motivation later in this chapter. For comparisons between students, differences between individuals in a science classroom are commonly examined with respect to different identity factors, such as gender, social background or scientific aptitude (Aikenhead, 1996; Barton, 1998; Brickhouse et al., 2000). A common reasoning in research is that these groups create conflicts of interest, and certain groups are marginalized as a result of not aligning with the culture of science (Brickhouse et al., 2000). As a consequence, the objective of equity is often mentioned as an important goal for school science (Johansson, 2015).

From this subchapter, Identity gives the impression of a vague construction, loosely tied to culture. Defining identity in general would require a definition too broad for this thesis. Even within the realm of science culture, “doing” science and “being” a scientist are two different perspectives (Archer et al., 2010). In a more general interpretation, defining identity either as something people do or something they have may be divisive, but focusing on one without acknowledging the other would be analogous to ignoring the multifaceted nature of identity (Pozzer & Jackson, 2015). In the following subchapter, I will attempt to approximate a definition of identity that best serves the thesis.

2.2.2 Defining identity

The term “Identity” in research studies is often defined from the study’s context. On the one hand, it is often narrowed down to apply to a specific setting, e.g. science education (Shanahan, 2009). On the other hand, identity can be divided into its different factors (such as gender, race or social class) (Gee, 2000). In other words, it cannot easily be defined without a context. There is a general consensus throughout the history of identity in education, that identity is created within social contexts, and is not isolated within a person (Shanahan, 2009). In other words, identity is a concept in the sociocultural dimension. As with representations, identity can potentially be approached from a cognitive perspective, and can be seen as something processed extensively within the individual. Even then, identity moves cyclically between the internal cognitive and external social dimension, and this internal processing of identity ultimately culminates in social expression (Cote & Levine, 2002). Furthermore, within the sociocultural dimension, identity can be decomposed into concepts based on self and culture (Cote & Levine, 2002). The term “Self” may appear similar to identity on the surface, and in research, the two words are often used interchangeably (e.g. Cote & Levine, 2002; Kozoll & Osborne, 2004). Oyserman et al. (2012) state that, “Self and identity researchers have long believed that the self is both a product of situations and a shaper of behavior in situations.” (p. 70). This may resemble a sociocultural perspective on identity, but Oyserman et al. (2012) also addresses the issue of self and identity as different concepts. Overall, research studies comparing self and identity are far from unified in their definitions. Even so, a general assumption in the relationship between self and identity is that identities can be numerous, and are all contained within the self (Oyserman et al., 2012). Identity is also considered by Oyserman et al. (2012) as dynamic and context-dependent.

While the components of identity can vary depending on social context, identity have two recurring facets in identity theory that make up its whole: One connected to the identity-holder, and one to interactions with other individuals or the culture, e.g. Personal/ego and social identity (Cote & Levine, 2002), or possessed vs. negotiated identity (Pozzer & Jackson, 2015). They all mirror the duality of “doing” versus “being” identity (Archer et al., 2010, p. 621). Negotiated identity detaches the concept of identity and treats it as something that is expressed to others. In this view, identity is something we do, and does not exist unless we engage in some kind of meaningful social interaction (Pozzer & Jackson, 2015). More precisely, Pozzer and Jackson (2015) writes that:

> We do not possess an identity or any part of it independently of our interactions with others; it is in and through interactions with others that we become a self, that we construct identity. (p. 220)

Since the negotiated identity is a product of interaction, it presents identity as something dynamic: it is ever-changing, always deconstructed and reconstructed, and never a finished product (Oyserman et al., 2012; Pozzer & Jackson, 2015). This is because, even if an identity has been established by a student, it will change the next time he or she engages in interaction (Pozzer & Jackson, 2015). Another way to interpret Pozzer and Jackson’s (2015) approach is that identities are unstable, and can be understood as a “performance” that is acted out a little differently every time it is put on the stage – here the science classroom (Archer et al., 2017; Barton, 1998). In a similar way, Gee (2000) defines identity as, “Being recognized as a certain "kind of person," in a given context” (p. 99). His emphasis on recognition implies that the performance must be received by someone in order to be meaningful. Put differently, the performance of negotiation requires an audience to interpret the identity put forward in the performance, or there will be no identity to perceive and negotiate. Gee (2000) presents a need for an “interpretive system”, something that functions in the same way as the aforementioned audience, but as a context instead of the people themselves:

> The interpretive system may be people's historically and culturally different views of nature; it may be the norm, traditions, and rules of institutions; it may be the discourse

> and dialogue of others; or it may be the workings of affinity groups. (Gee, 2000, pp. 107-108)

I will refer to Gee's interpretive system (Gee, 2000) as an identity system, as it defines the domain where associated identity negotiations are relevant. A person in an identity system can be recognized through their discourse, actions and ways of being as they are performed, and associates them with his or her identity. Additionally, the system often dictates what traits make up people's roles, or positions in the system (Gee, 2000). As an example: an upper secondary school science student can express his or her knowledge of the curriculum at every opportunity, and flaunt his or her high grades. However, the student will not be considered a "science person", unless there is some receiving party in the system, like a teacher or fellow student, that recognizes their performance. Those with a position of authority within the identity system of science would thus recognize those who present an attempt at scientific performance.

In summary, identity can be demonstrated as something we do, rather than something we are. Additionally, the identities we negotiate through discourse will be used to build recognition in the system or culture. Cote and Levine (2002, p. 143) likens it to a financial transaction, where the discourse is a "cash-in" that results in recognition, and subsequent increase in "capital", or position within the system.

I have judged a negotiation approach to identity as the most sensible for my thesis, as the characteristics of school science outlines and privileges certain identities created and moderated by the culture as a whole, rather than by individuals (Aikenhead, 1996; Archer et al., 2017). Additionally, a negotiation approach to identity makes it easier to operationalize identity without significant consideration of self (Oyserman et al., 2012). I also argue that a negotiation approach is the best fit considering the thesis statement.

2.2.3 Identity in school science and the culture of science

A philosophy within science is the need for proliferation of science knowledge to people outside its field. Put simply, the goal of "science for all" (Lemke, 2001, p. 300). In school science, we can translate this as including students in the culture of science in such a way that regardless of their disposition towards the subject, this requires the student to align his or her identity to the culture of school science first and foremost, as it is a subculture of "real" science (Aikenhead, 1996). Aikenhead (1996) argues that this alignment process may be an easy or difficult transition for many students, and may vary between students. He categorizes students according to how difficult they find the process of "border-crossing" (pp. 5-7). Border–crossing refers to the students' transition from one culture or subculture to another, where the culture of school science is Aikenhead's focus. I find it necessary to comment on what research theory sees as constituting as culture.

Science is often treated as objective and neutral. However, the impression of science is naturally the student's own, which is always subjective to some degree, regardless of scientific objectivity (Driver, Leach, & Millar, 1996). Conversely, if the science culture is too cold and impartial when presented to students in teaching, this may alienate students, causing them to distance themselves, rather than to identify with it (Aikenhead, 1996; Lemke, 2001). This alienation issue may appear as a tug-of-war between the individual student and the culture of science as a whole. The student's investment in science culture is resisted by its pragmatism, cold facts and precision, ultimately causing the student to branch away from science in their education (Holmegaard, Madsen, & Ulriksen, 2014). Indeed, while both teachers and students have been shown to be motivated out of curiosity and personal interest (which are both products of identity expression) when teaching science, the motivations are threatened by the expectations of objectivity that comprises an archetypical scientific identity (Archer et al., 2017; Osborne, Collins, Ratcliffe, Millar, & Duschl, 2003). If the situation in school science learning calls for a subjective teaching model more focused on cultural application, feeling and personal inquiry, as some studies argue (e.g. Osborne, Collins, et al., 2003; White & Frederiksen, 1998), then investigating student identity could possibly aid in making school science appeal more personally to the student.

In a school science context, Barton (1998) describes student identity as: "who we think we must be to engage in that science" (p. 380). This gives the impression that students assume there exists a "correct" way of doing school science. Science itself can be considered a culture, where school science is a subculture applied to the classroom setting of school (Aikenhead, 1996). From Aikenhead's (1996) objective to understand science as a culture, it naturally follows that this science culture will be characterized by the practices of its members, that is, scientists. Students are not native to science as a culture. They move between subcultures where, in the case of science, "the subculture of science has borders that many students may find difficult to negotiate." (p. 14) Students thus have varying degrees of success when they transition to the subculture of school science, as they may struggle to negotiate their identities. The scientist is thus painted by the practitioners of science culture as something of an ideal, a set of personal traits that best embodies the nature of science culture. Students may get the impression of these traits embodied in their peers in school science, seeing them as intelligent, but socially and emotionally detached, as if choosing to study science automatically makes you a stereotypical scientist (Taconis & Kessels, 2009). Choosing to study science could be a strategy of pragmatic career planning, where the student is simply hedging their bets in the educational market (Bøe, 2012). Although science teachers may strive to approximate school science with the actual culture of science, simply taking on science's stereotypical features does not accomplish this in and of itself: "Unfortunately, the "taught" science curriculum, more often than not, provides students with a stereotype image of science: socially sterile, authoritarian, non-humanistic, positivistic, and absolute truth." (Aikenhead, 1996, p. 10). Brickhouse et al. (2000) further explore the effect of an inherently masculine school science environment on girls, and how science culture does little to elevate students with interest for science to actual scientist status. Some researchers have also compared school science culture to other ones, like student's everyday culture, or the super-culture of "real science" (Aikenhead, 1996; Archer et al., 2017; Bøe, 2012; Holmegaard et al., 2014; Osborne, Simon, et al., 2003). In these studies, a recurring argument is that there is a significant transition between being a student in science class, to properly dedicating oneself to science. Students' future prospects about becoming a scientist or not, would have the student build recognition within the classroom, as what I call an identity system of science, up until the point where he or she either renounces his or her interest, or formally becomes a scientist.

On the topic of motivation for choosing science, Bøe (2012) shows, through her study of upper secondary school students' choice of studying science, that interest in the subject of science would be the ideal student motivation for pursuing a science career, but that students are also motivated by the impression that mastering science makes you appear intelligent. This stems from an image of science as a difficult or high-status subject. The connection between student motivation and recognition becomes apparent if these student motivations are interpreted as "investing" in the identity system of science, with recognition from the identity system of science as the inevitable "payout" otherwise (See (Cote & Levine, 2002, pp. 141-147) about how people "invest" in "identity capital"). Indeed, Archer et al. (2010) show from a longitudinal, but similar study, that students' interest in science, even one persisting from a young age, does not automatically equate with continuing to study science later on. In the introduction, I mentioned, in the introduction, the dwindling population of students following a science-related course, despite its increasing relevance in higher education (Bøe, 2012; Kozoll & Osborne, 2004; Schreiner & Sjøberg, 2007; Taconis & Kessels, 2009). Combined with the previously mentioned difficulty of becoming invested in science through personal interest, science itself is often called out as the one that has to "change", accommodating its culture to prospective science students, rather than the other way around (Holmegaard, 2015; Taconis & Kessels, 2009). Cote and Levine (2002) describe how: "'identity capital' denotes [investments] in who [we] are." (p. 147). Thus, if students are to "invest" in a science identity, it has to be attractive to them, essentially gaining them some kind of "profit" by being labeled a scientist. Next, I will elaborate on the possible motivations for such investments.

2.2.4 The student's motivation in comparison to identity and making representations

Here, I will focus on what students want to achieve through establishing identity in science. This section will deal with why a student's motivations are relevant to identity when making a representation.

When students sit in a science classroom situation, and are asked to make a representation, e.g. a drawing, it is natural to assume that they have certain expectations to what it should look like. Conversely, when the student tries to make sense of a representation, it is natural to assume he or she has some form of impression of what information it is supposed to convey. As put by Kress and Selander (2012), there are "'recognised', 'canonical' forms of representation." (p. 268). This means that in a culture such as science, certain forms of representations are chosen as "accepted" ones, with what constitutes as acceptance being defined by whoever holds power within the culture (Kress & Selander, 2012). From his or her impression about what is recognized in science, the student judge whether a representation is recognized. The student still has his or her own interpretation of the representation, and in recreating the concept, the student aims to make a representation that is recognized, but also makes sense to him/herself (Kress & Selander, 2012). Within identity negotiation and students' identity performances in school science, there is a significant amount of research showing how their performances and motivations are guided by factors within school science culture (Archer et al., 2017; Barton, 1998; Brickhouse et al., 2000; Knain, 2005). The question of what students consider a scientific representation is consequently important when looking at how they approach the construction of it. As argued by Barton (1998): "to act in science class, students must have their own understandings of how it is they can act and of who it is they must be to successfully participate in a particular construction of science." (p. 380) Thus, in addition to being expected to make a good representation, students may make up an impression of how they should proceed making it according to their science proficiency. Put in the broadest terms, students may be motivated to make a representation that is "scientific". While there is obviously no strict, objective answer to what makes a scientific representation, there are certain ways of visualizing and constructing a representation that are celebrated by the culture of science (Lemke, 2010). Thus, students not only make representations according to their impression of what makes it scientific, but also to make sense of it from their perspective, and make that perspective explicit (Ainsworth et al., 2011). Students' representation construction process becomes less straightforward in the event that the process is shared between students: Each student may not only have their own impression of what is "accepted" in science, but also have each a different opinion on the design of the representation (Bezemer & Kress, 2008). Consequently, negotiation in representation construction emerges, as all students involved in the construction aim to explicitly communicate their own interpretation to the others (Ainsworth et al., 2011).

