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Interdiciplinarity in the Basic Science Course

A study of how network analysis can be used in Science Education

Ida Viola Kalmark Andersen
Speciale

August 2017

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Abstract

In recent years cross-cutting skills have been emphasized as impor-tant in school curricula. One approach in teaching such skills is to introduce interdisciplinary teaching methods in the school programs. In 2004 a compulsory integrated science course was introduced in the most popular Danish upper secondary school programs (Stx). This course was called the Basic Science Course (BSC). One of the objec-tives for the BSC was to increase the collaboration between the science disciplines by requiring the different science disciplines to work to-gether in an interdisciplinary fashion.

This thesis explores the interdisciplinarity of the BSC in three dif-ferent aspects of the curricula; the intended curriculum was studied through official curriculum documents, the implemented curriculum by classroom observations and interviews with teachers and the real-ized curriculum through observations of the BSC exam situation.

For all three curricula, network analysis in various forms was used for a visual and quantitative analysis of the qualitative data. New variants of both linguistic and action networks were developed in order to investigate the interdisciplinarity of the BSC. In addition, the networks were expanded to also investigate the focus on the learning aims in the three curricula.

Although interdisciplinarity was a requirement in the curriculum documents, the network analysis showed no overwhelming focus on interdisciplinarity in the intended curriculum. In the implemented curriculum, the dominating trend was a pluridisciplinary degree of interdisciplinarity where the disciplines work in parallel rather than as a cooperation on a common topic. The study of the realized cur-riculum indicated that the BSC exams may be of both pluridisciplinary and (true) interdisciplinary character. However, as this part was a proof of concept study of only two exam situations, more data needs to be analyzed in order to demonstrate a clear trend.

In this study, the various forms of network analysis showed to be an advantageous method when used to describe and analyze the in-terdisciplinarity and learning aims of the intended, the implemented and realized curriculum of the BSC program. These various forms of network analysis provide a new way to investigate curriculum align-ment.

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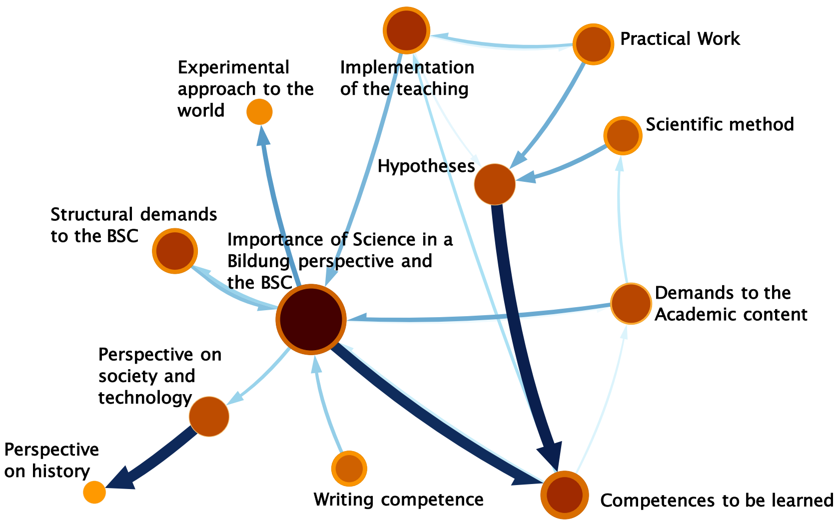
INTERDISCIPLINARITY IN THE BASIC SCIENCE COURSE

IDA VIOLA KALMARK ANDERSEN



A study of how network analysis can be used in Science Education

Niels Bohr Institute
&
Department of Science Education
Copenhagen University

July 2017

SUPERVISOR:
Jesper Bruun

ABSTRACT

In recent years cross-cutting skills have been emphasized as important in school curricula. One approach in teaching such skills is to introduce interdisciplinary teaching methods in the school programs. In 2004 a compulsory integrated science course was introduced in the most popular Danish upper secondary school programs (Stx). This course was called the Basic Science Course (BSC). One of the objectives for the BSC was to increase the collaboration between the science disciplines by requiring the different science disciplines to work together in an interdisciplinary fashion.

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RESUME

I de senere år er tværgående færdigheder blevet fremhævet som værende vigtige i lærerplaner for uddannelser. En måde at undervise i sådanne færdigheder er ved at indføre tværfaglige undervisningsmetoder i uddannelserne. I 2004 blev der introduceret et obligatorisk naturvidenskabeligt kursus i det almene gymnasium (acs Stx). Dette kursus blev kaldt naturvidenskabeligt grundforløb (NV). Et af målene for NV var at øge samarbejdet mellem de naturvidenskabelige fag ved at kræve, at de naturvidenskabelige fag arbejdede sammen på tværs af fagområder i et tværfagligt forløb.

Dette speciale undersøger det faglige samspil i NV i de tre forskellige pensummer; det intenderede pensum blev studeret gennem officielle lærerplaner, det realiseret pensum ved klasserumsobservationer af NV forløb samt interviews med lærere og det lærte pensum gennem observationer af NV eksamenssituationen.

For alle tre pensummer blev netværksanalyse i forskellige former brugt til en visuel og kvantitativ analyse af de kvalitative data. Nye varianter af både lingvistiske- og handlingsbaserede netværk blev udviklet for at undersøge tværfagligheden i NV. Derudover blev netværkene udvidet til også at undersøge hvilke læringsmål, der var fokus på i de tre pensummer.

Selvom fagligt samspil var et krav i lærerplanenerne, viste netværksanalysen af det intenderet pensum ikke noget overvældende fokus på graden af det faglige samspil. I det realiserede pensum havde den dominerende tendens i det faglige samspil karakter af flerfaglighed, hvor fagene arbejder parallelt snarere end at skabe et fælles fagligt emne. Undersøgelsen af det lærte pensum indikerede, at NV eksamenerne kan være af både flerfaglig og fællesfaglig karakter. Eftersom dette udgjorde et pilotstudie af kun to eksamenssituationer skal flere data analyseres for at demonstrere en klar tendens.

I denne undersøgelse viste de forskellige former for netværksanalyser sig at være en fordelagtig metode til at beskrive og analysere det faglige samspil samt læringsmål for det intenderede, realiserede og lærte pensum i naturvidenskabelig grundforløb (NV). Disse forskellige former for netværksanalyse giver en ny måde at undersøge sammenhængen mellem de tre pensummer.

ACKNOWLEDGEMENTS

This master thesis marks the end of my studies at the Niels Bohr Institute and the Department of Science Education at the University of Copenhagen. Even though my physics journey took a little longer than first expected. I am thankful that these institutions have provided all the academic possibilities I could wish for, despite various administrative challenges and the student progressive reform. This thesis is a product of a change in viewpoint and a change in methodology. This interdisciplinary study combines the best of both worlds; physics and didactics. Making this interdisciplinary study has been a great challenge and I am thankful to the Institute of Science Education for providing an open environment with room for discussion and my questions.

First of all I would like to express my gratitude to my supervisor Jesper Bruun for given me the opportunity of doing this interdisciplinary study and being the most enthusiastic supervisor I could have wished for. Thanks for all the discussions and your commitment in my project.

A special thanks to the six teachers for letting me observe their implementations of the BSC and taken time out of their busy schedules in order to participate in my study. Also a thanks to the five class for a lot of interesting questions and comments on my study. I especially owe a thanks to the students, who allowed me to observe their exams. You are so brave.

A deep-felt thanks to Julie Hougaard Overgaard, for introducing me to another branch of physics and given me the courage to change direction, in order to combine physics and didactics. For that and many good talks I am very thankfully.

Thanks to Robert Feidenhans´l, Kim Leffman and Ian Bearden for encouraging and supportive advice during my education at NBI, and for reminding me that one can accomplish great things as a teacher.

Thanks to Bente Markussen and Gitte Michelsenfor endless talks about everything and nothing, you both deserve a big hug. Thanks to Nadja and Christina from the secretariat on Institute of Science Education for eating lunch with me and providing me with cookies the last three week of my thesis process.

Thanks to my upper secondary school girlfriends for pulling me out of the thesis office and remind me of the reality and life on the other side. Also a great thanks to my University girlfriends, for confirming that the thesis sump is not always a festive place to be. Nonetheless,at some point the thesis will be done.

Thanks to the other students at the thesis office at the Institute of Science Education for sharing countless breaks, good discussions and advice. A special thanks to Mathilde and Nine of countless discussion and good times.

Furthermore, I greatly appreciate the support from my friends and family. They have been overbearing of me when I seemed to disappear into the thesis for extended periods. A special thank to my mother and father for cheering for me the last month of this process. Thanks to grandmother Gerda for cheerful and encouraging texts. A special thanks to Gitte and Henirik for letting me stay at their house during the last week of this process. It almost felt a little bit like a holiday, even though a lot of time was spent on correcting this thesis.

Finally, I would like to thank my boyfriend Mikkel Schou Nielsen for his great support and belief in me. For proofreading the many pages and making sure that I got dinner every evening the last month of this process. For spending weekends at my office, to make sure that I was not sitting all alone. For carrying me through some of the darker times during this thesis process as well as helping me cherish the breakthroughs and successes, I am forever grateful. Your high fives, hugs and kisses help me through this long process.

CONTENTS

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ACRONYMS

DER Danish Educational Research

BSC Basic Science course, in danish Naturvidenskabeligt Grundforløb, NV

USS Upper secondary school

Stx Upper secondary school leaving examination, in danish Studentereksamen

GLC General Language Comprehension, in danish Almen Sprogforståelse, AP

MSC Multi-Subject Coursework, in danish Almen Studieforberedelse, AT

ME Ministry of Education, in danish Undervisningsministeriet, UVM

CDA Critical Discourse Analysis

NA Network analysis

TDNA Thematic discourse network analysis

1 INTRODUCTION

In recent years cross-cutting skills have been emphasized as important in school curricula all over the world [National Research Council, 2012, Ananiadou and Claro, 2009]. Cross-cutting skills have also found their way in to the Danish educational system both in terms of new courses and new exam types [Regeringen et al., 2003, UVM, 2016]. According to Danish Government [2017], The Danish Confederation of Trade Unions and Confederation of Professionals in Denmark [Løvgren, 2017] from the labor force, the future labor market will demand these cross-cutting skills. They all argue, together with the Global Research Council [2016] that interdisciplinarity has a key role when addressing the grand challenges that society faces now and in the future. But how should these cross-cutting skills be taught and learned?

One approach to teach such skills is to use various forms of interdisciplinary teaching methods [Schaal, Bogner, and Girwidz, 2010]. However, teachers are educated and used to teach in a disciplinary way, and interdisciplinarity teaching is difficult to manage [Ananiadou and Claro, 2009]. It requires time, coordination and willingness to teach outside the areas that the teachers would normally teach. These obstacles may lead to teaching situations which may seem interdisciplinary on the surface but are in reality just two or more disciplines working with the same broad theme.

In 2004 the Upper secondary school reform [Regeringen et al., 2003] was passed and was implemented in the school year 2005/2006. One of the aims with the reform was to increase the interdisciplinarity in the different upper secondary school (USS) study programs in order to give the student cross-cutting skills. In the most popular of upper secondary school programs (Stx), a new compulsory integrated science course was introduced. This was called the Basics Science Course (BSC). One of the objectives for BSC was to increase the collaboration between the science disciplines and introduce the students to science through work with basic elements of natural sciences. The focus of the BSC should therefore be on the commonalities and the differences within the science disciplines [UVM, 2013b] requiring the different science disciplines to work in an interdisciplinary fashion. However, the question is whether the BSC has succeeded in teaching in a truly interdisciplinary way or merely teaches separate disciplines in parallel.

The aim of this thesis is to investigate the interdisciplinarity in the Basic Science Course (BSC) of the USS study program Stx. The study explores the interdisciplinarity through the lens of network analysis, in the three different curricula: the intended curriculum, the implemented curriculum and the realized curriculum. The various forms of network analysis methods provide a new way to investigate curriculum alignment. Here in relation to the interdisciplinarity of the BSC but also in relation to the learning aims of the BSC.

The intended curriculum is in this study represented by the curriculum documents for the BSC. The interdisciplinarity of the intended curriculum is studied by using the mixed-method approach Thematic Discourse Network Analysis TDNA. This method creates a thematic map from the BSC curriculum documents. Based on this map the interdisciplinarity of the intended curriculum can be characterized.

The implemented curriculum is in this study represented by classroom observations of six teacher specific BSC implementations and interviews with the six teachers. The interdisciplinarity of the implemented curriculum is studied using network analysis to transform the observed teaching into activity maps, based on these maps and different network properties the interdisciplinarity of the six different BSC implementations can be characterized.

The realized curriculum is in this study represented by two BSC exam situations. This was performed as a proof of concept study of the method. The interdisciplinarity of the Realized curriculum is studied using network analysis to transform the observed exam situations into dialogue maps. Based on these maps and different network properties, the interdisciplinarity of the two BSC exam situations can be characterized.

By investigating all three curricula a more comprehensive overview may be gained in order to discuss to which degree interdisciplinarity is present in the BSC.

1.1 NAVIGATING THROUGH THIS THESIS

As shown in Figure 1, this thesis is divided into parts due the the investigation of the three different curricula. The first four chapters are general parts. The next three chapters relate to one of the three curricula, and the two final chapters gather the study.

In Chapter 2, the theoretical framework used in this thesis is described. At the end of this chapter the formal research questions are formulated.

In Chapter 3, a framing of the study is presented. In this chapter I describe the Basic Science Course (BSC). The different data types of this thesis are described and related to the three different curricula. At the end of this chapter a thorough description of the six observed BSC implementations is given.

In Chapter 4, the methods used in this thesis are elaborated. The methods use are outlined in the order of the three curricula; first the intended curriculum, then the implemented curriculum and finally the realized curriculum.

In Chapter 5 - Chapter 7, results of the three curricula are presented and interpreted; one chapter for each curriculum (see Figure 1).

The three result chapters is followed by a discussion in Chapter 8. The conclusion in Chapter 9 is the final chapter of the thesis, which gives an overview of the whole study and what was found during the study.

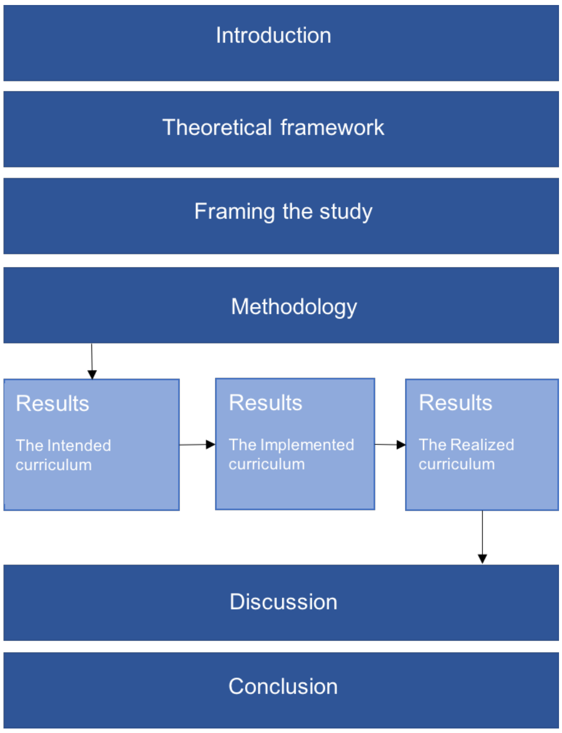


Figure 1: Overview over the structure of this thesis

I wish you happy reading.

Ida Viola Kalmark Andersen, Copenhagen, July,2017.

2 THE THEORETICAL FRAMEWORK OF THIS STUDY

This chapter gives an introduction to the theoretical frameworks used in this thesis. The first part introduces the idea of the intended, implemented and realized curriculum. The remainder of this thesis is built on that idea. The second part of the theoretical framework elaborates on the concept of interdisciplinarity. In the third part the theoretical frameworks for the methods are introduced; network analysis is explained and framed as a viable way of connecting data relevant to each of the three curricula to the idea of interdisciplinarity. Beside from the network analysis, the method of critical discourse analysis have also been used to analyze the interdisciplinarity and will be elaborated after the network analysis. Finally, having established the theoretical framework the formal research questions of this thesis is formulated at the end of the chapter.

2.1 CURRICULUM - A PLAN FOR LEARNING

The word *curriculum* originates from Latin and refers to a track or a course to be followed[1]. In educational use the word curriculum (in Danish "pensum") is often associated with formal education and therefore refers to the content of a student's educational program. But the curriculum is much more than a static statement or a document of a formal education program. It is *a plan for learning*. *A plan for learning* can be found at different organizational levels of society [Akker, 1998]:

- The government-level. Here political and administrative decisions about the curriculum are made.
- The school- and classroom-level. Here the teachers' implementations of the curriculum are executed.
- The learner-level. Here the impact of the curriculum is viewed through the output of the learner.

At all the organizational levels, decisions about the educational aims are made, and at each level different stakeholders are involved. The different stakeholders influence the way the curriculum might be viewed at the particular level. At the government-level we find the visions of the curriculum developers. At the school- and classroom-level we find the teachers who are responsible for the implementation

1 Originally the word curriculum refers to round racing track which Greek and Roman chariots raced.

of the curriculum, which often is affected by practical challenges such as time and space. At the learner-level we find the students (or learners), who perceive what is taught by the teacher and translate it into new knowledge. Each organizational level has a curriculum domain that should be coordinated with the other curriculum domains of the organizational levels. In the next section these domains will be elaborated. In the rest of this thesis these domains will be referred to as the intended curriculum, the implemented curriculum and the realized curriculum and together they will be referred to as the three different curricula.

2.1.1 *The Three Different Curricula*

The curriculum domains are by Dolin [2013] referred to as the intended, the implemented and realized curriculum (in Danish det intenderede, det realiserede og det lærte pesum). In short terms, the intended curriculum consists of the curriculum plans. The implemented curriculum is the teachers actual teaching, and the realized curriculum consist of the competencies which the students learn. A more refined typology of the curriculum domains is presented in Table 1 inspired by [Akker, Fasoglio, and Mulder, 2010].

Intended	*Ideal*	Visions, rationale and the basic philosophy underlying a curriculum
	Formal/Written	Intentions as specified in the curriculum documents and/or materials
Implemented	*Perceived*	Curriculum as interpreted by its users, here teachers
	Operational	Actual process of teaching and learning, also called the curriculum-in-action
Realized	*Experiential*	Learning experiences as perceived by learners
	Attained	Resulting learning outcome of learners

Table 1: Typology of curriculum representations inspired by [**vancurriculum:2**]

In the next sections I will elaborate on the content of three different curricula and relate them to the Danish educational system and teaching tradition. The intended curriculum is determined by the educational organizational system. In Denmark the intended curriculum is determined and issued by the Ministry of Education (ME). The intended curriculum expresses the purposes, goals, and aims for educational programs. These are often set by the curriculum policy makers, in Denmark the Danish parliament. As seen in Table 1 [Akker, Fasoglio, and Mulder, 2010] the intended curriculum comes in two forms; the *ideal* and the *formal*. The *ideal* curriculum is the original ideas and visions of the curriculum developers. This part of the intended curriculum sometimes take inputs and demands from experts outside the school systems into account. For example this could be demands or inputs from the labor marked. When these ideas and visions of the developers are written down to produce a document, the *formal* curriculum is constituted. In Denmark these documents are formally adopted as laws (the laws constituting the upper secondary study programs).

The *formal* curriculum also consists of documents which have been developed inside the school system, for example the specific disciplines' curricula documents and the associated guidelines(in Danish de fagspecifikke lærerplaner and their vejledning), which are officially approved the ME. These specific disciplines' curricula contain the subject-matter content, the purpose of the specific discipline and the academic aims for the specific discipline. A specific curriculum might also contain statements about the processes of teaching and learning. These are often a logical consequence of the academic aims of the curriculum. For example one of the academic aims for the Basic Science Course BSC is that students should develop the skills of investigation in different environments (i.e. in the lab and in the field). Such an aim would imply that teaching should provide opportunities for the student to undertake investigations in relation to the content of BSC. Finally the curriculum might contain information about the assessment, which also is the case in the Danish educations system. Dolin [2013]describes the intended curriculum in short terms, "It is the systems requirements for what the students should learn through the teaching(...). It (the intended curriculum) is the desirable" [Dolin, 2013b, p. 131](*my translation*, see original text in appendix Section A.1).

The implemented curriculum unfolds at school- and classroom-level and is also viewed in two forms, the *perceived* and the *operational* curriculum. The *perceived* curriculum refers to the interpretation of the users of the intended curriculum who most often are the teachers. The *perceived* curriculum takes the philosophy of the teacher, the lesson plans and practical circumstances into consideration. It is therefore an interpretation of what should be taught when considering the above-mentioned things. The actual teaching which takes place in the classroom is classified as the *operational* curriculum. The implemented curriculum therefore considers the expertise of the teachers in interpreting the ideas of the curriculum developers and putting them into practice. In the Danish education tradition the individual teacher has ample opportunity to interpret the intended curriculum in many ways [Dolin, 2013b]. The topics and the problems which are introduced to the students and the way they are taught, can therefore vary from school to school and from class to class. Teachers only need to make sure that content specifications in the intended curriculum are fulfilled.

The realized curriculum is related to the learner and is divided into two; the *experiential* and the *attained* curriculum. The *experiential* curriculum is the actual learning experience of the students in the teaching situation. The *attained* curriculum is the students' learning outcome of the teaching situation [Dolin, 2013b]. While the *operational* curriculum (which is part of the implemented curriculum Table 1) is mostly delivered to a whole class, the realized curriculum focuses on what the individual student learns. The learning of the individual student depends on many thing; what was known before, each student's interests, abilities, motivation and the circumstances of the classroom situation. By using tests and examinations, the educational system tries to judge what is learned by the student which is a way to assess the realized curriculum.

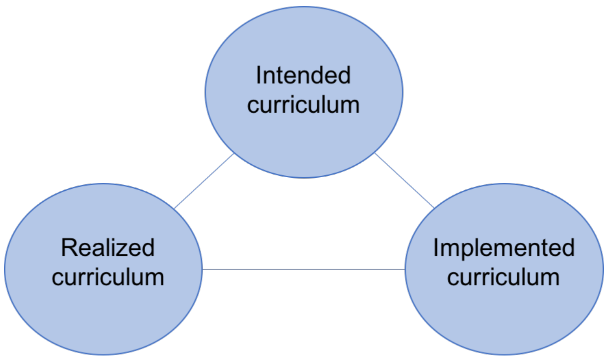


Figure 2: Overview over the three different curricula. Each curriculum is represented with a light blue circle, the lines between the circles indicate a connection between the two curricula. Hence the intended curriculum sets the demands for the implemented curriculum. The implemented curriculum sets a frame for the teaching situation and frame for what should be learned in the realized curriculum. What is then learned in the realized curriculum should have a connection to the demands in the intended curriculum.

As seen above there is a long way from the curriculum developers' visions for the teaching to the teaching situations performed by the teacher, and then to the learning outcome of the students. Therefore, gaps between the three different curricula can easily occur. These gaps can result in a mismatch between expectations and reality. One way to address the alignment of the three different curricula is by looking at the academic aims (in Danish faglige mål).

2.1.2 *The Academic Aims*

The academic aims and the academic content (in Danish faglige mål of fagligt indhold) are the heart of the specific disciplines curricula. The academic aims describes what the student should be able to do (at the end of the course/discipline) in terms of competencies. These aims relate to the specific discipline's knowledge areas, skills, methods and the terminology. But also aims for general and personal skills are present for example: analytical skills, communication skills, initiative, responsibility, creativity and collaborative skills. Together, these can be seen as a description of the competences intended by the ME. The rest of the specific discipline curriculum is structured after the disciplinary specific content(in Danish kernestof), how the teaching should be organized in general terms and how the evaluation should be [Hobel, 2013]. All these skills are described in the intended curriculum as the desirable; the students should develop these. In the implemented curriculum it is the teacher's job to organize the teaching so that it supports the students' ability to achieve these competencies. In the realized curriculum these competencies are assessed by different kinds of formative feedback, tests or, in the case of this study, an examination. The academic aims constitute a good tool for researchers who want to study the alignment of the three different curricula. Therefore the academic aims are one of the things which have been investigated in this study. The main focus for this study has been if there is an alignment of interdisciplinarity in the Basic Science Course BSC when looking at the three different curricula. In order to investigate the interdisciplinarity a theoretical framework must be established.

2.2 INTERDISCIPLINARITY

What is the correct term, when one wants to describe collaboration between two disciplines in general? And is it the same term when the collaboration is between two or more teaching disciplines in the Danish Upper Secondary School, USS? These are actually interesting questions because it depends on in which setting you ask the question. Lately, in Denmark and in Danish terms, the quick answer to this type of question has tended to by *interdisciplinarity*(in Danish *tværfaglighed*). At least if one asks the question in the public space. The public meets the word "*interdisciplinarity*" many places in educational contexts; to work with an *interdisciplinary topic* (in Danish *tværfagligt emne*) or *interdisciplinary project* (in Danish *tværfagligt projekt*). We also have university educations in Denmark who brand themselves as being an *interdisciplinary education* (*tværfaglig uddannelse*), like the educations Health and IT and Public Health[Lindvig and Ulriksen, 2016]. *Interdisciplinarity* has in Danish become an overall term, which describes all forms on how two disciplines collaborate [Klausen, 2011b]. Contrary to this, Danish educational researchers DER seem to agree on the term *disciplinary interplay* (in Danish *fagligt samspil*) as the overall term for collaboration between two disciplines. The term *interdisciplinarity* in Danish often is equivalent to the Danish terms *fagintegration or fællesfaglighed* [Klausen, 2011a]. If one takes a look in international education research, the confusion about the word interdisciplinarity is the same but some of the vocabulary about interdisciplinarity has similarities[Lindvig and Ulriksen, 2016]. In this thesis I will use the term *interdisciplinarity* as the Danish educational researcher (DER) use the term *disciplinary interplay*. By this I mean that there are different ways in which disciplines can collaborate and different degrees of interdisciplinarity. In the next sections, I will describe the different degrees of interdisciplinarity and argue for its justification in the Danish USS.

2.2.1 *The degrees of interdisciplinarity*

In 2004 a reform of the USS was presented by the Government [Regeringen et al., 2003], with this reform interdisciplinarity became a larger part of the USS than before. Now more than 10 years after the reform has been implemented, the term interdisciplinarity still feels like an unknown territory for most of the teachers [Klausen, 2011b]. Therefore, in USS, interdisciplinary in practice means that more than one teacher is affiliated with the course or project. Hence teaching must be planned and coordinated between the teachers in order to clarify the objectives for the course or project. Dolin [2013] introduces three overall objectives for interdisciplinarity:

> - Achieving trans disciplinary competencies (i.e professional qualifications which are included in several subjects) such as analytical methodology, report writing, etc.
>
> - Achieving personal/social competencies e.g independence, teamwork skills, etc.
>
> - Deeper (subject) knowledge of the topic including an increased understanding of the opportunities and limitations of the problem.
>
> [Dolin, 2013a , p. 240],(*my translation*, see original text in appendix Section A.1)

When the teachers of an interdisciplinary course or project are to write down the intended learning outcome (ILO), this outcome will often have characteristics of one or more of the three overall objectives introduced by Dolin [2013]. Most of teachers (5 out of 6) who participated in this study had written down ILO. The interdisciplinary courses are therefore formed by the specific learning outcomes and therefore differ from each other. Besides the learning outcome, the practical circumstances at the USS can also effect or form the degree interdisciplinarity in a course. For example are modules allocated where two teachers are present? Is time allocated for the teacher to plan the course etc. ?

I will now describe the different degrees of interdisciplinarity based on E. Jantsch [Jantsch, 1972] definitions of interdisciplinarity which is one of the most influential model [Klein, 1990]. Jantsch's definitions of interdisciplinarity have appeared in a variety of contexts either as the original definitions or as basis for further development [Klein, 1990, Lattuca, 2002, Moran, 2010, Newell, 1994, Stehr and Weingart, 2000]. Jantsch's definition of interdisciplinarity was chosen as a basis for the theoretical framework of this thesis as Jantsch's definitions have some similarities with the way Danish educational researcher (DER) divides the different types of *disciplinary interplay* [Ulriksen, 2008]. Jantsch's definitions will therefore be put in relation to how the Danish educational research divides the different types of *disciplinary interplay* (in Danish *fagligt samspil*) and how it is used in the Danish USS. This is done in order to create a conceptual framework for the degrees of interdisciplinarity used in this thesis.

Jantsch [Jantsch, 1972] starts by defining the term disciplinarity as a science in isolation. This term can in relation to DER's respond to the term *enkeltfaglighed* when it is put in a USS context. According to Jantsch, it is from this term one can increase the interdisciplinarity by increasing the two things: cooperation and coordination. The next step is to add more disciplines in order to gain multidisciplinarity (in Danish mangefaglighed). Multidisciplinarity is characterized by a variety of disciplines offered simultaneously but without making a explicit relationship between them. If one should put this term into a perspective of the Danish USS, it often corresponds to an ordinary school week where the student have a lot of different subjects; Danish, English, Biology, Physics etc. Nonetheless none of the subjects try to cooperate or establish explicit relations between them. Jantsch illustrates these two terms as shown in Figure 3.

We now come to the four degrees of interdisciplinarity which DER also refers to in terms of *disciplinary interplay*. The first is crossdisciplinarity (in Danish støttefaglighed) which is characterized by having a main discipline. This main discipline provides the problem and the questions which should be answered in the course. These questions require technical help from another discipline in order to uncover one

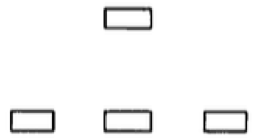


Figure 3: Jantsch's way of illustrating the terms disciplinarity and multidisciplinarity. [Jantsch, 1972, p.15]

or more of the questions. This could be when the language disciplines are used for translating a scientific article which is used in the natural science disciplines or the use of the math discipline in Physics or other natural science disciplines [Dolin, 2013a], see Figure 4.

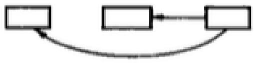


Figure 4: Jantsch's way of illustrating the term crossdisciplinarity. [Jantsch, 1972, p.15]

Pluridisciplinarity (in Danish flerfaglighed) is by Jantsch described as cooperation without coordination [Jantsch, 1972]. In a Danish context Dolin [Dolin, 2013a] describes it as cooperation between two disciplines about a joint topic. The disciplines work in parallel with the same overall topic but each discipline has their own questions to be answered. Due to this, there is a risk that the link between the disciplines may seem a bit constructed both from the students' and the teachers' point of view [Klausen, 2011a]. Another characteristic with this degree of interdisciplinarity is that the teachers only meet in the beginning and in the end of the course [Hobel, 2013]. This is maybe one of the reasons why it is easier to do these types of courses or projects since there are less coordination and planning between the teachers [Klausen, 2011a]. In Figure 5 the pluridisciplinarity is illustrated.

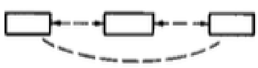


Figure 5: Jantsch's way of illustrating the term pluridisciplinarity. [Jantsch, 1972, p.15]

The type of cooperation and coordination that Jantsch calls interdisciplinarity has many terms in Danish: Dolin calls it fagintegration and Klausen calls it fællesfaglighed. In Jantsch's definition the disciplines becomes coordinated by a higher level concept, see Figure 6. According to Klausen [Klausen, 2011a] the problem in a interdisciplinary course cannot be solved by one discipline only. Such a problem demands a cooperation between disciplines. Dolin describes it as cooperation with a joint problem where the contributing disciplines subordinate to the joint problem.

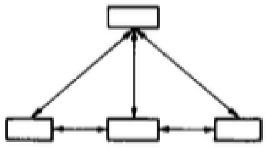


Figure 6: Jantsch's way of illustrating the term interdisciplinarity. [Jantsch, 1972, p.15]

Last but not least we have transdisciplinarity (in Danish fagoverskridelse).This is the highest degree of interdisciplinarity according to Jantsch. Here all disciplines in the system are coordinated towards a common purpose. Hence, all the disciplines need to cooperate in order to obtain the common purpose. It is the specific problem which is the focus of a transdisciplinary cooperation. The specific problem regulates the teaching content and methods used. This degree of interdisciplinarity can sometimes push the disciplines' self-understanding, and even get two or more disciplines to merge into completely new disciplines [Dolin, 2013a]. A challenge when working transdisciplinary is to distinguish between the separate disciplines' limitations due to the fact that separate disciplines do not stand out as well-defined and delimited [Klausen, 2011a]. Instead the disciplines blend together. An example on transdisciplinarity in USS could be the new discipline Biotechnology (in Danish Bioteknologi) which is a combination of the disciplines biology and chemistry. Here two disciplines are combined in order to construct a whole new discipline which has its own methods and own self-understanding.

These four degrees of interdisciplinarity can all be represented in the different interdisciplinary courses or projects in the Danish USS. Doing a transdisciplinary course or project is quite ambitious for a USS student. However, a specific interdisciplinary project can easily contain elements of transdisciplinarity. Each of these four degrees of interdisciplinary can contain the three overall objective for interdisciplinary introduce by Dolin [Dolin, 2013a] to a greater or smaller extent.

2.2.2 *Why interdisciplinarity?*

With the reform in 2004 [Regeringen et al., 2003] interdisciplinary work got a more prominent role in Danish USS. If we take a look at the different curricula plans for the new interdisciplinary courses like General Language Comprehension GLC (in Danish Almen Sprogforståelse, AP) , Multi-Subject Coursework MSC (in Danish Almen Studieforberedelse, AT) and the Basic Science Course BSC (in Danish Naturvidenskabeligt Grundforløb, NV) [UVM, 2013a, appendix 8,9,45], we will find following arguments for working interdisciplinary. *1) Challenge creative and innovative skills (of the students), 2) (the students should be able to) relate to the outside world in a reflective way, 3)(the students should be able to) relate to methods and disciplines in a reflective way* and *4) for societal, ethical or historical perspectives* [UVM, 2013a,appendix 8,9,45]. These are the arguments found in the curricula plans relating to the term Allgemein Bildung (in Danish almendannelse). The term Bildung will be further elaborated in Section 3.2.

According to Dolin [2013] interdisciplinarity has certain advantages when it comes to learning. He lists up five advantages and three disadvantages of interdisciplinary work. The disadvantages are:

1. Work-related (or time-related): Interdisciplinary work demands that the teachers plan, coordinate and evaluate the interdisciplinary course/project together. Hence, it is more time demanding for the teachers.

2. Confidence-related: Often in an interdisciplinary teaching situation, the teacher has to teach in new or unknown areas of a discipline which for many teachers can be associated with insecurity.

3. Academic-related: To teach in new or unknown areas of a discipline can lead to a lower level of the academic content in the teaching.

[Dolin, 2013a]

Fortunately, Dolin has five advantages of doing interdisciplinary work in the Danish USS.