One last motivation that I will mention is the motivation of power. The word "Negotiation" typically evokes an impression of a social interaction. In social interaction, such as discourse, it can be compared to the issues of equity mentioned in 2.2.1, where it is tied to students' difference in power in the science classroom. (Barton, 1998; Brickhouse et al., 2000). In classroom research, it is common to assume the participants in this negotiation interaction to be teacher and student in a bargain for interests (e.g. McCarthy, 1991; Tsafos, 2009). There is, however, a gap in competence and authority between the two, with the teacher being the dominant figure of authority in the classroom (Archer et al., 2017; McCarthy, 1991). Thus, in a negotiation between teacher and student, the teacher is the superior in terms of power, and negotiates with the appropriate authority (D. F. Brown, 2004). However, student groups may exist as their own systems of power. As will be demonstrated in chapter 4, certain identity performances can also be used by students to vie for domination within a student group (Archer et al., 2017; Jordan, Cowan, & Roberts, 1995), where the dominating authority of the teacher is mostly absent.

2.3 Discourse and Identity Negotiation

To introduce the concept of identity negotiation, I will first introduce the definition of identity negotiation presented by Ting-Toomey (2015) as a foundation. She describes identity negotiation as:

> the role of verbal and nonverbal message exchanges between the two or more communicators in maintaining, threatening, or uplifting the various sociocultural group-based or unique personal-based identity images of the other in situ. (Ting-Toomey, 2015, p. 1)

From this definition, negotiation is presented as a process of communication between individuals that affects the identity of the participants. There are however, some issues that prevent me from using the definition as-is.

Firstly, the definition implies a possession perspective of identity; something a person has or obtains. While this perspective is not mutually exclusive to Ting-Toomey's (2015) negotiated identity, and the two may exist in combined forms (Pozzer & Jackson, 2015), Ting-Toomey presents identity as a product of traits. She does divide identity into personal and social (2015), which on the surface can be likened to the possession-negotiation relation of Pozzer and Jackson (2015). This take on social identity however, is described as: "According to social identity theory, social (or sociocultural) identities can include ethnic membership identity, social class identity, and family role issues" (Ting-Toomey, 2015, p. 1), which compares identity more to the traits of a culture or group of individuals, rather than the process of interaction between the culture's members. That said; research on negotiation or social identity has been shown to often focus on issues unrelated to the actual execution, or "doing," of science, rather focusing on position within the culture, e.g. equity among students (Arnold & Clarke, 2014; Brickhouse et al., 2000; Pozzer & Jackson, 2015). Others keep the possession definition of identity, relegating the topic of student interaction to other terms semi-related to identity, such as agency (Arnold & Clarke, 2014; Shanahan, 2009). Other divergent terminology arises when we consider student motivations as a source of negotiation: Negotiating science, or even "doing" science in general could be considered a means to achieve higher status in the culture of science, the educational system, or simply show oneself as a "smart" person through scientific achievement (Holmegaard et al., 2014). Nevertheless, negotiation remains a central term, as interaction is central to the negotiation approach to identity. Interaction between students becomes the context mode for negotiation, which I will refer to as discourse. Knain (2015) considers discourse as “Text in context” (p. 4). I consider interaction analogous to text in the sense that it is interaction that is sensitive to its setting. In this case, a classroom science setting. A student’s identity negotiation in this setting will be dependent on his or her familiarity and appropriation of the science genre and culture (Knain, 2015). Thus, mastering science discourse means mastering the interpretation and communication of the science genre (Hicks, 1995; Knain, 2005).

2.4 Scientific literacy

Scientific literacy is traditionally associated with simply recognizing and locating words and concepts, but a proper elaboration on scientific literacy should consider not only more complex processes like interpretation and inquiry (Norris & Phillips, 2003), but also the social context that includes the values and ideologies of science (Mork & Sørvik, 2015). Even if literacy is commonly connected to texts and reading, pictures and drawings serve a similar purpose in developing students’ genre competence (Knain, 2005; Tytler et al., 2013). Knain (2005) ties student identity to the literacy of science as a genre: Students can familiarize themselves with science to incorporate their identity in it, which in turn affects their mastery of the science genre. The purpose of teaching students to be scientifically literate is to make the students participants in issues within society and culture. In other words, educating students for citizenship (Kolstø, 2001). In summary, scientific discourse is known not only by the reading and recognition of terms and concepts, but by how students use those terms and concepts in talking, writing and drawing in science.

2.5 Frameworks for analysis

2.5.1 A framework for analyzing performances

In this section, I build on the statement that practitioners of school science has a preference for certain methods and approaches that often mirror the ones preferred in science culture proper (Aikenhead, 1996). Archer et al. (2017, pp. 751-759) propose a number of celebrated identity performances based on observations of teachers and students in science classes in six London-situated schools. Three of these performances were the most prevalent performances in discourse activities, and used the most through class sessions. The performances are described in short here:

> *"Tick box learning"* ("Educational performativity"): Learning "to the test." This is a performance focusing on short-term attainment of knowledge for the purpose of favorable results or achievements within science. A common motivation for this performance was found by Archer et al. (2017) to be tests, evaluations and other forms of assessment of the students' work. Additionally, both teachers and students found this prioritization of achievement to oppose what they deemed more "ideal" motivations, like interest and curiosity in the science subject. Nevertheless, students prioritized the performance, because it was judged an important performance by the school, as well as the educational system as a whole. Moreover, students that attain favorable assessment, may be motivated by the accolades that follow, e.g.: being seen as "smart" because of high grades or significant interest in science (Archer et al., 2010; Taconis & Kessels, 2009). I will rename this type of performance for later use, renaming "Educational performativity" to "Assessment performance." The word "Educational" implies a larger institutional focus on students' performance, while I mainly focus on performance as judged by the teacher and student peers within the scope of the teaching session. While students may also be motivated by assessment tied to academic interest, career choice and higher education (Bøe, 2012; Holmegaard, 2015), those are long-term goals that happens over a timespan too great to be affected by a single teaching session, which is the scope of my data.
>
> *"Doing the right thing"* ("Behavioral compliance"): Being disciplined and "following orders". A performance in accordance with authority (teacher's orders, class rules, etc.) It is a mostly teacher-controlled performance because, as previously mentioned, the teacher is usually the greatest force of authority in the classroom. Behavioral compliance amounts to demonstrating behavior celebrated by the teacher, exemplified by docile, non-disruptive and orderly actions.
>
> *Doing science through "muscular intellect"* (Being "right/brainy/smart"): A performance that shows consistent display of scientific knowledge, giving the impression of being "smart" or a "science person". It differs from the other two performances in that it concerns "doing science" rather than "doing school". This performance goes beyond just having the right answer and writing it down. Recall that

> identity requires recognition to have meaning (see 2.2.2, (Gee, 2000)). While recognition usually follows in social interaction, students doing science through muscular intellect actively seek and are motivated by identity recognition. The "muscular intellect" performance in Archer et al.'s (2017) research was mostly student-controlled, and dominated by boys. An explanation for this could be the traditional image of science as masculine (Aikenhead, 1996; Brickhouse et al., 2000), but also the tradition that boys' performances tend to be more overt, in a fashion that celebrates aggressiveness or masculinity (Francis et al., 2010; Renold, 2001). In comparison, Archer et al. (2017) also calls the performance "being macho" (p. 756), stating that boys are not only more dominant in their displays, but that boys also fall more naturally into the science stereotype.

It is also noted by Archer et al. (2017) that even if teachers and students were shown to have their own personal preferred performances (such as being curious and explorative, which both students and teachers in their study deemed favorable over the aforementioned three), these were usually not the most dominant ones. Archer et al. (2017) suggests that since Behavioral Compliance, Assessment Performance and Muscular Intellect are the dominant performances, and students trying to avoid them for ultimately more favorable performances would have a more difficult time being recognized in school science. Furthermore, celebrating such a performance may marginalize other performances that would be better for learning (Archer et al., 2017).

2.5.2 A framework for analyzing discourse status

I have stressed in a previous section (2.2.4) how students may strive to make their representation recognized in science. Even so, how students position themselves when asked to make a representation does not necessarily contribute to making the representation more scientific. In the negotiation process, they can take a stance on a continuum of discursive identity, or "status", as suggested by B. A. Brown (2004). Brown conducted an extensive study in a Californian high school science class, collecting different types of observational data, including video footage, and student writing and interviews. He investigated how participation in science culture in high school created conflict between minority students (B. A. Brown, 2004). While the topic of minority students is outside the focus of my thesis, Brown nevertheless contributes to the topic of identity by examining how students' identity cause them to act when having to negotiate in school science culture. Most importantly, through his findings, he presents a number of statuses, or states, that make up a student's discursive identities in science. Students change between these. B. A. Brown (2004) explains that, "These changes [in states] reflected cultural affiliation, cultural conflict, as well as the influence of social interaction among students." (p. 824). From this explanation of states, the parallels to alignment with science culture become apparent, as students' display of status may indicate and compare to their difficulty in "crossing over" to the culture of science (Aikenhead, 1996).

Brown's (2004) status framework differs from Archer et al's (2017) identity performances in that it represents a hierarchical gradient: While performances are observed as distinct events, states are part of a continuous spectrum, where lower states transition into higher. Here, lower and higher means different levels of incorporation of scientific discourse. Students move through these states as their discourse progresses (B. A. Brown, 2004). It may appear logical to assume a higher incorporation of scientific discourse would be "better" than a lower, but according to B. A. Brown (2004) this case is not a given. Nor is change from one state to another a rigid transition: For example, in going from the lower status called Opposition to the higher status of Incorporation (as described below), a student does not necessarily have to first display Maintenance status, even though it lies between Opposition and Incorporation on the scale. Here are the different states presented in short, from lower to higher states, based on B. A. Brown (2004):

> *Opposition status:* The student actively opposes the use of science in their actions. There is little or no attempt to use science terminology or discourse, and any encouragement to change that is rebuffed. Opposition differs from the next higher status (Maintenance) in that the student not only ignores the nature of science, but motivated to actively avoid scientific discourse, substituting science terminology with everyday words and phrases, and relegating responsibility for scientific explanation to others. Opposition status is connected to more typically disruptive acts, such as rowdiness and physical and vocal exertion. Meanwhile, celebrated behavioral performances are characterized by being quiet and orderly (Francis et al., 2010; Renold, 2001).

Maintenance status: The student employs a limited usage of scientific discourse, and only uses it until the use of other, more non-scientific terminology is found more advantageous. The student acknowledges the usage of scientific terminology, but the use of scientific terms is discarded if it jeopardizes the negotiation of non-scientific identities. In other words, this discourse transition is triggered by: "cultural politics that motivate shifts from specific forms of science discourse to broader, less technical genres of discourse use." (B. A. Brown, 2004, p. 828). Thus, it is the student's non-scientific identity that is "maintained."

Incorporation status: The student engages in continuous scientific discourse without switching to a non-scientific genre of expression. The student struggles to fully incorporate scientific discourse in their work, and continuously strives towards a higher level of incorporation.

Proficiency status: The student uses scientific discourse extensively and consistently. He or she not only shows a high degree of school science mastery, but also utilizes it to the point where it has become a natural, integrated part of his or her school identity performance. The student does not seem to find it difficult to use scientific discourse over an extended period. Additionally, he or she may have integrated it in their personal identity, using scientific terms and expressions, and engaging in science talk in more personal situations, where science is not the main focus.

A student who is higher on the continuum will naturally talk and act in a way closer to scientific discourse, but what makes discourse scientific? When B. A. Brown (2004) established a continuum for students' discourse states, he emphasized students' use of scientific terminology as characteristics for recognizing the different states. He often marked transitions from scientific to non-scientific discourse based on shifts in terminology. While searching for scientific terms provides a straightforward way of identifying states, there are other elements in discourse to consider. Adding to the characteristics of student discourse is Hicks (1995), who states that discourse is not neutral, but is inherently loaded with ideologies. In particular, she includes science and math talk as academic discourse. My argument here is that defining to what degree students conduct scientific discourse, as opposed to more casual everyday discourse, is not reliant on terminology only. Whether students' discourse could be judged as scientific would seem less than exact, but an approximation would be that they demonstrate scientific literacy.

I have now presented a number of elements that can be used to analyze students' performances and states. However, what frameworks we have for analysis still has one significant area that it does not cover. The research from Archer et al. (2017) and B. A. Brown (2004) cover the topic of identity extensively, but lacks an inherent representation-oriented connection. For the next subchapter, I attempt to connect representation construction, and whatever negotiation is done to ensure said construction.

2.6 Negotiation and representation construction

I could argue that making representations is an important situation that students can negotiate identity through. What is negotiated in spoken language and text is not necessarily synonymous with what is put down in drawings. While representations have been established as a semiotic resource, there is no guarantee students making a representation will use it as a resource in negotiation. Students may negotiate identity when creating visual representations, but when does the representation actually serve the negotiation, and function as more than a visual retelling of information? In investigating students' identity negotiation when producing representations, it would not be unreasonable to assume the negotiation process is connected to the representation at all times: In the filmed classroom drawing sessions, that were used to collect data (see method chapter), the students' only task at hand is the drawing, thus it should naturally be the topic of their negotiation. Should this not be the case however, then detaching the representation from the student talk would also detach them from each other as two workable elements of literacy (Mork & Sørvik, 2015).

3 Method

In this chapter, I go into detail of the method I used for collecting and analyzing the data, as well as the justifications thereof. Both the data and the method are part of the REDE-project (See introduction). Consequently, they are governed by the needs and overall structure of the project. First, I will describe in detail the context and student sample, as well as the design for the classroom session.

3.1 Collection of data

3.1.1 Context and sample

The population for the research consisted of a Norwegian upper secondary school class in their first year. The school is situated in the Oslo area. The subject in question was first-year Natural sciences (Norw: Naturfag for Vg1, studieforberedende), which is a compulsory subject for all students in the programme. Not every student in the class was part of the sample used for data. Sample distribution is described under the subchapter “Groups”.

The school has cooperated with REDE previously, and the teaching design has been used in a separate study two years prior to ours (in 2016). In consideration of this thesis, the two studies are related, but standalone works. While I will not refer to the 2016-study directly, I do not rule out the possibility that it can be used to expand upon my research in the future.

3.1.2 Tools and technical considerations

The raw data consisted of video footage captured using front-mounted, head-strapped cameras on a selected student in each drawing group, which included both video and audio recording. Thus, the classroom session was filmed entirely from their viewpoints, with one exception: An additional camera was placed facing the teacher. This one was in a fixed position and did not follow the teacher as he moved through the classroom. The camera students were also spread towards both the front and back of the room. Additional, simultaneous audio recording was used for some groups, as backup measures. The researchers were present throughout the entire session, for technical management of equipment between segments, but did otherwise not attempt to influence the class during filming. Thus they took the role of “complete observers” or “non-interventionists”, who are as detached as possible from the classroom setting, aside from being present in the room itself (Cohen, Manion, & Morrison, 2000, p. 457). In practice however, this detachment was not absolute, as anyone not part of the natural setting in a filming observation will affect the classroom situation to some degree (Cohen et al., 2000). The cameras were also a source of influence, as the video footage showed several students being distracted by them on occasion.

3.1.3 Groups

Four groups were subject to observation and interviews and consisted of four students each. However, some groups temporarily diminished to three members in certain in-class sequences and during interviews. For the purpose of ease of referral, I will hereinafter refer to the groups in numbers ("group 1", "group 2", "group 3" and "group 4").

The group composition was arbitrary: Students were divided into groups without concern for students' traits, like gender or subject knowledge. Normally, student consent would be a concern for which students could be put in a group, as those who did not agree to be a part of the data would have to be excluded in accordance with informed consent (Cohen et al., 2000). In our case, this was not an issue, as the entire class had given their written consent to being included in the footage without exception.

3.1.4 Classroom observation

The data collection process consisted of filming in the students' science class. The lesson we observed and collected data in consisted of approx. two and a half hours of teaching session, divided into segments of approx. 45 minutes each (The time discrepancy was filled by breaks between the segments). Three researchers were present for the observation, myself included.

3.2 Teaching design

The students' first task was to briefly discuss in pairs what words and concepts they related to the greenhouse effect. The class was then introduced to a demonstration experiment that mimicked the effect of CO_2 on the temperature in the Earth's atmosphere when exposed to sunlight. I will refer to this model as demonstration model 1 (See figure 3.1).

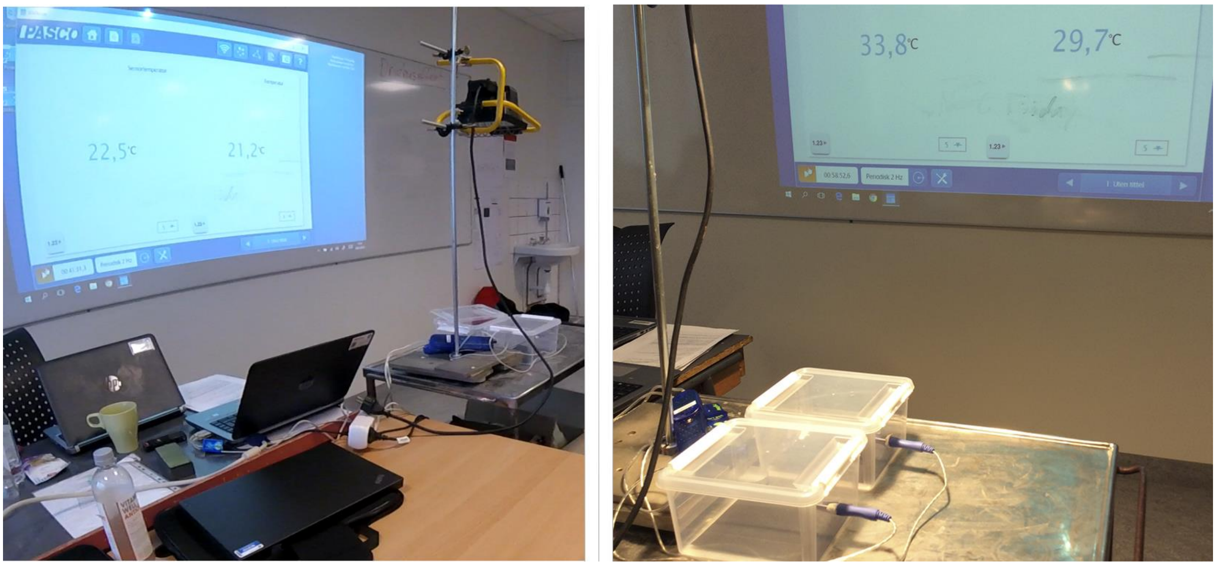

Figure 3.1: Pictures of the demonstration model 1. The boxes are connected to an instrument measuring temperature, which in turn is connected to the computer, projecting the temperature on the screen. The left picture shows the temperature at the start of the experiment, while the right picture shows the temperature at the end.

The demonstration model 1 consisted of two boxes, one filled with CO_2 and one containing only air, both exposed to a lamp representing the sun. The temperature was recorded using digital thermometers, one embedded in each box, where the difference in temperature was supposed to represent the aforementioned atmospheric CO_2 effect. The experiment showed that the box containing CO_2 had a significantly higher difference in temperature than the other. Figure 3.1 displays the temperature in each box on the screen (the box with CO_2 on the left side of the screen, the box without CO_2 on the right). Following this was several segments that alternated between teacher explanation to the class as a whole, and in-group drawing exercises. Each student group was asked to produce a drawing for each of these segments. The first drawing was an illustration of the demonstration model 1. The next drawing was supposed to be an improvement on the first. Each group produced and presented three drawings in total, first in pairs, then in groups of four (merging the pairs). The first drawing was supposed to represent the experiment model, with the second one being an improved model, made as a consensus drawing between two pairs. The last drawing was an illustration of the model applied to Earth as a whole, using an image in their natural science book as reference. They were also asked to explain the last drawing in groups. Lastly, the teacher presented another demonstration experiment in plenary. This was also a model of the effect of CO_2, but did not contain any temperature measurements. Rather, it was used as a metaphorical example of equilibrium in the atmosphere. The teacher used a punctured plastic bag with napkins inside to represent the atmosphere and the contained CO_2 respectively. As the bag was filled with water, some of it was absorbed by the napkins, which caused an increased amount of net water, which in turn represented the increase in temperature.

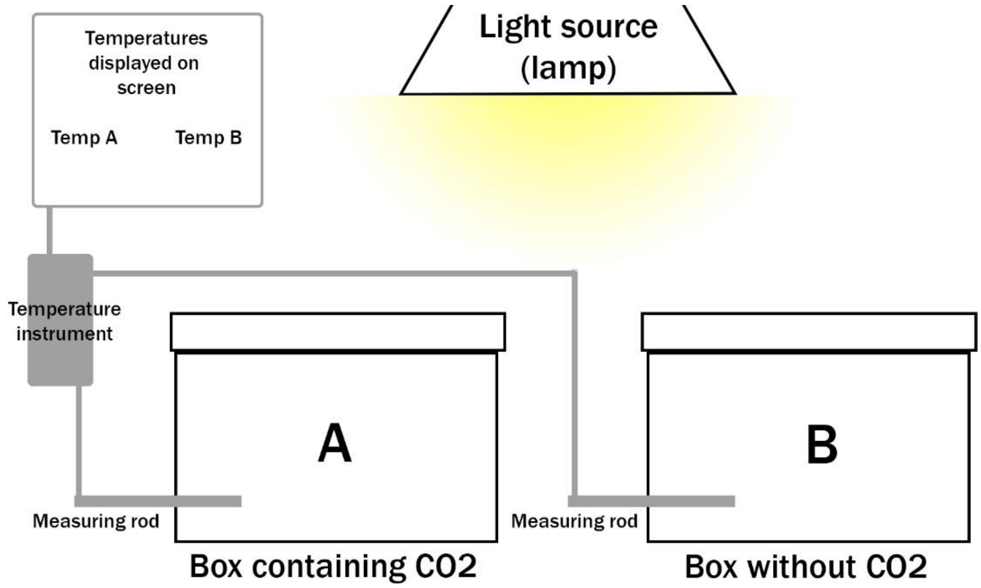

Figure 3.2: A diagram version of demonstration model 1.

Interviews with the students were conducted as a follow up to the classroom observation. Students were interviewed in select focus groups of three or four, using the same groups as the ones used in their group work when drawing during class. The groups were kept the same, as a majority of the questions concerned their work as a group. The interviewers were the researchers who had previously conducted the classroom observation, including myself. Two pairs of interviewers handled two groups each. Brinkmann and Kvale (2015) characterizes a focus group as a group interviewed as one interview object, as opposed to 1-on-1 interviews. A focus group interview is an open-ended form of interview that promotes discussion within the focus group. The aim is stated to be “not to reach consensus about, or solutions to, the issues discussed, but to bring forth different viewpoints of an issue.” (p.175) To accommodate a more deduction-oriented first part of the data analysis, we chose to direct some of the questions towards the students’ impression of group discourse, and their own personal disposition towards science in general.

An interview guide was developed prior to the interviews proper, both to make sure the interview contributed to the specific interests of this thesis, but also to structure the course of the interview (Brinkman & Kvale, 2015). The interviews were recorded using video and sound recording, using the same equipment as for the classroom observation. One of the interviewers handled the head-mounted camera used for the interview.

3.3 Transcription and coding software

The classroom and interview videos were transcribed using the Inqscribe software. The software Atlas.ti was used for coding of raw and transcribed files, and for export to text files. The software in question has been used previously in the research project, and thus is judged the best option in comparing data. Transcriptions were split between myself and another master student in the REDE-project. Transcription is often a time-consuming process (Brinkman & Kvale, 2015), and this distribution of transcription work shortened the time it took to transcribe the data. We used the same procedures and software for transcription, and communicated possible discrepancies during transcription to retain cross-comparison compatibility between classroom observation and interview transcripts (Brinkman & Kvale, 2015).

3.4 Student drawings

Aside from video observation and interviews, the drawings that student groups made were also made available for analysis. When analyzing the students' discourse, they unsurprisingly made references to their drawings during classroom observation. The drawings were mostly used to complement the analysis of the transcripts, and were not coded in-depth, like the transcripts.