1. Academic-related: Many current and central issues today, cannot be captured by the existing disciplines. We therefore need interdisciplinarity in order to educate students how to understand and apply academic knowledge across the different disciplines.

2. Synergy-related: By working at the same problem in more than one discipline, the teachers might save time on epistemological understanding among the students.

3. Pedagogical-related: It can be a motivating factor as well as a challenging factor to work with a problem across disciplines for some students.

4. Learning-related: Interdisciplinary work trains the students to transfer the knowledge learned in class into new connections or situations.

5. Attitude-related: Interdisciplinary work can change the students' and the teachers' attitude and opinion towards the disciplines. The teachers get new knowledge about other disciplines than their own. This might change the teachers' perspective on their own disciplines as well as other disciplines. The students might get motivated to be interested in new disciplines that they were not interested in before.

[Dolin, 2013a]

There will be advantages and disadvantages when working interdisciplinary both from an educational researcher's point of view, the teachers' point of view, the students' and the society's point of view. All these groups can argue back and forth about why interdisciplinary work is good and why it is bad. But how can one find out how interdisciplinary work is portrayed in a course like BSC? Is the interdisciplinarity portrayed the way the intended curriculum states it? Can one find all degrees of interdisciplinarity in different implementations of the BSC? And how can one find out if student actually learn to work in an interdisciplinary way? One way to look at the three different curricula and their interpretation of interdisciplinarity is by using the method of network analysis.

2.3 NETWORK - AN ANALYTICAL APPROACH IN SCIENCE EDUCATION

In this thesis, the main method is the translation of qualitative data into network graphs. This is done to gain quantitative measures out of the qualitative data which hopefully should contribute to the interpretation of the network graphs as well as the qualitative data (observations). These types of qualitative data are presented in Chapter 4. In general network graphs are tools which offer a visual representation of complex systems with many interactions. In recent years, a number of researchers within education research have started to use network analysis as a way of understanding the ways of teaching and learning [Bruun, 2016].

Bodin[2012] uses network analysis to map the adjacency of epistemic elements where the epistemic elements are developed as a group of student statements expressing beliefs, knowledge or resources used in the learning situation. Brewe, Bruun and Bearden uses network analysis on a multiple choice test (i.e. the Force Concept Inventory test) in order to identify conceptual modules that are present in student responses [2016]. In their study they finde nine different ways on how students interpret the physical concept force. Elmeskov, Bruun, Nielsen [2015] apply linguistic network analysis to written curriculum documents as a way of visualizing the connections in the documents.

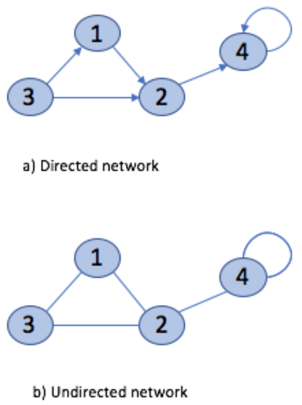
A fourth way of using network analysis in an educational research context is in 'action' mapping networks. These kind of networks have the purpose to show data which describes some kind of behavior as a network. Overgaard [2015] uses 'action' maps to map out students interacting with each other in a learning situation. Jensen [2015] uses 'action' mas to map out the activities and interactions which are happening in a classroom during class. In [Dolin, Bruun, Jensen, Niemienen, and Nielsen, 2017] the dialogue between a teacher and a student is mapped as network using the idea behind 'action' mapping.Furthermore, new ways of combining network analysis with other analysis types into mixed-methodologies are finding its way in the research of science education. As in Lindahl, Brunn and Linder [2016] that combines thematic discourse analysis with network analysis in order to create a new way of analyzing students' discussions. In [Lindahl, Bruun, and Linder, 2016] the network analysis was used to distinguish between different discussions. The network analysis revealed a structural aspect to the discussions. These structural patterns in thematic maps helped visualizing, adding nuance to and inform interpretation of qualitative analyses. In this case the network analysis was able to facilitate the generation of greater depth and breadth for the analytic outcomes of the students discussion.

For this study I have used different types of network analysis for different types of curricula. For the intended curriculum I have used a mixed-method approach inspired by [Lindahl, Bruun, and Linder, 2016]. My method builds on a linguistic network analysis combined with a critical discourse analysis CDA (which is elaborated in Section 2.4) in order to visualize the curriculum documents and to see if the combination of the network analysis and the CDA would facilitate a greater depth to the curriculum analysis. The implemented curriculum was analyzed using 'action' mapping of the observed data in order to get an activity map. This method was inspired by [Jensen, 2015]. For the realized curriculum a method inspired by [Dolin, Bruun, Jensen, Niemienen, and Nielsen, 2017] was used to make a dialogical map of the observed exam situation in order to map out the themes of the exam. In the next sections I will give a brief introduction to network basis and the network properties which play a crucial role in my data analysis.

2.3.1 *Network basis*

A network consists of a set of entities which in network literature are called *nodes*, and the interactions between them called *links*. Put in everyday words; *" a network is, in its simplest form, a collection of points joined together i pairs by lines"*[Newman, 2010, p.1]. One of the key aspects of networks is that it can visualize and thus give a spatialization of an abstract complex system. The spatialization and the appearance of the network elements (nodes and link) can be manipulated. For example changes can be made to size and color of nodes, the thickness of the links between the nodes and the position of the nodes. In order to manipulate the appearance of the nodes and links of the network, we need to find a way to keep track of the links between the nodes. For that purpose we use what is called an adjacency matrix.

Before looking at the adjacency matrix, we first need to establish that the links of a network can either be directed or undirected. When links are directed the information of the network can only flow in one direction from one node to other, like in Figure 7a where information from node 1 only flows to node 2. If the links are undirected information can flow both way like in Figure 7b where information from node 1 can flow both node 2 and node 3. A network is therefore called directed if all of its links are directed; its called undirected if all of its links are undirected [Barabási, 2016].



$$A_{ij} = \begin{pmatrix} 0 & 0 & 1 & 0 \\ 1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 \end{pmatrix}$$

$$A_{ij} = \begin{pmatrix} 0 & 1 & 1 & 0 \\ 1 & 0 & 1 & 1 \\ 1 & 1 & 0 & 0 \\ 0 & 1 & 0 & 1 \end{pmatrix}$$

Figure 7: a) A directed network and its adjacency matrix. b) An undirected and its adjacency matrix. Notice that in both figures node 4 has a link from node 4 to node 4, this type of link is called at self-loop.

The adjacency matrix in a directed network has N rows and N columns with the elements A_{ij} taking following values:

- 1, if there is a link pointing from node *j* to node *i*
- 0, if node *i* and node *j* are not connected.

In the adjacency matrix for an undirected network there is two entries for each link. Hence, the matrix is symmetric $A_{ij} = A_{ji}$.

From the adjacency matrix elements, we can obtain the *degree* of any node. The *degree* is the measure of how many connections a given node has and the number of links linked from one node to another. In an undirected network the node's degree is the sum over either the rows or the columns of the adjacency matrix.

$$k_i = \sum_{j=1}^{N} A_{ji} = \sum_{i=1}^{N} A_{ji} \tag{1}$$

In a directed network, where the links can be classified as arrows pointing from one node to another, two separate degrees of each node is produced; one of the links going into the node called the incoming degree and one of the links going out of the node called the outgoing degree. For a directed network the sum over the adjacency matrix's rows provide the incoming degree and the sum over the adjacency matrix's columns provides the outgoing degree.

$$k_i^{in} = \sum_{j=1}^{N} A_{ij} \qquad\qquad k_i^{out} = \sum_{i=1}^{N} A_{ji} \tag{2}$$

It is not only the nodes that have a measure. The links also have a measure called *edge weight* (a link can also be called an edge). The *edge weight* is a measure of how many times the link appears in the data set between the same two nodes. The weight of each link is determined by the researcher who constructs the network. The *edge weight* is therefore the sum of these weights and is indicated by the thickness of the link. The *edge weight* represents the degree of contact between to nodes. Frequent contact between two nodes can therefore be illustrated with a thicker link.

2.3.2 *Modularity*

When processing a network it can often be an advantage to identify communities consisting of nodes that are specially associated with each other. This is called community detection which has it owns research field in network science [Newman, 2008]. As a measure for the quality or strength of the network division into these communities, the network property *modularity* is often used. The network property *modularity* compares the number of links within a community with the number of links obtained from the same group of nodes from a randomly rewired network in order to decide if the original community corresponds to a dense community or its connectivity pattern emerged by chance [Blondel, Guillaume, Lambiotte, and Lefebvre, 2008]. The *modularity* allows us to decide if a particular community partition is better than others. The *modularity* of a partition is a scalar value between −0.5 and 1,5, where positive values (high *modularity*) implies better partition. Hence, the network might be divided into communities. By using the adjacency matrix we can calculate the *modularity*.

$$Q = \frac{1}{2L} \sum_{(i,j=1)}^{N} \left(A_{ij} - \frac{k_i k_j}{2L} \right) \delta(c_i, c_J) \tag{3}$$

Where A_{ij} is the adjacency matrix of the network. If the links of the network are randomly placed, the expected number of links between node *i* and *j* is given as $\frac{k_i k_j}{2L}$, where k_i and k_j is the degree of the two nodes and **L** is the total number of links in the network. Given a division into communities, the sum of all nodes within the same community will represented by a value **Q**, which is the *modularity*. The delta-function makes sure that we only sum over nodes in the same community as the function is 1 if the node *i* and *j* is in the same community else the function will give 0. c_i and c_j, can be interpreted as functions of node *i* and *j*, which relate to the community the nodes are belonging to [Barabási, 2016]. As mentioned above **Q** can both be a positive or negative scalar which indicates a deviation from a randomly generated network with the same number of links. If $\mathbf{Q} = 0$ there will be no deviation from the random network. If $\mathbf{Q} > 0.3$ the network has a tendency to be divided into communities and if $\mathbf{Q} > 0.5$ the network is characterized as being highly modular [Clauset, Newman, and Moore, 2004].

In this study I have create a number of networks which represent different teachers' implementations of the BSC and networks which represent exam situations. By calculating the *modularity* of these networks, I can analyze whether teachers' implementations of the BSC and exam situations can be classified as divided. Thereby comment on whether this division is related to the interdisciplinarity. Maybe the division can even be related to the degree of interdisciplinarity. As I would expect pluridisciplinarity to be visible in a network as a sharp division between the different disciplines, interdisciplinarity to be visible as a focus on general science related skills, while transdisciplinarity would be visible as a mixing between disciplines.

2.3.3 *PageRank*

PageRank is a network property which measures the concentration of the information flow through the node. Therefore the network property PageRank indicates involvement and relative importance of a node in relation to the other nodes[Bodin, 2012, p. 6]. If one think of it intuitively, the flow must be higher through nodes with a high *edge weight* and a high *degree*. Hence, the nodes with thicker arrows and more connections will have a higher Page Rank, see Section 2.3.1 for definitions of *edge weight* and *degree*. The PageRank algorithm was developed by Page, Brin, Motwani, and Winograd [1999]. The algorithm was made in order to test the assumptions that more important websites are likely to receive more links from other websites. This was interesting for Page and Brin as they in 1996 had made the Google search engine as a part of their PhD projects at Stanford University [Brin and Page, 1996]. The algorithm by Page and Brin can be described as follows:

$$PR(A) = \frac{(1-d)}{N} + d(PR(T1)/C(T1) + ... + PR(Tn)/C(Tn)) \quad (4)$$

where PR(A) is the PageRank of page A, i.e. the PageRank of the specific node A which we want to obtain. $PR(T_1)$ is the PageRank of page T_1 which link to page A, i.e. $PR(T_n)$ is the PageRank of all the nodes which are linked to node A. $C(T_1)$ is the number of outbound links on page T_1, i.e.e. $C(T_n)$ is the number of outgoing links(out-degree) on the node T_n. d is a damping factor which can be set between 0 and 1. N is the total number of pages on the web, i.e. the total number of nodes in the network. All this can also be written as :

$$PR(A) = \frac{1-d}{N} + d \sum_{T_i \in M(a)} \frac{PR(T_i)}{L(T_i)} \quad (5)$$

In this study the PageRank has been used as an measure of importance of the different disciplines participating in the Basic Science Course BSC in relation to the observed data from implemented curriculum and realized curriculum. The PageRank has also be used as an importance measure in relation to the academic aim in the implemented curriculum and realized curriculum. Moreover the PageRank measure received from the networks in this study was used in some of the depicted of the networks. The PageRank is then depicted as the size of each node in the networks.

2.3.4 *ForceAtlas2 a way of visualizing a network*

One way to visualize the communities in a network is by defining the network as a physical system. In Gephi [Bastian, Heymann, and Jacomy, 2009], the network program used for this thesis, an algorithm called ForceAtlas2 is included which provides a force directed layout. Meaning that:

> "Nodes repulse each other like charged particles while edges attract their nodes like springs. These forces create a movement that converges to a balanced state. "
> [Jacomy, Venturini, Heymann, and Bastian, 2014]

The ForceAtlas2 algorithm is designed as an energy model where the nodes converge to an equilibrium like in Newtonian mechanics. Hence the formulas used in this algorithm are inspired from the laws of physics. The attraction force F_a is based on Hooke's law of springs and the repulsion force F_r is derived from Coulombs law. In mathematical terms the attraction force F_a and the repulsion force F_r between node 1(n_1) and node 2 n_1 are given by :

$$F_a(n_1, n_2) = d(n_1, n_2) \tag{6}$$

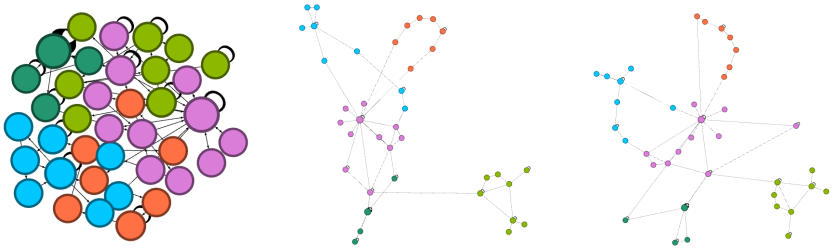
$$F_r(n_1, n_2) = k_r \frac{(deg(n_1) + 1)(deg(n_2) + 1)}{d(n_1, n_2)} \tag{7}$$

Here the function $d(n_1, n_2)$ is the distance between node 1 and node 2 (n_1 and n_2) and $(deg(n_1)$ is the degree of node 1. Hence $(deg(n_2)$ is the degree of node 2. k_r is a repulsion constant. If one takes a look at the fraction, we see that 1 is added to both degrees, this is due to the fact that isolated nodes with a degree of zero should repulse other nodes. ForceAtlas2 is a continuous layout, meaning that it calculates the forces between the nodes continuously while the layout is running. As the network obtains equilibrium the nodes are settled in positions where a balance between the attraction forces and the repulsion forces are reached. One have to be aware that a node can find a local equilibrium and somehow stick to that. Therefore it can be necessary to perform a manual perturbation where the node is dragged out of it position in order to obtain a new equilibrium. This is essential in order to make a reliable representation as the node often can stick in a "false" position. Figure 8a shows one of my data sets where the ForceAtlas2 algorithm is applied. The size of the nodes are determined by the PageRank, and the color of the nodes indicates which community the node belong to. There are many links in this data set hence the high attraction force.

The program Gephi also provide additional settings to the ForceAtlas2 algorithm, for reshaping the network. In this thesis I have used the ForceAltas2 algorithm with the two additional settings called LinLog and Dissuade Hubs. In the LinLog mode the attraction force is logarithmic and is given by:

$$F_a(n_1, n_2) = \log(1 + d(n_1, n_2)) \tag{8}$$

Again the function $d(n_1, n_2)$ is the distance between node 1 and node 2 (n_1 and n_2). Inside the logarithmic term 1 was added to prevent $\log(0)$. In the LinLog mode the attraction force is not linear thereby producing an effect where the communities of the network are tightened. The effect of this setting is clear when we compare Figure 8a and Figure 8b. We clearly see that the attraction force is weaker due to the logarithmic term.



(a) ForceAtas2 (b) + LinLog (c) + Dissuade Hubs

Figure 8: Network layouts with different types of forces added: (a) is only the ForceAtlas2 algorithm, (b) is the same as (a) with the LinLog setting added, (c) is the same as (b) with the setting Dissuase Hubs Added.

The Dissuade Hubs mode were also used when visualizing the networks. This setting shapes the network with the most important nodes in the central position. In the Dissuade Hubs mode, the node's importance is determined by a high in-degree compared to an high out-degree. Hence the attraction force is divided by the out-degree of the node:

$$F_a(n_1, n_2) = \frac{d(n_1, n_2)}{deg^{out}(n_1) + 1} \tag{9}$$

The Dissuade Hubs mode reduces the centrality of the hubs with a high out-degree, as this could be a false authority, this is showed in Figure 8c. The plus 1 in the denominator is to avoid zero division for nodes with no out-degree.

2.4 DISCOURSE ANALYSIS AND CRITICAL DISCOURSE ANALYSIS

As mentioned in Section 2.3 a mixed-method approach was used to analyze the data from the intended curriculum. The mixed-method was inspired by [Lindahl, Bruun, and Linder, 2016] where they combined thematic discourse analysis with network analysis into a mixed-method approach called Thematic discourse network analysis (TDNA). They then used this mixed-method approach to analyze students group discussions. In my version of a thematic discourse network analysis, I have substituted the thematic discourse analysis with a critical discourse analysis. In the following section the discourse analysis and the critical discourse analysis used in this study will be elaborated.

The discourse analysis have been an analytical tool since the middle of the 1980's and is primarily used within the humanities and social sciences. The term "discourse analysis" covers a number of different types of discourse analysis. However, these analyzes have some similarities in relation to meta theory, theory and methodology [Philips, 2015]. A discourse is a way to give meaning to and to interpret the world [Jørgensen and Philips, 1999]. The term discourse signalizes a particular understanding between language and reality. One might say that the language forms and regulates meanings and the production of meanings in relation to how people think and communicates. The discourse analysis is applied in mapping the overall structures which form the human thoughts and language in different knowledge regimes. In each knowledge regimes there are rules for what is considered true and false as well as what can be said and not said. The truth is a construction determined in the different knowledge regimes. In educational contexts, the discourses regulate the different disciplines including the use of language and other forms of expressions. So for a given discipline there is a specific discourse related to that discipline which constructs the rules of what is recognized as the discipline's domains. This means that we in the discipline of physics have a specific discourse which determines the discipline genres and statements which are important in physics. This physics discourse is constructed based on the way physics is spoken and understood inside the field of physics.

It is important to be aware of the fact that discourses change over time and space in relation to social, cultural and historic conditions [Philips, 2015]. It means that this study can only describe the discourses which are present now since the discourses will change over time. One way a discourse can change in relation to educational perspective is when a new reform is implemented and the curriculum therefore is changed like it happened in 2005 [Regeringen et al., 2003]. A discourse change can also happen without a change in the curriculum or other ministerial documents since "power" or a "discourse" cannot be owned by a person, a state or a group with a specific interest. Instead, it is something which spread over different social practices [Jørgensen and Philips, 1999]. Therefore different discourses compete in order to determine what is the truth. Even though the different discourses construct the world in their own way and sometimes contrast each other, they all contribute to the discursive production of significance. The discursive production of significance can be understood as a production where different discourses co-articulate in a meaning formation in a social practice. Thus, a temporary hegemony can be obtained in this battle of constructing the meaning and truth between the different discourses. It is therefore possible to talk about a dominance and subordination relationship within the various discourses.

In this study, Norman Fairclough's critical discourse analysis (CDA) was used for analyzing the curriculum plans throughout time. Fairclough's CDA is linguistic-oriented. The purpose with his analysis is to show that the changes in the language can be related to social and cultural changes [Jørgensen and Philips, 1999]. According to Fairclough, texts contain several meaning potentials in the language, and it is in the interpretation process that the meaning is created. This happens within a certain discursive practice in a given genre[2]. This genre is (must be) well know for the recipient. Fairclough argues that discourse only exist in the language where they form a link between the text and the social practice. Due to these things, Fairclough's model is extremely useful for curriculum analysis since there are many steps in the interpretation process between the sender(s) and the recipient(s) before the curriculum can be implemented in classroom.

In the analysis there are two essential aspects; the communicative event and the orders of discourse. The communicative event is a way of using language. It could be a film, an interview or a curriculum text. Hence, the communicative event could be written or spoken. In this study the communicative event consists of the curriculum plans and the associated guidelines for the BSC program. The orders of discourse can be described as the sum of the discourses which are used within a specific social domain or social institution. It is here a particular genre is constituted through the use of language in a specific social practice. An example could be that the ME uses a particular discourse in their inquiries to the teachers at the upper secondary school in Denmark through curricula, instructions etc. The teachers then use other discourses within the genre in their work with the curricula, instruction and so on. It is the sum of these discourses which Fairclough calls the order of discourse. The order of discourse therefore controls the communicative event. This order constitutes the framework for which discourses and genres are available. But at the same time places restrictions on what can be said in a given social context. Therefore the order of discourse is both a system which forms the communicative event and is shaped by the communicative event. For Fairclough the order of discourse is open for change. If new discourses from another order is articulated, they can contribute to construct a new reality and hence a new order of discourse [Jørgensen and Philips, 1999].

2 A genre could be the political system, the education system, the media etc.

2.4.1 *Fairclough's three dimensional model*

It is the communicative event which is the core for Faircloughs CDA. As mentioned above, it is essential for Fairclough to show the connection between the language and the social world. Fairclough therefore makes an analytical division and argues that each communicative event has three dimensions; a text, a discursive practice and a social practice, see Figure 9. An ideal discourse analysis must, according to Fairclough, consist of all three dimensions and the connections between the dimensions. However, it should be noted that although Fairclough makes this sharp analytical division of the communicative event, he believes that in practice it is not possible to separate the analysis so rigorously. An analysis of a text must involve discursive practice and vice versa [Norman, 1992].

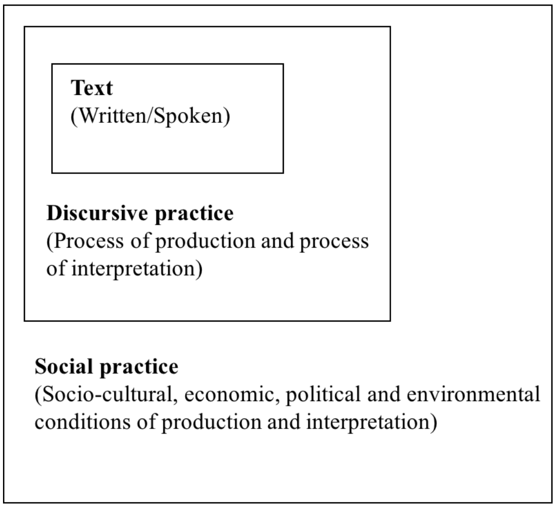


Figure 9: Fairclough's 3 dimensional model for discourses [Norman, 1992, p.73]

The first dimension of Fairclough's three dimensional model is the text. As Fairclough uses a linguistic-oriented approach to discourse analysis, he argues that linguistic features of the text play an important role for the analysis. Due to this, Fairclough uses a lot of different linguistic analysis tools when analyzing a text. These could be metaphors, grammar, vocabulary, language practices, meaning constructions etc. According to Fairclough, these tools have an impact on the construction of social relations and identities in the discourse [Norman, 2008]. But at the same time Fairclough emphasizes that as a user of discourse analysis, you (the analyst) must select the analytical tools which you find relevant for your concrete empirical perspective.

The middle part of the model is the discursive practice. This part of the model deals with the conditions under which the text is produced, and how the text draws on existing texts and discourses [Jørgensen and Philips, 1999]. The analysis of the discursive practice also relates to the text although not in a linguistic way. Fairclough means that the relation between the text and the social practice is mediated by the discourse practice. Therefore properties of the social practice form the text through the discursive practice. On the other hand, the text also forms the social practice. Therefore it is important in the analysis of the discursive practice to take a look at how the text is produced and consumed [Norman, 2008]. This part of the analysis becomes more interpretative according to Fairclough because you as a analyst are more dependent on possessing a social and cultural understanding. What is important to Fairclough with the discursive practice is:

> " to link the linguistic analysis with an intertextual analysis to bridge the gap between text and language on one side and society and culture on the other side." [Norman, 2008, p. 130],(*my translation*, see original text in appendix Section A.1)

The last dimension of the model is the social practice. In this part of the analysis, the discursive practices are linked to the social structures and power relations which they also belong to. Fairclough argues that this part of the analysis can be done at different levels of abstraction such as a narrow context, a broader context of institutional practices or an even wider societal context [Norman, 2008]. As the social practice also consists of non-discursive elements, Fairclough argues that it might be necessary to include sociological and cultural theories. However Fairclough does not go into further details about how this should be done in practice. The overall purpose with the analysis of the social practice is defined by Fairclough as follows:

> " The general objective here is to specify: the nature of the social practice of which the discourse practice is a part, which is the basis for explaining why the discourse practice is as it is; and the effects of the discourse practice upon -the social practice."[Norman, 1992, p. 237]

The application of CDA together with the TDNA in the analysis of the intended curriculum will be introduced in Section 4.1

2.5 RESEARCH QUESTIONS

I have in the former sections elaborated the theoretical framework for this thesis. The purpose of this thesis was to investigate the interdisciplinarity within the Basic Science Course BSC in the three different curricula, intended, implemented and realized curriculum. All the investigations were based on the approach of network analysis. This leads to following research questions.

- How is interdisciplinarity characterized, through the lens of thematic discourse network analysis, in the intended curriculum of the BSC?
- How is interdisciplinarity characterized, through the lens of activity maps, in the implemented curriculum of theBSC?
- How is interdisciplinarity characterized, through the lens of dialogue maps, in the realized curriculum of the BSC?
- How can the three types of network analysis be used to describe/discuss alignment between the three curricula ?

In order to investigates these four research questions several things were done. The different BSC curricula throughout time have been made into thematic maps in order to see if there were any changes to the interdisciplinarity or other things over time. Network analysis have been applied to the data from the implemented and realized curriculum to produce respectively the activity network maps and dialogue network maps. From these maps (both the activity maps and the dialogue maps) the network properties modularity and PageRank were calculated, to investigate whether they can be used to characterize the degree of interdisciplinary in the implemented and realized curriculum. Besides from the interdisciplinarity, the PageRank was used to investigate the alignment of the learning aims between the implemented and realized curriculum in order to examine what is taught and learned in a specific BSC implementation.

In the next chapter I will explain the framework in which this study was conducted to answer my research questions.

3 FRAMING THE STUDY

This chapter gives a short introduction to the Danish upper secondary school program (USS) and the basics program on Stx which was introduced with the Upper secondary school reform [Regeringen et al., 2003] in 2004. In addition a more through description of the Basic Science Course (BSC) based on the documents of the Ministry of Education (ME) is included in this chapter. At the end of this chapter a description of the five observed BSC implementations is presented. These five implementations set the frame for this study.

3.1 THE UPPER SECONDARY SCHOOL PROGRAMS

In Denmark, there are four different upper secondary programs each with a specific profile. *Hf- higher preparatory examination* and *Stx- upper secondary school leaving examination* consist of a broad range of subjects from the fields of the humanities, natural sciences and social sciences. The focus is to give the students general knowledge and act preparatory for further academic programs. *Hhx-Higher Commercial Examination* focuses on business and socio-economic disciplines. Finally *Htx- Higher Technical Examination* has its focus on technological and scientific subjects [UVM, 2017d]. *Hf* is a two-year program whereas the three other programs (*Stx*, *Hhx*, *Htx*) are three-year programs. In 2004 theUSS reform [Regeringen et al., 2003] was passed which was implemented in the school year 2005/2006. This reform introduced fundamental changes in both the structure and the content of the upper secondary programs. The new structure divided the three-year programs into a basics program in the first half year and a specialized study program lasting two and a half years. This study focuses on BSC which was one of the three new courses of the basics program at the Stx introduced with the reform.

3.1.1 *The basics program on Stx*

The idea behind the basics program was to introduce the students to the working methods at the Stx as well as give the students insight and understanding of the different academic disciplines [Kapersen, 2013]. This should make the student more confident in: 1) Choosing the right specialized study program ($2\frac{1}{2}$years) and 2) make the student more capable of completing the entire education at the Stx [Regeringen et al., 2003]. The basics program on Stx consists of ordinary disciplines: Danish, Mathematic, Physics etc. and three interdisciplinary courses; General Language Comprehension GLC (in Danish AP), Multi-Subject Coursework MSC (in Danish AT), The Basic Science Course BSC (in Danish NV). These three new courses mark some of the changes in the content of Stx, as these three new courses add an interdisciplinary dimension [Kapersen, 2013].

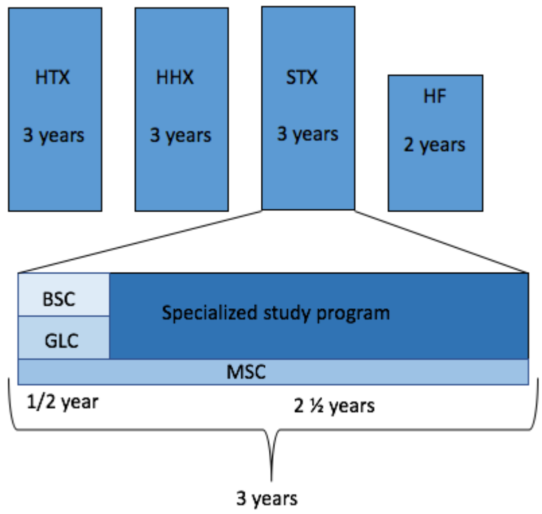


Figure 10: Overview over the four different USS programs. The structure of Stx is illustrated with the half year basics program followed by a two and a half year specialization program, note that MSC is a part of the study program for all three years.

The three courses have different aims both in interdisciplinarity and academic content. The purpose of MSC is to link Humanities, Natural Sciences and Social and Behavioral Sciences in an interdisciplinary interaction. It also aims at preparing the student for further studies at higher educational levels. This course is a part of the study program for all three years. The content of GLC comprises applied linguistics, grammar, the history of language, second language acquisition strategies and Latin i.e. interdisciplinary work between Humanities disciplines. The GLC and BSC are both short courses and are therefore connected to the basics program. Since this study focuses on the BSC, a more thorough description of the course is given in the next section.

3.2 THE BASIC SCIENCE COURSE

BSC is a mandatory course and part of the basics program. It was introduced with the reform in 2004 [Regeringen et al., 2003]. One of the objectives of BSC was to increase the collaboration between the disciplines of natural science and give all students elements from Biology, Physics, Chemistry and Physical Geography [Regeringen et al., 2003]. One of the academic aims of BSC is to introduce the student to science through work with the basic elements of natural science. The focus should be on the commonalities and the differences within the natural science disciplines [UVM, 2013b]. Therefore BSC must consist of exemplary and contemporary thematic issues where the scientific disciplines are required to work in a interdisciplinary fashion.

Another objective of the BSC is to make the students aware of the importance of knowing and understanding scientific thinking. This in order to make the student able to relate the strengths and limitations of scientific knowledge. Moreover, the students also have to achieve knowledge about a central scientific issue which supports their curiosity and commitment for natural science and encourage them to learn more about science [UVM, 2013b]. You could argue that there are three overall aspects of this course. 1) Introduce all four science disciplines (which is taught in Stx) through contemporary thematic issue(s). 2) Learn the scientific way of thinking. 3) Create motivation about Science.

For this thesis project I have focused on how the interdisciplinarity and the academic aims of BSC are expressed in relation to teaching and learning. To set the stage, the following section gives a description of academic identity, the overall course aim, and the academic aims of BSC from the 2013 curriculum issued by the Ministry of Education ME [UVM, 2013b].

The academic identity of BSC is described as the introduction to natural science through exemplary and contemporary issues which should be supported by an experimental approach.

> The Basic Science Course represents the introduction to natural science in upper secondary school Stx through working with the basic elements of natural science with emphasis on the coherences in natural science. BSC consists of exemplary and current issues combined with an experience-oriented and experimental approach to the outside world. [UVM, 2013b], (*my translation*, see original text in Appendix, Section A.2)

It is clear that the main focus of BSC is on thematic topics with relevance to the outside world which should provide an experience-oriented and an experimental approach to natural science.

When it comes to the overall course aim of BSC it points in many different directions.

> Students should through the teaching of BSC realize the importance of knowing and understanding scientific think-

> ing, and they must be able to relate the scientific knowledge to its strengths and limitations. Students should acquire knowledge about some key scientific problems and their social, ethical or historical perspectives so that they can express a knowledge-based opinion on issues and problems with a natural sciences aspect. Finally, students' curiosity and commitment towards the natural sciences should be supported and encouraged. [UVM, 2013b], (*my translation*, see original text in Appendix, Section A.2)

This course aim of BSC supports the general ideas behind the implementation of the basics program in Stx. In this case it introduces the field of natural sciences both in knowledge content and scientific methods. By using exemplary topics and relating those to outside perspectives, BSC should motivate and encourage the students to choose a specialization at Stx with a natural science element [Regeringen et al., 2003]. Notice that in the curriculum text the focus is on supporting the curiosity of the students towards natural science where in the reform papers the focus is on getting more students to choose a natural science specialization by motivation through the BSC. In the law text [Regeringen et al., 2003] the BSC is used as an acquiring campaign where curriculum text [UVM, 2013b] is about creating curiosity among the students.

This part about understanding scientific thinking and be able to relate to scientific knowledge supports the idea of Bildung which is a large part of the Danish school system and therefore also a large part of Stx [Kapersen, 2013]. As Dolin and Krogh [2010] write Bildung (German: *Allgemein Bildung*, Danish: *Almendannelse*) is not explained easily. Bildung has focus on development of the individual student in order to prepare the individual student for participation in society. In short terms Bildung should emphasize the general character development of the student. Since Bildung is described as a development of general character and a preparation for participation in the society, the dimension of natural science is often left out [Sjøberg, 1998]. With the reform in 2004 [Regeringen et al., 2003] it was decided that the natural science part of Stx should be strengthened and it was specified that natural science was a part of Bildung [Regeringen et al., 2003]. This decision is expressed in the overall course aim. This is seen both in the part about understanding scientific thinking and relating scientific knowledge as well as the student acquiring knowledge about science in order to express themselves.

The academic aims, which the student should fulfill, are described as follows:

> The students should be able to:

> - perform practical studies and observations both in the laboratory and in the field (of nature) in order to create and evaluate simple hypotheses.
>
> - apply models which qualitatively and quantitatively describe simple relations in nature and see the models' possibilities and limitations.
>
> - communicate a scientific topic with proper application of academic vocabulary.
>
> - put into perspective the contributions of science to technological and social development through examples.
>
> - demonstrate basic knowledge of science identity and methods.
> [UVM, 2013b],(*my translation*, see original text in Appendix, Section A.2).