3.5 Analysis of data

3.5.1 Thematic analysis

I conducted a thematic analysis of the classroom observations and the interviews in an attempt to identify patterns in the data. What constitutes thematic analysis is not well-defined by any means, nevertheless it can be described a qualitative analysis method centered around identifying themes. As put by Braun and Clarke: “Thematic analysis is a method for identifying, analysing, and reporting patterns (themes) within data.” (Braun & Clarke, 2006, p. 6). Braun and Clarke (2006) define themes as:

> A theme captures something important about the data in relation to the research question, and represents some level of patterned response or meaning within the data set. (p. 10)

Ultimately, the objective for analysis is to arrive at some recurring element in students' behavior that shows ties to how they do identity. I do however not rule out the possibility that students might not show any consistencies in negotiating identity, and finding a pattern is not a given. Themes or patterns are products of analysis of the data material, but there is no hard threshold for when the data becomes "important" enough to qualify for a certain theme (Braun & Clarke, 2006). It is possible that themes that don't fit the coding schemes will occur, which is why the coding frameworks are both based on an initial open-ended analysis, as well as left open to additional themes through later investigation.

3.5.2 Coding

Coding is, in its simplest form, a labeling of data, and organization according to those labels (Cohen et al., 2000). More precisely, the data is segmented and put into categories fitting the labels, or codes (Creswell, 2014). In my coding process, this means connecting my codes to sets of text that originate from transcribed data. This connection labels the text excerpt with whatever property the code represents. My coding process will follow Braun and Clarke's guide for thematic analysis (Braun & Clarke, 2006). While there are other ways to go about the analysis, such as those described by Cohen et al. (2000) and Brinkmann and Kvale (2015), the steps of analysis tend to coincide.

The literature makes a distinction between inductive and deductive/theoretical analysis (Braun & Clarke, 2006; Brinkman & Kvale, 2015; Derry et al., 2010). This means either creating the coding framework based on the data collected (inductive), or adapt selected sets of data depending on the framework and area of interest (deductive) (Maxwell, 2005). Inductive analysis has also been called open coding (Cohen et al., 2000; Maxwell, 2005), meaning that the coding scheme develops as the data is uncovered and sorted into a hierarchy that is not pre-established. In essence, the two types of analysis are opposites, and the question of which one to use boils down to whether the analyst or the data itself is the driving force. That said, they should not be treated as extremes on opposite sides, and an inductive approach still requires the data collection to answer to the topic (Braun & Clarke, 2006).

Before making codes, it is necessary to get an overview of the data. What codes will produce relevant results, given the data? For my analysis, I chose to employ both inductive and deductive analysis, although not necessarily combined. Rather, the two were used recursively, and applied in separate stages of data analysis, and while the focused coding (presented in the next sub-chapter) is based on a deductive framework, the analysis started as inductive (Creswell, 2014).

When I started the analysis, but before starting coding proper, I established a brief overview of the data. In the transcription process, the transcripts had omitted most of the irrelevant student talk, but I conducted a second "filtering" process to further remove parts that did not contain anything related to the teaching material or discourse. What transcripts and video footage remained was then used to code. The coding scheme was constructed by an initial rough categorization of themes, such as discourse and representational work. This first categorization of coding contains no hierarchical organization of codes and themes, due to it being a dig for relevant codes. Essentially, this first step consists of creating "raw" codes (Braun & Clarke, 2006). These raw codes were made inductively from the data, meaning they were not picked based on an existing framework (Braun & Clarke, 2006). From these initial codes, I constructed themes that together with the theory from Archer et al. (2017) and B. A. Brown (2004) would become the framework for analysis. The next step is essentially the transition from inductive coding to deductive coding (Creswell, 2014). I moved to the stage of focused coding to limit the codes, so they became specialized according to theory (Charmaz, 2014). Here, I again looked at the observation data, categorizing the transcripts according to the framework. Once I had collected codes to support the themes of the framework, I then returned to an inductive approach to consider possible themes that were not covered by the framework, but otherwise popularly related to discourse, identity or representations. The codes presented in sub-chapters 3.6 and 3.7 are the products of the focused coding. Additionally, even if they were not part of the focused codes, I will also present findings in chapter 4 that may merit cursory interest to the themes.

In the following sub-chapters I will elaborate upon what the different codes entail, and what kind of student acts are associated with the different codes. There are two distinct groups (or themes) of codes, namely, Performance strategies (Archer et al., 2017), and statuses (B. A. Brown, 2004). These two groups span their own axes and are analyzed largely independently of each other initially. The Performance strategies framework also contains sub-categories for two of the performance types. Comparisons, as well as themes that do not coincide with Performance strategies and statuses, will be explored in the later chapters.

3.6 Framework and subcategories of identity performance

To categorize the different components of the students' negotiation, I have constructed a coding framework. The purpose of this framework is to categorize the codes of the students' identity performances, and operationalize any potential patterns, or lack thereof. The framework is heavily based on the three performances presented by Archer et al. (2017). For simplicity, these are presented in short:

1. "Tick box learning": Assessment performance
2. "Doing the right thing": Behavioral compliance
3. Doing science through "muscular intellect": "Being right, being brainy and being macho"

   (Archer et al., 2017, pp. 751-758)

First I will describe the codes based on the previously mentioned performances by Archer et al. (2017). While the performances could be utilized as-is, as Archer et al. (2017) provide concrete examples of performance display from their own research, I felt the need to mold the framework to my own agenda and context. Using a preconceived framework for finding performances shows characteristics of a deductive approach (Braun & Clarke, 2006; Derry et al., 2010): Ultimately, I ended up with a framework of set codes and categories. The inductive part of the analysis came into play when I attempted to decide how to subcategorize the performances, thus, in the early stages of analysis, the data content was still being familiarized, meaning the frameworks used for analysis were not made until after a set of initial codes and themes (Braun & Clarke, 2006; Cohen et al., 2000). For the development of performance subcategories, I used the student interviews to create a meta-perspective on the students' behavior and adapted the identity performance framework to my context. Subcategorizing the performances stems from a need to make a more precise fit to my observational data, as my context is of a different scope than Archer et al's (2017).

Table 3.1: Performance strategies/motivations.

Main performance category	**Subcategories**	**Code**
1. Assessment performance		1. Assessment Performance
2. Behavioral compliance	1. Authority compliance 2. Group compliance	1. Authority Compliance 2. Group Compliance
3. Muscular intellect	1. Scientific precision 2. Using scientific terms 3. Flaunting of science knowledge	1. Scientific precision 2. Scientific terminology 3. Flaunting science

3.6.1 Assessment performance

An assessment performance means, in broad terms, to do what is expected by whoever holds authority in the classroom, (like the teacher, or peers) in a way that enables good results. In essence, the students are being motivated by whatever criteria are used to assess their work (Archer et al., 2017). In the data material I used however, there was no presence or mention of formal assessment, like examinations or grades, linked to the students' tasks. I therefore identify this performance from what assessment students receive from the teacher or other students in class. Generally, a student's assessment performance can be directed towards whoever holds the position to grant the student "recognition of their attainment". (Archer et al., 2017, p. 753) This could include teachers, but also fellow students as peers. Lastly, assessment needs not be final, and may happen at any point during the representation construction process.

3.6.2 Behavioral compliance

Archer et al. (2017) derive a large part of the performances in their framework from plenary teaching sessions, where the teacher addressed the entire class at once. There, Behavioral compliance played a significant role, with an emphasis on behavior like keeping quiet when the teacher talked, and not disrupting other students' work. In contrast, our data had little to no opportunities for addressing Behavioral compliance in plenary. The arena of authority was shifted to each group. Thus, the performance has to be reconceptualized from complying to the authority of the teacher, to also include compliance from whatever behavior is celebrated within the group. This results in two sub-categories of performance:

- *Authority compliance:* Being addressed due to behavior from the teacher. If one student within a group should display a teacher-like dominance, that would also qualify. In general, one party must hold a clear position of authority. Note that it does not have to be communication between people to qualify: simply following established rules and norms (like always raising your hand to speak in class) also qualifies, as rules themselves can hold power of authority in the classroom (Jordan et al., 1995).

- *Group compliance:* Addressing behavior within a group. It does not have to include every member of the group, as long as the group dynamic is affected. This could also include behavior between groups.

3.6.3 Muscular intellect

Archer et al. (2017) describe Muscular Intellect as a performance of science through dominating displays, but do not necessarily include what constitutes a science student's performance itself. To include how a student is doing science, as opposed to only displaying it to other students, I will assess students' impressions of what constitutes an archetypical scientist from our interviews. In table 3.1, subcategories in Muscular Intellect are all based on what criteria the students perceived as "scientific" when asked what characterizes representations in science. The Muscular Intellect performance means the student displays his or her proficiency in science in a way that strengthens his or her image of being a "science person" (Archer et al., 2017, p. 756). Corresponding to this, in interviews, students gave away certain characteristics of what they believed was a scientific representation construction method. I will thus use the following three subcategories of Muscular intellect:

- *Scientific precision:* A recurring consensus among the students in general was that a scientific construction of a representation would incorporate precision and accuracy, to a degree that went beyond what was necessary for school students such as themselves.

- *Using scientific terms:* Another characteristic of scientific construction is naming scientific phenomena and using terms and explanations beyond just everyday descriptions. This impression was also cursorily outed by students in our classroom observations.

- *Flaunting scientific knowledge:* Students displaying their scientific knowledge, intentionally, or not. This one was not mentioned as much in our interviews, but coincides with the original definition of muscular intellect (Archer et al., 2017).

Recall that Assessment performance, Behavioral compliance and Muscular intellect are outed as the most common classroom performances, but are not necessarily the only ones that can occur. Indeed, Archer et al. (2017) note that these performances often do not even align with what performance is really desired by students and teachers. In making a coding scheme with these performances, I could include a category for the performances that do not fall under any of the three above, however, this would require an extensive exploration of identity performance as a term, something that is beyond the scope of this thesis. Archer et al. (2017) do not define a specific domain that encompasses all possible performances. The three identity performances that they present are merely the most dominant in a classroom "power struggle", and any performances that are less pronounced in observation simply do not affect this relationship enough to affect the discourse situation (Archer et al., 2017). In actuality, several factors could modify power within the classroom, such as popularity (Francis et al., 2010), effort of achievement (Archer et al., 2010) and even simply displays of physical superiority, like athletics (Francis et al., 2010; Renold, 2001), neither of which carries exclusively scientific connotations. Not to mention, different classrooms have different performance dynamics (Archer et al., 2017) and are different arenas for meaning construction (Hicks, 1995).

3.7 The status continuum

For the second framework, I incorporate the statuses, or states, from Brown's Discursive Identity Domain (2004, p. 825). Unlike identity performances, the status framework used is lifted more directly from the source. They are presented by name and code in Table 3.2. To note the ordered nature of the states, they are numbered 1 to 4, from "low" status to "high". To further emphasize the hierarchical relationship on this continuum, I will label S1 and S2 as "low-incorporation states" and S3 and S4 as "high-incorporation states".

Table 3.2: statuses (From Brown, 2004, p. 825)

Status	Code abbreviation	Characteristics
Opposition	S1	The student opposes the use of science discourse, yields speech opportunities to others. Avoids using science terminology.
Maintenance	S2	The student attempts to participate in discourse and use science terminology, unless they are motivated otherwise.
Incorporation	S3	The student attempts to participate in science discourse and use science terminology, but struggles to incorporate science in his or her discourse.
Proficiency	S4	The student demonstrates science discourse with ease, uses science terminology with high proficiency.

3.8 Challenges in validity and reliability

The validity of a study, in simple terms, is given by whether the study represents its stated purpose and scope. Although validity is more of a gradient, as there is no such thing as absolute validity. There will always be leeway for the degree of the study's validity (Cohen et al., 2000). According to Shenton (2004), validity and reliability carry positivist connotations that can create issues in qualitative research, and a better term would be trustworthiness. In naturalistic inquiry, Lincoln and Guba (1985) uses credibility, transferability, dependability and confirmability to represent internal and external validity, reliability and objectivity respectively.

The objective of internal validity is, as described by Cohen et al. (2000) is: “Internal validity seeks to demonstrate that the explanation of a particular event, issue or set of data which a research provides can actually be sustained by the data.” (p. 183). Credibility on the other hand, deals with whether the findings are accurate with respect to the researcher’s reality (Creswell, 2014; Shenton, 2004). External validity encompasses the degree to which the research can be generalized. In qualitative research, transferability amounts to whether the findings can be compared to a context outside the research context. In other words, the findings should be transferable, and thus applicable to settings, people and situations not included in the research (Cohen et al., 2000). In qualitative research, there are two threats in particular that may affect the method in general. These are Reactivity and Researcher bias (Maxwell, 2005).