These academic aims are a central part of this thesis study and are therefore further analyzed and interpreted in Chapter 5.

3.3 THE DIFFERENT DATA TYPES OF THIS STUDY

Due to the multiple intentions of BSC, it is interesting to investigate the alignment of the three different curricula; the intended curriculum (the curriculum issued be the ME), the implemented curriculum (the curriculum which is taught in the classroom), and the realized curriculum (the curriculum which the students are tested in) relative to the academic aims and interdisciplinary perspective.

Therefore this thesis consists of three different data collections with one for each curriculum as listed in Table 2. For a definition of the three different curricula, see Section 2.1.1.

CURRICULUM	DATA
Intended	Curriculum documents of BSC from ME
Implemented	Observed BSC implementations and interviews
Realized	Observed BSC examinations

Table 2: The various data types used in this study divided into the three different curricula

For this thesis, the intended curriculum is constituted by the curriculum documents of BSC and their corresponding instructions of BSC issued by ME. Three curricula were selected due to changes in the curriculum by ME in the years 2003,2007, and 2010 [1]. This made it possible to investigate changes in the interdisciplinarity requirement and the academic aims from the ME over time.

When it comes to the implemented curriculum, the data consist of observations of BSC in action. Five different BSC implementations have been studied primarily by making classroom observations. In addition to these classroom observations, interviews have been made with the teachers involved in the BSC implementations. A description of the different BSC implementations is found in Section 3.4.

The study of the realized curriculum is based on data from the exam situations of BSC. It was possible to attend the exams of two of the five BSC implementations. One of the BSC implementations hosted a group examination while the other BSC implementation hosted an individual examination. It is important to be aware of the fact that the exam's grade of BSC is going to be on the student's certificate but is not a counting grade [UVM, 2013b]. The grade will therefore not be included in the student's final grade average.

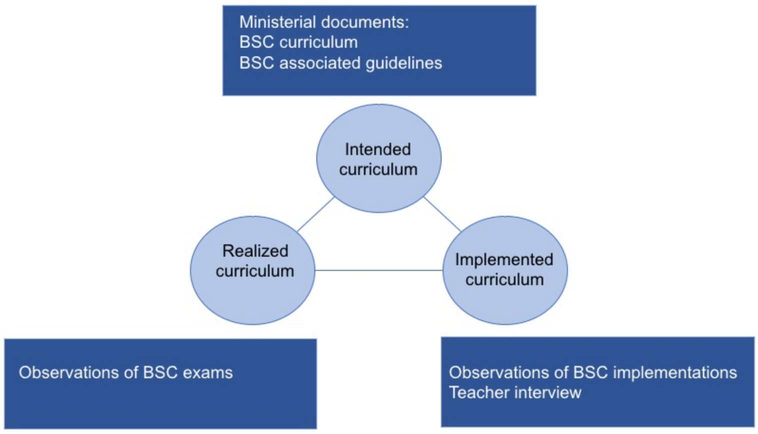


Figure 11: The three different curricula and their respective data sources. The three different curricula are shown in the light blue circles, and the different data sources are shown in the blue rectangles.

3.4 THE BSC IMPLEMENTATIONS OBSERVED

For this study, five different BSC implementations have been observed. The basis for the choice teachers was that they were the first to show

1 There have been no changes in the curriculum of BSC since 2010, except from the new reform 2017. Therefore the curriculum from 2010 is the same as the curriculum from 2013. However, other changes have been made in the executive order of the Stx in 2013. Therefore the year has been updated

interest in my investigation. The choice of observing five implementations was to ensure data from different implementations as well as observe enough modules in each implementation. The different BSC implementations took place at three different USS. Five different classes and six teachers participated in the study, see Table 3. The numbering of the implementations is firstly based on which School it took place on and secondly which order the implementations were observed. One implementation deviated from the rest of the implementations as the class worked with Project Based Learning Techniques [Blumenfeld et al., 1991]. The other implementations followed a more traditional set of teaching activities like blackboard teaching, smaller group work about an assignment for a given module etc.

CLASS	TEACHER	SCHOOL
Class 1	Teacher A & Teacher B	USS α
Class 2*	Teacher C	USS α
Class 3	Teacher C & Teacher D	USS α
Class 4*	Teacher E	USS β
Class 5	Teacher F	USS γ

Table 3: Table over the different BSC implementations. Classes, teachers and schools which have been observed for this project. The star indicates that the examination data come from Class 2 and 4

3.4.1 *The different schools' organization of BSC*

In the curriculum for BSC in 2016 there was no common content in contrast to all other disciplines at Stx. This allowed the individual school to structure the BSC implementations as they wished. Hence there was a big difference in the planning and execution of the BSC in each school [Dolin, Hjemsted, Jensen, Kaspersen, and Kristensen, 2006]. Therefore a description of the different schools' organization of the BSC is given in this section.

School α

At School α, the basics program of the first half year was structured so half of classes began with BSC while the other half had GLC. After about 10 weeks the two halves switched. At School α, it was up to the individual teacher teams to organize a BSC implementation. Thus each first year class had two science teachers assigned to plan and execute a BSC implementation. This allowed for many different types of BSC implementations and types of examinations at the same school.

The teachers' subject combination determined which science disciplines were represented in the specific BSC implementation. Usually the BSC implementation became a collaboration between two or sometimes three science disciplines according to the teachers at School α.

School β

At School β, the basics program was structured such that the GLC and BSC was taught side by side. Both courses must be completed before Christmas. At School β it was again up to the individual teacher teams to organize a BSC implementation. Again each first year class had two science teachers assigned to plan and execute a BSC implementation. This allowed many different types of BSC implementations. The school had chosen one exam form which was the same for all classes. It had been decided by the school that all four science disciplines must be represented in each BSC implementation. Therefore the two teachers must cover all four science disciplines in their specific BSC implementation.

School γ

At school γ, the basics program was structured such that the GLC and BSC was taught side by side. Both courses must be completed before the Autumn break. At School γ every first year class was taught the same BSC implementation. This BSC was planned by a selected group of science teachers who made all the material for the BSC implementation at the school. The school decided that a BSC implementation are constituted by three science disciplines, where Physics and Chemistry represent two of the three disciplines. Therefore, the only difference was whether it was Biology or Physical Geography which was included as the last science discipline in BSC implementation. Therefore each first year class was assigned three (sometimes two) teachers to execute the BSC implementation. The exams form was similar for all classes at School γ.

3.4.2 *The different classes and their BSC implementations*

The data collection of observing different BSC implementations started in mid August and ended in November. Since the 5 implementations took place concurrently, it was not possible to observe all modules of all the implementations. The observations were planned to get as much data as possible which was almost equally divided between the different implementations and teachers. In this section, the five different classes and their BSC implementations are described. For each implementation, a table is included which indicates the amount of modules observed.

Class 1 and their BSC implementation

Class 1 had the study specialization: Social Studies A-level, Physical Geography B-level and Mathematics B-level. This BSC implementation stands out compared to the four other implementations. The theme of this BSC implementation was Myth Busters [2]. The implementation was taught by two teachers; teacher A who usually taught Physics and teacher B who usually taught Physical Geography.

This BSC implementation was structured as a project based learning process. In the beginning of this implementation the students learned how to generate ideas throughout different kinds of innovation exercises. In this case the students identified different myths that could be tested. After the idea generation, the selection process starts. Each group of students narrowed down their ideas and ended up with one myth they could put to the test. Then the students investigated their myth in many ways for quite a long period of time (approximately 15 modules of 90 minutes). At the end of the testing process, the groups made a presentation of their own work. These presentations were presented to another first year class at the school. This other class assessed the work and presentations in order to pick a winner among the groups in class 1. In between the different segments of idea generation, idea selection, myth testing and presenting results, individual modules with different targets were placed. Each of these modules had a different theme e.g variable control, introduction to inductive method, data collection and how to make a graph. These modules were placed so they fitted into where the students were in their learning process, according to Teacher A and B. Teacher A's modules and most of the modules where both teachers were present were observed. The teaching performed by Teacher B alone was not observed. The BSC implementation in class 1 took place from mid August to the end of October where the exam was held.

Due to the project based learning techniques of this implementation, a lot of modules were spend on the students working on their myths by themselves and only using the teachers as supervisors, this took up 15 out of the total of 32 modules [3]. Of these modules four were observed. The observed modules mostly focused on the supervision that the teachers gave to each group. One of the individual modules was about data collection and data interpretation. This module was held for only half a class at the time. Hence, the module was

2 This BSC implementation is inspired by the television program MythBusters which first aired on the Discovery Channel back in 2003. The idea behind the show was to use elements of the scientific method to test the validity of rumors, myths, movie scenes, adages, Internet videos, and news stories. [Discovery Channel, 2017]

3 It was divided between the teachers in this way: Teacher A: 7 modules, Teacher B: 6 modules, Together: 2 modules

TEACHER	OBSERVED MODULES	MODULES IN TOTAL
Teacher A	6	12
Teacher B	0	10
Teacher A+B	9	10
The total amount	15	32

Table 4: The amount of modules taught by Teacher A and B separately and together. The second column shows the amount of modules observed of the BSC implementation.

performed twice. Only one of these modules was observed. Beside that one of teacher A's modules was used for writing a report in class. This module was not observed either.

Class 2 and their BSC implementation

Class 2 had the study specialization: Biology A-level, Social Studies B-level and Sports Science B-level. The theme of this BSC implementation was: The Body and Energy. The implementation was taught by two teachers and two subjects were presented. Teacher C taught in Physics, and the other teacher taught in Biology. Most of this BSC implementation was designed as a traditional science school program consisting of blackboard teaching, exercises, and classroom experiments. In this BSC implementation, 7 of the modules were used for a field trip in the middle of the implementation.

Only teacher C's modules and the modules where both teachers were present were observed since the other teacher did not want to participate in the study. In Physics, the primary topic was energy and how energy is converted from one form to another. Here physical concepts such as mechanical energy, thermal energy and energy conservation had a central role. I cannot comment on the teaching in biology as well as the teaching in relation to the field trip, since this was not observed.

The BSC implementation in class 2 was held from mid August to the 1st of November where the exam took place. The examination was a group exam with a total time depending on the number of persons in the group. Each group had prior to the exam made their own investigation which was based on the theme of the BSC implementation. The exam consisted of a presentation of the investigation and a dialogue between the students and the teacher. There were 5 minutes for each student in the group to present a single part of the investigation, 5 minutes for an exam dialogue between the teachers and the student and 5 minutes for assessment. Seven group exams were observed and recorded. The number of students in each group varied from two to five students. The amount of modules observed is shown in Table 5.

TEACHER	OBSERVED MODULES	MODULES IN TOTAL
Teacher C	9	14
Other teacher	0	12
Together	4	7
The total amount	13	33

Table 5: The amount of modules taught by Teacher C and Other teacher separately and together. The second column shows the amount of modules observed of the BSC implementation.

There were 7 modules where the two teacher taught together. 3 of these modules were not observed due to the fact that it was a field trip (3 modules = 1 field trip) for the class with limited tickets. After the field trip, 2 of teacher C's modules were used for finishing the data produced on the field trip. These modules were not observed either. Teacher C also hosted two writing modules where the student should make their written reports. These modules were not observed either.

Class 3 and their BSC implementation

Class 3 had the study specialization: Mathematics A-level, Physics B-level, Chemistry B-level and Biology B-level. This BSC implementation was a little different from the other classes since the class already had been taught in physics from August to mid November by teacher C. Therefore the class had already been taught in a specific science subject. Class 3 had started to learn about energy in their physics modules prior to the BSC implementation being taught. The theme of the BSC implementation was chosen in relation to what the class had already learned in physic. The theme was The Body and Energy. Thus, the implementation was a combination of Physics and Biology. Teacher C taught in Physics and Teacher D taught in Biology.

Half of the BSC implementation was designed as a traditional science school program consisting of blackboard teaching, exercises and classroom experiments. The exam was the same type as class 2 where each group should make their own investigation in relation to the overall theme. In order to prepare the students for the exam, a trial run of investigations was made. Therefore one quarter of the implementation (8 modules) was used for the students to make their initial own investigation, presenting it and receive feedback on it. The last quarter of the implementation (7 modules) was used for the students to make a new investigation which the students presented at the exam.

Both Teacher C's and Teacher D's modules were observed. The primary focus was on energy and how energy is converted from one form to another in the physics modules. Here physical concepts such as mechanical energy, thermal energy and energy conservation had a central role. In Biology the primary focus was on diet and nutrition and how and where the human body absorbs energy. Here topics like what to eat and what not to eat were debated. Key concepts like the digestive system and the role of blood had a central role in the teaching.

The BSC implementation in class 3 was held from mid November to the middle of December where the exam took place. The amount of modules observed is shown in Table 6.

TEACHER	OBSERVED MODULES	MODULES IN TOTAL
Teacher C	8	16
Teacher D	8	13
Teacher C+D	1	5
The total amount	17	34

Table 6: The amount of modules taught by Teacher C and Teacher D separately and together. The second column shows the amount of modules observed of the BSC implementation.

There were 5 modules were the two teachers taught together. 4 of these modules were not observed. These 4 modules were meant for the groups to work on their second investigation and exam preparation. In these modules the teacher became a practical and a professional helper/supervisor. It was not possible to follow the whole class at the same time as they all worked in different groups placed all over the school. It was also decided not to follow the teachers in this setup since they most of the time were waiting for a group of students to need them.

For the first investigation, 6 modules were structured as described above and only one of these was observed. 2 of Teacher C modules were used for group presentations of the first investigation project.

These modules were not observed either since the work which led to these presentations had not been observed.

Class 4 and their BSC implementation

Class 4 had the study specialization: English A-level, Social Studies B-level and Psychology C-level. The theme of the BSC implementation in this class was: Global Warming. The implementation was taught by two teachers. Teacher E taught the class in Physics and Physical Geography. The other teacher was responsible for Chemistry and Biology. This BSC implementation was designed as a traditional science school program consisting of blackboard teaching, exercises, and classroom experiments.

In class 4, Teacher E's modules were observed as the other teacher did not want to participate. In Physics the primary focus was on water and the water cycle. Here physical concepts such as density, temperature, and energy had a central role. The small Physical Geography part of the implementation focused on the side effects that the density of water and change in temperature can have on the thermohaline circulation; more specific the north Atlantic circulation pump and other weather phenomena. As only the modules of Teacher E were observed, I cannot comment on the teaching in Chemistry and Biology.

The BSC implementation in class 4 was held from mid August to mid November where the exam toke place. The examination was an individual exam with a total time of 15 minutes; 5 minutes for the student to present a topic specially prepared for this occasion, 5 minutes for an exams dialogues between the teachers and the student and the last 5 minutes were for assessment. Fourteen of these exams were observed and recorded. The amount of modules observed is shown in Table 7.

TEACHER	OBSERVED MODULES	MODULES IN TOTAL
Teacher E	11*	17
Other teacher	0	15
The total amount	11*	33

Table 7: The amount of modules taught by Teacher E. The second column shows the amount of modules observed of the BSC implementation. The star indicates that one module was used for an evaluation of the BSC implementation. This module was not analyzed and will therefore not contribute to the data.

Four modules out of the 17 modules were experimental. For safety reasons only half a class was allowed to perform the experiment at a time. Hence two different experiments were performed. Only one module of each experiment was observed. Besides the experimental modules, one module was use for watching a movie in relation to the topic of the BSC implementation. This module was not observed either.

Class 5 and their Implementation

Class 5 had the study specialization: English A-level, Social Studies A-level and Mathematics B-level. This BSC implementation also had the theme: Global Warming. Here, the BSC implementation was taught by three teachers; Teacher F who taught Physics, one teacher who taught Chemistry and one who taught Physical Geography. Only the physics teaching was observed for this BSC implementation since the other teachers did not want to participate in the study.

The implementation followed a traditional science school program. Hence, it included black board teaching, exercises, classroom experiments and a test module. The teaching performed by teacher F was observed. The focus was on water and the water cycle. Hence, a lot of the physics concepts were the same as in the BSC implementation of class 4. The teaching in chemistry and natural geography will not be discussed. The BSC implementation in class 5 was held from mid August to mid October. The exam took place just after the Autumn break. The examination was a group exam. These examinations were not observed. The amount of modules observed is shown in Table 8.

TEACHER	OBSERVED MODULES	MODULES IN TOTAL
Teacher F	8	14
Other teacher	0	12
Other teacher	0	11
The total amount	8	37

Table 8: The amount of modules taught by Teacher F. The second column shows the amount of modules observed of the BSC implementation.

Two out of the fourteen modules were written modules. The students used these modules for writing journals and making their final presentation. These modules were not observed.

4 METHODOLOGY

In this chapter, I introduce the different methods used to acquire and process data for this thesis. The sections on methodology are organized chronologically in the order which they were applied in the study. This whole project is characterized by an explorative work approach.

The data was collected over three periods of time relating to the three different curricula, see Section 2.1.1. The data for the Intended curriculum was collected in the spring of 2016 by contacting the national educational adviser of BSC in order to get hands on the official curricula and the associated guidelines documents through time (from 2003-2013) issued by the ME.

The second round of data collection started in August 2016 and ended in December 2016. This data cover the implemented curriculum. There are two types of data for the second part of the project. First an interview was conducted with the six teachers separately. Secondly, observations of the five BSC programs were completed. In the first module of all the five BSC programs, I presented my didactical project and showed the recorder and the observation guide to the students. It was explained explicitly that I only looked at the different teaching activities which occurred in the module, the interactions between the teacher and student, and which disciplines and academic aims these targeted. The students were told that if some of them were reluctant about the recorder they should let me know.

The third round of data collection was in November 2016 to January 2017. The data for the realized curriculum is divided into two types of data. Interviews with the teachers who here looked back at the completed BSC program and observations of two BSC programs exams. Only the exams where I was allowed by the student(s) were observed .

Each of the three curricula has different data types and aims. Different data types demand different methodology for both collecting and processing. This chapter is therefore divided into three parts. The first part is a description of the methods used in connection with the intended curriculum and how data for this curriculum have been processed. The second part covers the methods used for collecting data the implemented curriculum and the data processing for this curriculum. The third part deals with the methods used for the realized curriculum both in data collection and processing. As a final part of this chapter, the validity and reliability of this study is put into perspective as well as the limitation of the methods of the study.

4.1 THE INTENDED CURRICULUM - METHODOLOGY

The data for the intended curriculum are a set of written ministerial documents. These curriculum documents and their associated guidelines were analyzed using a mixed-methodology which combines the critical discourse analysis (CDA) with a network analysis (NA) into a thematic discourse network analysis (TDNA), inspired by [Lindahl, Bruun, and Linder, 2016]. In this study a new variant of TDNA have been developed in order to fit the data source. I have change the type of discourse analysis from a thematic discourse analysis to a critical discourse, as this type of discourse analysis is more suited for this specific data source. As mentioned in Chapter 2 the idea behind using this mixed-method was to achieve a greater depth and breadth in the outcome of the analysis. A CDA provides an understanding of the different themes in relation to the content of the curriculum. Where the NA of the same document provides structural aspects to the analysis. By combing these two methods, an iterative process can be performed in order to align the themes of the network map with the themes from the CDA. In this section, a brief introduction will be given to the three different methods; the CDA, the NA using a text-mined approach and last the TDNA.

4.1.1 *CDA - from a text to themes*

The methodology of Fairclough critical discourse analysis CDA, described in Section 2.4.1, has been used here to analysis the curriculum for BSC and its associated guidelines issued by ME. The method of CDA has been used in order to explore the themes of the BSC curriculum. The intention of using Faircloughs CDA as a method is that it can be used for comparing the themes of intended curriculum throughout time. In addition the themes found in the CDA can also be used to compare the intentions from the ME with the teacher's focus in the implemented curriculum and the realized curriculum. Due to changes in the curriculum of BSC, a CDA has been performed on both the BSC curriculum from 2005 [UVM, 2005], the BSC curriculum from 2008 [UVM, 2007] and the BSC curriculum from 2010 [UVM, 2010].

Figure 12 shows an example of the application of Fairclough's three-dimensional framework on the BSC curriculum from 2005 and the associated guidelines for BSC from 2005. The themes obtained from applying the method of CDA is described in Chapter 5. If one substitutes the year 05 with 08 or 10, then one has the communicative event for the BSC curriculum and the associated guidelines from the years 2008 and 2010.

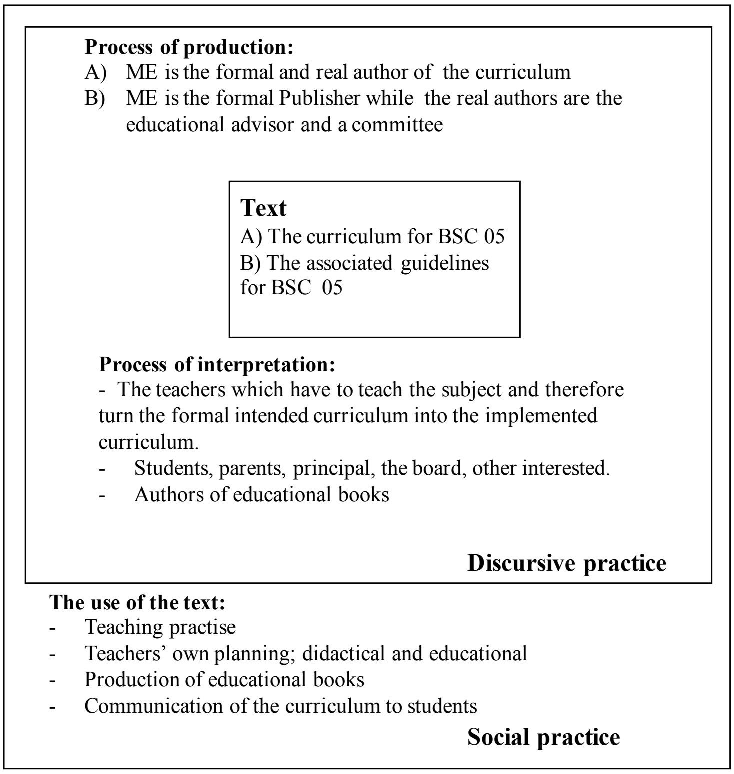


Figure 12: The curriculum for the Basic Science Course 2005 (BSC 05) in Fairclough 3 dimensional framework

The themes obtained in the CDA will be used together with a linguistic network analysis when the mixed-method called the thematic discourses network analysis TDNA is carried out. In the following sections the method of linguistic network analysis and the method of thematic discourse network analysis (TDNA) are elaborated.

4.1.2 *Network analysis - turning a text into a map*

In order to turn a text into a linguistic network, one has to make a choice of which process to follow since mapping out a text can be done in many ways. It can be done by mapping out every single word in the text as it was done by Masucci and Rodgers[2006]. Here George Orwell's novel 1984 was mapped into a network word by word. This quickly gives a very large and complex network where words there are irrelevant to their study falsely appears to be central.

The idea for mapping the curriculum documents issued by the ME was to look for patterns in the map and how these patterns change when the curriculum was updated in time and the wording of the text might have changed. As Bruun [2009] argues, the writers of the curriculum texts have to make choices when performing the specific wording of the documents. According to Bruun, we often find that curricula documents or scientific literacy use sentences which contain different words or phrases but actually express the same meaning. The idea is therefore to determine these linguistic differences, analyze and group them with fewer sentences. This will help reduce the complexity of the map and the complexity of comparing the curricula throughout time.

Therefore, a few simple rules are applied in order to text-mine the curriculum text. As Bruun also points out; *"this way of mapping a text relies on the assumption that a person conveying information in writing has different ways of emphasizing the importance of different parts of the information."*[Bruun, 2009]. Therefore if a specific theme is important, the writer may choose to use a word or a set of words illustrating the theme many times. The theme could also be emphasized by linking the theme to many other themes. Therefore the reader will encounter the theme many times or in different contexts when going through the document. In both cases the theme will emerge from the text.

4.2 THE INTENDED CURRICULUM - DATA PROCESSING

In this section I will go through the practical steps of how to turn a text into a network. In order to turn a text into a linguistic network, a procedure on how to handle the text has to be performed. Therefore a set of rules is construed on how to separate and parse different sentences. These rules are based on the definitions made by Bruun [Bruun, 2009]. Bruun's definitions can be found in Appendix B. In this case of turning the BSC curriculum into a network, the overall procedure can be divided into two smaller procedures; first a procedure of splitting sentences and secondly a procedure of adjusting the sentence.

4.2.1 *First step of creating an linguistic network from a text*

The procedure of splitting sentences is about changing the long sentences from the original curriculum which contain lots of statements (or actions) into one-statement sentences with one *actor* acting on a *concept* in a specific *context*. This procedure is inspired by [Bruun, 2009] and uses the definitions made by Bruun, see Appendix B for a complete list of definitions. The procedure used on the BSC curriculum documents is as follows:

Procedure of splitting sentences

1. Identify a sentence.
2. Find all commas and "and"s in the sentence.
3. Split sentences with commas and "and"s into new sentences.
4. Identify the parts which are linked and make the link explicit by splitting the sentence.
5. Repeat step 1-4 until all sentences consist of one statement .

This procedure is now illustrated with a long sentence translated by me from the BSC curriculum from 2010 (§2.1) [UVM, 2010]. The original Danish sentence can be found in Section A.3.1. The procedure is also illustrated with the Danish sentence in Section A.3.1.

> The students should be able to perform practical studies **and** observations**,** both in the laboratory **and** in the field (of nature)**,** in order to create **and** evaluate simple hypotheses.

In this sentence we find the word **and** three times and two commas. Therefore we start by splitting the first part of the sentence up, this gives us four sentences.

> The students should be able to perform practical studies in the laboratory in order to create **and** evaluate simple hypotheses.

> The students should be able to perform practical studies in the field (of nature) in order to create **and** evaluate simple hypotheses.

> The students should be able to perform observations in the laboratory in order to create **and** evaluate simple hypotheses.

> The students should be able to perform observations in the field (of nature) in order to create **and** evaluate simple hypotheses.

The to words *create* and *evaluate* are linked to the first part of the sentence *The students should be able to*. Therefore we have to make the link more explicit. We will then end up with eight sentences.

> The students should be able to perform practical studies in order to create simple hypotheses in the laboratory.

> The students should be able to perform practical studies in order to evaluate simple hypotheses in the laboratory.
>
> The students should be able to perform practical studies in order to create simple hypotheses in the field (of nature).
>
> The students should be able to perform practical studies in order to evaluate simple hypotheses in the field (of nature).
>
> The students should be able to perform observations in order to create simple hypotheses in the laboratory.
>
> The students should be able to perform observations in order to evaluate simple hypotheses in the laboratory.
>
> The students should be able to perform observations in order to create simple hypotheses in the field (of nature).
>
> The students should be able to perform observations in order to evaluate simple hypotheses in the field (of nature).

As mentioned earlier, the overall procedure of turning a text, in this case a curriculum text, into a network can be divided into two smaller procedures; the procedures of splitting sentences, as described and illustrated above, and the procedures of adjusting the sentence. As Bruun writes: *The reason for adjusting the sentence is to ensure comparability between the documents*[Bruun, 2009]. Therefore we remind ourselves that we want one-statement sentences with one *actor* acting on a *concept* in a specific *context*. This gives the following adjustment procedure.

Procedure of sentences adjustment

1. Identify the subject of the sentence.
2. Change passive forms to active forms see Appendix B for definition.
3. Change nouns derived form verbs to active verbs see Appendix B for definition.
4. If the subject of the sentence is not an actor, change it to a relevant actor. Bruun comes with following example: "Scientific literacy is an individual's..." is changed to "The scientific literate person"+ a verb [Bruun, 2009].

After performing these two procedures the text should now be completely transformed into one-statement sentences. Before the sentences can be made into a spreadsheet, which can be turned into a network, a final check is made. The final check was proposed by Bruun in [Bruun, 2009].

Final Check

1. A parsed sentence may have precisely one statement.
2. A parsed sentence must start with an actor.
3. The statement describes features about the actor.
4. A parsed sentence has no passive form of verbs.
5. A parsed sentence has no nouns derived from verbs.
6. The parsed sentence must be grammatically meaningful in itself

If all these six steps are fulfilled for the parsed sentences, it is time to move on to the next step of turning a text into network. The next step focuses on creating a data file from the sentences from above. The requirement for the datafile is that it can convert the one-statement sentences into a network using a network analysis program, in this case Gephi [Bastian, Heymann, and Jacomy, 2009]. One way to do that is to create a spreadsheet from the sentences. I will now go through the steps of how to turn the parsed sentences into a spreadsheet and which choices one have to face. This process is inspired by Bruun [2009].

4.2.1.1 *Making a data file from the sentences*

As mentioned above, the next step in the process of obtaining a linguistic network is to transform the sentences found with the rules above into a data file which the network analysis program Gephi can read. First of all we need to think about what a linguistic network illustrates. A linguistic network illustrates the relation between the words and how their adjacency appears in a text. Thus, the words are nodes, and a link marks that two words follow each other in a sequence [Masucci and Rodgers, 2006]. *Word i* links to *word j* if *word i* is followed by *word j* in the text. The weight of the link from *word i* to *word j* is therefore equal to the number of times, in the list of one-statement sentences, *word i* is followed by *word j*.

With this in mind, a trial network is now created as an example from the one-statement sentences from Section 4.2.1: *The students should be able to perform practical studies in order to create simple hypotheses in the laboratory.*

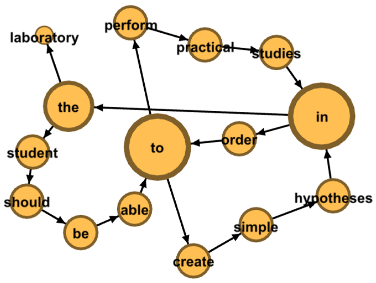


Figure 13: This network shows the representation of the sentence written above. In this figure, all words from the sentence are represented as a node. The size of the nodes is depending on how many links the node has to other nodes; the network property called degree.

The problem with this network is that common words make it difficult to find and discern meaningful patterns in the network. In Figure 13, we can see that words like *in*, *to* and *the* have a larger value (degree) than the rest of the words. Words like these are classified as common words. These common words often obscure important information embedded in the network representation of the sentence, and they provide little or non-relevant information for the purpose of this study. Therefore, I used a text-mining approach for dealing with this problem. I chose to remove all common words from the one-statements sentences [1]. This was done since common words like *is, it, to, a, on, of, the, in etc.* will not in themselves tell us something about how the different themes in the curriculum of BSC are linked to each other. However, there are some exceptions. Some common words like *to* and *in* can have a structural purpose like the word *in* in the last part of the sentence above (...in the laboratory). Here *in* helps indicate the placement of where the action is happening. Therefore the word has a structural purpose and is assigned to the category of structural words. In the corresponding network, the structural words are placed as links whereas words, which contribute to information about the text are placed on nodes.

In order to get a data file, which programs like Gephi can turn into a network, the one-statement sentences are transformed into a spreadsheet. This is done by applying the following rules: 1) remove the common words which can **not** be classified as structural words. 2) Create a spreadsheet with three columns. 3) In the first column is *word i*, which is the word where the link starts from. 4) The second column is *word j*, which is the word where the link goes to. 5) The third column contains the structural word between *word i* and *word j* if any. This procedure is now performed on the sentence from above; *The students should be able to perform practical studies in order to create*

1 Notice that the data files made from the different BSC curricula are in the original language Danish, and therefore it was Danish common words which were removed.

simple hypotheses in the laboratory. It gives the following spreadsheet (Table 9) which translates into the network in Figure 14.

WORD I	WORD J	STRUCTURAL WORD
student	should	
should	perform	able
perform	practical	
practical	studies	
studies	order	
order	create	to
create	simple	
simple	hypotheses	
hypotheses	laboratory	in

Table 9: Here is an example on how a data file made from a one-statement sentence, which have been text-mined, looks like.

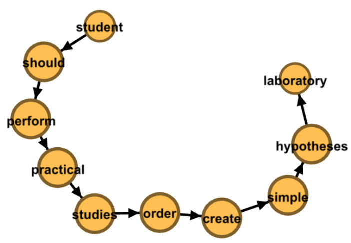


Figure 14: This network shows the representation of the data file in Table 9. In this figure all common words have been removed and only words with information is left. These words are represented as nodes. The size of the nodes depends on how many links the node has to other nodes, the network property called degree. When a whole text is transformed into a network, the picture become more complex

With the common words removed, the network representation now clearly shows the words which carry valuable information. This information is clearly read as there are no common words to obscure the picture. Figure 14 also illustrates how networks can be seen as a set of connections, so-called directed links (indicated by the arrows), between entities (nodes).

The last thing which should be mentioned in this section is that the data files for the BSC curriculum are created in Danish. This was done so that no information was lost in the translation. Hence, the network representation in Chapter 5 is in Danish. However before the final network representations can be obtained, the method of *TDNA - A thematic discourse network analysis* needs to be explained.

4.2.2 *TDNA- A thematic discourse network analysis*

The idea for preforming this mixed-method analysis on the intended curriculum was to get a greater depth and breadth in the outcome of the analysis as mentioned in Section 4.1. The hope was to find the main themes of the BSC, which the teaching is supposed to be build on. If these themes were found, it would be possible to compare what is written in the curriculum issued by ME with what the teacher teaches in the classroom when it comes to BSC. This mixed-method was suggested by M. Lindahl, J. Bruun, and C. Linder [Lindahl, Bruun, and Linder, 2016]. Lindahl et al. developed a way of integrating network analysis with qualitative discourse analysis in order to get a bottom-up systematic approach to generating themes in data. In the case of Lindahl et al. the data consisted of student discussions of sustainability which were transcribed in order to make a qualitative discourse analysis and a linguistic network. The process of integrating the methods of discourse analysis and network analysis, developed by Lindahl et al. [Lindahl, Bruun, and Linder, 2016], is described and illustrated below, see Figure 15.

In this section the process of TDNA will be described according to [Lindahl, Bruun, and Linder, 2016]. Afterwards I will describe how this method was used on the curricula documents for the BSC issued by ME. The process of TDNA can be illustrated as a cycle, see Figure 15. The cycle starts with conducting a discourse analysis and creating a linguistic network. Then a network analysis program called Infomap [Rosvall and Bergstrom, 2008] is used in order to simplify and highlight the regularities in the network structure and their relation. Infomap decomposes the network into modules by optimally compressing a description of the information flow on the network. What Infomap does in relation to the TDNA is that it takes the linguistic network and turns it into a map of connected modules. This is shown in Figure 15 in the box with the title *Uncharacterized Thematic map*.