3.8.1 Reactivity and researcher bias

Reactivity is a prominent threat to validity in qualitative research. It is the effect of the researcher’s presence and influence on the data (Cohen et al., 2000; Maxwell, 2005). Our classroom observation was naturalistic and with the researchers in a strict observer role. Thus, we aimed for minimal researcher influence. Maxwell (2005) argues that in observation, the researcher’s presence is often insignificant to the influence of the setting itself. With our focus on making the researchers as invisible as possible, their presence is seen as a minimal issue. In comparison, the presence of the cameras may account for much greater influence. In that sense, it would be more prudent to assess “Instrumental” reactivity, which is the effect the research instruments have on the students (Cohen et al., 2000). Seeing as the students carried the camera on their heads, it seems inevitable that the students pay occasional attention to it, especially in group discourse situations where most of the group members have to address the person with the camera directly. As predicted, the students were shown to be distracted by the camera during filming, often uttering curious theories about the footage. In addition, the camerawork was essentially put in the hands of the student. The students did not have any research directives that secured proper filming throughout the observation session. As such, some of the footage was occasionally inconsistent. Conversely, were we to entrust the camerawork to the researchers, researcher reactivity would become a threat to validity (Cohen et al., 2000).

In interviews, the researcher is in a much more prominent role, and researcher bias is another threat that may occur. Researcher bias is caused by the researcher trying to steer the conduct and conclusion or the research according to his or her expectations and values (Maxwell, 2005). In the interview situation, students are focused on the interviewer, and the face-to-face situation opens possibilities for biased questions and answers (Cohen et al., 2000). Brinkman and Kvale (2015) describe trustworthiness in the through several steps, with trustworthiness presented as:

> "Validity here pertains to the trustworthiness of the subject's reports and the quality of the interviewing, which should include a careful questioning to the meaning of what is said and a continual checking of the information obtained as a validation in situ." (p. 284)

One of the ways we controlled the interview was by adhering to our interview guide. My personal bias during interviews would be related to the lack of existing research directly connected to my thesis question. I may look for identity relations where there are none, stemming from a sort of "data starvation". Having a well-developed interview guide, helped remedy this threat, as well as communicating it with the research team that was responsible for the interviews. Finally, some degree of bias will always be present, as I acknowledge that a completely objective method is unrealistic (Maxwell, 2005).

3.9 Ethical conduct in research

Video is the main form of raw data collection for the REDE project, and the project is therefore subject to strict guidelines regarding confidentiality and data processing. Student drawings, video footage and transcriptions of said footage were all anonymized. Names in transcript text, on images and in video and audio footage were all either replaced with unrelated placeholders or omitted. Said placeholder names are used in the results chapter. My master's project is subject to the legality ramifications of the REDE project. Prior to participating, the students had to fill out a consent form (see appendix B).

4 Results and discussion

In this section, I will present the main findings yielded from the observation and analysis of data. The results section is, like the method, divided into two parts based on the performance and status frameworks. In addition, I will present results that do not directly fall under the framework performances, but nevertheless merits interest. I will address performances and states through the questions from the introduction:

- What identity performances did the students exhibit during their work with representations?

- What discourse states were demonstrated by students when working with representations?

To exemplify possible relationships between performances and states, I will also present a three student cases in-depth. Finally, I will comment briefly on gender and how it affected discourse. Each subchapter here contains a discussion of the results. I chose to discuss the results as they are presented. This is because I refer to several excerpts that serve as examples, and performances and states should also be addressed separately. In Chapter 5, I present an overall interpretation of the analysis, and comment on whether the results in this chapter actually help to answer the thesis statement.

4.1 A note on the class' background in representational work

Before presenting the resultant performances and states, I will give a brief overview of how students presented their previous experience with representational work and group work. Through interviews, every group, except group 2, stated that the lessons we collected the data in had been partially or wholly different from what they were used to. Group 2 meanwhile, described it as routine, stating that:

> ***Nils:*** *It's mostly been the same as it always is in natural science. That he writes what this is, draws an example and all that, and then we just follow and ask him questions.*

Note that Nils did not mention the part where the students were tasked with making representations in groups, and the practical demonstration of the effect of CO_2 prior, which all the groups agreed was different from the regular teaching:

> ***Ragnhild:*** *It was maybe a bit more, more, that is, we don't usually have that much projects, or, I mean, we don't usually have these demonstrating things, […], on the board. So he doesn't usually have it like that, it's rare that we bring equipment like that […]. It was different.*

In summary, drawing in groups and having a visual, experimental demonstration was something the students seldom experienced in natural science otherwise. Additionally, all groups commenting on this difference in teaching structure (having hands-on experiments and group drawing), also experienced it as positive. Even so, most simply answered "No" when asked whether they associated anything with the word "representations", giving vague or detached interpretations at best. Ulrik from group 3 associated it with "demonstration", likely alluding to the demonstration experiment from the classroom session. This seemed to coincide with having had little drawing–related work in natural science class in the past, and that representations were not reflected on explicitly in class (cf. Tytler et al., 2013).

When asked if they wanted to pursue more advanced subjects, quite a few students were continuing with science subjects in their second and third years. Only a few students showed interest in continuing with natural science subjects after upper secondary school, and none of the students had reached a definite decision. This could imply a choice motivated by utility, where the students choose natural science subjects because of the later choices those subjects offer (Cf. the argument for "hedging all bets") (Bøe, 2012).

4.2 What performances did the students exhibit during representational work?

4.2.1 Assessment performance in results

The teacher did not conduct any direct assessment of the students' work. Thus, the displays of Assessment performance (see 3.6.1) were found to be mostly focused on students' assessment of their own work. The assessment in question consisted of continuously checking if their drawings met the criteria given by the teacher when he presented the task. The first drawings were also supposed to match the demonstration model. In that sense, there was very little assessment on the general quality of the representation, but more on what elements should be included to improve or finalize it. Exemplified from one segment from group 3:

> ***Teacher:*** *Just reminding you that you have to try to show the difference between the two boxes. That something happens in one box that doesn't happen in the other. That it's not two quite equal. That there has to be something that happens. That one of [the boxes] becomes warmer.*
>
> ***Hans:*** *That [box], exactly the one you draw now is the* CO_2 *one?*
>
> ***Susan:*** *Yes, because it has much higher temperature. But then it's… A few [waves] send in... They have to be shorter. What now? 'cause I need to include the carbon and show that there is gas there.*
>
> ***Hans:*** *Yes, but that you can just write up.*
>
> ***Susan:*** *Yeah, can do that.*
>
> ***Hans:*** *And how you did here that the one…*
>
> ***Ulrik:*** *But we've already drawn that though.*
>
> ***Hans:*** *Yes, but you're supposed to hand in that one as well.*
>
> ***Ulrik:*** *Oh yeah, I understand. Like that. Are we going to make a cutout?*
>
> ***Susan:*** *Yes*
>
> ***Susan:*** *I feel we can still include some more. Umm…*
>
> ***Hans:*** *(Unintelligible)*
>
> ***Susan:*** *That's what I'm thinking about. 'Cause there's always something more you can include, you know.*
>
> ***Hans:*** *Yeah, I know.*
>
> ***Susan:*** *Ole is going to come like, uhm, "Shouldn't you include that? You can put that there".*

Ulrik: *Should we just write… if it's heat instead. Instead of waves it's heat.*

In all groups there was an emphasis on completion of the representation. Especially for the second drawing, the groups emphasized "adding" elements. In that sense, assessment performance was continually practiced by every group, as they kept reminding each other about more elements that could be added. This coincides with what they said during interviews: Every group valued an equal contribution of effort from each group member. On the other hand, some elements were suggested omitted by the group, often reasoned as: "you can just write it down". A general trend among the groups was that concrete elements (such as the boxes and the temperature measuring instrument), that were visible in the demonstration model 1, were quickly and explicitly described by one or more students in the group before it was drawn. However, when the students were going to draw the more abstract elements (such as the lamplight rays and the atom model), there was more discussion within the groups, as they argued about the design of the abstract parts of the drawing. The wavelength and rays from the lamplight were also to be the most debated element of the drawing.

The absence of teacher assessment may be attributed to the fact that the teaching design was not made with emphasis on assessment, with the teacher conducting more subtle formative assessment when guiding the groups in their drawing process (Bell & Cowie, 2001). If we consider how all the students valued a group where the members are in accord, it would not be unrealistic to imagine the group as the "peer" the student has to seek recognition from through assessment performance (Archer et al., 2017).

4.2.2 Behavioral compliance in results

Interestingly, we observed no cases of teacher-corrected behavior. Naturally, when students work in groups, the teacher cannot maintain attention on every group at once, yet there were no events provoking the teacher away from whatever group he was currently situated at. The student groups were given a generous amount of time to work on their drawings, and as such, quite a few groups took time to engage in unrelated casual discussion. Regardless, I would argue that these non-topical discussions are still not considered opposition to behavioral compliance. As Archer et al. (2017) argue, "students whom we observed consistently performing behavioral compliance were not necessarily those whom we observed and/or who self-identified as performing a science identity." (p. 755). Students do not necessarily have to partake in a scientific performance in order to maintain behavioral compliance. The teacher is traditionally the source of rules and regulations (Jordan et al., 1995). Another explanation on the lack of behavioral compliance performance may be that, according to the students, the teacher is not involved enough in the students' group work. As put by Susan from the interview of group 3:

> ***Susan:*** *[The teachers] sort of, walks around it, they say like, some groups work well, some badly. They say, like, that you have to work. They, like, pace around, they don't check that, properly, because people think you can do a last-ditch effort, but that's kinda the mistake though.*

In Susan's words, the teacher's attention to behavior is single-minded at best. Even so, he is still involved himself with their group work to a certain degree, as he had several groups elaborate on their drawing during the lessons. The teacher was also described by one student as prioritizing understanding of science before behavioral correction. Yet another possibility explaining the lack of behavioral compliance is that the teacher and students of this class have built a relationship that does not create power struggles through behavioral compliance, that the students have simply "matured" past such power struggles (D. F. Brown, 2004).

In the case of group compliance (one of the sub-performances of Behavioral compliance), the students in each group quickly fell into different roles. Two of these roles stood out in particular. One was chosen as a "drawer", and was responsible for drawing the representation (the drawer was chosen through a selection process I will elaborate on in 4.5). The other role was the "leader". I name them as such because he or she was the person in the group who was the most vocal and had a tendency to direct the drawer. This is exemplified in the following excerpt from group 4, with Arjun as a drawer and Oliver as a leader:

> ***Oliver:*** *You have to draw the entire concept. So draw the temperature rod, the other box and the light.*
>
> ***Arjun:*** *Okay, then I do like this and there's a pole in here. How does that look though?*
>
> ***Oliver:*** *It goes all the way in.*
>
> ***Oliver:*** *Yes, that's good enough.*
>
> ***Arjun:*** *Is it good enough? Yes.*

Oliver: *And draw another one. There are two boxes.*

Arjun: *There are two boxes?*

Oliver: *Yes, so draw a similar one there. There are two of those plastic things. So draw another one.*

Arjun: *Yes, I can write it here then.*

Oliver: *Yes, just draw wherever you want.*

It can be observed that Oliver continuously guides Arjun as he draws. There is notably very little conflict between the students. Arjun reciprocates Oliver's leadership, cementing their roles further. In the same way a student's assessment performance might gain him or her recognition from the group, he or she may accept a role in order to keep the group in agreement. In our data, the "leader" was often self-proclaimed, and thus was less subject to group compliance. The position of drawer however, was somewhat more debated, as described in 4.7.

4.2.3 Muscular intellect in results

In discourse, most students did not show regular tendencies towards scientific precision, even if they stated it as a key characteristic of a scientific representation in the interviews. On the other hand, they also stated scientific precision as one of the differences between their representations and those of a proper scientist. As put by Nils in the interview:

Nils: *Scientists try to make it, like a hundred times more, even more precise. I mean, I don't think they draw as much by hand. Because it becomes really hard to draw the waves with the same height all the time, so it's probably more on PC, nowadays.*

Nils, like a number of the other students, seemed to be under the impression that, since scientists conduct more advanced research procedures, they can also afford higher precision. This can be compared to the students, who often felt the need to sacrifice precision in their drawing in favor of readability. By the students' impression, scientists value precision and complexity in their drawings. In contrast, the students themselves emphasized ease of understanding in their scientific representations. In the interview, when asked what makes a drawing "good" in natural sciences, Oliver answered the following:

Oliver: *It's to include the most possible detail, […] so people can understand it just by looking at it, with the least amount of explanation.*

While Oliver's comment may seem oxymoronic, as more details would possibly make the representation more complex, it highlights how, to the students, representations in the subject of natural science, and the "scientist's science" differs: The scientist has the proficiency and resources to focus on complex representations. Conversely, the science that the students encounter is school science should accommodate student understanding in its representations. Thus, a possible reason for the students to not demonstrate a significant amount of scientific precision, may be that they focus on what is a good drawing in school science, rather than "real" science (Aikenhead, 1996), making a drawing that is understandable for fellow students. Consequently, in the local system of the student group, there is not as much recognition for an identity performance that focuses on scientific precision.