This map is now a candidate for a thematic map, and the modules are candidates for different themes. The themes, which appear in the map, are now interpreted in relation to the result from the discourse analysis. This part of the process is what Lindahl et. al. classifies as

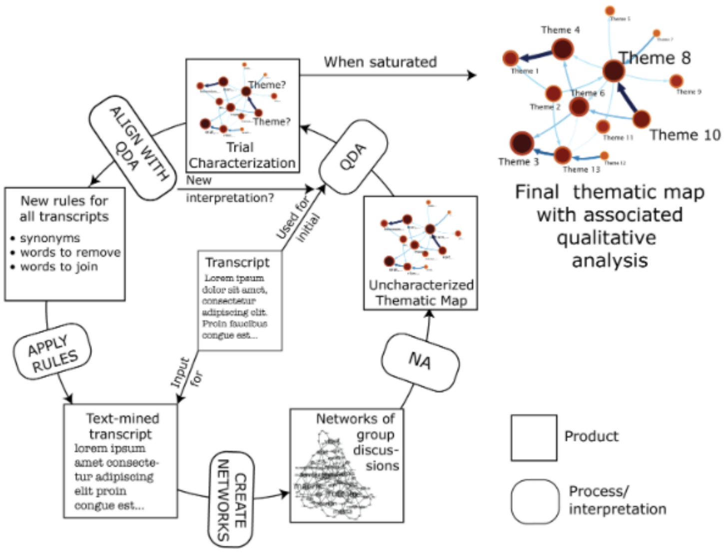


Figure 15: The process of performing TDNA from [Lindahl, Bruun, and Linder, 2016]

a trial characterization. Often the network analysis and the discourse analysis are not directly aligned in a meaningful manner in the trial characterization. Then the trial characterization will provide a basis for constructing rules for changes in the transcripts. These rules could be text-mining the transcripts, merging of synonyms or grammatical categories. After the new rules have been made, they are applied to the transcripts. This will result in a new linguistic network, which forms a new candidate for a thematic map with new candidate modules. This process is continued until at some point the thematic map and the discourse analysis should converge towards each other. This will result in a final thematic map with an associated interpretation.

In this study, the data differs from the work done by [Lindahl, Bruun, and Linder, 2016]. Lindahl et al. works with transcribed student discussions as data where the present study worked with written ministerial documents issued by ME. Due to the fact that I was working with ministerial documents, the critical discourse analysis CDA (described in Section 2.4) was chosen as the right approach to doing discourse analysis. In the work by [Lindahl, Bruun, and Linder, 2016] a qualitative discourse analysis was performed. As described in Section 4.2.1.1, I text-mined the curriculum documents from the beginning of the data process. Hence, the only rules which were applied to my data, after doing a trial characterization, was merging of synonyms or grammatical categories. Besides from these differences, the process for doing TDNA was the same. The results from the intended curriculum are presented, analyzed and interpreted in Chapter 5.

4.3 THE IMPLEMENTED CURRICULUM - METHODOLOGY

The data for the implemented curriculum was obtained by observing the implemented teaching of BSC and conducting separate interviews with the six teachers. The observations were transformed into code using an observation protocol, field notes and audio recordings for each module. This was done in order to highlight the principal activities, how these activities were related to the interdisciplinarity and the academic aims of the BSC. These codes were then processed with the software Gephi [Bastian, Heymann, and Jacomy, 2009]. Gephi is a software for graph and network analysis (NA). As a supplement to Gephi, the coding language R was used to calculate different properties of networks in order to compare the different implementations. Going from the classroom observations of the different implementations to complex structures in a network graph is a long process. In Section 4.4 this process is explained. The interviews with the teachers were used as supplement and support of data. First the two qualitative methods of classroom observations and interviews will be described. Then a description of how to turn qualitative observations into a network will be presented.

4.3.1 *Classroom observations*

As mentioned in Section 3.4.2, five BSC implementations were observed. I attended as many modules of each implementation as possible. The next sections give a description of why I chose participant observation as a method and what I did as a participant observer in and outside the classroom. This whole project is characterized by an explorative work approach. Therefore some methods were explored as they were used. In the following, the methods will be described as they were explored. Therefore the wording will have a more storytelling character.

4.3.1.1 *Why observations and how to observe?*

From the beginning of this project, the idea was to observe different implementations of the BSC program and use these observations as a data source. I chose to do observations as I thought that observations would make my field work authentic. As long as the teacher and the class accepted me as a fly on the wall, I would be able to look at the teaching and the teaching environment without disturbing it. Or at least I would be disturbing at a minimum. In this case I would be able to see how the teachers and students behaved in a natural environment instead of asking them questions. I would see how the students and teachers interacted with the different activities, and how they interacted with each other without me being a part of the interaction. It was with all these intentions I performed the first observation of a

BSC module.

Prior to the first observation, an observation protocol was made. A description of the protocol can be found in Section 4.3.1.3. Already after the first observation, several questions arose: *Should I answer students' questions? Should I answer the teacher when he/she asks for feedback on their teaching? What should I do when the teacher addressed a question at me in class?*. I therefore quickly realized that I was not a fly on the wall. The students wanted to use me as a teacher when they could not get in contact with their own teacher or when the queue for obtaining help was too long. The teachers wanted my opinion about aspects of how the module went. It could be from reflecting on the different activities of the module, if the learning aim(s) of the modules were fulfilled, or how the students had worked throughout the module. Again, I was not sure whether I should answer. Realizing that I was not an objective observer but a part of the teaching situation, I needed to figure out what kind of observer I now was. My role had changed from a fly on the wall to suddenly having a form of a participating role in the classroom.

4.3.1.2 *Participant or observer or something in between*

Participation and observation are two very different approaches to qualitative data collection. As described by Thomas Szulevicz in [Szulevicz, 2015] these two approaches can appear contradictory. A true participant can affect the situation in a way where no research is meaningful, and a pure observation will remove the researcher from the setting of the observation. So the big question is how to find a balance between participating and observing, and what affects this balance? As described above, I was clearly not a fly on the wall so what really happened when I "observed"?

As an inspiration, a PhD-student from the Department of Science Education had prior to my observations given me a book about Participating and observing with the words; "when you are unsure or frustrated about your method, this is where to look"". This book soon became essential for me in this project both in relation to understand the method of participant observation and in relation to become a participant observer. K. M. DeWalt and B.R DeWalt presented in [DeWalt and DeWalt, 2010] participant observation as a method where the researcher takes part in the activities of those whom the investigation is about. Hence, it is connected to the anthropological way of working. DeWalt and DeWalt write:

> "The method of participant observation is a way to collect data in a naturalistic setting by ethnographers who observe and/or take part in common and uncommon ac-

tivities of the people being studied "[DeWalt and DeWalt, 2010, p.2]

Due to the fact that participant observation combines two contradictory processes, it is important to distinguish it from pure participation and pure observation and find the balance between those two things. DeWalt and DeWalt define four degrees of participation when observing [DeWalt and DeWalt, 2010, p.22-24]:

- **Nonparticipation** - is when the researcher is observing a phenomena from outside the research setting with no interaction at all between the researcher and the people in the setting. It could be watching the discussion in an online chat forum like the cult TV-series SKAM. Here we (as researchers) are able to follow the Facebook chats of the characters of the TV-series [Andem, 2015].
- **Passive participation** - is when the researcher is present in the setting while observing but the researcher does not interact with the people in the setting. The researcher can be defined as a spectator. An example could be people who count passengers in a train.
- **Moderate participation** - is when the researcher is identified as a researcher and only occasionally participate in the setting. This could be with clarifying questions to the group being studied.
- **Complete participation** - when the researcher becomes a member of the group which is studied.

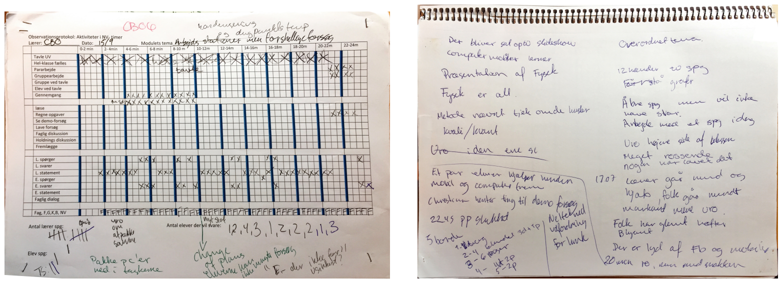
When I was observing the BSC implementations, I aimed to be what DeWalt and DeWalt define as a **Moderate participant**. Therefore I aimed to have a peripheral membership and limited interaction with the students and the teacher. Since I observed five different BSC implementation at three different schools, the location for observation was rarely the same. Some modules were taught in regular classrooms. Other modules were taught in laboratory-like classrooms. As an observer, I usually got a chair in the back of the classroom often with limited or no desk place. My placement in the back of the class actually helped emphasizing my role as someone different from the students and the teacher. Hence, it emphasized my role as a peripheral member of the setting. I thought that my presence might have seemed odd to the students. However, since I was present in their first module of the BSC implementation, I became a part of the setting for the full BSC implementation. I became one of the persons which the students connected with having modules in BSC. This became very clear as the students only asked the teachers about my presence when I was not attending a module. The students asked like in the way that something was missing. Since I observed five different BSC implementations, an observation protocol was made in order to maintain the same focus for observations in all five implementations. Furthermore, this was done in order to make the five implementations more comparable.

4.3.1.3 *Observation protocol*

The observation protocol was made prior to the observations and adjusted when necessary. The observation protocol was made with inspiration from [Newton, Driver, and Osborne, 1999]. The observation protocol can be found in Appendix C. As the observation protocol shows, there were three main foci for the observations. The first focus related to the activities happening in the module. It could be blackboard teaching, group work, performing experiments etc. The second focus related to the interaction between the student(s) and the teacher. For example: a student asks a question, the teacher answers and vice versa. The third focus related to the interdisciplinarity of the teaching. Here it was noted to which natural science discipline the content of the module was related: physics, biology, chemistry, natural geography or of interdisciplinary nature. These three things were noted every 30 second in the protocol by a cross see Figure 16a. Besides that, I counted what was countable; students in class, number of questions from the teacher and the students, number of answers from student and the teacher, number of times the teacher asked a question and answered himself or herself etc. I also noted whether the students followed the teaching or did something else [2].

All these countable things were written as field notes (see Figure 16b) in my observation book where the protocol was on one page and there was room for taking notes on the other page. The field notes from the classroom observations were used for justifying the marks in the observation protocol. The field notes were also used for recalling the teaching situation when a specific module was turned into a network. Besides having the observation protocol and field notes for every module observed, the modules were also recorded on audio. During these five implementations a total of 90 hours audio were recorded corresponding to observing 60 modules. All of these modules were translated into code in order to translate the observations into networks. This process is described in Section 4.4.

2 The list is long when the students' attention moves from participating in the teaching situation to the computer or smart-phone screen; Facebook chats and feeds, Instagram, multiplayer online games, Netflix, news, shoe shopping, hand-ins from other disciplines, ordering food and I could continue.



(a) Completed observation protocol (b) Field notes

Figure 16: Example of a completed observation protocol and an example of field notes taken during a module.

4.3.1.4 *The Teachers' interest in the observations*

As mentioned in Section 4.3.1.1, the teachers were really interested in the things I observed. Both regarding the students' participation in the observed module but also in their own performance as a teacher. This often led to the teachers asking me questions such as; *Did this activity work? Was it too hard for the students to understand todays' topic? Is it just me or was class completely out of focus today?* etc. In the beginning it was difficult to figure out whether I should go into these feedback conversations with the teachers or whether I should not. I ended up answering the questions and talked to the teachers about the observed module when I was asked. I tried my best to be as objective as possible. Therefore I used the counted information as well as the information from the observation protocol to verify my impressions. Whether these small talks with the teachers have influenced the teachers' way of planing and executing the next module(s) is hard to say. One thing these small talks about the teaching did have an effect on was the second round of interviews with the teachers. Here it was now possible for me to make the interview more personalized in order to focus on the specific BSC implementation. In the following section, the method of interviews and the interviews performed with the six teachers will be described.

4.3.2 *Interviews with the teachers*

Interviews are widely accepted as research tools in qualitative research [Kvale and Brinkmann, 2009]. As Kvale denotes in [Kvale, 1994], the interview as a conversation differs from everyday spontaneous exchange of words by being a more thorough conversation focusing on the questioning and listening. In a interview there is focus on structure and purpose of the interview, which provides the interviewer with the control of the conversation(interview). It is therefore important to remember that an interview is not a conversation between equal parties/persons. This, due to the fact that the interviewer defines and controls the interview situation. The reason for performing these interviews were to gain information on how the teachers interprets the academic aims and the importance of the BSC. How they incorporate these things into an actual BSC implementation and whether they in the end achieved what they wanted from BSC. The main theme of the interviews were, naturally, based on the aims of this thesis. The interviews were chosen to be held as 'one on one' conversations. The individual interview was carried out as a dialogue between two people (an informant and an interviewer). This allowed the teacher (the informant) to talk about experiences which might be unique to the person and perhaps would not be addressed in less private circumstances.

The interviews were in the form of a semi-structured interview. I wanted to survey the teachers' interpretation of the BSC and the subjects which they found interesting about the BSC. Kvale and Brinkmann describe the semi-structured lifeworld interview as follows:

> "The semi-structured lifeworld interview is an attempt to understand themes from daily life from the perspectives of the informant (. . .) It approaches ordinary conversation, but has as a professional interview a purpose and entails a certain approach and technique; it is semi-structured – it is neither an open conversation nor a closed questionnaire" [Kvale and Brinkmann, 2009, p.45](*my translation*, see original text in Section A.3).

Therefore the semi-structured interview is characterized by having a pre-defined subject of interest and a direction of the conversion. The intention is to let the conversation flow freely around the subject which is being discussed. This allows me, as the interviewer, to pursue the same theme and thereby the opportunity to see if there is any patterns between the six teachers or any change between what the teachers says prior and post to the five implementations of BSC. The semi-structured interview guide and content for the interview will now be presented.

4.3.2.1 *The interview guide and performing the interview*

The interview guide was made with the intention of letting the conversation flow freely around the pre-defined subject as mentioned above. In order to understand how the teachers relate to BSC and the interdisciplinarity within in the course, I needed to know how the teachers were planing and executing an implementation of the BSC. In addition, I wanted to know if they had any previous experience with BSC and what their experience were. The themes within the interview guide ranging from "BSC- in general" to "the specific implementation of BSC". In the first interview was regarding the planning of the implementation. In the second interview the focus was on the conducted implementation. The themes were; "what should or had the students learned"(*should* relates to the first interview and *had* to the second interview), "the interdisciplinarity of BSC", "The cooperation between the teachers in relation to BSC", "BSC as a program", "personal opinions regard BSC". The themes were inspired by an earlier study dealing with teachers' experiences of interdisciplinarity in regarding to the MSC implementation (in Danish AT) at Stx, where teachers were interviewed [Jensen, 2015].

When performing an interview, I chose to act objectively and with a conscious naivety as Kvale describes in [Kvale, 1994,p. 44]. This also means acting like not knowing what it means to teach an implementation of BSC and thus "forgetting" my own experience with BSC. This would help me minimize entering an internal communication, which I could risk forgetting later and thereby lose information. I aimed to be an objective interviewer who explored the field. In order to really explore and delve into the descriptions made by the teachers, a number of follow-questions were performed. The follow-up questions could be something like "What do you mean, when you say..?", "When you say..., then what do you mean?" or "How would you explain that?". Before executing the first interview with the six participating teachers, two trial interviews were performed on two other teachers. These two teachers had taught the BSC program many times. One of them had taught the program (every year) since it had been introduced back in 2005. After these trial interviews, I revised the interview guide based on my experiences from these two trial interviews and the suggestions from the two teachers. The final version of the interview guides can be found in Appendix D.

All interviews were conduct in roughly the same way differing only in the amount of attention each theme was given. Some of the teachers had a clear time limit which was crucial for the length of the interview and thereby also the amount of information I was given by the teacher. I chose to transcribe all the interviews because rereading the interviews could result in new interpretations of known phenomena.

4.3.2.2 *Transcriptions of the interviews*

The interviews were recorded and transcribed verbatim, except from expressions like *uhh* and *hmm* have only been written down when they were significant for the answer of the informant. Commas have been used abundantly in the attempt to create a readable document. I have tried to ensure that each interview was transcribed as soon as possible after it had taken place. This was also done in order to carry my reflections on to the next interview. The full transcriptions are available in Appendix E (in Danish). The interviews were used as a supplement to the observed data. The idea was to see if what the teachers said about interdisciplinarity and which learning aims their implementation focused on supported or contradicted what was observed.

4.4 THE IMPLEMENTED CURRICULUM - DATA PROCESSING

As mentioned in Section 4.3 the observations from the five BSC implementations were transformed into code. This code was then visualized as networks. In order to quantify the observations and thereby make the five networks more comparable, different network properties were then calculated. In order to process the data as systematical as possible, each 15 seconds were given a label consisting of four codes. Hence a 90 minute module was given 360 labels; one for each 15 seconds. Three of the codes came from the three head categories in the observation protocol. The first code category classifies the *Activity* which was taking place in the module, the second code category classifies the *Interaction* between the student and teacher (or student and student), the third code category classifies the *Subject/course* which the content of the module was related to. Besides the three code categories which relate to the observation protocol, a fourth code category was introduced to classify the content in reference to the learning aims of the BSC program.

The fourth code category, *Learning aim*, was introduced as a way of making it possible to compare the networks from the different curricula (the intended, the implemented and the realized see Section 2.1.1) regarding the big question: *what is taught and learned in the BSC program?* This category was not noted in the observation protocol and therefore the category was added to the three other codes by listening to the audio recordings of the modules. For each 15 seconds, an activity code, an interaction code, a subject/course code and a learning aim code were assigned the label. Hereby each label consisted of four codes (three codes from the observation protocol and one for the learning aim). Listening to the audio recordings of the modules was also used as a confirmation of the three other code categories by comparing what was noted in the observation protocol with what was said in the audio recordings. This was also done as the time interval of the observational protocol was in 30 seconds intervals and the time interval for the labeling was 15 seconds. So in order to make sure that the right codes were put on each 15 second label, the audio recordings were used as a control tool.

This way of turning classroom observations into networks was inspired by the master thesis by Jensen [2015]. In the tables below the code assigned to each of the four categories is presented. Besides the codes there is a translation and a short description of each code. These codes are also found in Appendix F. The intention with putting the codes in the Appendix was for the reader to have easy access to the codes while looking at the network for the implemented curriculum in Chapter 6. This would hopefully help the reader's interpretation of the networks.

By using the codes from Table 10 to Table 13, each 15 second interval from each observed module would get a label like "**blt_tas_phy_p**"; a label consisting of four codes. This label indicates that the activity at this time interval was characterized as a time where the teacher was teaching at the blackboard. The interaction code and the subject/course code (the second and third codes) tells us that the teacher asked a question in relation to a physics content. The fourth code relates the label to one of the learning aims of BSC, in this label the teacher asked a question which put the physics content into perspective. This could be in relation to technology, history etc. If one should put the label into one sentence it would look something like: *Blackboard teaching where the teacher asks a question which put the physics content into perspective.* A label like this would often be followed by the label: "**blt_san_phy_p**" which translates into the sentence: *Blackboard teaching where the student answers a question which put the physics content into perspective.*

Most of the codes in Table 10 to Table 13 are self-explanatory. Nonetheless some codes requires an elaboration. Starting with Table 10, the code **rev** means that earlier taught knowledge is reviewed one more time. This often takes place in the beginning of a module where the teacher makes a review of what was taught in the last module. This is done with the intention that the students remember what they have learned. But the code could also be used when a homework assignment is reviewed for the whole class after being corrected by the teacher. This could br done as a way of following up on the homework assignments. The code **exe** means doing an exercise a different kind, which is unrelated with doing experiments or demonstration experiments. The type of exercise could be done in any class in any module (Danish, English, Math, Physics etc.), and they focused on team building, idea generating or had a motivational purpose. These exercises were only present in the BSC implementation taught by Teacher A and Teacher B in class 1.

We now continue with the codes in Table 11. The codes **tst** and **sst** indicate that the teacher and the student, respectively, express themselves without it being a question or an answer. An example could be a explanation from the teacher (or student) or a comment made by

	ACTIVITY	
CODE	TRANSLATION	DESCRIPTION
blt	Teaching at the blackboard	The teacher is teaching at the blackboard.
gwr	Group work; reading	Group reading the instructions or assignments.
gwc	Group work; calculating or solving small task	Group solving assignments by calculation or other small task.
gwad	Group work; academic discussion	Group having an academic discussion.
gwp	Group work presenting a product	Group presenting work or assignment for the rest of the class.
gww	Group work; written assignments	Group making reports, journals, logbook, posters etc.
exp	Doing experiment	The students do experiments in pairs or in a group.
dex	Demonstration experiment	The teacher performs a demonstration experiments for the whole class.
it	Working with IT-programs	Students install software or work with IT-programs.
mov	Watching a movie	The students watch a movie in class.
test	Performing a test	The students is given a test in class.
sbb	Student by blackboard	A student goes to the blackboard to present work.
rev	Review of what is taught	The class is reviewing earlier taught assignments, themes etc.
exe	Exercises	The class/group do exercises like team building, idea generation etc.
sww	Student written assignment	Students writing reports, journals, logbook by themselves.

Table 10: Activity codes, translations and descriptions

INTERACTION		
CODE	TRANSLATION	DESCRIPTION
tas	Teacher asks	The teacher asks a question.
tan	Teacher answers	The teacher answers a question.
tst	Teacher statement	The teacher gives a statement without asking or answering a question.
sas	Student asks	The student asks a question.
san	Student answers	The student answers a question.
sst	Student statement	The student gives a statement without asking or answering a question.
sd	Student dialogue	The students having a dialogue in pairs or in a group.
sil	Silence	When nothing is said.
tf	Teacher as facilitator	The teacher works as a learnings facilitator/consultant.
gui	Guidance of a project by teacher	When a teacher guides one group in their project and the rest of the groups work by themselves.
nc	No code	When the recordings are too blurred to encode

Table 11: Interaction codes, translations and descriptions

SUBJECT/COURSE		
CODE	TRANSLATION	DESCRIPTION
bsc	BSC	Interaction with BSC in an interdisciplinary content.
phy	Physics	Interaction with physics in an academic content.
che	Chemistry	Interaction with chemistry in an academic content.
bio	Biology	Interaction with biology in an academic content.
geo	Physical Geography	Interaction with Physical Geography in an academic content.
mat	Mathematics	Interaction with Mathematics in an academic content.
inn	Innovation	Working with innovation, following the KIE - Model
nac	Non-academic	Interaction with non-academic content

Table 12: Subject/course codes, translations and descriptions

a student (or teacher). The code **sil** was only used when there were completely silence in the classroom. It is therefore often used in relation to the activity of reading. The code **nc** stands for no code. It was only used if the audio recordings was to blurry to understand and if there was nothing noted in the observation protocol. The code **tf** implies that the teacher acts as an facilitator of learning . This interaction appears when the activity was group work and the teacher walked around between the groups while monitoring and helping the groups. The last code to be explained for Table 11 is **gui** meaning that the teacher guides one group on their project while the rest of the groups are working by themselves. This term was only used when supervision was scheduled as a specific activity for the module, meaning that all groups received guidance one group at the time. The code **gui** differs from the code **tf**, as **gui** was scheduled guidance in a room with just one group and the teacher. The guidance session had a specific focus set by the teacher(s) of the module. The focus could be: how far the group was with their investigation or how to present their work. In contrast **tf** was not scheduled or planned. The teacher was walking around between the groups helping when a question popped up or when a group was stuck and thereby facilitating help

LEARNING AIMS		
CODE	TRANSLATION	DESCRIPTION
h	Hypotheses	Working with hypotheses; preparing, reviewing, comparing etc.
pi	Practical Work	Develop, understand, apply, analyze, evaluate practical work which could be lab experiment, demonstration experiment, field experiments etc.
m	Models	Describe, formulate, understand, apply, analyze, evaluate, compare models.
co	Oral communication	Presenting scientific work orally.
cw	Written communication	Making reports, articles, poster in written form.
p	Perspectives	Setting science in relation to the community, technology, ethics and history.
si	Scientific identity	Depends on the program. It is characterized by the subject-specific themes and words students must learn. It could be the water cycle and the knowledge in relation to that.
sm	Scientific method	Work with the methods of science: inductive, deductive hypothetical, variable control, qualitative and quantitative investigation.

Table 13: Learning aims codes, translations and descriptions

as needed.

In Table 12, the subject/course that contributed to the BSC program is translated into code. The code **inn** might need some elaboration. In executive Order of Law for the Study Stx (also called The Upper Secondary School Law for Stx) [UVM, 2013a], it is written that students must achieve a creative and innovative competence during their education. Therefore elements of innovation can appear in the implementations of BSC. The reason why this is separated from the other subjects is that these sessions relate to exercises or work which are based on the KIE-Model [Jensen and Andersen, 2012]. In short terms the KIE-Model defines three different rooms which the students should work in; The creative space (in Danish: det kreative læringsrum, K) where ideas are created. Ihe innovative space (in Danish: det innovative læringsrum, I) where ideas are further developed, possibly into a finished product, and last the entrepreneurial space (in Danish: det entreprenante læringsrum, E) where ideas are realized and spread. This way of working takes time for the students to learn. Therefore subjects like physics and chemistry were neglected in the beginning of the BSC implementation as the students had to learn a new way of working/learning. Due to this, innovation got its own code **inn**. This code was only used in the BSC implementation taught by Teacher A and Teacher B in class 1. The code **inn** was often used in relation to the activity code **exe**. The last code from Table 12 which needs elaboration is the code **nac** meaning non-academic content. This code was used when the teacher or the students talk about things which are not related to the BSC implementation. An example could be when the teacher asks the students to close their computers and put self phones a way, which could also be called classroom management.

The fourth code category is found in Table 13. It represents the learning aims in relation to the BSC program. These codes were made on the basis of the academic aims, which are presented in Section 3.2, were issued by ME [UVM, 2013b] and compared with the results from the intended curriculum analysis. Most of the codes are self-explanatory when they are compared with the academic aims of the BSC course. However the code **si** might need some further explanation. The general description is the themes and wording which the students must learn in the specific BSC implementation. Since BSC does not have a specific content (in Danish: kernestof) in the curriculum description, this identity must be defined for each individual implementation of BSC. Therefore the five implementations which I followed had their own words and subjects which related to the scientific identity of the specific implementation. In class 1 the **si** code contains topics concerning myths and ways to bust the myths. In class 2 and 3 the **si** code contains topics on how the human body work seen from different subjects (in both cases physic and biology). In class 4 and 5 the **si** code contains topics like the water cycle effect on global warning from a physics and physical geography perspective.

In Table 14 is an example on my coding of an observation. The example is from Teacher D's first module and starts 24 minutes and 30 seconds into the module. The first column indicates the time stamp. The second column indicates the translation of what was observed in the class, and the third column shows the final encoding of the observation.

TIME	TRANSLATION	CODE
00:24:30	Blackboard teaching where the teacher asks a question about scientific methods in BSC	blt_tas_bsc_sm
00:24:45	Blackboard teaching where the student answers a question about scientific methods in BSC	blt_san_bsc_sm
00:25:00	Blackboard teaching where the teacher makes a statement about written communication in BSC	blt_tst_bsc_cw
00:25:15	Blackboard teaching where the teacher asks a question about written communication in BSC	blt_tas_bsc_cw
00:25:30	Blackboard teaching where the student answers a question about practical work in BSC	blt_san_bsc_pi
00:25:45	Blackboard teaching where the teacher makes a statement about practical work in BSC	blt_tst_bsc_pi

Table 14: Example of observations encoded on the basis of the observation protocol and the audio recordings. This is from Teacher D first BSC module with class 3.

By translating all the modules into code and placing the modules of each teacher in chronological order, it is possible to make a network over each teacher's implementation of BSC. The networks were created with the program Gephi [Bastian, Heymann, and Jacomy, 2009]. Gephi was also used for calculating the weighted degree of the nodes in the networks. The network properties such as pagerank and modularity were calculated in the program 'R' [R Development Core Team, 2008] using the igraph package [Csardi and Nepusz, 2006]. The results from the implemented curriculum are presented, analyzed and interpreted in Chapter 6.

4.5 THE REALIZED CURRICULUM - METHODOLOGY

The data for the realized curriculum was obtained by observing exam situations from two implementations of BSC. The observations were transformed into code using field notes and audio recordings from the exam situations. This was done in order to highlight what happened in the exam situation in relation to the interdisciplinarity and the academic aims of the BSC. These codes were processed with the software Gephi [Bastian, Heymann, and Jacomy, 2009] in the same way as the data from the implemented curriculum. The coding language R was again used to obtain different properties of the networks in order to compare the different exam situations but also to compare the exam with what the student had been taught in the implementation. Thus, the results were interpreted as network graphs. Going from an exam situation to complex structures in a network graph is a long way. In Section 4.6 this process is explained. In the following will be given a description of how the observation of the exam situations was conducted and then a description of how to turn a qualitative exam observation into a network.

4.5.1 *Observations during the exam*

Before the approach to observing an exam situation is explained, there are two things which are important to mention. The first important thing to mention is that all students who participated in having their exam situation observed had given consent prior to participating in this part of the study. For further elaboration on how the student consent was collected see Section 4.7. The other thing which is important to mention in this context is that the BSC exam was at that time not a counting exam. This means that the student would get a grade for the exam performance but the grade would not be a part of the final grade average. From the school's and teachers' point of view the BSC exam was therefore used as a test of the students' readiness and abilities to complete the USS education. According to the teachers who participated in this study. In each of five implementations of BSC, the teachers clearly explained to the students that the exam of BSC had no influence on their final grade average. Notwithstanding, it would have consequences if they failed the BSC implementation. On two of the schools a failed BSC exam triggered a conversation with the principal regarding whether the student could meet the requirements for Stx. If the student felt able to meet the requirements for Stx, a reexamination was held. On the other school a conversation with the same topic was required with the student counselor. Here a reexamination was not required.

In Section 4.3.1.2 four different degrees of participant observation were described. These are: Nonparticipation, Passive participation, Moderate participation and Complete participation. When I was observing the exam situation, I aimed to be what DeWalt and DeWalt [DeWalt and DeWalt, 2010] defined as Passive participation. Passive participation is described as an observation method where the researcher is present in the observed setting. However, the researcher does not interact with the people in the setting. One might say that I became a spectator of the exam situation. All the exams which were observed took place in a regular classroom where the student either sat at the table with the teachers or stood in front of the blackboard while the teachers were sitting at the table. The exams were with internal censorship[3]. In both cases the two teachers which had taught the BSC implementation were present at the exam. I was placed in the back of the class in order to make myself as invisible as possible thereby not interfering with the exam situation. My placement emphasized my role as an observer who was not a direct part of the exam situation but more a spectator of the exam.

There was no observation protocol for the exam situation. Instead detailed field notes were obtained. The field notes focused both on countable things like how many questions were asked by the teachers and how many times the student answered the questions. The field notes also contained information on the learning aims supported by the different statements, questions, and answers expressed by the student and the teachers. It was also noted if the student managed to express himself/herself in an interdisciplinary way or if the student only talked in a disciplinary way. At the end of the exam situation, the grade was also noted. To support the field notes, audio recordings of the exam situations were performed.

This gave a total data amount consisting of 14 individual exams and 7 group exams (in total 26 students). This translates into 6 hours and 56 minutes of audio recordings. This would take several weeks to analyze and translate into networks. In collaboration with my supervisor, a decision was made to select two exam situations in order to test if it is possible to translate an exam situation into a network. First the group exams were excluded as they might be more difficult to compare since the group size varied from two to five persons. Then 14 individual exam situations were left. Two exams were then chosen on the basis of the final grade. By selecting one exam with a high

3 Meaning that the censor is from the same school as the exterminator

grade and the other with a low grade. This part of the study is a proof of concept study in order to tryout the method of turning an exam situation into a network. In addition to test if it was possible to obtain a result about the interdisciplinarity and the learning aims in an exam situation. It is the first time this method, inspired by [Dolin, Bruun, Jensen, Niemienen, and Nielsen, 2017], is used to transform an exam situation into a network. The process of translating an exam situation into a network is described in Section 4.6.

4.6 THE REALIZED CURRICULUM - DATA PROCESSING

The exam situation from the BSC implementation was transformed into code. This code is then visualized as a network. In order to quantify the two exam situations and hereby making the two exam networks more comparable, different network properties were calculated. In order to translate the observed exam situation into a code as systematically as possible, a time interval was selected. Each time interval was given a specific label. A time interval of 5 seconds was selected since it is approximately equal to the time it takes to say a common phrase. Each time interval was given a label consisting of 8 codes; 4 codes relating to the teacher and 4 codes relating to the student. By listening to the audio recordings of the exam situation and comparing the audio recordings with the field notes, a label was assigned to each time interval. The way of labeling the time intervals was inspired by [Dolin, Bruun, Jensen, Niemienen, and Nielsen, 2017].

Even though the label consists of 8 codes; there are only four categories which contribute to the labeling. This means that the label was first given four codes for the teacher, one for each of the four categories and then four codes for the student was added to the label. These four student codes were taken from the same categories as the teacher codes. The four categories was: *Person talking*, *Dialogical Aspect*, *Subject/course* and *Learning aim*. The last two categories are the same as the last two categories for the implemented curriculum. This was done in order to make the networks comparable across the different curricula (the intended, the implemented and realized see Section 2.1.1). The codes, translation and descriptions for the categories *Subject/course* and *Learning aim* can be found in Table 12 and Table 13.

The way of turning an exam situation into a network was done in the same way as the classroom observations with the exception that two of the categories were changed and the label now consisted of 8 codes (and not 4 codes as with the classroom observations). In the table below the codes for the two new categories are presented. Besides the code, there is a translation and a short description of each code. These codes are also found in Appendix G. The intention with putting the codes in the Appendix was that the reader can have easy access to the codes while looking at the network for the realized curriculum in Chapter 7. This would hopefully help the reader's interpretation of the networks.

PERSON TALKING		
CODE	TRANSLATION	DESCRIPTION
s	Student	Student talking.
t	Teacher	Teacher talking.

Table 15: Codes for the person who is talking, translations and descriptions

The codes from Table 12 and Table 13 are elaborated in Section 4.4. The codes in Table 15 to Table 17 are self-explanatory but notice that Table 17 is a continuation of Table 16. Together the two tables form the category *Dialogical aspect*. One thing needs an elaboration or clarification in Table 16 and Table 17. The codes, which contains a question, an answer or a statement, are also marked with a H or a L. The letter indicates whether the expression can be categorized as a having high-level taxonomy or low-level taxonomy. The high- and low- level taxonomy refers to the revised Bloom's taxonomy [Krathwohl, 2002]. In this study a low-level taxonomy is associated with remembering and understanding. A higher-level taxonomy is associated with application, analysis, evaluation and creation.