Science terminology, like scientific precision, was not a performance students readily demonstrated. The majority of the students were content with substituting science terms with everyday terms (such as "send up/out" instead of "emit" or "radiate"). While most students gave extensive explanations for scientific phenomena, they preferred explaining through "everyday" terms. In the event that they tried incorporating scientific terms, this tended to create conflict with the rest of the group, as shown in this example from group 3:

Susan: *The wavelength becomes, what you said, the wavelength is longer after, after the electrons have taken the energy.*

Ulrik: *Naah, isn't it like the wavelength gets longer when it's de-excited?*

Susan: *De-excited?*

Ulrik: *De-excited.*

Susan: *De-excited. What the heck*

Ragnhild: *De-excited and excited yes*

Susan: *Yeah, I was wondering about that too*

Ragnhild: *What do you mean? What it means?*

Susan: *Yee*

Ragnhild: *Excite, that's when it jumps up towards, and then de-excites, going down*

While "de-excited" is a legitimate scientific term, the group was largely unfamiliar with it. Even if Ragnhild attempts to use the term of de-excitation, she eventually has to resort to everyday terminology to be able to explain it. While the students seldom used scientific terminology, there was an exception: "Waves/wavelength" was a term that occurred frequently, often in relation to drawing the rays from the lamp. The term stands out, likely because drawing the rays/waves was one of the elements that was most focused on in the theoretical part of the representation.

Flaunting science seldom occurred without the other two sub-performances of muscular intellect. It makes sense that the use of scientific precision and terminology is part of flaunting science, as the two were perceived by students to be key characteristics of science. As mentioned, scientific precision and terminology were largely unnecessary to the students in constructing the representations. However, this only seemed to strengthen the effect scientific precision and terminology had on flaunting science. The cases of flaunting science that were observed often incorporated terms and explanations that went beyond what was required for the drawing, as shown by Nils in this excerpt from group 2:

Nils: *It's very nice. Where's the tungsten filament?*

Dora: *Yes, it's coming now*

Nils: *That's good*

Anna: *You know what the string is called?*

Nils: *Yeah, but there's no tungsten…*

Dora: *I think you're forgetting what you're talking about now*

Anna: *He tries to get a 6 (the highest grade) in natural sciences*

The tungsten filament is part of the classic lightbulb image, but is not necessary to convey the impression of a light source. Nils goes beyond what is needed for the drawing, while still staying within a scientific performance. He also attempts to correct the drawing through his performance, making it more precise by adding a tungsten filament, even if it is not necessary for comprehension.

4.2.4 Summary of performances

In general, the students showed signs of all performances. It was difficult to pinpoint if any one performance was more popular than others, since the performances themselves were not used in conjunction with each other to a significant degree. However, what the students used the performances for differed between assessment performance/behavioral compliance and muscular intellect. The students imposed criteria for what the representation should look like and for their group’s behavior, all to the benefit of their representation. On the other hand, performances of muscular intellect did not seem to be aimed at the students’ representation construction. Certain students did show the three sub-performances of muscular intellect, scientific precision, the use of scientific terms and flaunting a scientific impression. However, the student did not prioritize the sub-performances for their representation, instead focusing on criteria such as readability, and including enough details.

4.3 What states were demonstrated by students?

The overall first impression when examining the occurrence of the different states, was that the frequency of occurrence was not equal between states. Recall that the status continuum is a continuous measure, and as such, a student does not have to be limited expressing one discrete status at a given time. Most examples were found during discourse situations, where the students attempted to explain the phenomenon of the greenhouse effect. I will also consider the students’ explanations during the interviews, as they were asked to explain their drawings there as well.

4.3.1 Low-incorporation states

From my observations, S1 and S2 were largely interchangeable, as there were few cases of unambiguous display of S1 only. An S1 status would be recognized by a forced absence of scientific terminology and reasoning. Rather, displays of S1 was represented mostly in shorter comments. While both the S1 and S2-states means a student avoids scientific discourse, a common way of doing this in the data at hand was simply avoiding discourse altogether. Students demonstrating this status attempt to motivate a shift in the responsibility for discourse, or as B. A. Brown (2004) puts it: “yielding speech opportunities to fellow classmates.” (p. 824) Even so, students did not generally avoid discourse individually. When they conducted scientific discourse, everyone in the group usually contributed to some degree. This aligns with their statements during interviews when asked about group work. A general consensus among the students was that in group work, everyone should contribute to the task at hand. Interestingly, the groups did shy away from scientific discourse at times, but often did so in unison. In those cases, the students gave the impression of being “done” with their task. In this situation, since they move away from discourse altogether, I argue that there is no longer any (scientific) discourse to avoid within the system that is their group. The situation would be closer to something akin to an S0-status, which I have not defined at all.

4.3.2 High-incorporation states

When comparing S3 and S4, the S3-status was by far the most abundant. This could be attributed to the fact that the criteria for S4 is quite demanding, even if the status often is recognized by a student simply answering confidently, without making mistakes (B. A. Brown, 2004). S4 was thus generally not displayed by many students, however it was the status that coincided the most with performances of muscular intellect.

During interviews, students were somewhat more inclined towards an S3 status, in the event that they displayed otherwise low-incorporation states during classroom observation.

> ***Co-interviewer:*** *Does [the absorption] have anything to do with [the box bottom] being black?*
>
> ***Susan:*** *Yes, that it’s black makes it absorb all types, and compared to for example green, it takes out the green- what is it? Now I think I’m mixing things up, but. It takes the green because- No, it takes up everything, but sends out the green. Or is it opposite?*

The above excerpt is a clear case of S3: Susan starts out accurately explaining how the color black works, but quickly becomes uncertain. Regardless, she tries to follow through with her explanation, before inquiring for answers.

4.3.3 Summary of states

While all states were represented during the lesson, S2 and S3 were significantly more prevalent than S1 and S4. The lack of S1 discourse may be because the groups were focused on the task of drawing, and the group collective dissuaded the idea of opposition. The lack of displays of S4 may be because it is a status with possible prerequisites. For a student to display an S4 status, he or she often has to be experienced in scientific discourse and recognized by other students and teachers as such (B. A. Brown, 2004). Thus, it makes sense that not every student is capable of displaying an S4 status regularly, and becoming able to do so may take longer than a single lesson. In general, S2 and S3 states were most prevalent when constructing the theoretical part of the representation (cf. Fredlund et al., 2017). This was especially apparent when the students were drawing the lamp rays. Several students struggled with the concept of absorption and how the wavelength changed, however, this was also the concept that students were generally most determined to properly explain. For other terms, the students tended to be more inclined to move from S2 to S3 if it served the representation construction.

4.4 Demonstration cases

In this section, I will present three cases as examples of in-depth analysis of the students' discourse. These cases were chosen because they exemplify a more dynamic discourse, where the students show states and performances through interacting with others (for the first two cases) and through their representations (for the last case).

4.4.1 A case of dominating performance without science focus

Within certain groups there existed a somewhat more prominent dynamic in relation to behavioral compliance. While all groups avoided the stereotypical disruptive or rowdy behavior that usually provokes teacher action (D. F. Brown, 2004), one student, Teo, occasionally performed an identity that mimicked corrective orders typical of a teacher (D. F. Brown, 2004).

> ***Teo:*** *So it's that advanced, eh! Yes, we're not done yet, girls.*
>
> ***Dora:*** *Are you drawing an electron…*

Teo: *No, I can't be bothered to.*

(Teo gives the sheet to Klara)

Klara: *Can you write on the side? Should I write on the side?*

Teo: *Yeah.*

Dora: *Hehehe, [Teo] doesn't want to take it, but he'd like to see it done.*

We see that Teo addresses the girls in an attempt to finalize the drawing. We saw that every group "disconnected" from the task at hand at certain points. This would, by theory, oppose celebrated behavior, however it was not usually addressed, as per the above example. Moreover, Teo eventually hands responsibility for the drawing to Klara. In addition, following this excerpt, he moves away from discourse altogether, taking a moment to "slack off".

Teo: *'cause it's infrared radiation, right. Yeah, but it's the black paper. Right? But since it is a CO_2 gas disturbing, no, I don't know what it's named, but… you yawning because of me?*

Dora: *He just looks up like that every time.*

Teo: *Okay, but it's whatever with the explanation. This is a good drawing.*

Anna: *Can you explain, because I don't get it?*

Teo: *Then [Dora] comes and just wants to correct it.*

Dora: *But it sends out a lot of those things.*

Teo: *Those what?*

Dora: *Those wave-things.*

Teo: *What [grade] did you get in natural sciences again?*

Dora: *Aah, stop*

Here we can see that Teo does not necessarily oppose the scientific discourse, like an S1 status implies. Nevertheless, he dismisses the discussion when someone else in the group ceases to pay attention. For discussion: The first comment from Teo could by itself resemble an S3-status, but quickly moves towards lower states. Interestingly, he also goes as far as to repeatedly dismiss the others' attempt at science discourse as well. Notably, this contrasts with his lines in his previous excerpt in 4.4.1. While what Teo does may seem contrary at times, all his "orders" contribute to increasing the "power" of his identity performance (cf. Jordan et al., 1995). Recall that students are able to compete for power through discourse, but not necessarily in a way that utilizes scientific argumentation (Archer et al., 2010; Francis et al., 2010; Renold, 2001). It is possible that Teo's dismissals are a way of exerting power without having to resort to science discourse directly.

4.4.2 A case of high-incorporation status and muscular intellect

A high-incorporation status and a performance of muscular intellect may appear to share a number of similar cues, as exemplified by Nils in this example:

> ***Nils:*** *(Talking about the sun) Yes, back to this. It sends out all kinds of stuff. Hits the Earth's surface after eight minutes and seventeen seconds, and then the Earth's surface absorbs it. And then we'll send it out as heat energy, that is, infrared radiation.*
>
> ***Elise:*** *Yes*
>
> ***Nils:*** *Again, or several different things then, because it has to jump to some… place again, and then it zooms up, or in all directions, then, but… So it zooms up, and it will hit because we have a lot of CO_2 in the air, hit a CO_2-molecule and then it will absorb and send out again.*
>
> ***Elise:*** *In another direction?*
>
> ***Nils:*** *Yes, in all the different directions.*
>
> ***Elise:*** *Yes*

Nils: *So that's why it can send back down, like we se eon the drawing. And it can og up again, and just continue like totally… So if it doesn't hit anything, it will for example like we have here, then it will just og straight out.*

Elise: *Yes*

Fatima: *So it goes straight out if it doesn't hit anything?*

Nils: *Yes*

Elise: *But does it go in the same wave, or frequency or energy-thing as the one it got?*

Nils: *Eeh, depends a little if it jumps from the same level. Butt hat energy won't just disappear like that. But if it is divided like it can do, because it's from 400 nanometer, no, nanomillim, no nanometer to one millimeter.*

[…]

Elise: *Totally agree. Ehm, yes. Why does the sun emit different wavelengths?*

Nils: *Because it meets a lot of different gases on the way. And it's because of the sun, that is made of…*

Elise: *Isn't it because of the heat and stuff?*

Nils: *70, consists, of, like circa 70 percent hydrogen gas, eh and 27 percent, eh, helium then it's two percent plasma that's metals that's liquid in the middle and it will send out because there's so much warmth because it's like that…*

Elise: *That last percentage.*

Nils: *No, two, three percent is plasma. Then there's like 200 atom explosions with fission where the atom cores melt together, or hit each other that happens a lot, eh, that creates a lot of energy, and that hits all the things, heat up, and sends out everything.*

Elise: *Yes, but isn't it like, since it's so hot on the sun, the atoms start to move slow-*

Nils: *Yeah, but it's because the energy from the explosion leaves as heat energy and hit other molecules and then they'll start vibrating and send out a lot.*

Elise: *And it takes eight*

Nils: *Eight minutes and seventeen seconds… before it hits the Earth's surface*

Nils showed a high frequency of participation in discourse, both during observation and the interview, often being in charge of scientific explanations. He is also implied to be a high-achieving student, as other students in his group theorized he was aiming for top grades in natural sciences. Nils provided explanations that demonstrated several traits of a high-incorporation status (B. A. Brown, 2004). First, he uses scientific terms, like "thermal energy", and "Absorption", which otherwise were observed as two of the more difficult terms to grasp. He also fulfills the criteria for a muscular intellect performance: Aside from the consistent use of scientific terminology, he also emphasizes precision, going into detail beyond what is necessary for the task, and states all quantities in precise numbers. Most importantly however, is how he flaunts his science knowledge: It is obvious that knowing the intricacies of fusion (even if Nils erroneously describes fusion as fission), and the exact travel time for the sun's rays is not necessary to understand the task at hand. Even so, Nils persistently elaborates upon scientific explanations that go beyond what is required, or even topical. Moreover, this seems to catch the interest of the others in the group. In this case, Nils builds power through his discourse, much like Teo in section 4.4.1. However, Nils' method is different, and may even seem opposite of Teo's: Instead of moving away from science discourse, Nils delves deeper into the topic. Even if he does not seem to marginalize others' scientific standing with his flaunting, like Archer et al.'s (2017) original definition of muscular intellect, ultimately, the result of Nils' performance is that he is seen as a "science person" (Archer et al., 2010).