By using the codes from Table 15, Table 16 plus Table 17, Table 12 and Table 13 (and in that order) for each 5 second interval of an exam situation, a label consisting of 8 codes for each time interval can be created. An example of a label could be:

"**T_TInv_Tbsc_Tco_nS_noSd_noSs_noSla**"

This label is now explained code by code. The first code indicates whether the person is talking or not. The **T** tells us that the teacher was talking during these 5 seconds. The second code indicates the dialogical aspect from the teachers' side. The **TInv** code indicates that the teacher was making an invitation towards the student in order to get the student to say something. The third code has a relation to what subject/course the content is about. In this case the teacher talked about a BSC specific content hence the code **Tbsc**. The fourth code tells us that the phrases, which the teacher was saying, have a relation to the learning aim 'oral communication'. Therefore the code becomes **Tco**. These are the four codes for the teacher. The last four

DIALOGICAL ASPECT		
CODE	TRANSLATION	DESCRIPTION
Inv	Invitation	When the teacher makes a broad invitation to make the student say something. Often used in the beginning of a dialogue e.g. “Could you tell me something about ...”
Upt	Uptake	When a teacher incorporates the student responds into the next question hence making the student reflect further about what was said.
Foc	Focus	The opposite of uptake. Focus can be on a specific learning aim, course or topic.
PreV	Precise valuing	When the teacher precise values what the student say. This might not be strictly positive.
PreC	Precise correction	Explicit correction of what is said.
GE	General evaluation	General praise or criticism.
HoQ	Higher order question	Question that aims at the higher levels of new Blooms taxonomy (application, analysis, evaluation, creation).
LoQ	Lower order question	Questions that aims at the lower levels of new Blooms taxonomy (remembering and understanding).

Table 16: First half of codes for the dialogical aspect of the situation, translations and descriptions

code are for the student.

DIALOGICAL ASPECT CONTINUED

CODE	TRANSLATION	DESCRIPTION
HoA	Higher order answer	Answer that aims at the higher levels of new Blooms taxonomy.
LoA	Lower order answer	Answer that aims at the lower levels of new Blooms taxonomy
HoS	Higher order statement	Statement initiated by the student which aims at the higher levels of new Blooms taxonomy.
LoS	Lower order statement	Statement initiated by the student which aims at the lower levels of new Blooms taxonomy.
Sum	Summarizing	When the teacher sums up or repeats what was said by the student without an evaluation or correction.
Qnu	Student questing /non-understanding	When the student explicit asks the teacher to repeat the question. Used as an indication of the student being unsure or unable to answer.

Table 17: Second half of codes for the dialogical aspect of the situation continued, translations and descriptions

The fifth code of the label tells us if the student is talking or not. Here the student was quiet, hence the code **nS**. The sixth code tells us the dialogical aspect from the student side. Since the student was quiet, there was no dialogical aspect. Therefore the code became **noSd**, which stands for no student dialog. The seventh code relates the student's saying to a subject/course. Again the student was quiet, hence the code **noSs**, which translates into no student subject. The eighth and final code relates the student's saying to a learning aim of BSC. Again the student was quiet. The code **noSla** translates to no student learning aim. If all this information should be summed up in one sentence, it would sound something like: The teacher made an invitation towards the student in order to make the student talk about a BSC content. However, the student was quiet. This label would often take place in the beginning of an exam situation, where the teachers often said something like: "*Can you tell me(the teacher) something about what we have worked with in the BSC implementation*"

I will present two other examples of labels from an exam situation. One where the student was talking and the teacher was quiet, and one where they were both talking. The first example:

"**nT_noTd_noTs_noTla_S_SHoS_Sbsc_Ssm**"

This translates to: the teacher is quiet while the student is talking in higher order statements about the scientific methods in BSC.

The other example is:

"**T_TLoQ_Tbio_Tpi_S_SLoA_Sbio_Spi**"

This translates to: The teacher asked a lower order question about the practical work in biology. The student makde a lower order answer about the practical work in biology.

The network for the two exam situations was performed with the program Gephi [Bastian, Heymann, and Jacomy, 2009]. The network properties such as pagerank and modularity were calculated in the program 'R' [R Development Core Team, 2008] using the igraph package [Csardi and Nepusz, 2006]. The results from the realized curriculum are presented, analyzed and interpreted in Chapter 7.

4.7 ETHICAL CONSIDERATIONS

When working with people as a data source some ethical considerations must take place. Therefore consent forms were produced and given to the teacher prior to the interviews and observations. The teachers should then give their consent to that I could perform observations in the classroom and interview them as well. The consents were given separately meaning that it was possible to participate in the interviews and not the observation part of the study and vice versa. The consent form can be found in Appendix H. Regarding the classroom observations, I presented the purpose of the project, showed the recorder and the observation guide to the students in the first module of all the five BSC programs. The students were told that the data would be anonymized, and if they did not want to participate, they would be removed from the study. All interviews were introduced with information concerning the research that the teachers participated in and how the data would be exposed later. The interviews were anonymous for the purpose of having a trustful conversation.

When it comes to the data collected during the students' exam situations, the consent forms were carried out a little differently. All the students were first informed about the research regarding the exam situations in class two weeks prior to the exam. The students were informed that all the data would be anonymized. Then the teacher sent all the students an e-mail (written by me) which the students should respond to if they did **not** want to participate in this part of the research. At the exam, the student was asked individually if he or she wanted to participate in the research. Thereby allowing me to observe and record their exam. This time the student was asked orally in order to give an oral consent. The e-mail which the students received can be found in Appendix H.

4.8 VALIDITY AND RELIABILITY OF THIS STUDY

A theme in qualitative research is discussing the validity and reliability of the research when evaluating the quality of the research [Østerud, 1998]. In this study a combination of qualitative and quantitative methods are used. The two methodologies belong to different epistemological paradigms. Roughly, the division between qualitative and quantitative can be stressed by the generalization that qualitative methods explore phenomena in the natural context. This is in contrast to the quantitative methods that explore phenomena in a context-free setting which makes it possible to control different variables. In quantitative methods, the analytical foundation is based on numbers while the analytical foundation of qualitative methods is based on words [Østerud, 1998]. As the methodologies belong to different epistemological paradigms, the two methodologies therefore have different assessment criteria when the quality of the research is addressed. In this section the assessment criteria for quantitative and qualitative research methods are reviewed along with a discussion on the methods used in this study.

Is the research rigorous?

In order to assess if the quantitative methods are rigorous the following criteria are used:

Internal Validity - evaluate if the research findings describe the phenomena the research seeks to describe.

External Validity - evaluate if the research is valid in other contexts. Thus if it is transferable.

Reliability - concerns whether the results from the research are repeatable.

Objectivity - seeks to eliminate the researcher from the process.

In my study the major methods used have been qualitative methods: the participant observation, interviews, the coding process and the analysis of the network. Only the generation of the networks and the numbers calculated from the networks have been quantitative. The criteria for quantitative methods are hard to fulfill when all the data is collected using qualitative methods and the first part of data processing also is qualitative. In terms of ensuring reliability as well as the rest of the criteria, it would have been preferable if several persons had coded the same data in order to validate the different coding categories for the implemented and realized curriculum. The same thing applies for the linguistic network analysis, where the rules applied to the second around of adjustments could have used some validation by more than one person.

The different networks were all constructed in the same way and within the same curricula. Hence all networks for the intended curriculum are constructed in the same way. The networks of the different BSC implementations were constructed in the same way, and the networks of the exam situations were constructed in the same way. The networks sketched the observed structures in a valid way both in relation to the different implementations of the BSC and the exam situations. In both cases, the different implementations and the exam situations, the positions of the different nodes in the specific network were verified in relation to my observations. Nonetheless since all data was collected using qualitative methods and the analysis was qualitative, the important question to ask is: Is this research reliable and valid in the terms of the assessment criteria for qualitative methods?

Is the research trustworthy

In the 1980s, Lincoln and Guba [1986] matched the criteria for assessment of methods in the quantitative domain with those for qualitative research. They introduced the term *trustworthiness* of qualitative research as a substitute for the term *rigor* which relates to the assessment of quantitative research. The criteria for trustworthiness are formulated in the following way:

Credibility as an analog to internal validity. Credibility assesses if the results are congruent with reality. Lincoln and Guba [1986] suggest three techniques to enhance credibility of qualitative research; A prolonged and persistent engagement in the context inquired will add to credibility to the elements that the researcher identifies as salient in the context. A triangulation of the methods used to collect data is when several methods are used to collect the data or multiple researchers collect data in the same setting. Debriefing sessions with a disinterested professional peer will keep the researcher "honest"(Lincoln and Guba, 1986, p.77).

Transferability as an analog to external validity. Transferability applies to how well the results can be applied in other contexts. This is tricky in qualitative research since qualitative results tend to relate to the contextual setting in which they are found. How could information about interdisciplinarity in a specific course in the Danish USS be transfered to another situation? The methodological technique to provide transferability is called a *thick description* [Geertz, 1994]. A thick description accounts for detailed field notes with information of the context inquired. This descriptive data provides others with information to eventually do further analysis.

Dependability as an analog to reliability. This relates to the process of the research. Dependability emphasizes the stability of the data over time. Therefore the records of all the different research processes must be accessible.

Confirmability as an analog to objectivity. Confirmability also seeks to limit personal bias. Although, here the method is to make the analyzing process transparent by showing that the outcomes are not products of the researchers' imagination but have emerged from the empirical data and have been treated according to chosen theory.

As mentioned above, quantitative and qualitative methods have many differences and have been conceived as two opposite approaches to research. In the 1990s, some studies started to break down this division [Østerud, 1998]. This thesis attempts to set an example of how the two approaches can be combined.

For the intended curriculum, debriefing sessions was held prior to the combination of the critical discourse analysis with the network analysis. This was carried out together with my academic advisor Jesper Bruun in order to debrief the topics found in the CDA and keep me "honest" as a researcher. As all curriculum documents and the associated guidelines for the BSC program through time were analyzed, this indicates a prolonged and persistent engagement in context which adds to the creditability of the research. I believe that the networks, somehow, provides a thick description. The salient characteristics of the curriculum plans investigated are visible in the networks of the intended curriculum and it could be possible for someone else to use the information in these networks in another study. The methodical approach to the intended curriculum, here the handling of the data in relation to the CDA, the linguistic network analysis and the combination to thematic discourse network analysis(TDNA) are aimed presented in a transparent manner in this chapter.

The implemented curriculum was based on participating observations and interviews. In order to secure credibility, several methods were used in observation process. I used an observation protocol which secured that the observations had the same focus in all the modules observed. Besides the observation protocol, additional field notes were taken and all classes were recorded on audio. This was a triangulation of data collection, which enhanced the credibility of the qualitative method. Due to the way the observation protocol was structured, it would be possible for another person to recreate the coding procedure for the first three codes in the label of the implemented data. The last code in the label (learning aim) was generated from the fields notes and the audio records and therefore another person might find other codes compared to mine. Along with my observations, I met with my academic advisor Jesper Bruun to debrief the observations. Again the networks provides a thick description. The salient characteristics of the different BSC implementations investigated are visible in the networks and perhaps someone could use the information in these networks in another study. The visibility of the network characteristics was tested at a student workshop. Here a group of students was given the description of a specific implementation and the corresponding network (and code categories) in order to classify characteristics of the network and to check if the written description of the specific implementation matched the network. This also adsd credibility to my analysis of the network due to the a large overlap between student analyzes and my own analysis. The final networks were also discussed with my academic advisor in order to stay "honest" as a researcher. The methodical approaches used in relation to the implemented curriculum, here are aimed presented in a transparent manner in this chapter from the observations done in the classroom to creation of the final networks. The interviews were used to match the teachers' own reflections with the results of my networks in order to validate the interpretation.

In the exam situations, which constitute the realized curriculum, the observation process was a little bit different from the observation process of the BSC implementation. Here, there was no observation protocol so my observations were written as field notes. In addition, the audio recordings of the exams were performed in order to enhance the credibility of my method. Here, the networks also provide a thick description and the debriefing discussions over the final networks with my academic advisor Jesper Bruun helped me stay "honest" in the interpretation of the data. The methodical approaches used in relation to the realized curriculum are aimed presented in a transparent manner in this chapter from the observations done at the exam situation to the creation of the final networks.

Notwithstanding the above, I cannot neglect the fact that another researcher would have observed other features than I did and made other conclusion. Obviously, another researcher would have used other codes in the coding process and probably applied other rules in the TDNA. Furthermore, another researcher might have analyzed the networks in another way than I did. These are the rules of the game when doing qualitative research.

4.9 LIMITATIONS

All research has its limitations. In this section, the limitations found in this project are commented on.

The main limitation in this research was the time limit. As I wanted a wide range of information in study, I chose to follow six different teachers' implementations of the BSC. Due to the fact that all BSC are taught from August to December (most implementations are taught from August to October), it was not possible for me to participate in all the modules of each BSC implementation. This would of course have been preferable since the comparability of the different implementations would have been better. I chose to treat all the implementations in the same way and compare the implementations based on all the data I've received - but I'm also aware that my results may depend on the observation times.

Time was also a large factor in the analyzing process of the exam situations. If I had had more time, I would have analyzed more exam situations and hopefully found a way to analyze the group exams. This would have produced a more sophisticated view on the interdisciplinarity and the transfer between what is taught and learned in the BSC program.

As the new curriculum plan for BSC was delayed, it was not possible to include the new curriculum in the analysis of the intended curriculum. Again, this was due to time limitations.

It would have been valuable to have made a thorough interview analysis of each of the 12 interviews. The interviews, which where performed prior to the implementation, would have been an excellent data source for the perceived curriculum as many of the questions targets the teachers interpretation of the BSC. A thorough analysis of the prior interviews might have contributed to the interpretation of the activity maps. The post-implementation interviews focused more on what had been taught and what the teacher thought the students had learned from the BSC implementation. A thorough analysis of these interviews would probably have contributed with valuable information about what was taught and learned in relation to what is shown in the activity maps and dialogue maps.

Only applying participant observations and audio recordings to obtain data for the implemented and realized curriculum can be seen as a methodological limitation. It could have been valuable with video recordings of the different implementations. In order to examine the realized curriculum it would have been valuable to analysis the students reports, logbooks and final written product from the different implementations.

4.10 Summary of methods used in this thesis

Before continuing to the chapters which contain the results, I want to summarize which data that relates to which curriculum and which methods have been used to study the different curricula.

For the intended curriculum, the data consists of the BSC curriculum and the associated guideline throughout time. To study this curriculum a mixed-method approach called thematic discourse network analysis (TDNA) have been used in order to create thematic maps of the BSC curriculum. Notice that the method builds on a linguistic network analysis combined with a critical discourse analysis CDA, which is a new variant of TDNA that was developed in this thesis.

For the implemented curriculum the data consists of observations of six teachers' specific BSC implementations and interviews with the six teachers. To study this curriculum, network analysis has been applied in order to produce activity maps for each of the implementations. The interviews were used to compared the result from the activity maps with the teachers' reflections.

For the realized curriculum, the data consists of observations of BSC exam situations. To study this curriculum, network analysis has been applied in order to produce dialogue maps for two of the exam situations. Since this constitutes the first attempt in the literature at analyzing exam situations using network analysis, two exams were selected as a proof of concept study.

For an overview of the many different data source and methods see Figure 17.

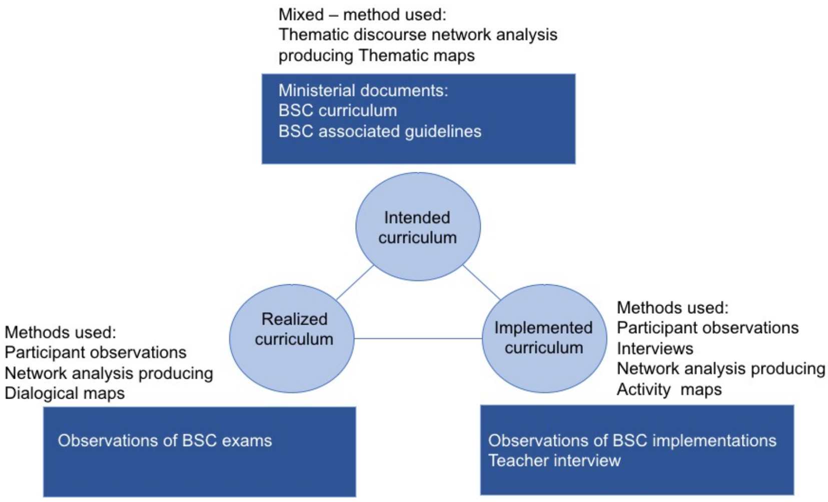


Figure 17: Overview over the three curricula, their respective data and the methods used to investigate them. The three different curricula are shown in the light blue circles, and the different data sources are shown in the blue rectangles. Above each rectangle the methods used to investigate the data are stated.

In the next three chapters the results for each of the three curricula are presented.

5 THE INTENDED CURRICULUM - RESULTS AND INTERPRETATION

In this chapter the curriculum documents of the Basic Science Course BSC throughout time have been analyzed using the mixed-method of thematic discourse network analysis TDNA, see Section 4.2.2 for a thorough description of the method. The aim of the investigation was to study how interdisciplinarity is portrayed in the curriculum documents and associated guidelines for the BSC both written by Ministry of education ME. Thus, they constitutes the intended curriculum which is investigated in this thesis.

The idea was to take a curriculum document and the associated guidelines from the BSC from the years 2004, 2007 and 2010 and turn them into a network. This method was used to map out the themes of the curriculum in order to investigate which themes were connected and if interdisciplinarity was to found be as a individual theme. Since the reform entered in 2005, the curriculum document has been changed 3 times. Therefore the network analysis was also used to visualize the three curriculum documents over time. As mentioned in the section above, the TDNA is a mixed-method which in my case combines critical discourse analysis (CDA) with a linguistic network analysis. In the first part of this chapter, the themes found by using the CDA is presented. The second part presents results from the first step of the network analysis where changes were made in order to obtain the final networks. In the third part of this chapter the final networks are presented, and changes throughout time is visualized. Finally, the learning aims for the BSC is obtained on the basis on the curriculum network from 2010.

5.1 THEMES FOUND WITH THE CRITICAL DISCOURSE ANALYSIS

By using CDA on the curriculum documents and the associated guidelines from the years 2004, 2007, 2010, the following eight overall themes were obtained. There were small differences in some of the overall themes from year to year. If there were differences within the theme, these differences will be elaborated when the theme is described.

- *The identity of the BSC as a course* - This theme constitutes BSC as a discipline in the Danish USS. In the curriculum from 2004 and 2007 this theme is supported by following statement: "*BSC is... an introduction to natural science commonalities and differences* *through working with fundamental elements of the disciplines biology, physics, chemistry, and natural geography". My translation. The original text can be found in Section A.4 [UVM, 2005,2007]* which clearly defines which disciplines the BSC is based on but also that the main focus for this course is the commonalities and differences of science. In the curriculum of 2010, theme of science identity changes: *"the introduction to natural science (...) through working with the basic elements of natural science with emphasis on the coherences in natural science." My translation. The original text can be found in Section A.4 [UVM, 2010]*. Here there are no specific disciplines which constitute the BSC. The course is constituted by natural science in general. This could indicate that five years after the reform the BSC has it's own identity and does not depend on the existing disciplines. Another change is that now the focus of the BSC has shifted a bit. Where until 2010 the focus was on both commonalities and differences of science, from 2010 until now the focus has been on the coherences in science.

- *Structural demands to the BSC* - This theme covers the requirements that the BSC should fulfill. In all three curricula, we find the idea of putting the student in a active learning position as well as the inductive teaching principle (in Danish: det induktive undervisningsprincip)[1]. It is also within this theme one finds the requirements regarding the interdisciplinarity. This requirement changes over time when looking at the three different curricula plans. In 2005 *"the BSC implementation should be based on thematic topics which are preferably pluridisciplinary", My translation. The original text can be found in Section A.4 [UVM, 2005]*. This indicates that the BSC back in 2005 not necessarily had a interdisciplinary dimension which also is the conclusion in the evaluation report [Dolin, Hjemsted, Jensen, Kaspersen, and Kristensen, 2006]. In 2007 the word *preferably* (which appears in the curriculum plan from 2005) was changed to the word *normally* indicating that the implementations should focus more on the interdisciplinary dimension of the BSC. In 2010 the last part of the sentence was changed to *"thematic pluridisciplinary topics"*. Now all implementations should be interdisciplinary at least to a pluridisciplinary degree. The requirement of interdisciplinarity in BSC evolves from being preferable pluridisciplinary to being based on pluridisciplinary topics according to the curriculum plans. It is also worth noticing that while the requirement of the interdisciplinary is increased, the number of disciplines required to contribute to the BSC is decreasing. In 2005 all 4 science disciplines should be involved whereas in 2010 the number of disciplines involved is not mentioned in the curriculum plan

1 This principle focus on letting the student work on a open problem in order to prioritize independent work processes

but in the associated guidelines it is elaborated that two or more disciplines should constitute the BSC.

- *Importance of science in a Bildung perspective* - In all three curriculum plans this theme is largely represented which also supports the Danish teaching tradition [Dolin and Krogh, 2010]. This has a focus on development of the individual student in order to prepare the individual student for participation in society: *"they(students) can express a knowledge-based opinion on issues and problems with a natural sciences aspect", My translation. The original text can be found in Section A.4 [UVM, 2005,2007,2010].* In order to fulfill this goal the BSC should *"show the relevance and the application of natural science in relation to society "my translation Section A.4 [UVM, 2005,2007,2010].* These statements are the same in the three curriculum plans.

- *Scientific thinking* - This theme is also represented in all three curricula and the follow sentence is found in all of them:*"to know about and understand scientific thinking ... ", My translation Section A.4 [UVM, 2005,2007,2010].* Scientific thinking in relation to the BSC covers that the student should be able to create and evaluate a hypothesis, be able to address if a model or experiment is qualitative or quantitative and to see the possibilities and limitations of science. In 2010 a new academic aim was presented in the curriculum:*" (the student should be able to) demonstrate basic knowledge about scientific identity and methods", My translation. The original text can be found in Section A.4 [UVM, 2010].* This indicates that the scientific way of thinking moves from being directed at a specific experiment or model which the students had performed to have more of a philosophy of science approach to the scientific thinking. One could therefore argue that in the year of 2010 this theme should be called scientific thinking and scientific methods. This puts new demands on the teaching and learning process of the BSC as the teachers now also should implement a philosophy of science aspect to the program.

- *Practical work* - This theme covers the practical aspect of BSC; doing practical investigations both in nature and in the lab. The practical investigation covers performing an experiment, creating hypotheses in relation to experiments, analyzing data with and without IT-tools, applying models to the data and evaluating the experiments' hypotheses, data, model etc. This has been such a central part of the BSC from the beginning to now that it was explicit mentioned that *"practical investigations must constitute a significant part of the education time", my translation Section A.4 [UVM, 2005,2007,2010].*

- *Put science into perspective in relation to history, society and technology* - This theme is also central in the BSC program. This theme is not only used to support the Bildung aspect of the BSC but also used in order to support the students' curiosity and commitment as these perspectives often are much easier for the student to relate to. Therefore it was written into the academic content that the topic of the BSC implementation must show the relevance of science in a social and historical perspective. Beside from the academic content, a whole academic aim is dealing with the same theme: *"(The students should be able to) put into perspective the contributions of science to technological and social development through examples."my translation Section A.4 [UVM, 2005,2007,2010]* During the years there was a little bit of disagreement about which of the three perspectives (history, technology and society) was most important. Nonetheless in all the three curricula the three perspectives are present although the order of the perspective changes. Finally it is worth mentioning that this theme is also found in the criteria for assessment as the students must be able to put their results from their own practical investigations into persecutive.

- *General competencies to be learned by the student* - This relates to the skills which the student should acquire during the BSC program. These competencies can also be found in the individual disciplines of natural science. It could be: communicate a scientific issue, include theoretical knowledge and consideration, and finally use academic concepts correctly. These have been identical from the introduction of the BSC to now. This theme is primarily based on the academic aims and the criteria of assessments of the curricula documents for all three years [UVM, 2005,2007,2010]. The writing skills which the students also must acquire during the BSC program are not a part of this theme as they form a theme.

- *Writing competence* - This specific competence is the only skill which is mentioned many times in the curricula (of all years), for the reason that *"the students must work with different kinds of written assignments, which should be planned with a clear progression in the demands towards a final written product ", My translation Section A.4 [UVM, 2005,2007,2010]*. This is an important skill since the evaluation of the BSC program was made on the basis on the final written assignment. Therefore this skill must be trained in various ways with different forms of written assignments according to the curricula developers.

These were the eight discourses which were obtained using Fairclough's CDA on the curricula documents and the associated guidelines for the BSC. It is these discourses which will be used in the trial characterization of the thematic discourse network analysis TDNA. Here the themes of the critical discourse analysis will compared and interpreted in relation to the linguistic networks of the three different curricula from the years 2005, 2007 and 2010. In the next section the linguistic network is presented as are the rules which were applied to the transcripts after the first trial characterization.

5.2 FIRST ROUND OF NETWORK ANALYSIS AND TRIAL CHARACTERIZATION

The three curriculum plans from the years 2005, 2007 and 2010 were made into linguistic networks using the method described in Section 4.2. Thus, the curriculum was first turned into one-statement sentences. Then a text-mining procedure was performed on the one-statement sentences, and finally the text-minded one-statement sentences were turned into a spreadsheet which the network analysis program Gephi[Bastian, Heymann, and Jacomy, 2009] could read. Figure 18 is an example on how the linguistic network of the BSC curriculum from 2005 [UVM, 2005] looks. Here the nodes' size was determined from the weighted degree of the node. The visualization of the network was performed by using the ForceAtlas2 algorithm. See Section 2.3.4 for further elaboration.

By looking at Figure 18 one sees that the node with the word student (in Danish elev) is a lot bigger compared to the rest of the nodes. This indicates that the student is a central part of the curriculum plan. As the "student" node have many links going in and out of the node, hence this node has a large weighted degree. That the student node is central in the curriculum plan might not seem that odd as the curriculum plans are used for describing; what the student should, how the student should learn it, often how the student must be tested in the end and which criteria of assessment the student must fulfill in order to pass. Therefore it makes good sense that the student node is big and central.

From look at the Figure 18 one sees that most of the nodes are gathered in the middle of the network in one big mess. In the lower part of Figure 18 there is small community of 10 nodes which are tightly bound to each other and are removed from the rest of the network. The community of nodes all have a relation to the natural science node. Either they relate to the students express themselves about it, being curious about or making a commitment to it. Nonetheless it is still hard to see if this would still be one community if the student node was diminished as the community points in two directions when it comes to putting a theme on it. If one compares the community with the themes obtained with the CDA, the community is split between the two themes " **The importance of science in a Bildung perspective**" and "**General competencies to be learned by the student**". Due to this and the fact that the student node is so central and therefore dominates the network, a rule must be applied in order to diminish the student node and the effect of that node.

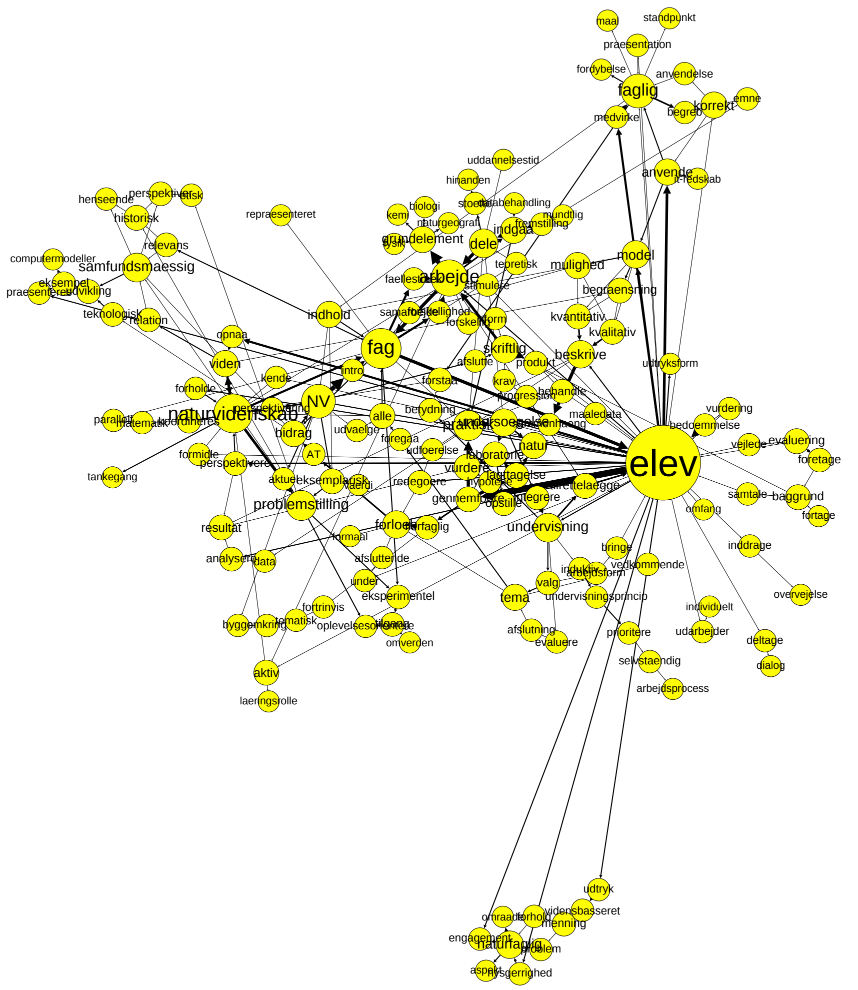


Figure 18: Here the BSC curriculum from 2005 is presented as a linguistic network. The node size is determined from the degree of the node.

Besides from the community in the lower part of Figure 18, it looks like there could be communities in the upper right side and the upper left side of Figure 18. The community in the upper right side has strong connections to the the student node. However, the central node of the community has relation the academic part of the BSC. The community in the upper left side of Figure 18 has a clear relation to the theme **Put science into perspective in relation to history, society, and technology** from the CDA. For the rest of the network, it is difficult to assign themes since the central part of the network is so compact and dense. It is therefore time to make new rules which can be applied in order to continue the TDNA. See Figure 15 for an overview of where in the TDNA process we are.

5.2.1 *New rules and Infomap*

As mentioned above, a rule had to be made in order to diminish the effect of the student node. First an attempt was made to remove the word student completely from the transcripts in order to see if a complete removal of the word would solve the problem. This resulted in a network which was non-coherent since there was a lot of free nodes which had no connection to the rest of the network. Therefore a complete removal of the word student was not an option as I was interested in finding themes' and the themes connection in the network. I then took a look a the one-statement sentences (the transcripts) in order to figure out when the word student was frequently used. I found two places in the transcripts where the word student where used frequently in the same way. When comparing the two places in the transcripts to the originally curriculum text, I found out that the frequent use of the word student could be traced back to two specific sections of the curriculum text; the academic aims and the evaluation. Due to this, it was then tried only to remove the words student in these two part of the transcript. This rule diminishes the student node while still keeping coherence in the network.

Furthermore, some synonyms and grammatical categories were merged in order to reduce the complexity of the network. This could for example be that the word *application* was merged with the word *apply* so only the word *apply* is used (in Danish anvende og anvendelse). Or the two Danish words *forskellighed* and *forskellig* was merged into the Danish word *forskellig*. In English, these translates to the words difference and different.

After applying the new rules to the transcripts for all three curricula plans through the years. The network analysis called Infomap [Rosvall and Bergstrom, 2008] was used to visualize the data. Infomap was used to simplify and highlight the regularities in the network structure. In relation to the TDNA, Infomap takes the linguistic network, as is looks in Figure 18, and turns it into a map of connecting modules this resulting map can be classified as a thematic map. In the next section the results of the TDNA will be presented.

5.3 FINAL MAPS OF THE INTENDED CURRICULUM - THE RESULT OF THE TDNA

In this section, the final maps of the three curriculum plans from the years 2005, 2007 and 2010 are displayed. They will be displayed in chronological order from 2005 and onwards. At the end of this section, a comparison of the three curricula throughout time is presented in an Alluvial diagram, which is a diagram that reveals changes in networks over time [Rosvall and Bergstrom, 2010].

The thematic map of the BSC curriculum 2005 is presented in Figure 19 compared to Figure 18, this gives a simpler and more clear overview of the network.

Each "node" in a thematic map represents a module of several nodes from the original network. These modules are called themes of the thematic map. The title for each module of the thematic map has been interpreted in relation to the CDA. This means that the collection of words from the nodes in each module have been investigated and compared to the CDA in order to find an appropriate title. The modules of the thematic map were then named based on the interpretation [Lindahl, Bruun, and Linder, 2016]. When a theme of a module coincided with a theme of the CDA, the name from the CDA was used for sake of simplicity.

The full sized thematic maps can be found in Appendix K

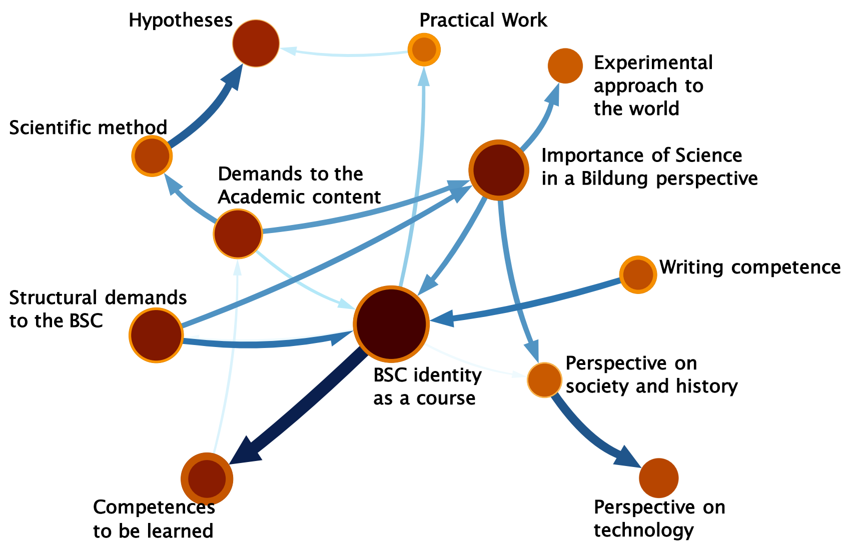


Figure 19: The final thematic map for the BSC curriculum from 2005. The BSC curriculum of 2005 is divided into 12 themes.

As mentioned, each module of the thematic map has been interpreted in relation to two things. The first thing was to look at which words did the module consist of from the linguistic analysis. The second thing was to compare these words with the themes of the CDA in order to see if a theme was suited for the module. The Infomap algorithm finds 12 modules in the map of the BSC 2005 curriculum as seen in Figure 19. This indicates that there might be 12 themes where the CDA only found eight themes. In Figure 19 we recognize some of the themes from the CDA. The large module in the middle of Figure 19 has the theme "**BSC identity as a course**" which also was a theme in the CDA. Besides this theme, the seven other themes from the CDA were also found in the thematic map: **"Structural demand to the BSC", "Importance of Science in a Bildung perspective", "competences to be learned", "writing competence", "practical work", "perspective on history, society and technology" and "scientific thinking"**. Notice that the title of theme "**Scientific thinking**" has been changed to "**Scientific method**" and that the "**Put into perspective**" theme has been divided into two themes, on with focus one society and history and one with focus on technology.

Furthermore three new themes have appeared. To connect the themes of "**Practical work**" and "**Scientific method**" we have the theme called "**Hypotheses**". In the CDA hypotheses, this was not a theme in itself but contains words that could be found in both the theme of "**Practical work**" and "**Scientific method**". The TDNA reveals that the theme of "**Hypotheses**" is an important theme in itself, hence the module size, and that it is actually this theme which links the two themes "**Practical work**" and "**Scientific method**" together.

The new theme "**Demands to the academic content**" sets a frame for which requirements the academic content shall meet. From looking at the thematic map one can actually deduce some of the demands. From the academic content it should be possible to learn about scientific methods and the importance of science as well as the identity of BSC. In the end, the competence which the student must acquire in the BSC program must be done through work with the academic content.

The third new theme originates from the theme "**Importance of Science in a Bildung perspective**".However, in contrast to the importance of science in relation to the individual student, this theme focuses on the way science "works". Therefore the theme is named "**Experimental approach to world**".

Before moving on to the BSC curriculum plan from 2007, some final remarks on the thematic map from BSC'05 will be given. It is quite interesting that the module "**Writing competence**" only has a link to the module "**BSC identity as a course**" and no relation to the module with other "**Competence to be learned**" as these two modules focuses on the skills that the students should learn and therefore you might expected these two modules to be connected. It is also worth noticing which way the arrows of the links are pointing in this constellation. The link point from the "**Writing competence**" to the "**BSC identity as a course**". This would indicate that the "**Writing competence**" helps to define the "**BSC identity as a course**" whereas the other "**Competence to be learned**" are defined from the "**BSC identity as a course**". This is seen from the link pointing from the "**BSC identity as a course**" toward "**Competence to be learned**".

Another thing which is worth taking a look at is the links going in and out of the module "**Structural demands to the BSC**". It makes good sense that there is both an in-going and out-going link between the module "**Structural demands to the BSC**" and the module "**BSC identity as a course**" as the BSC identity sets some structural demands for the BSC course and vice versa. But the link between the module "**Structural demands to the BSC**" and the module "**Importance of science in a Bildung perspective**" can at first sight seem a little bit odd. For how can the "**Structural demands to the BSC**" affect the "**Importance of science in a Bildung perspective**"? The answer is found by taking a look at the words constituting the two modules. This is called looking at the submodules. Here one finds that there is a structural requirement that the BSC implementation must be related to the Multi-Subject coursework (MSC, in Dansih AT). The MSC course has focus on the "**Bildung perspective in relation to natural science**", humanities and social and behavioral science. Therefore there is a link between those two modules, and therefore the direction of the link is pointing from the "**Structural demands to the BSC**" module and the "**Importance of science in a Bildung perspective**" module.

The thematic map of the BSC curriculum 2007 is presented in Figure 20.

In the thematic map BSC'07 we find 12 module. Each module is given a theme in relation to the interpretation of the module. Eight of the modules have a theme identical the modules in the thematic map of BSC'05. The two modules which focus on the perspectives (see upper left corner in Figure 20) have changed a lot compared to the map of BSC'05. Before (in BSC'05) the perspective "string" consisted of two modules. The first module had the theme perspective in relation to society and history and the second module had the theme perspective in relation to technology. See lower right side of Figure 19. Now the themes of the two modules have shifted so that the two themes

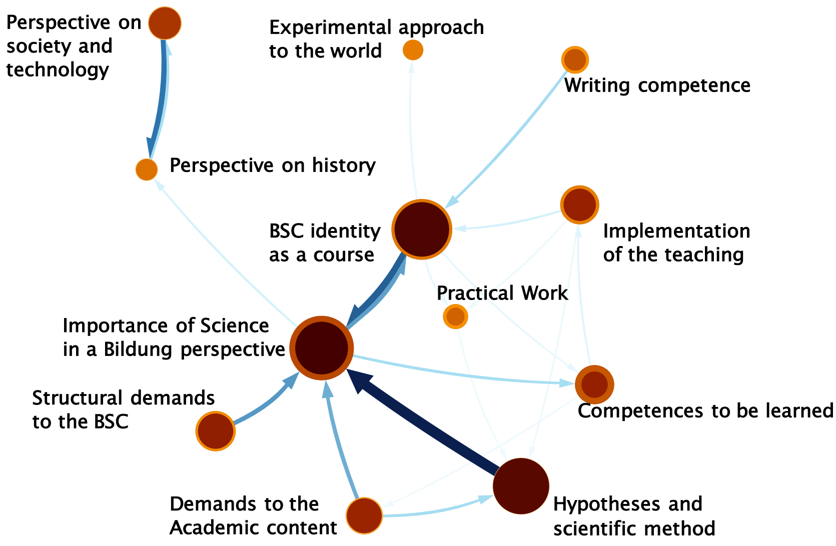


Figure 20: The final thematic map for the BSC curriculum from 2007. The BSC curriculum of 2007 is also divided into 12 themes like the thematic map BSC'05.

now are called;"**Perspective on history**" and "**Perspective on society and technology**". The two modules still represent the part of the BSC program where the gained knowledge should be put into perspective. However the connection between the two themes is a little bit different from the curriculum plan of BSC'05 to BSC'07 both in themes as well as in the link constellation.

In the thematic map of BSC'07 we see that the two themes: "**Scientific method**" and "**Hypotheses**" from BSC'05 have been merge into one theme. See Figure 20 in the lower right corner. This indicates that the hypotheses are more tightly bound to the scientific method. Hence, it is less connected to the practical work than in BSC'05. This argument is supported by the fact the the link between the themes "**Hypotheses and scientific method**" and "**Practical Work**" is more narrow compared with the the link between the themes **Hypotheses** and **Practical Work** in the thematic map of BSC'05.

A new theme also appears in the thematic map of BSC'07. This theme is called "**Implementation of the teaching**". This theme is where we find the requirements for the implementation. Hence which themes the BSC implementation should support. If we take a look at the out-going links from the module "**Implementation of the teaching**", we see that this theme is connected to three other themes. Hence, the taught implementation of the BSC should enable the students to: undertake practical work, work with hypotheses and scientific method and support the identity of BSC. Besides from the three outgoing links from this theme there is also one incoming link. This link originates from the theme "**Competences to be learned**". Thus, the competences to be learned set a frame for how the implementation of the BSC program should be implemented.

As a final remark to the thematic map of the BSC curriculum 2007, it is worth noticing that in general the links between the themes have become narrower. Nonetheless the number of links is approximately the same with 16 links in the map of BSC'05 and 17 links in the map of BSC'07. However, in the map of BSC'07 there are now two places where we find a connection between themes gives both ways (there are both an in-going and an out-going link).

The thematic map of the BSC curriculum 2010 is presented in Figure 21:

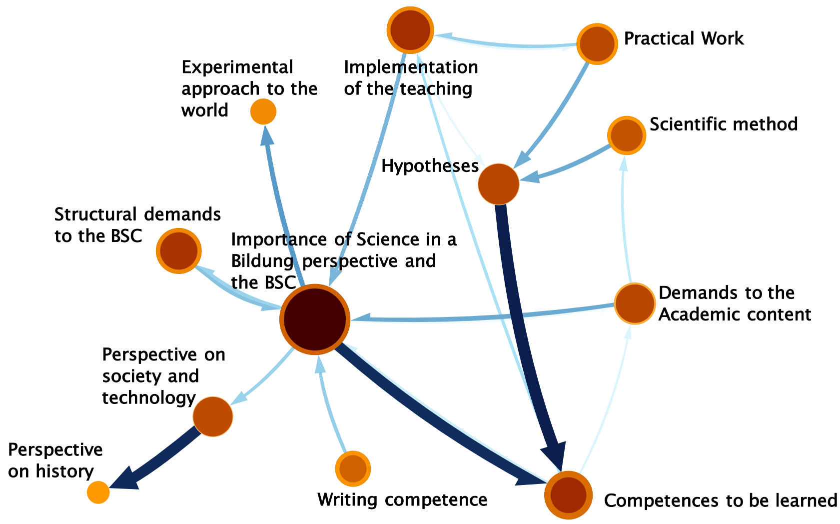


Figure 21: The final thematic map for the BSC curriculum from 2010. The BSC curriculum of 2010 is divided into 12 themes the same as the two other thematic maps from 2005 and 2007.

Again we have 12 modules in the thematic map which tells us that the BSC curriculum from 2010 also consists of 12 themes, see Figure 21. We can directly recognize nine themes from the BSC'07 map (see Figure 20). The last three themes; **"Hypotheses", "scientific method"** and **"Importance of science in a Bildung perspective and the BSC"**, are also recognizable but appear in a new constellation when the map of BSC'10 is compared with the map of BSC'07. "**Scientific method**" and "**Hypotheses**" are once again two separate themes like it was in the thematic map of BSC'05. See Figure 19. The theme of "**Hypotheses**" again forms the connection between the themes of "**Practical work**" and "**Scientific method**".

Since a theme has split into two themes another two themes have to have merged in order to stay with 12 themes. The two themes which have merged now constitute the big module in the center of the thematic map of the BSC'10. In both the thematic map of BSC'05 and BSC'07 we had the two themes: "**BSC identity as a course**" and "**Importance of Science in a Bildung perspective**". These two themes have now been merged into the theme:"**Importance of science in a Bildung perspective and the BSC**". This indicates that the identity of the BSC course is now more related to the importance of science. By looking within the submodules in the thematic map, one notices that the BSC program no longer is defined as a course consisting of four different disciplines (physics, biology, chemistry and natural geography) but as a course consisting of natural science. This could indicate that the BSC program is no longer interpreted as a collection of different science disciplines but instead now constitutes its own discipline/course.

Some final remarks to the thematic map of the BSC'10. It is worth noticing that the two themes relating to the perspective themes have switched place from the thematic map of BSC'07 to the thematic map of BSC'10. See Figure 20 and Figure 21. It is also interesting that the two themes of "**Practical work**" and "**Scientific method**" are not connected directly. This might indicate that the theme "**Scientific method**" has more focus on the philosophy of science part of scientific method and does not focus on relating the methods of science to the practical work which the students perform. In the thematic map of BSC'10 we again find an increase in connections going both ways between two themes (there are both an in-going and an out-going link) compared to the thematic maps from the other years. In the thematic map of BSC'10 we find four of this type of connections.

5.3.1 *Changes throughout time - the Alluvial diagram*

A way to map change in networks is by using a so called alluvial diagram. An alluvial diagram can be used when networks have significant clustering [Rosvall and Bergstrom, 2010]. If the networks have significant clustering, the alluvial diagram can be used to reveal structural changes between the clusters of two or more networks. The data from the three different BSC curriculum plans are now plotted as an alluvial diagram in order to reveal if there are any structural changes to the BSC curriculum plan over time. See Figure 22. Notice that the time scale goes from left to right (from 2005 - 2010).

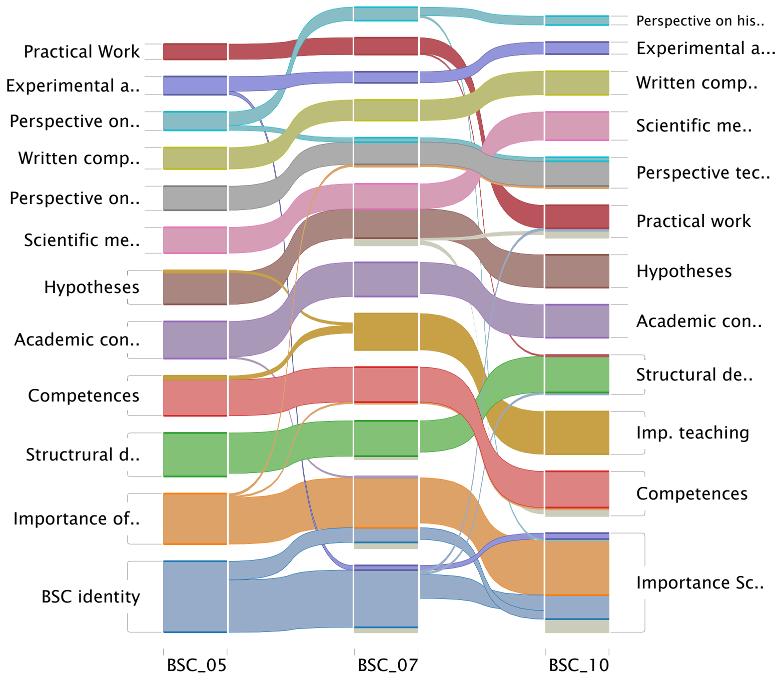


Figure 22: The alluvial diagram over the BSC curriculum plans from the years 2005, 2007 and 2010. In the right and left side of the alluvial diagram, the names of the modules found in the thematic map as shown. In the bottom of the figure, the time of when the BSC curriculum is from is shown.

Figure 22 shows that there are some changes in the way that the modules cluster over time. Hence, this reflects some changes in the BSC curriculum over time. If one takes a look at the two themes in the left side of the alluvial digram, the themes called "**BSC identity as a course**" (illustrated with the light blue color) and "**Importance of science in a Bildung perspective**" (illustrated with the orange color), one finds that there is a structural change from the BSC'05 to BSC'07. The theme "**Importance of science in a Bildung perspective**" in 2007 also contained something which was portrayed as the BSC's identity back in 2005. This is visualized by both the orange and the light blue colors being included in the theme "**Importance of science in a Bildung perspective**" in the BSC'07 curriculum. See the lower part of the middle section in Figure 22. By looking at the alluvial diagram in Figure 22, it is very clear that these two themes were merged in the BSC'10 curriculum.

As mentioned when the thematic map of the BSC'07 was elaborated, a new theme called "**Implementation of the teaching**" appeared in the year 2007. By looking at the alluvial diagram in Figure 22, one can see that the most of the theme is completely new. Nonetheless one can also find elements which earlier were associated with the themes "**Competence to be learned**" and "**Hypotheses**". This can be found be looking at the mustard yellow color in Figure 22.

In the three different thematic maps we observed that the two themes; "**Hypotheses**" (illustrated with the brown color in the alluvial diagram) and "**Scientific method**" (illustrated with the pink color in the alluvial diagram) started with being two separate themes in BSC'05, they then merged into one theme in BSC'07 and then they separated into two themes again in BSC'10. This is also visualized in the alluvial digram in Figure 22. If one look at the brown and pink colors in the diagram, we see that they are first separated in the left side of the diagram. Then they are merged in the middle part of the diagram, and lastly they ate separated yet again in the right side of the diagram. Finally it is also possible to track the change of the perspective themes in the Alluvial diagram. However, this task is left for the reader.

5.4 finding the learning aims of the bsc using the thematic maps

In the data processing of the implemented and realized curriculum, a code category called learning aims was used as a part of the label. See Section 4.4 and Section 4.6. This code category was made on basis of the academic aims of the BSC program (the academic aims for the BSC program can be found in Section 3.2). However, most of these learning aims can actually be found by looking directly at the thematic maps of the BSC. The eight learning aims are described in Table 13. Here we refresh them by their names: *Hypotheses, Practical Work, Perspectives, Scientific method, Scientific identity, Written Communication, Oral communication* and *Models*. The first six learning aims can be directly recognized from the thematic maps if one paraphrases two of themes a little bit from "**Writing competence**" to *written communication* and the theme "**BSC identity as a course**" to *Scientific identity*. In Table 13, a description of each learning aim can be found. This description also matches the themes from the thematic map.

The two last learning aims, *Oral communication* and *Models*, which cannot be found from a direct look at the thematic maps are found when one looks at the module "**Competences to be learned**". In the submodules of the module "**Competences to be learned**" words like "conversation" and "presenting" are found, which relate to the learning aim *Oral communication*. Within the submodules the words model, data and results also appear. These words relate to the learning aim

Models. The word model also appears within the submodules of the theme "**Scientific method**". Thus, it is possible to find the learning aims using the thematic maps of the BSC curriculum.

5.5 OTHER COMMENTS TO THE INTENDED CURRICULUM

The idea for doing these thematic maps for the intended curriculum was to see which themes were connected and if the interdisciplinarity had its own theme. The first part of the idea was successful as the thematic map shows the connection between the different themes. In addition the alluvial diagram also made it possible to see structural changes in the thematic maps over time. When it comes to interdisciplinarity, the result was not convincing. The requirements of interdisciplinarity in the BSC program was only found in the theme "**Structural demands to the BSC**", and the interdisciplinarity only constitutes a minor part of theme. Within this theme the word "*Pluridisciplinarity*" is found, and it is found in all three curricula throughout time. If one trace the word back to the curriculum documents, the word "*Pluridisciplinarity*" is mentioned in the section of the curriculum called "Principles of didactics" (in Danish Didaktiske principper). This section tells the readers, in this case the teachers, how the BSC program should be organized. I will return to this in the discussion of the study in Chapter 8.

The modularity of each curriculum network was calculated in the program 'R' using the algorithm *infomap.community*. This was done in order to check if that the modularity was lager than 0.3 and that the network therefore had a tendency to be divided into communities, in this case thematic modules. The modularity for the three different thematic maps was respectively; BSC 2005 = 0.54, BSC 2007 = 0.52, BSC 2010 = 0.51. All three modularities were larger than 0.3. Hence all three thematic maps have a tendency to divide into modules. If one should interpret on the relatively high modularity which is found in all three BSC curriculum maps. It might indicate that the curriculum plan of BSC consists of many different elements which are not all bound together.

6 THE IMPLEMENTED CURRICULUM-RESULTS AND INTERPRETATION

In this chapter the results of the five different implementations of the BSC, which have been analyzed using the method of network analysis described in Section 4.4, are presented. The aim of this part of the investigation was to study how the interdisciplinarity is expressed in different implementations of the BSC program since the teaching situation is a major part of the implemented curriculum. The five implementations of the BSC program and teacher interviews together constitute the implemented curriculum which is investigated in this chapter.

The main idea with this investigation was to take the five different implementations of BSC and turn them into activity maps as an attempt to quantify the teaching situation. All the networks in this chapter were constructed on the basis on 4 code categories which are found in Table 10- Table 13 and in Appendix F. Notice that all the characteristics of the network were determined empirically.

The networks in this chapter were all constructed so they represent the whole implementation of the BSC by each teacher, these networks are called activity maps. This means that the activity map in Figure 23 was constructed on the basis of 11 observed modules performed by Teacher A. By constructing the activity map in this way, the five different BSC implementations, results in six different activity maps; one for each teacher.

These six activity maps, one for each teachers' part of the BSC implementation, were each visualized in two ways, giving a total of 12 activity maps; two activity maps for each teacher. In the first activity map from each teacher, the node size was determined by the weighted degree of the node. The weighted degree is the sum of all the connections going in and out of the node. The weighted degree of the node translates into the amount of time spend on each node. Hence, a large node indicates that a lot of time was used on that node. In the second activity map the node size was determined by the PageRank of the node. The PageRank indicates the specific node's level of involvement and relative importance in relation to the other nodes of the activity map. It is important to mention that in the appearance of activity maps, the size of the node cannot be compared across the different teachers' implementation of the BSC. This is due to the fact that the activity maps are constructed independently of each other. The node size can therefore *only* be directly compared within the same activity maps.

In the next sections, I will present each teachers' individual activity maps. Then a presentation of the scores calculated from the activity maps will be given. The modularity and the PageRank are used to characterize the interdisciplinarity in the different BSC implementations. The PageRank of the learning aims will also be presented in order to see which learning aims the different BSC implementations target.

6.1 TEACHER A IN CLASS 1

The two activity maps from Teacher A's implementation of the BSC are found on Figure 23 and Figure 24. The program Gephi was used to visualize the activity maps. All self-loops were removed in order to get Gephi to visualize the activity map in a proper manner. It is also the program Gephi which found the communities in the activity map. The two activity maps from Teacher A are identical in structure. Hence, they have the same amount of communities, and the communities consisted of the same nodes in both activity maps. The only thing which differs is the size of the nodes. In Figure 23, the size of the nodes was determined by the weighted degree which allows us to see how much time has been spent on each node. In Figure 24, the node size of the node is determined by the PageRank which indicates the relative importance of the individual node. By comparing the node size in the two activity maps, one can see which nodes the most time has been spent on in the implementation and can be compared to the nodes with the relative highest importance in the implementation. This has proven to be a useful tool in the interpretation of the teachers' activity maps. I will now first characterize the different communities in the activity maps of Teacher A, and then the two activity maps are compared relative to node size. This produce will be the same for all the teachers' activity maps.

It might be helpful to find Appendix F in order to recall what the different codes in each label stand for. This will hopefully be helpful in order to interpret the activity maps. The full sized activity maps can be found in Appendix K

Teacher A's activity maps were divided into seven communities by Gephi each represented with a different color. See Figure 23. In general Teacher A spends a lot of time on different types of group work. Hence the, three largest nodes in Figure 23 contain codes related to group work (gwad and gwp). This fit well with the implementation description that focuses on project based learning. See Section 3.4.2 for the implementation description. In addition to this, one will notice that the most frequently used subject code (third code of the label) is "bsc" which indicates that this implementation focused on general science and not individual science disciplines.

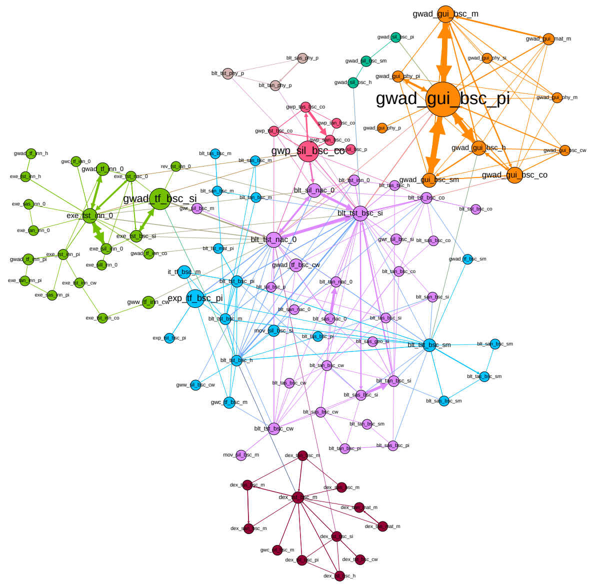


Figure 23: Activity map over 12 modules of Teacher A's BSC implementation in Class 1. The node size was determined by the nodes' weighted degree.

Figure 24: Activity map over 12 modules of Teacher A's BSC implementation in Class 1. The node size was determined by the nodes' PageRank.

If we take a look at the seven different communities in Figure 23, they all have different characteristics. The green community is characterized by innovative exercises. This is seen in the labels where the two codes "inn" and "exe" are frequently represented. However, it is interesting that the largest node in this community contain neither of the two codes mentioned before. Instead it has the code "gwad_tf_bsc_si" which is translated into that a group has an academic discussion about BSC's identity while the teacher works as a learnings facilitator. This could indicate that the innovative exercises are one way to access the BSC's identity for this specific BSC implementation.

The bordeaux colored community could be named "demonstration experiment" in relation to the BSC. All the nodes in this community have the same activity code ("dex") and the same subject code ("bsc"). The interaction between the Teacher A and the students took place as lectures from the teacher as well as dialogue between teacher A and the students. The primary learning aim which the community targets is Models indicated by the code "m".

The pink community in the top of Figure 23 is characterized by the student groups presenting their work with BSC. Hence, it is the learning aim oral communication that is the focus of this community. The largest node of this community "gwp_sil_bsc_co" translates into that one group is presenting their work about BSC, while the other groups are quiet. The group presenting hereby trains oral communication. The small gray community placed above the pink community in Figure 23 puts the subject physics ("phy") into perspective ("p").

The large orange community in the top right corner of Figure 23, shows that a lot of time is spend on guiding the student groups, in relation to different learning aims. The largest nodes in the orange community are related to the subject of BSC. Nonetheless, one can also find nodes with the subject code "phy" and "mat" indicating that the two disciplines physics and mathematics also contribute to the students' work. The little dark green community on the left side of the orange community (see Figure 23) represents when the student groups work by themselves without guidance.

The blue and purple communities placed in the center of Figure 23 overlap each other. They are both characterized by containing a lot of black board teaching ("blt") about the BSC subject ("bsc"). They also both target many of the learning aims. However, the interaction between Teacher A and the students is a little bit different in the two communities. In the blue community, Teacher A primarily lectures the students ("tst") whereas in the purple community there is more dialogue between Teacher A and the students indicated by questions and answers from both Teacher A and students ("tas", "san", "sas", "tan"). Another difference between the two communities is that one finds experiments in the blue community ("exp"). In the purple community one finds nodes which are related to being of non-academic character ("nac").

By comparing the node sizes between Figure 23 and Figure 24, one finds that a lot of time is spend on group work. However, what stands out as an important node according to the PageRank is teacher-led activities. The largest nodes in the PageRank activity map (Figure 24) have the code "tst". This indicates that the teacher explanations/lectures are important and governing for the BSC implementation. The largest node in Figure 24 is "blt_tst_nac_o" which translates into blackboard teaching where the teacher lectures about non academic content. This label, consisting of these four codes, appears when the teacher for example tells the student to close their computer, put away their self-phone, or performs a name call in order to register if the students are present etc. The label could be classified as classroom management. The activity of classroom management does not take a lot of time if we look at Figure 23 but it is quite important according to Figure 24.

6.2 TEACHER C IN CLASS 2

Teacher C's activity maps, from the implementation in class 2, are divided into seven communities consisting of minimum 5 nodes each and 2 very small communities consisting of 2 nodes,see Figure 25 and Figure 26. The latter two will be commented on later. Overall the communities of Teacher C's activity map can be divided into three themes; individual science disciplines, general science represented with the code "bsc" and a mix of those two themes. By looking at the activity map in Figure 25, one will find that the largest node is blue with the label "exp_tf_bsc_pi". Thus, a lot of time was spent on doing experiments with relation to science in general. Here the teacher worked as a learning facilitator. Teacher C has probably walked around helping the student groups during the experiments when help was needed.

Furthermore, we see some quite big links in the purple community. See Figure 25 in the lower part of the figure. The three largest links form a triangle between the nodes; "blt_sas_phy_si", "blt_tan_phy_si" and "blt_tst_phy_si". This triangle illustrates a classroom dialogue where the students ask questions about the identity of physics, then the teacher answers the question and continues to lecture which leads to a new student question hence the triangle structure. The node "blt_tst_phy_si" also forms a triangle structure with the two other nodes, "blt_tst_phy_pi" and "blt_tst_nac_o". This triangle is a lecture triangle as the teacher lectures about different things; here physics identity and practical work within the discipline of physics. The last node is classified as classroom management as mentioned earlier. By looking at the direction of the links, we find that the teacher most often starts with some kind of classroom management and then continues to lecturing about physics.

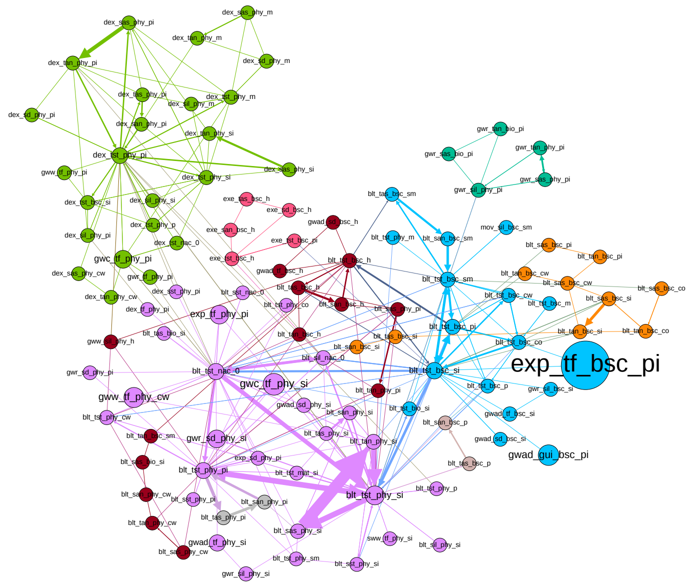


Figure 25: Activity map over 13 modules of Teacher C's BSC implementation in Class 2. The node size was determined from the nodes' weighted degree.

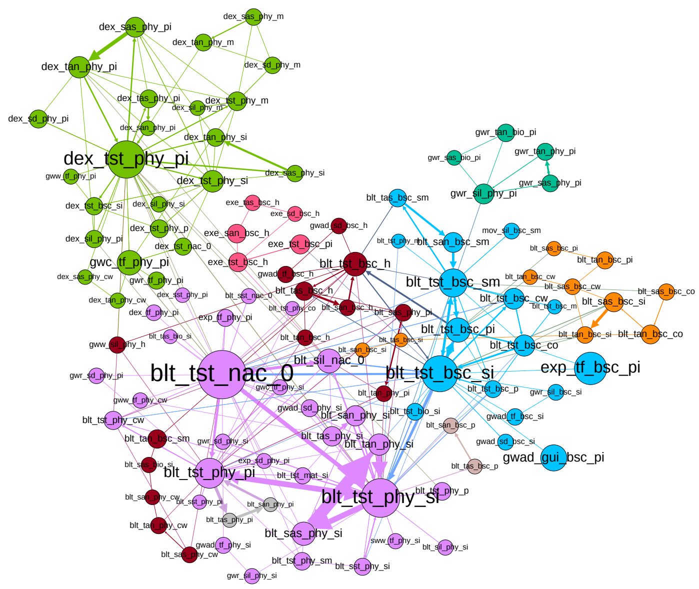


Figure 26: Activity map over 13 modules of Teacher C's BSC implementation in Class 2. The node size was determined from the nodes' PageRank.

The different communities in Figure 25 will now be reviewed in more general terms. The large green community in the top left corner of Figure 25 is characterized by the activity "dex" and the subject "phy". The community therefore focuses on demonstration experiments in physics. The little blue-green community in the right side of Figure 25 focuses on the student groups reading in different individual science disciplines; here biology and physics. In this community we again find two dialogue triangles which are based on students' questions. The purple community is characterized by the subject physics. Almost every node in this community has the code "phy". So this community is about learning physics through various activities, interactions and by targeting various learning aims. Next to the purple community in the lower left side of Figure 25 two gray nodes appear; "blt_tas_phy_pi" and "blt_san_phy_pi". These two nodes combined with the node "blt_tst_phy_pi" constitutes another dialogue triangle. However, here the teacher asks the questions and the students answer. I have no idea why the program Gephi has put those two nodes in a separate community as they fit perfectly into the community. So for the rest of the analysis and interpretation these two nodes will be considered as part of the purple community.

The blue and orange communities are both characterized by focusing on science in a general way. Thus, the code "bsc" is dominating in both communities, see Figure 25. Where the orange community emphasizes classroom dialogues with different learning aims, the blue community is more teacher regulated with lectures that support the different learning aims. The little light gray community, in between the purple and the blue community, is a classroom dialogue about putting the BSC implementation into perspective. This community both couples to the blue and purple communities. However, the internal link between the two nodes is so strong that they remain the separate community. The little pink community addresses the learning aim hypotheses in a general science manner by the students doing different exercises.

Finally, the red community is a mixed community in many ways. It is mixed between subjects; 7 nodes have the code "bsc", 6 have the code "phy" and one have the code "bio". The activities are a mix between blackboard teaching and group work, and the learning aims are a mix between hypotheses, scientific method and written communication. However, the community can be characterized as having a focus on the dialogue between the students and the teacher. It is within this community the students and the teacher tries to combine the different subjects of the implementation to a whole.

If the node sizes between Figure 25 and Figure 26 are compared, one finds that a lot of time is spent on doing experiments. However, this activity is not the most important part of Teacher C's BSC implementation. Again we find, as we did in Teacher A's activity maps, that teacher-led activities have great importance. The largest nodes in the PageRank activity map (Figure 26) have the code "tst". Once more this indicates that the teacher explanations/lectures are important and governing for the BSC implementation. The largest node in Figure 26 is like in Figure 24 the "blt_tst_nac_0"; node, the so called classroom management node. The activity of classroom management do not take a lot of time if we look at Figure 25 but it is quite important. The nodes which constitute the two elaborated triangles in the purple community also have a relative high importance. Nonetheless, it is the nodes where the teacher lectures ("tst") which are most important.

6.3 TEACHER C IN CLASS 3

Teacher C's activity maps, from the implementation in class 3, are divided into six communities all illustrated with a different color see Figure 27 and Figure 28. The communities of Teacher C's activity maps can be divided into two themes; individual science disciplines and general science represented with the code "bsc". Overall more time has been spent on general science "bsc" than individual disciplines. It is actually possible to draw a dividing line along the boarder between the purple and green communities, further past the purple community and finally in between the green-blue and blue commnity. We will then have the teaching relating to general science on the right side of the line and individual science disciplines on the left side of the line. By looking at the activity map in Figure 27, one will find two big nodes relating to experiments and three relative big nodes relating to different types of group work. This indicates that a lot of time was spent on group work both in relation to experiments and academic discussions about practical work. We can see that Teacher C has spent a lot of time on lecturing ("tst") about scientific methods, models, practical work and the identity of science. The size of the links in the area around these nodes is quite big which indicates that Teacher C tries to connect the different learning aims of BSC by jumping back and forth in his lectures.

As mentioned above, the six communities can be divided into two themes; individual sciences disciplines and general science indicated by the code "bsc". We have two physics communities; the orange and the green. See Figure 27. The orange community is dedicated to demonstration experiments, and the green primarily is indicated by blackboard teaching and doing experiments in physics. The green-blue community is a biology community.

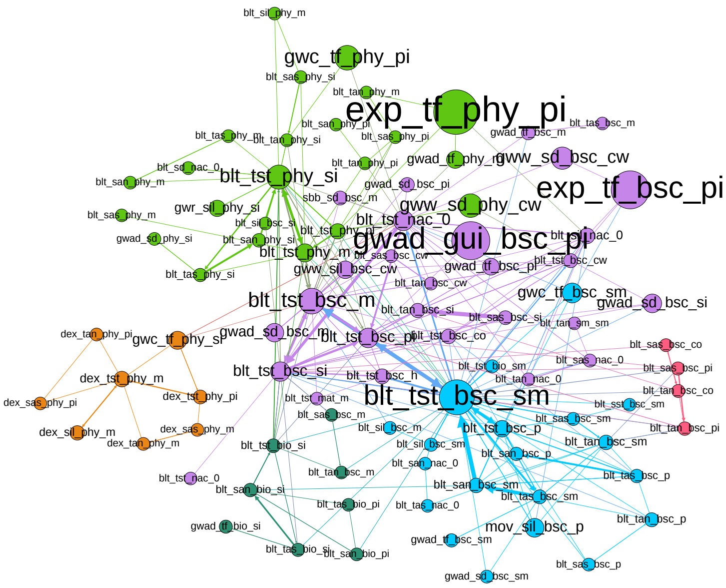


Figure 27: Activity map over 9 modules of Teacher C's BSC implementation in Class 3. The node size was determined from the nodes' weighted degree.