For those students who did not stray from discourse altogether, there were some that described the scientific elements in non-scientific terms. In S2, the student turns to a more non-scientific, personal mode of discourse. In S4, the student may do the opposite, and turn his or her "regular" classroom discourse more scientific (B. A. Brown, 2004). As an example, we again turn to Nils. As previously shown, he frequently displayed a high-incorporation status, justifying scientific phenomena with accuracy. More importantly however, he did this as a seemingly routine process, having "employed science discourse and its use of technical terminology as a component of their everyday discursive practices." (B. A. Brown, 2004, p. 829). On the other hand, he also shows examples of the reverse, using an everyday word to replace a scientific term, making his own analogy:

Nils: *Mhm, CO_2 will be like a blanket, right? Can we say that it's a blanket*

Teacher: *Yes, some call it that. But, uhm…*

Nils: *What would you call it? I call it a blanket, see*

Teacher: *You want to call it a blanket?*

Nils: *Yes*

Teacher: *Yes*

Nils: *It's so easy to understand*

Teacher: *Yes*

Nils: *And the black [sheet]. Should we say, like, albedo value? I'm just asking*

Teacher: *No, what's the point is…*

Nils: *Because the black [sheet] has low albedo value*

Teacher: *Yes*

Nils: *Or because it absorbs a lot. White has high…*

Teacher: *Mhm. But the point is now to actually show the rays and what happens with them and what happens in the box with CO_2, that doesn't happen in the other box.*

Nils: *Yeah, okay.*

Here, Nils vehemently sticks to his own definition of the atmospheric layer of CO_2. He later folds, and switches between calling it a "blanket" and a "shield", but nevertheless makes analogies to everyday phenomena. This was also shown in the previous excerpt, although not as prominent. He uses everyday terms in place of scientific ones (like saying "sends" instead of "emits"), but he still attempts to justify his own understanding of the scientific concept. The teacher is cautious in affirming Nils' analogy, which could be because it may cause misconceptions later (Wong, 1993).

4.4.3 A case of performance through drawing

Several groups in our observational data opened with designating a "drawer": Someone that takes the responsibility of drawing the group's representation. Often, this choice was made on the basis that he or she "made pretty/good-looking drawings". While this could be classified along the lines of a "Technical/aesthetic aptitude" performance, it neither affects the expression of science in discourse, nor is it motivated to dominate other performances. In my analysis, I do however not rule out the possibility of aesthetics as a trait students might prioritize in their representations, as aesthetics build on feelings, and investing oneself in a subject is bound to evoke some sense of subjectivity (Lemke, 2010).

Up until now, the identity negotiation that I have analyzed from the student representation construction activity has been verbal in nature. The observation data made it clear that the students' talk was their main method of discourse. However, the drawings themselves also signify a performance, as they contain the student's intent and impression of how a scientific drawing is supposed to look (Knain, 2005; Lemke, 2010). In a sense, this leads back to the students' intent improve or finalize their drawing (Cf. the chapter introduction). The teacher emphasized, shortly after the students were given their first drawing task, that they should try to replicate and explain the demonstration model 1, but also include important elements that were not plainly visible, such as electromagnetic waves and the CO_2 gas. One of these elements was the model of the atom where the electron is excited and de-excited, and emits photons. While this is not quite scientifically accurate, the teacher still opted for the excitation explanation. The atom model was only added to the drawing after the students had drawn the concrete representation of the demonstration model 1. Figure 4.1 and 4.2 shows the two first drawings from group 3. In figure 4.2, that they have included the atom model. The construction of the atom model took up most of their discourse when making the drawing in figure 4.2. Other elements, such as the artistically constructed box nameplates from figure 4.1 ("A" and "B"), became less of a priority. This suggests that, as their representation transitioned from naturalistic to theoretical (Fredlund et al., 2017), so did their negotiation.

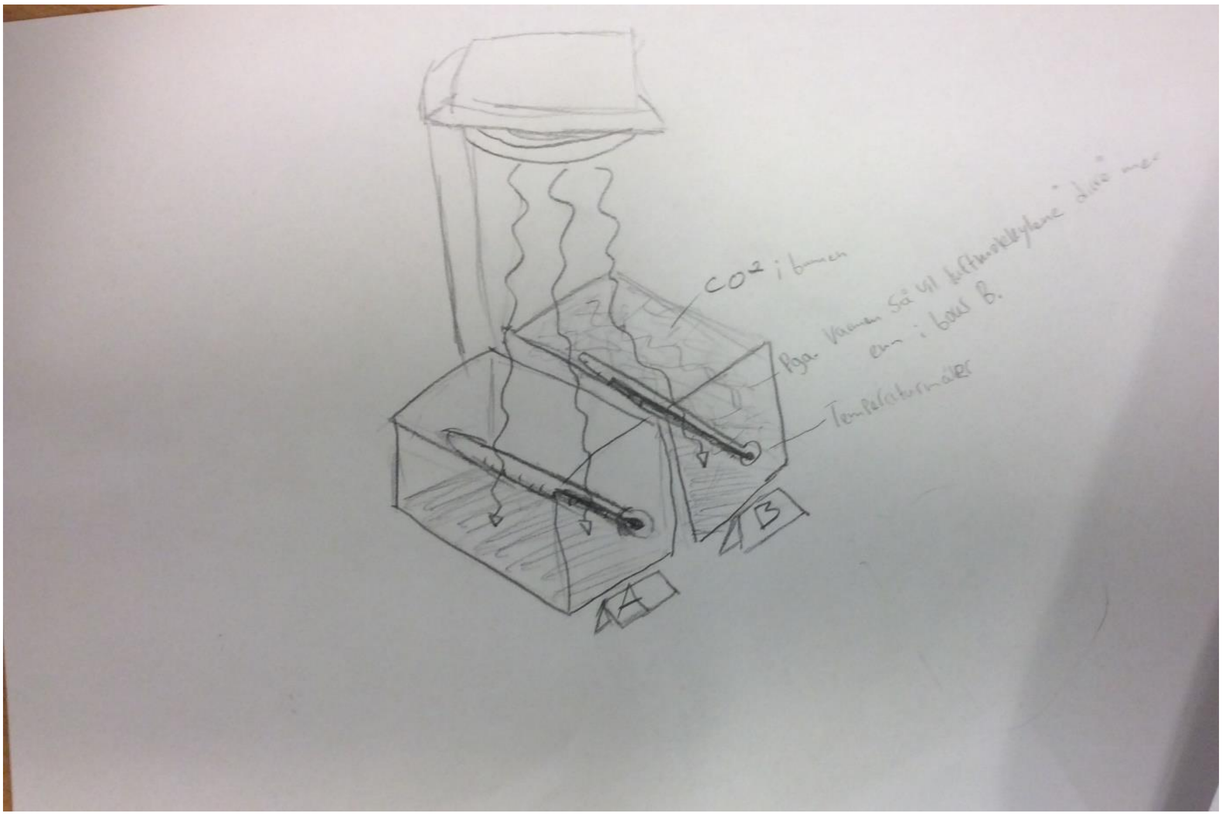

Figure 4.1: The first drawing from group 3

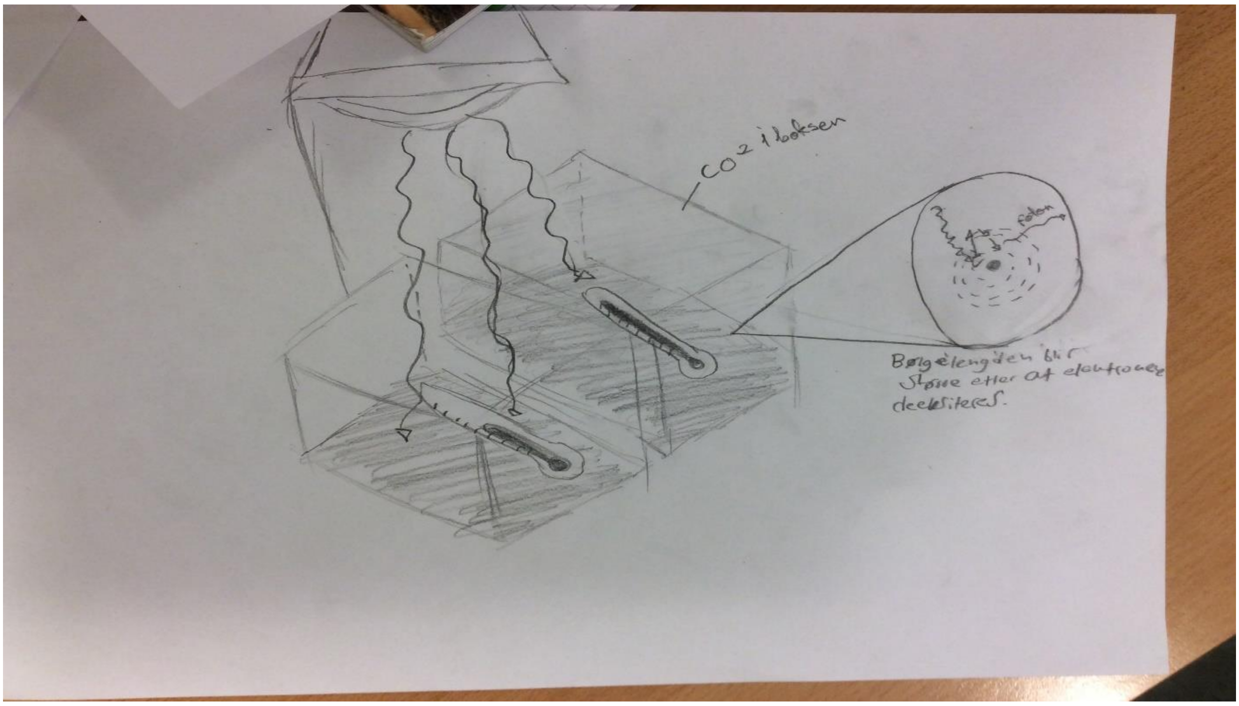

Figure 4.2: The second drawing from group 3

4.5 A comment on observed gender roles

I have chosen not to investigate the student sample divided into boys and girls, neither have I assessed or coded students' negotiation with respect to gender. Even so, my findings suggest a certain pattern across the four groups where the students addressed the gender component of identity directly. This merits interest, especially considering the popularity of examining gender roles in identity research, or at the very least acknowledging differences between them (e.g Archer et al., 2010; Brickhouse et al., 2000; Renold, 2001).

Every group prioritized early on who would have the responsibility of drawing the representation. While there was little debate, they often appointed a girl, on the basis that "they draw better". Although what the students consider "better" or "prettier" in this scenario, is most likely of aesthetic nature, as opposed to scientific. Boys in groups 2 and 3 immediately dismissed themselves from volunteering by stating that they "couldn't draw (well)". In group 1, Klara (a girl) uttered the same statement, but in contrast, took the responsibility of drawing anyway. However, even if some of the students fronted their own individual lack of drawing skill, so as to be relieved of "drawing duty", there were also comments on differences between boys and girls. While the girls were outed as the best drawers, the boys were, by contrast, not expected to be as artistically inclined.

> ***Anna:*** *It was already perfect, so we only have to draw the same.*
>
> ***Anna:*** *Teo, can you explain what happened here? I didn't get it.*
>
> ***Klara:*** *Should I just draw that*
>
> ***Dora:*** *Just draw that it's black. Oh, you've done that.*
>
> ***Anna:*** *Can you explain it?*
>
> ***Klara:*** *(To Teo): You're the one demanding I draw it better, so maybe you can draw it then.*
>
> ***Teo:*** *Okay, fine.*
>
> ***Klara:*** *No, don't draw on that, my drawing.*
>
> ***Dora:*** *Just let him draw on that. It's fine.*

Klara: *Don't draw, like, «guy-ugly».*

Dora: *Klara, you're good at drawing.*

Teo: *Okay.*

Klara: *Draw those things there.*

We see that the students have some preconceived notions about whether boys or girls are most likely to be good at drawing. It is, however, hard to generalize the difference between genders from our four groups by themselves. Who was attributed as "drawers" could be based on what displays of skill they had experienced from that person in the past, as the ones that assigned them to drawing were confident in their statement, regardless of gender. Even so, it merits interest that group 4, the only group consisting exclusively of boys, displayed no arguments against choosing someone for a drawing role. Only later, during the interview, did they justify their choice, simply stating: "It was that Arjun drew because he's better at drawing." giving no further elaboration, although they also described their group as easily reaching an agreement in general.