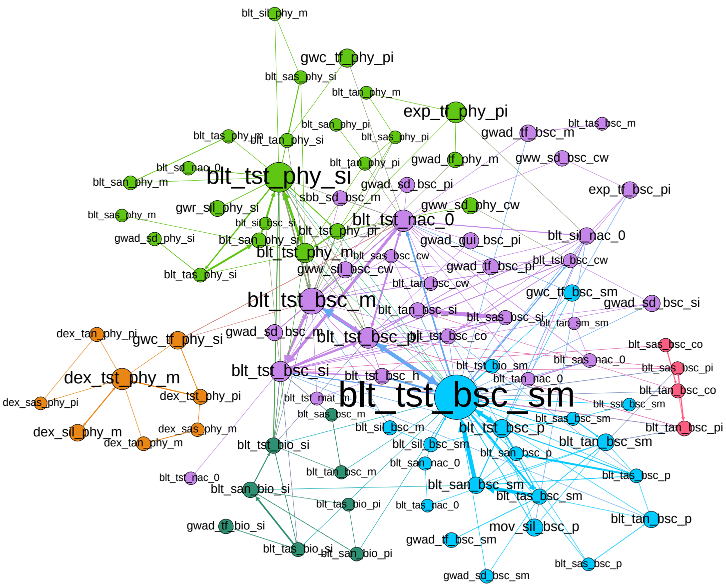


Figure 28: Activity map over 9 modules of Teacher C's BSC implementation in Class 3. The node size was determined from the nodes' PageRank.

The last three communities focus on science in general. The little pink community in the right side of Figure 27 is characterized as classroom dialogue about practical work and oral communication. Then the two large communities are left; the blue and purple communities. They both focus on general science (hence the code "bsc"). However, where the purple community consists of doing experiments supported by teacher lectures about various learning aims, the blue community focuses more on dialogue which primarily targets the learning aims scientific method and perspectives of the BSC despite the large lecture node.

If the node sizes in Figure 27 and Figure 28 are compared, one finds some differences. The large nodes about experiments and group work have become the same sizes as most of the other nodes in the activity map. This indicates that even though a lot time is spend on these activities, the relative importance of these experiments is small. However, the teacher lecturing about demonstration experiment is relative important compared to the time spent on the activity. See the change in the orange community in Figure 27 and Figure 28. Again we find, as we did in Teacher A's and Teacher C's class 2 activity maps, that teacher-led activities have great importance. The largest nodes in the PageRank activity map (Figure 28) have the code "tst". The central node in the green community indicates that the lecturing in the identity of physics is quite important for this specific implementation. Nonetheless, this time the "blt_tst_nac_o" node is not the most important node. The most important node of this implementation is related to the scientific methods used in general science.

6.4 TEACHER D IN CLASS 3

Teacher D is responsible for the second discipline in the BSC implementation in class 3, Teacher C is responsible for the physics contribution and Teacher D is responsible for the biology contribution. Teacher D's activity maps are divided into seven communities. See Figure 29 and Figure 30. Overall the communities of Teacher D's activity map can be divided into three themes; individual science disciplines consisting of 4 biology oriented communities, two general science communities and one mixed community. If we look at Figure 29, we find that the three largest nodes have some type of group work in common, for example student groups doing experiments (the large dark gray node), student groups writing an assignment (the large blue node) and student groups having academic discussions. A lot of time was therefore spent on these three specific group activities. However, the rest of the nodes in the activity map primarily have codes of blackboard teaching of some kind ("blt" and "rev"). This indicates that the blackboard activity is often used but with different types of interactions, different combinations of subjects and targeting different learning aims.

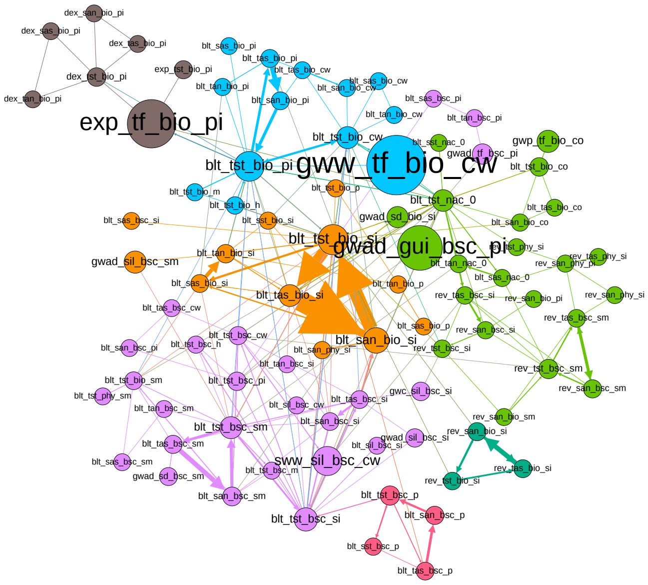


Figure 29: Activity map over 8 modules of Teacher D's BSC implementation in Class 3. The node size was determined from the nodes' weighted degree.

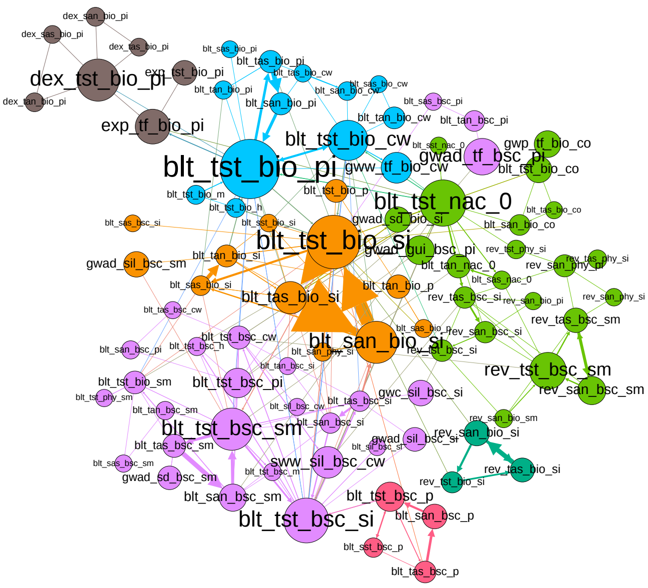


Figure 30: Activity map over 8 modules of Teacher D's BSC implementation in Class 3. The node size was determined from the nodes' PageRank.

Looking at Figure 29, the large orange links stands out. These links create a triangle which illustrates a classroom dialogue as mentioned in relation to Teacher C's BSC implementation in class 2. In the orange community in Figure 29, we see that it is the teacher who asks the questions and the students who answer. Generally in the activity map of Teacher D's BSC implementation, all the thick links indicate a classroom dialogue triangle where the teacher asks the questions. This type of dialogue triangle can be found in all seven communities.

The four communities with biology in common are characterized as follows. The dark gray community in the top left corner of Figure 29 represents the learning aim practical work in relation to biology. The orange community in the middle of Figure 29 mostly focuses on the identity of biology, which is explored by different kinds of classroom dialogues. The green-blue community in the lower right side of Figure 29 represents a classroom dialogue where knowledge about the identity of biology is reviewed. The blue community is characterized by the connection between the learning aims practical work and written communication. This could indicate that the focus was on how to present practical work in written texts e.g scientific reports and journals.

In Figure 29 two communities focus on science in general. The little pink community in the lower part of Figure 29 is identified as questions and answers about science perspectives. The purple community is besides general science "bsc" characterized by the activity blackboard teaching ("blt"). In this community there is a good mix of both classroom dialogues and lectures targeting different learning aims.

The last community is the green one, see Figure 29. This community is a little harder to characterize as it is a mixed community. It is mixed between subjects, consisting of both "bsc", "phy", "bio" and the "nac" codes. The activities are a mix of blackboard teaching in terms of the student gaining new knowledge and in terms of old knowledge being reviewed. In addition, the community also have some nodes indicating group work. One of them is even the third largest node in Figure 29. The learning aims are a mix between practical work, scientific identity, scientific method and oral communication (from the "blt_tst_nac_0" code, one will also gain the 0 as a learning aim. This is equal to targeting any learning aim). However, the community can be characterized as having focus on the dialogue between the students and the teacher. It is within this community, the students and the teacher try to combine the different subjects of the implementation to a whole.

By comparing the node sizes between Figure 29 and Figure 30, we find as we did with all the other activity maps presented that teacher-led activities have a great importance. The largest nodes in the PageRank activity map (Figure 30) have the code "tst". In this activity map the "tst" nodes, see Figure 30, often constitute one corner of a dialogue triangle. This could indicate that the classroom dialogue is quite important for this specific BSC implementation. It might also tells us something about Teacher D's teaching style which seems to be based on getting the students to participate in a classroom dialogue instead of Teacher D lecturing. What we cannot tell from the activity map is how much of the class is participating in the dialogue. Is it only one or two students or is it the whole class? We also notice that all the nodes containing a code for group work which are large in Figure 29 have become smaller in Figure 30. However, the purple node with the code "gwad_tf_bsc_pi" has become significant larger indicating that this activity, where the students groups are discussing and doing practical work, is important.

6.5 TEACHER E IN CLASS 4

Teacher E's activity maps, from the BSC implementation in class 4, are divided into nine communities, see Figure 31 and Figure 32. This is the largest number of communities for all the BSC implementations. Overall the communities of Teacher E's activity maps can be divided into the same two themes as Teacher C's activity maps for class 3. The themes are individual science disciplines and general science represented with the code "bsc". By looking at the activity map in Figure 31, one will find that the largest node has the codes "exp_tf_phy_pi". This indicates that a lot of time was spent on doing experiments. The second largest node has the code "gwad_tf_bsc_si". This means that a lot of time was also spent on students working in groups having discussions about the identity of BSC. In both activities, the teacher has worked as a learning facilitator. Teacher E was probably walking around while helping the student groups during the experiments when help was needed. Generally in the activity map of Teacher E's BSC implementation, there are many thick links forming different kinds of triangles see Figure 31. All the thick links indicate a classroom dialogue triangle where the teacher asks the questions. This type of dialogue triangle can be found in all nine communities. I will quickly go through these nine communities; first the six which represent the individual disciplines and then the three which represent the general science.

The little light gray community in the lower right corner of Figure 31 is the only community which is about natural geography ("geo"). This community is characterized by classroom dialogue about the identity of natural geography. The pink community in the middle is focused on the identity of physics, and the bordeaux colored com-

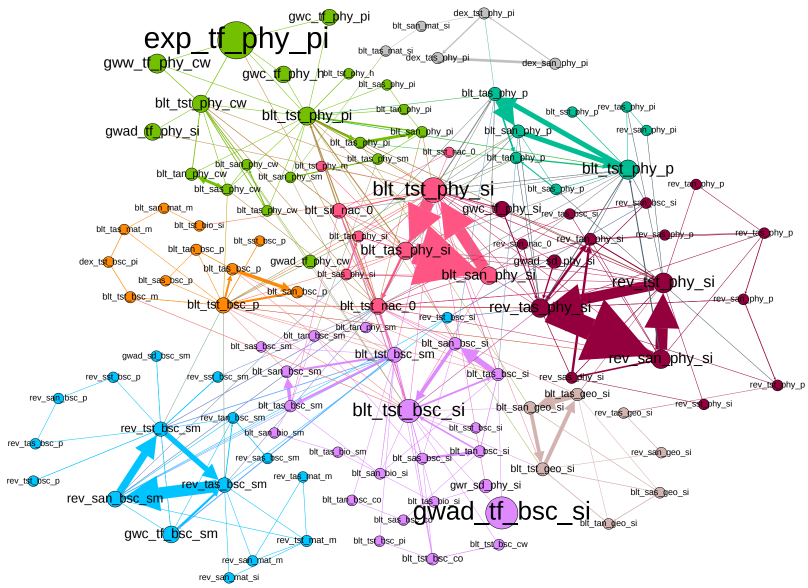


Figure 31: Activity map over 10 modules of Teacher E's BSC implementation in Class 4. The node size was determined from the nodes' weighted degree.

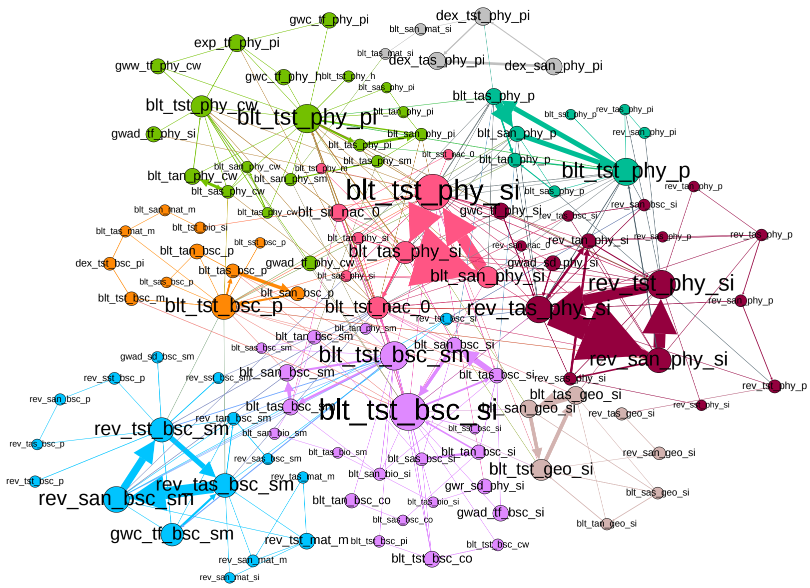


Figure 32: Activity map over 10 modules of Teacher E's BSC implementation in Class 4. The node size was determined from the nodes' PageRank.

munity in the right side of Figure 31 is focused on reviewing what is learned about the identity of physics. Both communities have a large dialogue triangle where the teacher asks the questions. The blue-green community deals with putting physics into perspective. Again we see a very clear dialog triangle. The gray community in the top of Figure 31 also have a dialogue triangle which is about demonstration experiments in physics. The green community is also related to physics. Here the focus is on practical work and written communication. This could indicate that the focus is on how to present practical work in writing e.g scientific reports and journals.

The remaining three communities are located in the lower left side of Figure 31. The orange community is about putting general science into perspective. The blue community is primarily focused on reviewing the methods used in general science. Again a very characteristic dialogue triangle is observed. In the right side of the blue community we also find four nodes relating to mathematics and the learning aim models. This could indicate that mathematical models have a connection to the method of science taught in this implementation. The purple community is primarily characterized by the subject general science ("bsc") with blackboard teaching as a primary activity. In this community we find several dialogue triangles.

By comparing the node sizes between Figure 31 and Figure 32, we find once more that teacher-led activities have great importance. The largest nodes in the PageRank activity map (Figure 32) have the code "tst". Like with Teacher D the "tst" nodes is in this activity map, see Figure 32, often constitute one corner of a dialogue triangle. As with Teacher D this could indicate that the classroom dialogue is quite important for this specific BSC implementation. It might also tells us something about Teacher E's teaching style which seems to be based on getting the students to participate in a classroom dialogue. The large nodes about experiments and group work now have the same size as most of the other nodes in the activity map. This indicates that even though a lot of time is spent on these activity, the relative PageRank importance of these experiments is small. This tendency was also seen in Teacher C's BSC Implementation in class 3.

6.6 TEACHER F IN CLASS 5

Teacher F's activity maps, from the BSC implementation in class 5, are divided into seven communities. These can be divided into the three themes individual science disciplines, in this case physics, general science represented with the code "bsc" and mixed where both the code "phy" and "bsc" is present. By looking at the activity map in Figure 33, one will find that the two largest nodes have the codes "exp_tf_phy_pi" and "gwc_tf_phy_si, indicating at a lot of time is spent on doing physics experiments and calculating physics assignment in student groups. In both activities the teacher has worked as a learnings facilitator, Teacher E has probably walk around helping the student groups during the experiments when help was need. The third largest node has the code "test_sil_phy_si", so a lot of time is also spent on students performing a test about the identity of physics. There is a couple of dialogue triangles, the most common dialogue is found in the blue community see Figure 33.

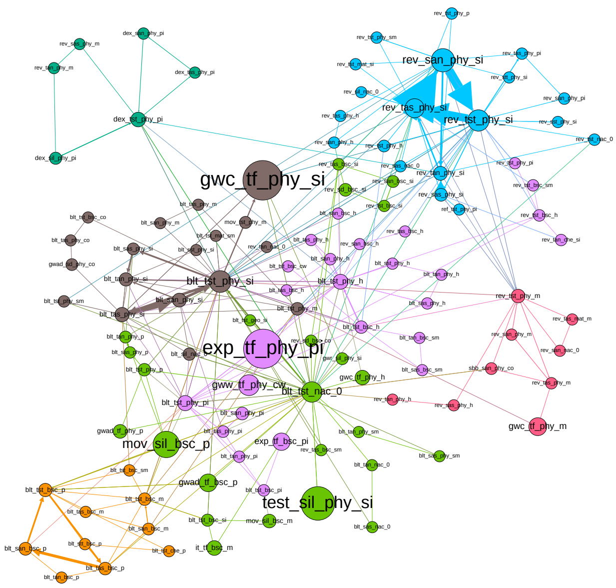


Figure 33: Activity map over 8 modules of Teacher F's BSC implementation in Class 5. The node size was determined from the nodes' weighted degree.

If we take a look at the communities focusing on physics, we have four communities. The large black one which is about the identity of physics indicating that a lot of times was spent on Teacher F lecturing or the student groups calculating different assignments relating to the identity of physics, see Figure 33. In this community one also finds two dialogue triangles; one where the teacher asks the questions ("tas") and one where the students ask the questions ("sas"). The blue-green community is besides the subject physics characterized by doing demonstration experiments and the learning aims practical work and models. The blue community is about reviewing the identity of physics which was taught in the black community. In the center of the blue community, one finds the most common classroom dialogue for this specific activity map see Figure 33. The little pink community also relates to reviewing physics but here the learning aims are hypotheses and models.

In Teacher F's activity map only one community is focused completely on general science. This is the orange community, see Fig-

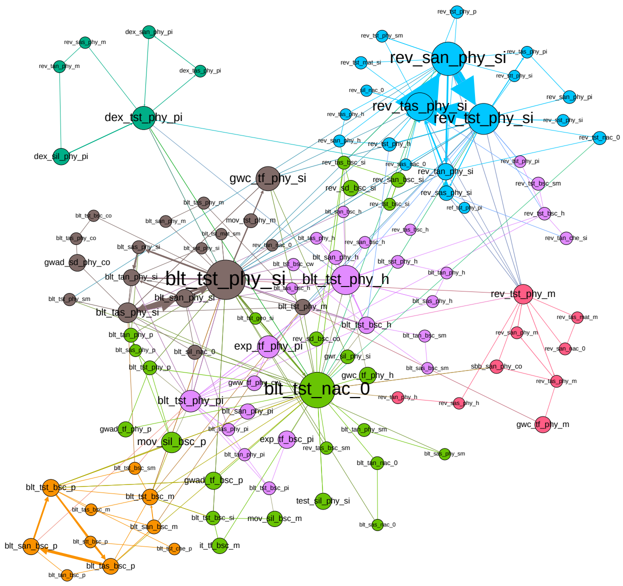


Figure 34: Activity map over 8 modules of Teacher F's BSC implementation in Class 5. The node size was determined from the nodes' PageRank.

ure 33. This community focus on both thing put general science into perspective and the models used in science. The green and purple communities are both a mix between physics and general science but with a predominance of physics nodes. The purple community is focused on the learning aims Practical work, hypotheses and scientific method. In the green community, the "bsc" nodes relate to the identity of general science in a reviewing perspective. The physics nodes focus on perspectives and the identity of physics.

By comparing the node sizes between Figure 33 and Figure 34, we find once more that teacher-led activities have a great importance. The largest nodes in the PageRank activity map (Figure 34) have the code "tst". Unlike Teacher D's and Teacher E's activity maps, the "tst" nodes in this activity map, rarely constitute a corner of dialogue triangle. This happens in the blue, black and orange communities and to a smaller degree of magnitude than in Teacher D's and Teacher E's activity maps. One also notice that in this specific BSC implementation, it is the identity of physics which has the most importance. This means that the nodes indicating experiments and practical work have become smaller in Figure 34 compared to Figure 33.

6.7 GENERAL COMMENTS TO ACTIVITY MAPS OF THE IMPLEMENTED CURRICULUM

By letting activity maps form an overall description of the implementations of the BSC program, some tendencies can be found. In the activity maps illustrating the weighted degree, a tendency for all six activity maps is that a lot of time was spent on experiments which supports the learning aim practical work. Nonetheless, this type of activity (experiments) has relative low importance in the PageRank of activity maps. The PageRank of activity maps have a tendency to show a high importance for teacher-led activities in the BSC implementations. Besides from general teacher-led activities there is one specific teacher-led activity which gained high importance in all six activity maps. This activity is the classroom management which node has the code "blt_tst_nac_0". This might have something to do with the fact that the BSC program being a part of the introductory program at the Danish upper secondary school Stx. Therefore most things are new to the students. Hence, the teacher must spent time and resources on telling about the rules, regulations and expectations as well as how to behave in the USS. From my observation protocols, I can see that such a session takes place in the beginning of almost every module before the actual teaching starts. Due to this, classroom management gained a high importance.

If we consider the activity maps separately, it is noted how all communities in the different activity maps can be classified by the subject present in the community. A community can either focus on an individual science discipline, general science (the code "bsc") or a mixed subject community. The activity maps from Teacher E's BSC implementation in class 4 and Teacher C's BSC implementation in class 2 only consist of two community types; the individual science disciplines and general science. In the rest of the BSC implementations, Teacher A, Teacher C in class 3 and Teacher D all have one mixed subject community. Teacher F has two mixed subject communities. This indicates that within these mixed-communities the degree of interdisciplinarity is higher compared to the rest of the communities.

In the activity map of Teacher D and Teacher E, a heavy dialogue structure appears in terms of dialogue triangles where the links are significantly thicker compared to the rest of the links. These dialogue triangles can be found in all the six activity maps. However, some triangles are more apparent than others. This indicates a specific teaching style, where the classroom dialogue is in focus. This teaching style couls be characterized as dialogue-based teaching [Dysthe, 1995].

6.8 THE INTERDISCIPLINARITY IN THE DIFFERENT BSC IMPLEMENTATIONS

In this section, the network properties modularity and PageRank of the subject codes will be presented. This will allow an interpretation of the interdisciplinary in the six teachers' part of the BSC implementations. These interpretations will be compared with the teacher's statements from the interviews conducted prior and post to the implementations.

In Table 18 is the modularity results from the six activity maps presented. The calculations have been made in the program 'R'[R Development Core Team, 2008]. One should notice that the modularity score for all the six activity maps is greater than $\mathbf{Q} > 0.3$. This indicates that the activity maps have a tendency to be divided into communities, see Section 2.3.2.

TEACHER	MODULARITY	Z-SCORE
Teacher A, class 1	0.62	5.16
Teacher C, class 2	0.53	4.17
Teacher C, class 3	0.40	9.81
Teacher D, class 3	0.60	4.24
Teacher E, class 4	0.69	6.15
Teacher F, class 5	0.55	4.66

Table 18: The modularity calculated for each teacher's corresponding activity map and the corresponding Z-score

Table 18 also presents a z-score for the modularity calculations. The Z-score expresses the deviations from random networks of the same size. Thus, this score can tell if the modularities are significant or not. The z-score is a statistical measurement given as:

$$Z = \frac{(Q - Q_t)}{\sigma_t} \qquad (10)$$

If #L is the total number of links in the network, then Q_t is the mean of the modularities from 100 simulations of the network where the links have been randomly redistributed 100×#L times. Each redistribution maintains all the nodes' degree. Hence 100 random networks are generated with the same degree distribution as the original network. Q is the modularity of the original network and σ_t is the standard deviation of the modularities from the 100 generated networks. The Z-score indicates the deviation of the modulation calculations from the mean of 100 random networks modularities - expressed per standard deviation of the 100 randomly generated network. In general if $Z > 1.96$, the modularity of the original network is accepted as different from the modularity of a random generated network at a 5% significance level [Spigel and Stephens, 2008]. Since all the modularities in Table 18 are larger than 0.3 ($\mathbf{Q} > 0.3$) and all the Z-scores ($z >> 1.96$) are significant, all the activity maps can be considered as being clearly divided into communities. The code which was used to get the Z-scores can be found in Appendix I.

The six activity maps in this chapter each represents one teacher's implementation of a specific BSC implementation. When a activity map is divided into communities, it can be interpreted as if the teaching by the six teachers in the five BSC implementations, also is divided into communities. This interpretation is consistent with my observations of the six teachers' part of the BSC implementations. Here the teaching did not always change between individual science disciplines and general science in terms of BSC. This even fits for some of Teacher A's implementation where the innovation part of the BSC implementation has very little connection to the other communities of the activity map, see Figure 23. Thus, the high modularity might tell us that the reflections made within the individual science disciplines rarely are coupled to the BSC specific topic of the implementation. This indicates that the degree of interdisciplinarity in the BSC implementations is at the lower end of the spectrum such as pluridisciplinarity where the individual science disciplines work in parallel with the same overall theme.

The PageRank is calculated for each subject within each teacher's implementation of the BSC. The results are presented in Table 19. Here the different subjects are placed in the first column. The subject codes are equivalent to the codes found in Table 12 where the code "bsc" represents general science, phy = physics etc. In the first row, the teacher and class are written as an abbreviation. Hence TAC1 stands for Teacher A Class 1 etc.

Table 19 shows that in each implementation there are two clear top scores when is comes to PageRank. These two top scores are divided between individual science disciplines and general science represented with the code "bsc". In four of the BSC implementations it was an individual science discipline which gained the highest importance in the implementation. In all four cases it was the teacher's own discipline, the specific discipline which the teacher should incorporate in the BSC implementation, which had the highest importance. In these four implementations, the general science part of the implementation had the second highest importance. In the remaining two BSC implementations, the subject with highest importance is

SUBJECTS	TAC1	TCC2	TCC3	TDC3	TEC4	TFC5
bsc	0.678	0.341	0.587	0.390	0.361	0.203
phy	0.040	0.547	0.259	0.035	0.491	0.692
che	–	–	–	–	–	0.005
bio	–	0.019	0.055	0.503	0.019	–
geo	0.003	–	–	–	0.065	0.004
mat	0.027	0.005	0.003	–	0.029	0.008
inn	0.132	–	–	–	–	–
nac	0.121	0.088	0.095	0.072	0.035	0.088

Table 19: PageRank scores of the different subjects in the different implementations of BSC

general science and on second place comes the individual science discipline. No teacher manages to combine all of the four natural science disciplines; physics, biology, chemistry and natural geography. From Table 19 one can also see that the subject mathematics is present in all five classes. The presence of math is not surprising since the BSC curriculum [UVM, 2013b] requires a collaboration with mathematics. However, the degree of importance paid to math shows a large variation across the implementations. Only in the implementations by Teacher A and Teacher E the PageRank is larger than 0.01.

In Teacher A's BSC implementation the PageRank score is 0.678 which is the highest PageRank for the subject code "BSC". This indicates that this is the most important subject in Teacher A's implementation, and since the focus is on general science the degree of interdisciplinarity also becomes higher. This is how Teacher A describes the specific BSC implementation in the post interview:

> [...](BSC) suggests that one can explore and one can play a little, and you (as a teacher) are not bound by the students to have a specific syllabus. It is also in the BSC, where there are two teachers(to cover at course), where we (teachers) can make some collaboration on a higher level than usual. It (BSC) is important because it is placed at the beginning and therefore important for the students' relation to the subject of science. (*Teacher A*, my translation. Original citation can be found in Section A.5)

Teacher A is very aware of the collaboration between the two teachers of the implementation. Another characteristic of Teacher A's interview is that Teacher A only refers to natural science with the general term science. Individual science disciplines are only mentioned two times in the whole interview with Teacher A (the discipline of physics). As shown in the quote above, Teacher A focuses on the student learning science in a broad perspective. This is also shown in Table 19 where the importance of individual science disciplines are minimal. This supports the indication of a high degree of interdisciplinarity. The other subject which gained a lot of importance in Teacher A's implementation is the subject innovation. This subject has not been investigated further as it is beyond the scope of this investigation. From what I observed, the innovation part of this BSC implementation was used to encourage the students' idea generation skills and team building skills.

I have observed two implementations with Teacher C; one in class 2 and one in class 3. In class 2, the subject Physics gained most importance with a PageRank of 0.547, and the general science part has a PageRank of 0.341. These two PageRank scores are much higher than the other PageRanks. In Teacher C's BSC implementation in class 3, the order of the PageRank scores has switched so that general science had a larger importance than the physics discipline. Here the PageRank of the BSC is 0.587 and the PageRank of physics is 0.259. Teacher C mentions in the interview that there was a difference between the two BSC implementations.

> In the first implementation (class 2), I think that there have been 2/3 physics theory, or 2/3 physics vocabulary introduced and 1/3 scientific method concepts. Where I thought that the minimum was mirrored in the second implementation (class 3), we (teachers and students in class 3) did not spend much time on the physical concepts in the second implementation. And I found that many of the BSC concepts were allowed to stand out. (*Teacher C*, my translation. Original citation can be found in Section A.5)

Teacher C's quote supports the PageRank scores very well, as the size of the "phy" score is twice that of the "bsc" score in class 2 which is reversed in class 3. This is an indication that the teachers are very aware of which subjects they are teaching, and whether the implementation is interdisciplinary or primarily characterized by one subject in this case physics. Teacher C then continues to talk about the different teacher constellations in the two implementations:

> What worked and what did not work is also about the constellation (teacher constellations) and some of it is about the class.(*Teacher C*, my translation. Original citation can be found in Section A.5)

Teacher C argues through the interview that it is the teachers' willingness to work together as a team which determines the degree coordination and collaboration in the implementation. In effect, these determine the interdisciplinary in the implementation. From Teacher C's PageRank score in the two implementations, one can argue that the degree of interdisciplinarity is higher in the implementation with class 3 than with class 2. From Table 19 one also sees that the importance of biology, which was the second subject of both class 2 and 3 BSC implementations, is higher in the implementation with class 3 than with class 2. This also indicates that there is more coordination and collaboration in the implementation with class 3 than with class 2.

Teacher D has a pretty high PageRank score in Biology of 0.503 and a general science PageRank of 0.390. This indicates that there is a clear focus on presenting the subject biology. Nonetheless at the same time the general science also has a high importance. Teacher D actually has the third highest importance in general science ("bsc") if the PageRank scores in Table 19 are compared across the BSC implementations. When Teacher D was asked to the interdisciplinarity of the implementation in class 3, the quick answer was: *I think that it (the interdisciplinarity of the implementation) is very good. (Teacher D*, my translation. Original citation can be found in Section A.5). This indicates an overall satisfaction with how the implementation in class 3 was executed. However, at the same time, Teacher D continues to reference what the students have learned about biology in the BSC implementation which makes it faster to go through these specific topics in the actual biology teaching.

> As an example, I can see that I can teach the subject about digestion rather quickly in this class (class 3) because I can build on the experiments we have already made.(*Teacher D*, my translation, original citation can be found in Section A.5)

Here Teacher D is completely aware that the students have been presented with a biology specific topic in the BSC implementation. Here, the BSC implementation is also used as an introduction to the individual science disciplines.

When one looks at Teacher E's PageRank scores, the physics score is the highest with 0.491 followed by the general science score of 0.361. Again the individual science discipline gained the most importance in this implementation. In this BSC implementation, Teacher E was supposed to teach the class 4 in the physics and natural geographic (code "geo") part of the BSC implementation. From the PageRank in Table 19 and the activity map in Figure 31, the primary focus seems to have been on the physics subject and not on the subject of natural geography. This might have something to do with the fact that Teacher E is educated in physics and mathematics and not in natural geography. Thus, Teacher E does not have a formal academic competence to teach in natural geography. Another thing to notice when one looks at Teacher E's PageRank scores is the importance of classroom management. The mean of the PageRank for classroom management (code "nac") across the six activity maps is 0.083. Teacher E's classroom management PageRank score is 0.035 and lower than the other teachers' classroom management score. This could indicate two things; 1) the class follows what is said by the teacher the first time. Hence, the teacher does not have to spent so much time on classroom management. Or 2) the teacher only says the rules and regulations one time and is not aware or does not want to comment on whether the students do other things than follow what is taught. By looking at my observation notes, it tends to be that Teacher E only does classroom management in the beginning of a module and for the rest of the module is not aware whether the students follow what is said or done.

When Teacher E was asked about the interdisciplinarity of the BSC implementation following was said:

> Time does that the implementation becomes a parallel course, I would think. There is no common plan. [...] But the pieces fit together (for the main topic of the implementation), I know that. (*Teacher E*, my translation. Original citation can be found in Section A.5)

This quote together with the PageRank scores indicate that this specific BSC implementation can be characterized as having a low degree of interdisciplinarity. It is most likely characterized as pluridisciplinarity where the individual science disciplines work in parallel with the same overall theme.

Teacher F has the highest PageRank score in an individual science discipline; the physics discipline with a PageRank score of 0.692. It is also here that we find the lowest general science score of 0.203. Teacher F is aware of the fact that the degree of interdisciplinarity in the specific BSC implementation is low:

> I do not that think the different disciplines play together because it was not something we've planned together. [...] So it did not work together as an integrated implementation (the BSC). Instead it was 4 parallel disciplines that looked at the same topic with different eyes. (*Teacher F*, my translation. Original citation can be found in Section A.5)

As with Teacher E, the BSC implementation in class 5 performed by Teacher F had a clear pluridisciplinary characteristics as the individual science disciplines worked in parallel with the same overall theme.

6.9 THE LEARNING AIMS IN THE DIFFERENT BSC IMPLEMENTATIONS

In this section, the result of the network property PageRank in relation to the code category learning aims will be presented. This will allow for an investigation of which learning aims are taught in the six teachers' part of the BSC implementations.

The PageRank was calculated for each learning aim within each teachers' implementation of BSC. The results are presented in Table 20. Here the learning aims are placed in the first column. The learning aim codes are equivalent to the codes found in Table 13 where the code "h" stands for hypotheses , pi = practical work etc. In the first row the teacher and class are written as an abbreviation. Hence TAC1 stand for Teacher A Class 1 etc.