5 Summary of results and closing comments

In this thesis I have investigated how upper secondary school students conduct identity negotiation when working with representations in science. Through an analysis of student interviews and observational data, I have shown how students' identity negotiation manifested through certain identity performances, as well as through display of discourse states (B. A. Brown, 2004). The results, show how performances of assessment performance, behavioral compliance, and muscular intellect are conducted by students doing group work with representations in the topic of climate change.

In this chapter, I will present an overall discussion of the results, reporting on the general patterns occurring in students' negotiation. I will summarize the results in order to see if they answer the thesis statement. Finally, I will suggest possible implications or further research.

5.1 Summarizing and answering the thesis statement

In analyzing the results on identity performances, students seem to distinguish between cultures of "real" science and school science in their performances. In my analysis, students did not usually identify with science culture. They occasionally used scientific terminology and explanations, but generally did not show discourse that matched with their impression of a scientist. This coincides with research such as Schreiner and Sjøberg (2007), where students are not necessarily inclined towards a scientific identity, even if they find the subject interesting. Rather, in my analysis students' negotiation showed characteristics more in line with school science. A pattern within identity negotiation that I found was that students negotiated on using elements in their drawings that contributed to comprehension of the drawing. They aimed to make a scientific representation that was understandable to them. The students also did not negotiate an everyday identity when working with the representation, as they did not make any references, or tie the phenomenon of global warming, to their own everyday culture, even if their discourse used a significant amount of everyday terms and explanations. In general, instead of negotiating a science identity or a more casual, everyday identity, students negotiated something closer to a school science identity.

In order to receive recognition from the group, the students had to negotiate their identity from certain positions of power within the group. Some positions were established based on perceived traits, such as being good at drawing. Throughout the discourse process, students vie for power, because it allows them higher authority in the negotiation of making the representation. Essentially, the group dynamic mirrors science culture as a whole: Those who hold a position of power has the authority to determine what is celebrated as scientific (Barton, 1998).

Finally, how do the research questions in the introduction of this thesis help answer the thesis statement? In chapter 4, I have attempted to answer the research questions, in order to investigate how students in upper secondary school negotiate identity when creating visual representations in the natural sciences topic of climate change. Recall that to negotiate identity can be seen as just a certain way of doing identity in discourse (Ting-Toomey, 2015), however doing identity has to be done in a setting that is able to recognize and reciprocate the identity that is done (Pozzer & Jackson, 2015). This setting is the culture the students exist in in the classroom; school science culture in this case (Aikenhead, 1996). From my analysis I find that students do indeed negotiate identity in their representational work, as they have several options to them in how they want to be recognized. A student can show different identity performances through their negotiation, and the ones I have presented here (Assessment performance, Behavioral compliance and muscular intellect) are only three possible ways he or she may get recognition from school science culture. States, on the other hand, show how the students' prioritizes their identity negotiation: A student may negotiate to be recognized by school science culture, but in doing so comes into a conflict, having to choose between a personal everyday negotiation, or a negotiation that is closer to "real" science (B. A. Brown, 2004). In short, students may negotiate their identity in school science culture, using identity as a tool for recognition. This is done through performances and taking on certain discourse states, because identity exists only in the interaction with others (Gee, 2000). What culture or system the identity is negotiated in, and other factors such as gender, may further alter this interaction.

5.2 Implications for further research

Through investigating students' identity negotiation, I found that students' identity negotiation in school science when working with representations, is aimed towards understanding of scientific concepts. The students use both everyday and scientific terms and explanations, but their method negotiating and making representations lies neither within the overly complex and uninviting culture of science (Aikenhead, 1996), nor within the students' everyday culture. Seeing as students struggle to combine the two cultures (Kozoll & Osborne, 2004), using school science as an intermediary could possibly be compared to, and used to establish, school science as a third space (Knain, Fredlund, et al., 2017).

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Appendix A – Interview guide

Intervjuguide Lillevik januar 2018

Tidsramme: ca. 20-30 min

Arbeidsformer

- Har dere oppfattet undervisningen som annerledes i dette prosjektet sammenlignet med andre prosjekter?
- Forbinder dere noe med «representasjoner, eller visuelle uttrykk»? Hør om de har eksempler på det
- Hvilke representasjoner har dere arbeidet med i denne timen/økta/perioden?
    - Eksempler?
- Hvordan liker dere å samarbeide? Er det noe dere synes er vanskelig med å samarbeide?
    - Hva er et godt samarbeid? El. Hva betyr det å samarbeide godt?
    - Hva vil dere si er forskjellen mellom det å jobbe alene og det å jobbe med andre?
- Har dere og naturfaglæreren deres (eller andre lærere) snakket noe om hvordan man jobber i grupper sammen i klassen?
- Hvis dere skal beskrive samarbeidet deres, hvordan samarbeidet dere i prosjektet?
- Har dere planer om å gå videre med naturfag?

Spørsmål knyttet til konkrete konsepter:

Åpningsspørsmål: Kan dere forklare hva som skjedde i dette forsøket?

- (Viser til demonstrasjonsforsøket, gjerne med bilde og spør hva som skjer og hvorfor).
- Hva representerer/viser denne modellen (jf. forsøket)?
- Hvilke konsekvenser har drivhuseffekten for jorda?

- Er dette temaet noe som dere har et forhold til?
- Er det noe fra hverdagen deres som dere forbinder med drivhuseffekten/global oppvarming?

Spørsmål knyttet til tegningene elevene lager:

Dere har laget denne tegningen av drivhuseffekten.

Kan dere si litt om hva den betyr? Hva tenkte dere når dere tegnet dette?

(Fremme bruken av begrepene absorpsjon, refleksjon, stråling (ulike typer) Spørre om hva pilene betyr)

- Hva er vanskelig med å lage en tegning som dette i naturfag?
- Hva tror dere læreren deres ser etter på slike tegninger?
- Hva er hensikten med å tegne på denne måten i naturfag?
- Ville dere lagd/brukt en slik tegning for å forklare drivhuseffekten for andre?

Avslutning

- Hva synes dere om denne måten å jobbe på?
- Har dere noen spørsmål til oss?

Appendix B – Form of consent

UiO : **Det utdanningsvitenskapelige fakultet**
Institutt for lærerutdanning og skoleforskning

Til elever og foresatte ved ... videregående skole

Dato: 15. Januar 2018

Forespørsel om deltakelse i forskningsprosjekt

Vi inviterer elever ved ... videregående skole til å delta i et forskningsprosjekt. Prosjektet heter Representasjon og deltakelse i naturfag (REDE). Det skal handle om hvordan elever kan lære naturfag gjennom å arbeide med grunnleggende ferdigheter. Det vil si å øve bruk av ulike typer representasjoner (uttrykksformer) som er viktige i naturfag. Dette kan være tale, skrift, bilder, diagrammer, grafer, tabeller og simuleringer. Målet for prosjektet er å gjøre utdanningene for naturfagslærere bedre. Prosjektet er et samarbeid mellom lærere og vitenskapelig ansatte fra Institutt for lærerutdanning og skoleforskning (ILS), Universitetet i Oslo, og ... videregående skole. Prosjektet ledes av professor Erik Knain. Med i prosjektgruppa ved ILS er førsteamanuensis Anniken Furberg, universitetslektor Ketil Mathiassen, postdoktor Tobias Fredlund og førsteamanuensis Kari Beate Remmen. Ved ... videregående skole ledes prosjektet av avdelingsleder....

Som en del av den ordinære naturfagundervisningen skal ... videregående skole planlegge og gjennomføre to til tre undervisningsprosjekt i samarbeid med forskere fra ILS. I disse prosjektene skal elevene gjennom ulike typer læringsaktiviteter få innsikt i temaer som for eksempel miljøspørsmål, klimaendringer og bærekraftig utvikling. Her vil bruk av ulike typer representasjoner stå sentralt. Undervisningsprosjektene gjennomføres i perioden oktober 2016 til oktober 2018.

I forbindelse med undervisningsprosjektene ønsker forskere ved ILS å utføre en forskningsstudie som retter seg mot elevers og læreres bruk av representasjoner. Vår rolle som forskere innebærer at vi vil observere undervisningen. Det vil si at vi studerer elever som jobber sammen, snakker med dem og stiller dem spørsmål om det de gjør og temaet de jobber med. Vi vil også gjøre videoopptak av elevene og det som skjer på deres dataskjermer eller arbeidsbord.

På denne måten kan vi jobbe videre med å analysere hvordan elevene og lærerne samarbeider i tiden etter at prosjektet er avsluttet. Vi vil også gjennomføre intervjuer med utvalgte elever knyttet til deres erfaringer med prosjektet. I tillegg vil vi samle inn elevenes for- og etterprøver, slik at vi kan undersøke elevenes læringsutbytte fra prosjektet.

Deltakelse i forskningsprosjektet innebærer at det gis samtykke til å bruke bildemateriale, intervjudata, elevprodukter (tegninger, modeller, figurer e.l.) og enkelte videoopptak som illustrasjoner i *forskningsformidling* (slik som doktor- og masteravhandlinger, fagartikler og foredrag) og *undervisning av lærerstudenter og lærere*. Materialet vil kunne vises for andre forskere i lukkede grupper.

Vi ber i tillegg om tillatelse til at datamaterialet kan brukes i presentasjoner av REDE-prosjektet på web og via andre mediekanaler som Naturfag.no. Dette vil være bilder/opptak av undervisningssituasjoner som illustrerer generelle lærings- og undervisningsmessige poeng. Her vil elevenes og lærernes ansikter være synlige. Som det framgår av samtykkeerklæringen, er det mulig å reservere seg mot den utvidede bruken av materialet beskrevet over selv om man sier ja til å være med i forskningsprosjektet. Hvis man kun sier ja på punkt 1 så er eleven anonym i all formidling. Forskere og masterstudenter utenfor REDE-prosjektet vil kunne få tilgang til å gjøre analyser på materialet, og da vil all publisering alltid være anonymisert selv om det er krysset av for utvidet bruk av datamaterialet.

Navn på skole, lærere og elever vil aldri fremkomme, hverken i forskningsformidling, undervisning eller presentasjoner av prosjektet. Video/lydopptak slettes og øvrig datamateriale anonymiseres ved prosjektets slutt i 2030. Alle elever må delta i undervisningen, men det er frivillig å delta i forskningsstudien. Eleven kan når som helst trekke seg uten å begrunne dette nærmere. Vi håper foresatte/elev vil gi oss den nødvendige tillatelse ved å undertegne og returnere svararket (side 3).

Vår rolle som forskere innebærer at vi er underlagt strenge etiske regler for hvordan datamaterialet kan brukes. Studien er meldt til personvernombudet, NSD, og opplysningene behandles i tråd med personopplysningsloven. For nærmere spørsmål kan du kontakte Erik Knain (22858252), eller ....

Med vennlig hilsen

Prosjektleder ved ILS, Erik Knain

Rektor ved ... videregående skole, ...

Samtykkeerklæring

Jeg har lest informasjonen om REDE-prosjektet som gjennomføres som en integrert del av naturfagundervisningen på ... videregående skole. Jeg er kjent med at den frivillige deltakelsen i forskningsprosjektet innebærer dokumentasjon ved hjelp av videoopptak, intervjuer, stillbilder og innsamling av elevprodukter.

1. **Samtykke i deltakelse i forskingsprosjektet. Vennligst kryss av**:

➢ Mitt/vårt barn deltar i forskingsprosjektet:
   ❑ Ja, jeg/vi samtykker

2. **Hvis ja, ber vi om at du/dere tar stilling til hvordan audiovisuelt materiale kan brukes. Vennligst ta stilling punktene nedenfor:**

   Med *audiovisuelt materiale* menes bilder, lydopptak og videoklipp der stemmer vil kunne være hørbare og ansikt vil kunne gjenkjennes. Det involverer også produkter laget av elevene som tegninger, illustrasjoner og modeller. Navn på skole, lærere og elever skal <u>ikke</u> knyttes til materialet.

➢ Audiovisuelt materiale kan brukes som illustrasjoner i foredrag, undervisning og forskningsartikler, og kan gjøres tilgjengelig i *adgangsbegrensede* digitale læringsplattformer til bruk i lærerutdanningen ved UiO.
   ❑ Ja, jeg/vi samtykker

➢ Audiovisuelt materiale kan brukes i presentasjoner av REDE-prosjektet tilgjengelig via *medier som ikke er adgangsbegrensede*.
   ❑ Ja, jeg/vi samtykker

Elevens navn:____ Klasse:__________

Foresattes underskrift: ____

____

Sted: ____ Dato: ______________________________

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