LEARNING AIMS	TAC1	TCC2	TCC3	TDC3	TEC4	TFC5
h	0.061	0.078	0.015	0.010	0.004	0.117
pi	0.146	0.300	0.151	0.191	0.099	0.116
m	0.160	0.040	0.195	0.009	0.028	0.089
co	0.105	0.028	0.025	0.029	0.012	0.019
cw	0.063	0.049	0.040	0.081	0.052	0.006
p	0.031	0.029	0.060	0.060	0.139	0.105
si	0.160	0.335	0.229	0.383	0.431	0.429
sm	0.068	0.057	0.19	0.165	0.200	0.032
o	0.210	0.088	0.095	0.072	0.035	0.088

Table 20: PageRank scores of the different Learning aims in the different Implementation of BSC

Table 20 shows that the science identity ("si") gained most importance of all the learning aims in five out of six activity maps. In Teacher A's BSC implementation, the most important learning aim is a tie between the science identity and models with a PageRank score of 0.160[1]. If one thinks back at the results of the intended curriculum, one might recall that the largest node in Figure 21 was the node called *Importance of science in a Bildung perspective and the BSC*. This node also contained "the identity of science". Therefore, it is not surprising that the learning aim "science identity" gained this high importance. The

1 The learning aim called "o" appears when non academic content, i.e. classroom management, is present in the label. Therefore this represents that there is no learning aim. The reason why Teacher A's "o" code appears important (0.210) is due to the fact the most of the innovation teaching covered none of learning aims, since it was mostly team-building exercises

practical work (pi) also receives a relatively high PageRank score in all of the six teachers' implementations. From the activity maps we also saw that a lot of time was spend on practical work.

From the comparison of the thematic maps of the 2010 intended curriculum in Figure 21 with the learning aims from the BSC curriculum [UVM, 2010], one might remember that all learning aims could be found within the thematic map of the curriculum plans. By looking at the thematic map in Figure 21, one would expect that the remaining learning aims (besides "si" and "pi") would have roughly the same importance. This is not what Table 20 shows. It is very different which learning aims gain more of lesser importance across the implementations. Some implementation show a focus on perspectives, others on the scientific methods and a third focus is on models. In general it can be said that all six teachers' part of the implementations are able to incorporate all of the eight learning aims. However, the learning aims are not evenly distributed. Often two to four learning aims get relative high importance and the rest of the learning aims have very low importance.

When the teachers were asked about which learning aims their specific BSC implementation had focused on, they generally said that the implementation focused on motivating the students and that students should receive some curiosity about science and the science disciplines.

> [...] The BSC is about creating curiosity and interest in natural science. (*Teacher E*, my translation. Original citation can be found in Section A.5)

Besides from this argument, all the teachers mention that the students should get an idea of how science works.

> They (the students) should have an idea of how people work within natural science, and they (students) must also try it out by doing experiments, etc. (*Teacher D* my translation. Original citation can be found in Section A.5)

As with the quote above, the importance of experiments and practical work was mentioned in all interviews. The way natural science works relates to the identity of science, and the experiments relates to the practical work. Thus, the teachers are aware of which learning aims they prioritize.

Table 20 shows that Teacher A in the BSC implementation of class 1 and Teacher C in class 3 both have the learning aim "Models" as the highest score for the implementations. These two PageRank scores are lot higher compared to the other implementations' scores "Models". From the interdisciplinary point of view, Teacher A BSC implementation have a higher degree of interdisciplinarity compared to the other implementations. This Teacher A's implementation could be an example of Jantsch's [1972] interdisciplinarity category, in which the discipline are subjected to a higher common level. In Teacher A's implementation the particular science disciplines would only be addressed if the students require them for their projects. The rest of the implementations would according to Jantsch [1972] be characterized as being of pluridisciplinary character. An observation could be that a focus on the learning aim "Models" can help to facilitate a high degree of interdisciplinarity between different individual science disciplines. However, claim calls for further investigations.

7 THE REALIZED CURRICULUM - RESULTS AND INTERPRETATION

In this chapter the results of the two exam situations of the BSC are presented. This has been a proof of concept study in order to test if it is possible to analyze exam situations with the method of network analysis described in Section 4.6. The aim with this part of the investigation was to study how the interdisciplinarity was expressed in an exam situation of a specific BSC program. The exam situation is one way to test what the student has learned during the BSC implementation. In this study the exam situations represent the realized curriculum.

As mentioned in Section 4.5, I have observed exam situations in two of the five classes. The BSC curriculum plan [UVM, 2013b] does not define the exam situation in specific terms except for these two requirements; the student's should deliver a written product and based on this product an academic conversion is to be held of minimum 10 minutes duration. Therefore the exam situation can vary between different Stx. This was also the case with the five BSC implementations which I observed. Each of the five BSC implementations had their own way of doing the exam situation. Some varied more than others. The observed exam situations were from the BSC implementations by Teacher C in class 2 and Teacher E in class 4. In class 2 the exam was held as a group exam, and in class 4 the exam was held as an individual exam. As this was a proof of concept study, I decided in dialogue with my supervisor to exclude the group exams as this type of data probably will be more suited for a bipartite network analysis like in the master thesis of [Overgaard, 2015]. Then 14 student exam situations were left of which all the 14 students were from Teacher E's BSC implementation. These individual exams can be analyzed using the method presented in Section 4.6. For this proof of concept study two exam situations were selected; one with a student gaining a high grade (Student 1) and one with a student gaining a low grade (Student 2).

In the next sections, I will present the two student's individual dialogue maps. Then a presentation of the scores calculated from the dialogue maps; the modularity and the PageRank, of the different subjects, are used to characterize the interdisciplinarity in the exam situations. The PageRank of the learning aims will also presented in order to see which learnings aims were targeted and tested in the exam. Finally, some general comments are given on the realized curriculum and the dialogue aspects of the exam situation in relation to what was observed during the exam.

As with the teachers' networks from Chapter 6, there are two dialogue maps for each student. In the first dialogue map the node size is determined by the weighted degree of the node. The weighted degree is the sum of all the connections going in and out of the node. The weighted degree of the node translates into the amount of time spent on the each node. Hence, a large node indicates that a lot of time was used on that node. In the second dialogue map the node size is determined by the PageRank of the node. The PageRank indicates the specific node's level of involvement and relative importance in relation to the other nodes of the dialogue map. It is important to mention that in the appearance of dialogue maps, the size of an individual node cannot be compared across the different students. This is due to the fact that the dialogue maps are constructed independently of each other. Node sizes can therefore *only* be directly compared within the same dialogue map. The dialogue maps presented in this chapter are visualized with the program Gephi. Again all self-loops are removed in order to get Gephi to visualize the dialogue map in a proper manner. The procedure of describing the dialogue maps will be the same as in Chapter 6. First some general remarks and community descriptions and then a comparison between the two types of dialogue maps are given.

7.1 STUDENT 1'S EXAM FROM CLASS 4

It might be helpful to find Appendix G in order to recall what the different codes in each label stand for. This will hopefully be helpful in order to interpret the dialogue maps. The full sized dialogue maps can be found in Appendix K

The dialogue maps of student 1's exam situation can be found in Figure 35 and Figure 36. The dialogue maps can be divided into five different communities each represented with a specific color. By looking at the dialogue map in Figure 35, one will find that largest node is within the dark green community. The label of the node indicates that the teacher is quiet and the student is talking about the identity of science in lower order statements (nT_noTd_noTs_noTla_S_SLoS_Sbsc_Ssi). Lower order statements refers to the lower-levels of the revised Blooms taxonomy [Krathwohl, 2002]. In this study the lower-levels is associated with remembering and understanding. A higher-level taxonomy is associated with application, analysis, evaluation and creation. The second largest node is found in within the center of the purple community. This node indicates that the student gives lower order answers about the identity of science while the teacher is quiet. Therefore a lot of time is spent on the student talking and answering questions about the identity of science

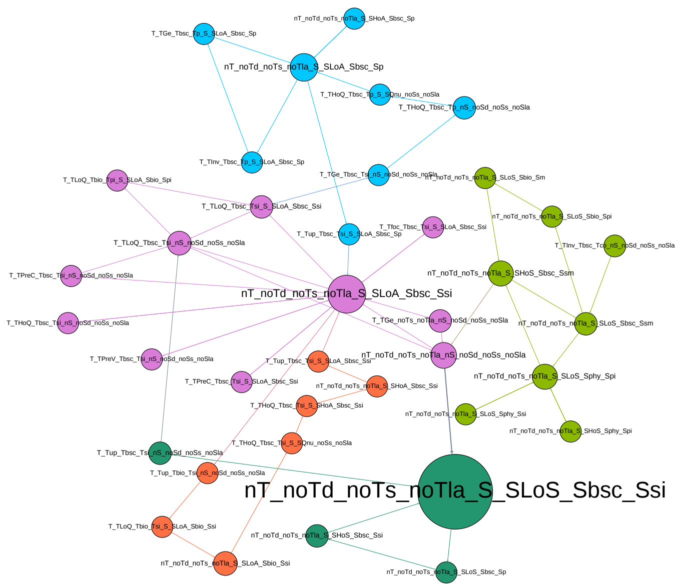


Figure 35: Dialogue map of Student 1's exam in BSC. The student is from class 4 and has experienced the BSC implementation of Teacher E. The node size was determined from the nodes' weighted degree. The exam duration time was 9 minutes 45 seconds

Figure 36: Dialogue map of Student 1's exam in BSC, the student is from class 4 and has experienced the BSC implementation of Teacher E. The node size was determined from the nodes' PageRank.

The two green communities are both characterized by the student making statements Figure 35. From the observations, I know that the first five minutes of the exam were a student presentation. These five minutes of student presentation has been divided into the two green communities. The light green community can be characterized as a mixed community where the lower part of the community is about physics (the three lower nodes), the upper part is about biology (the nodes highest up) and the middle part of the community is about general science ("bsc") and in particular about scientific method. This indicates that the student used the general method of science as a way to combine the two individual science disciplines biology and physics. The dark green community is mostly about the general identity of science but there is also a node including perspectives of general science. The dark green node which is placed far away from the three other nodes marks the teachers' uptake after the student presentation and indicates the beginning of the exam dialogue.

The three other communities are characterized as a dialogue between the student and the teachers. The blue community in Figure 35 is characterized as a dialogue about putting general science into perspective. The red community is defined as a dialogue about the identity of biology and general science. In the purple community, the dialogue focuses on the general science identity as well. The difference between the science identity in the red and purple communities is that the student answers all the questions in the purple community with a lower order answer. In the red community we have higher order answers or a higher order answer followed by a lower order answer.

By comparing the node size between Figure 35 and Figure 36 one finds that the node size of the big dark green node[1] stays the same size. This indicates that a lot of time was spent on this node but at the same time this activity is relative important. In Figure 36 there ares now three large nodes if we compare with Figure 35. The central purple node, which was also characterized as a large node in Figure 35, is now the same size as the large dark green node. This shows that the student answers about the scientific identity have gained a high importance. The central blue node, which shows the student answers about the perspective of general science, has also grown into a relatively important node. As this is an exam situation evaluated with a high grade it is expected that the student's answers and statements (in this case the student presentation) have a high importance in relation to the outcome of the exam. This importance is also found in the dialogue map.

1 with the code nT_noTd_noTs_noTla_S_SLoS_Sbsc_Ssi

7.2 student 2's exam from class 4

Figure 37 and Figure 38 show student 2's exam situation. As with student 1, these dialogue maps are divided into five communities represented by different colors. By looking at Figure 37, one will find that there are two large purple nodes and one relative large dark green node. The largest node in the purple community is the same as the largest node in student 1's dialogue map. In this node the student is talking about the identity of science in lower order statements[2]. Again this supports what was observed at the exam. The student first makes a five minutes presentation followed by a dialogue between student and teachers.

The other large node in the purple community illustrates silence. Neither student nor teacher say anything. The third largest node is dark green and is also related to the student presentation. Here the student talks about the scientific method in relation to general science while the teachers are quiet. From Figure 37 one can see that the most time spent on a specific activity is the student presentation. Nonetheless silence is also a large part of this exam.

Like with student 1, the five communities are divided into the two groups; student presenting and student-teacher dialogue. In the red and dark green community it is the student who talks. In the red community the focus is on physics in relation to different learning aims. The dark green community is mixed between individual science disciplines and general science meaning that two nodes relate to general science ("bsc"), two node relate to biology and one node relates to physics. The learning aims are focused on practical work and scientific methods. The constellation of nodes and links in the dark green community indicates that the student combines the knowledge about general science with the practical work relation to the individual science disciplines biology and physics.

The three other communities all have focus on dialogue between the student and the teacher, see Figure 37. The blue community is characterized as a dialogue about the identity of biology. In the dialogue in the light green community, the focus is on the practical work of physics. The purple community is a little bit different from the other dialogue communities as it also contains the large purple node where the student talks about the identity of general science. A node which is a part of the student's five minutes presentation. One reason why this node is closer connected to the purple community than to the other student presentation communities could be that this node has a strong connection to the silence node. The silence

2 The complete code on the node is nT_noTd_noTs_noTla_S_SLoS_Sbsc_Ssi

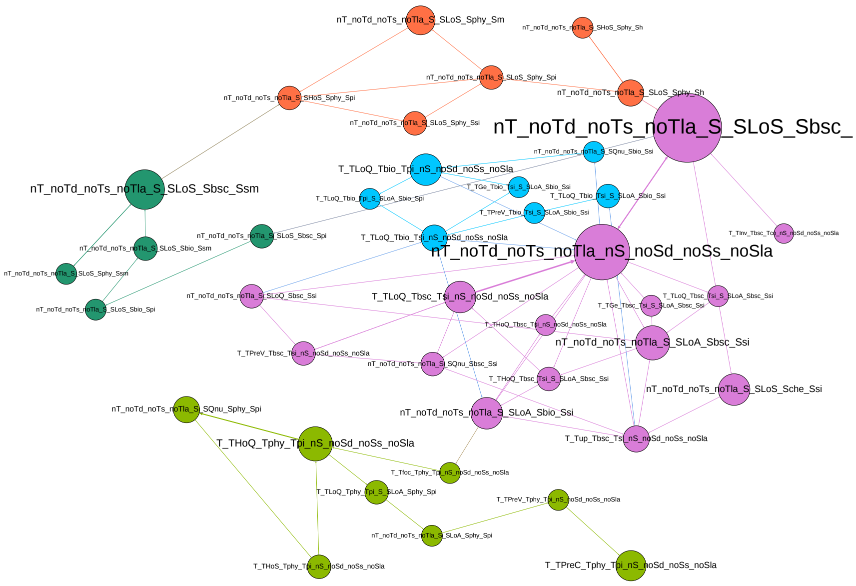


Figure 37: Dialogue map of Student 2's exam in BSC. The student is from class 4 and has experienced the BSC implementation of Teacher E. The node size was determined from the nodes' weighted degree. The exam duration time was 10 minutes 50 seconds. The complete code on the large purple node in the upper right side of the figure is nT_noTd_noTs_noTla_S_SLoS_Sbsc_Ssi

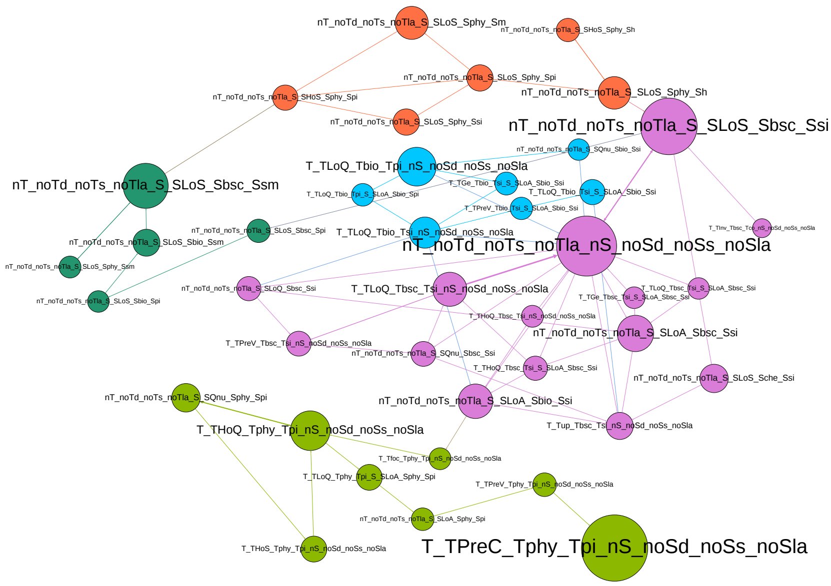


Figure 38: Dialogue map of Student 2's exam in BSC. The student is from class 4 and has experienced the BSC implementation of Teacher E. The node size was determined from the nodes' PageRank.

node has many connections and most of the connections has a relation to teacher questions and student answers. Due to the connection between the silence node and the presentation, the large presentation node about the science identity becomes purple. The rest of the purple community is characterized as a dialogue with focus on the identity of general science.

If one compares the node sizes between Figure 37 and Figure 38, one finds that the largest purple node, where the student talk about the identity of science, is a little bit smaller. In Figure 38 it is not the largest node. The largest node is now the silence node, which indicates that the silence is a relatively important factor in this dialogue map. The large node in the dark green community has become a little bit larger. So overall, the student presentation is still a very important factor in this exam situation. Another thing to notice is that the light green node, where the teacher corrects the student[3], has gained relatively high importance compared to the amount of time spent on this activity. In general the dialogue map in Figure 38 shows that the teachers' questions have gained more importance compared to the time spent on them. Nodes representing the student answers stay the same size. As this is an exam situation, it is expected that the student answers and statements (in this case the student presentation) have a high importance. In relation to the outcome of the exam, the dialogue maps in Figure 37 and Figure 38 show that the student's presentation has a high importance. However, there is a lot of silence both in a time and PageRank importance perspective. The silence has many links going in and out, which add to the silence's importance in the exam situation. Besides from this, the exam situation is dominated by the importance of the teachers' question and the lack of importance in the student's answers. This may not be surprising as this was the exam where the student received a low grade.

7.3 THE EXAMS AND THE INTERDISCIPLINARITY IN BSC

As with the networks from the five BSC implementations, the modularity of the two exams' dialogue maps have been calculated in order to classified if the dialogue maps had a tendency to be divided into communities. It was the hope that the modularity could contribute to an understanding of the interdisciplinary in the exams' dialogue maps. I will return to that after the scores have been presented. In Chapter 6 the PageRank was calculated for each subject in the specific BSC implementation in order to see the importance of each subject. This has also been done for the two exams' dialogue maps in an attempt to study the interdisciplinarity of the exam situation. In this section these network properties will be presented and interpreted in relation to the interdisciplinarity of the exam situations.

3 the node with the code T_TPreC_Tphy_Tpi_nS_noSd_noSs_noSla

STUDENT IN CLASS 4	MODULARITY	Z-SCORE
Student 1	0.62	4.66
Student 2	0.52	2.44

Table 21: The modularity calculated for the two student exams of BSC and the corresponding Z-Score

In Table 21 the modularity results from the two exams' dialogue maps are presented in this chapter. The calculations have been made in the program 'R' [R Development Core Team, 2008] and the code which was used to get the Z-scores can be found in Appendix I. A thorough description of how the Z-scores are calculated can be found in Section 6.8. One should notice that the modularity scores for both dialogue maps are greater than $\mathbf{Q} > 0.3$, which indicates that the dialogue maps have a tendency to be divided into communities, see Section 2.3.2. As described in Chapter 6, if $Z > 1.96$ then the modularity of the original network is accepted as different from the modularity of a random generated network at a 5% significance level [Spigel and Stephens, 2008]. In Table 21, the two Z-scores are both larger than $z > 1.96$, Therefore the two dialogue maps may be considered as being divided into communities.

The different communities in the two exams' dialogue maps can be divided in to two types of communities: 1) a community where the student talks and where the teachers are quiet. This type of community represents the student presentation. 2) A community where there is a dialogue between the student and the teachers. This tendency is clear in the Dialogue maps. If one looks at the how the division of communities are in relation to the different subjects, the pictures becomes a little bit more blurry. I find that in relation to subjects, the communities can be split into three types of communities which are the same three types as were found for the implemented curriculum: 1) a community consisting of one individual science discipline, 2) a community consisting of general science (in this case the code "bsc") and 3) a mixed community where the general science and the individual disciplines are mixed. Student 1's dialogue map has two communities which fit the mixed community category and three communities that fit most with the general science community category. In contrast student 2 has three communities which have most in common with the individual science discipline communities and 1 community which fits a mixed community. The last community fits best to a general science community. However, in contrast to the activity maps for the implemented curriculum, the communities in the dialogue maps are less clearly divided into subjects. The question is when a community of e.g four nodes is characterized as mixed? Is it when one node is different from the three other nodes or is it when we have a half-half situation? It is therefore more difficult to divide the exam dialogue maps into subject communities.

If I compare these two ways to divide the communities in (dialogue/ non-dialogue division vs. subject division) with what was observed at the exam situation in general, I can say that there was a clear division between the student presentation and the student-teacher dialogue. It therefore makes good sense that this division can be seen in the dialogue map. Regarding the subject division, some students divided their presentation into subjects, first biology then physics etc. Other students mixed everything together hereby obtaining a higher degree of interdisciplinarity. The teachers often start by asking questions about the topic where the student ended the presentation. Hence, the teachers make an uptake. From there the dialogue continues in various ways. When the teachers ask a question, they have a tendency to stay within the same topic of the question, hereby also subject, until satisfied with the answer or no more information from the student could be extracted. This could indicate that there might be a division in subjects as well as in dialogue/non-dialogue. An assumption of a division by subjects could actually be a good assumption, as there are some communities within the two dialogical maps which have a clear connection to either a general science or individual science disciplines. The mixed communities are still hard to characterize. This division indicates a low degree of interdisciplinarity in student 2's exam situation as there is a primary focus on individual disciplines and a clear division between general science and individual science disciplines. Therefore Jantsch's [1972] category pluridisciplinarity seems to describe Student 2's exam situation most aptly. Student 1's exam can according to Jantsch [1972] be characterized as being of interdisciplinary character. Individual science disciplines only occur when the student seems to require them as way of concretize general science terms. Hence little time was spent on individual science disciplines. Nonetheless there is still a division into subjects and therefore the category interdisciplinary applies. However, more data samples (here exam situations) need to be analyzed to investigate the tendencies to division by subject and division by dialogue/non-dialogue as were found in these two dialogue maps.

The PageRank was calculated for each subject within the two BSC exams. The results are presented in Table 22. Here the different subjects are placed in the first column. The subject codes are equivalent to the codes found in Table 12, where the code "bsc" stands for general science, phy for physics etc.

SUBJECTS	STUDENT 1	STUDENT 2
bsc	0.548	0.213
phy	0.064	0.238
che	–	0.013
bio	0.084	0.139
geo	–	–
mat	–	–

Table 22: PageRank scores of the subjects in the two exam situations

Table 22 shows that the most important subject for student 1 is the general science with a PageRank of 0.548.T this is also consistent with which subject most time was spent, see Figure 35. From student 1's perspective, the individual science disciplines have relative low importance. Student 2's PageRank in relation to subjects are more evenly distributed. The subject physics has the highest score with 0.238, and the general science has the second highest PageRank score of 0.213. In addition the subject biology also has some importance with a PageRank score of 0.139. This shows that the individual science disciplines in total gained more importance than general science at student 2's exam. It is important to note that none of the students managed to combine all of the four natural science disciplines; physics, biology, chemistry and natural geography. However, student 2 managed to combine three subjects where student 1 combines two. From these PageRank scores it looks like the degree of interdisciplinarity was higher in student 1's exam compared with student 2 as student 1's primary focus is on general science.

If one compares the two students' PageRank scores for the general science subject ("bsc") with Teacher E's "bsc" PageRank score of 0.361, we find that Student 1's "bsc" score is higher while Student 2 "bsc" score is lower. This also indicates a relatively high degree of interdisciplinarity in Student 1's exam. It is even higher than the degree of interdisciplinarity in the taught BSC implementation by Teacher E. When Teacher E was asked, in the second around of interviews (after the exams) if the students understood that the BSC was interdisciplinary in nature, the answer was:

> I think that they really do. The wise of them (the students) could see it. I think they have different views of whether they thought it was fun. But I think that they could understand it. That it (the different disciplines) was connected. (*Teacher E*, my translation. Original citation can be found in Section A.6)

7.4 THE EXAMS AND THE LEARNING AIMS OF BSC

In this section, the PageRank results in relation to the learning aims will be presented in order to interpret on which learning aims that occur at the two BSC exams. The PageRank scores was calculated for each learning aim for both BSC exams. The results are presented in Table 23. Here the different learning aims are placed in the first column. The learning aim codes are equivalent to the codes found in Table 13, where the code "h" stands for hypotheses , pi stand for practical work etc.

LEARNING AIMS	STUDENT 1	STUDENT 2
h	–	0.054
pi	0.080	0.172
m	0.014	0.018
co	–	–
cw	–	–
p	0.156	–
si	0.402	0.290
sm	0.044	0.069

Table 23: PageRank scores of the different learning aims in the two exam situations

Table 23 shows that the most important learning aim is the science identity which is consistent with the most important learning aim in the BSC implementation performed by Teacher E. One may also notice that not all learning aims are being covered at the exam situation. The two communication learning aims are left blank intentionally. The Oral communication learning aim is of course tested during the whole exam as the student ought to be communicating orally about a scientific content while using the right terms. Therefore all labels should have had the code "co". However, this would add one extra code to the label and confuse the picture. Therefore the learning aim oral communication was fulfilled to a higher or lesser degree, depending on how the student participated in the exam dialogue and how the student performed in the presentation part of the exam. When is comes to the learning aim written communication one could argue that it might be hard to test written communication at an oral exam. For class 4 the written assignment, which the student should hand in prior to the exam, was a slide show with their presentation. Since I don't have access to these slide shows, I am unable to comment on the learning aim written communication. If one disregards the learning aim written communication and takes that learning aim oral communication is fulfilled, one find that the both students cover six out of the seven remaining learning aims. Student 1 is missing the learning aim hypotheses where student 2 is missing the learning aim perspectives on science. As with the BSC implementation, the importance of the learning aims at the exam for these students is not evenly distributed. In student 1's exam the identity of science and the perspective on science gained the most importance. In student 2's exam the identity of science and the practical work gained the most importance.

7.5 GENERAL COMMENTS TO THE REALIZED CURRICULUM

In this section, the PageRank results in relation to the code category of dialogical aspect will be presented in order to compare the two exam situations. Lastly some general observations from my field notes for all of the observed exams will be presented.

The PageRank scores was calculated for each dialogue aspect of the two BSC exams. The results are presented in Table 24. Here the different dialogue aspects are placed in the first column. The dialogue aspect codes are equivalent to the codes found in Table 16 and Table 17. The code "HoA" stands for higher order answer, LoA stands for lower order answer etc.

DIALOGUE ASPECT	STUDENT 1	STUDENT 2
Student talk	0.74	0.60
HoA	0.064	–
LoA	0.401	0.210
HoS	0.061	0.053
LoS	0.169	0.256
LoQ	–	0.022
Qnu	0.042	0.062

Table 24: PageRank scores of the dialogue aspects in the two exam situations

First of all, Table 24 shows that student 1 talks more than student 2. One sees that student 1's answers have gained more importance than the student's presentation. This is the opposite case with student 2. Here the presentation gained more importance than the student's answers. In both student presentations, the students have both higher and lower order statements. When one looks at the students' answers, we see that student 1 both answers in higher order and lower order answers while student 2 only has lower orders answers. The code "Qnu" stands for when the student explicit asks the teacher to repeat the question. This is an indication that the student is unsure or unable to answer the question. The PageRank score for this code is a little bit higher for student 2 compared with student 1. This indicates that this dialogue aspect had more importance in the exam of student 2 than student 1. If one looks at the dialogue map for student 1 in Figure 35, the code "Qnu" can be found at two different nodes where in student 2's dialogue map in Figure 37 the code can be found on three different node. This tells us that the student 2 have used this dialogical aspect in three different relation and therefore it gain more importance in student 2 dialog map compared with student 1. The fact that student 1 talks more and that the answers have gained more importance compared with student 2 is in support with student 1 receiving a higher grade than student 2.

From my field notes from all of the observed BSC exam situations (both group and individual), it can generally be said that the students did well. A tendency was that if the student presentation focused on the general science, the dialogue also focused on general science, and the teachers only asked few questions to the individual science disciplines. However, if the student presentation was focused on the individual science disciplines, the dialogue also had this focus. It was clear that the students had focused their presentation on the science disciplines which the two teachers usually taught in. Hence, the primary science disciplines presented at the exam by the students were physics and biology as the two teachers had their background in these. It was more rare that the students talk about chemistry or natural geography. There was also a tendency to the teacher asking more questions in their background disciplines than the other disciplines which they also were responsible for. For Teacher E that means that most of the questions were related to (besides for general science) physics and very very few had relation to natural geography. On average (based on the 14 student exams) the student received around five physics question pr exam and less than one natural geography question pr exam. In total nine questions were asked which had relation to natural geography. This indicates that all the four science disciplines, which constituted this specific BSC implementation, were not equally represented. Hereby the exam reflected the BSC implementation performed by Teacher E very well. The question is if this reflects the intentions of intended curriculum.

8 DISCUSSION

In this study, the interdisciplinarity in the Basic Science Course BSC has been analyzed in the each of the three curricula; the intended, the implemented and the realized curriculum. Each of the three curricula has been analyzed through the lens of network analysis. Three different types of network maps were obtained; one for each curriculum. This chapter is a discussion exploring the research questions asked in Section 2.5

- How is interdisciplinarity characterized, through the lens of thematic discourse network analysis, in the intended curriculum of the BSC?
- How is interdisciplinarity characterized, through the lens of activity maps, in the implemented curriculum of the BSC?
- How is interdisciplinarity characterized, through the lens of dialogical maps, in the realized curriculum of the BSC?
- How can the three types of network analysis be used to describe/discuss alignment between the three curricula ?

In the following sections, I will discuss the findings of this study in relation to the research questions.

8.1 THE INTERDISCIPLINARITY IN THE INTENDED CURRICULUM

In this study, thematic maps of three BSC curriculum documents were shown one from 2005, one from 2007 and one from 2010. From these three thematic maps, an alluvial diagram was created in order to visualize the changes in the BSC throughout time. The three thematic maps all showed 12 modules indicating 12 themes for each of the three curriculum documents. Most of the themes occurred in all of the three curriculum documents. However, there were some changes over time, see Figure 22. Two themes were merged in the 2007 thematic map for then being split again in the 2010 thematic map. A new theme emerged in the 2007 thematic map and was still to be found in the 2010 thematic map. Finally the two largest themes in the first two thematic maps merged into one theme in the 2010 thematic map.

As mentioned in Section 5.5, the main purpose of using thematic maps for the intended curriculum was to see if the interdisciplinary aspect of the BSC program had its own theme and if so to see how this theme was connected with the other themes. The only place with a direct link from the thematic maps to the interdisciplinary framework presented in Section 2.2, was in the theme called "Structural demands to the BSC". Within this module, the word "*Pluridisciplinarity*" is found. However, it only constitutes a minor part of the theme. If one looks at the "Structural demands for the BSC" theme in the alluvial diagram in Figure 22, one finds that the theme remains roughly the same through all the years. This indicates that the structural demands hereby also the demands to the interdisciplinarity stay the same. The thematic maps are therefore not convincing when it comes to mapping out how interdisciplinarity should be coordinated in the BSC.

Looking at the different themes obtained with the thematic discourse network analysis (TDNA), one finds that a least two of them have the term "science" as a part of their theme name. In addition, many of the themes have a clear connection to how science is practiced. This confirms that the main focus of this course was an introduction to natural science. One could then ask if the word "science" is an indication of interdisciplinarity, as no specific disciplines are mentioned? The assumption for this investigation was that interdisciplinarity in the BSC program was defined from a coordinating perspective in the curriculum plan, i.e. some structural demands. However, this assumption could be wrong. Jantch [1972] argues that the interdisciplinarity comes when cooperation and coordination between disciplines increase. The assumption for this investigation only builds on the coordination part. But what about the cooperation part? One might argue that the overall term natural science is the result of cooperation between all the individual science disciplines. Therefore the word interdisciplinarity is an incorporated part of the overall term natural science.

As mentioned in the the beginning of this section, the two largest themes "The identity of BSC" and "The importance of science in a Bildung perspective" were merged in the thematic map of 2010 BSC curriculum document. This was a consequence of how the BSC program was defined in the curriculum plan. In the years 2005 and 2007 the BSC program was defined as a course consisting of four different disciplines; Physics, Chemistry, Biology and Natural Geography. This changed in 2010 where the BSC program was now defined as a course consisting of natural science. Again this is an indication that the term natural science is interdisciplinary in itself. If this is the case then the thematic map showed a high degree of interdisciplinarity, as most of the theme have a clear relation to the general term natural science.

The thematic maps of the BSC curriculum documents are a new way of illustrating a curriculum plan in a more visual way. The thematic maps clearly show the different themes of the BSC program and how they are connected. Whether it is a good way to characterize the interdisciplinarity of the BSC program depends on whether the coordinating part or the cooperation between disciplines is viewed as the constituting factor for interdisciplinarity.

At some point the interpretation of interdisciplinarity regarding the BSC program is left to the readers of the curriculum plans in this context the teachers who are teaching a BSC implementation. If the teacher focuses on the coordinating demands of the interdisciplinarity, the thematic maps would probably not be very helpful as they only state that there are some structural demands which should be fulfilled. If the teacher sees science as a overall term where interdisciplinarity is an incorporated part, the map illustrates the many things which characterize the overall discipline of science. This could be practical work, an experimental approach to the world, hypotheses and the scientific method. The map then becomes a visualization of the different topics or areas where individual science disciplines can contribute to understanding the commonalities and differences within the disciplines of science in an interdisciplinary way.

8.2 THE INTERDISCIPLINARITY IN THE IMPLEMENTED CURRICULUM

From my classroom observations six different activity maps have been created one for each teacher's specific implementation of the BSC. From the activity maps the network properties modularity and PageRank of the different subjects were calculated in order to investigate the interdisciplinarity of the different implementations.

As mentioned earlier, the modularity indicates whether networks tend to be divided into communities. In the activity maps the nodes are represented by different teaching activities, these activities' relation to student-teacher interaction, the subject of interest and finally the learning aim which the activity supports. The modularity of the activity maps therefore tells if the activities of the BSC implementations have a tendency to be divided into communities. As all six teachers' activity maps have a modularity over 0.3 (see Table 18) they can all be characterized as divided into different communities. Furthermore, five out of six maps have a modularity over 0.5 indicating that the maps are highly divided into communities. This implies that the different teaching activities are not intertwined. This means that it is very rare that a teaching activity changes from being about Physics in one moment to then being about general science in the next. However, the teaching activities often vary between being blackboard teaching, group work, doing experiments etc. Therefore it was expected that these type of variations would be visible in the activity maps as different communities. In addition to this type of division, the communities also revealed a division in academic subjects. A community could either be classified as focusing on; an individual science discipline, general science or a mixed-subject community. The fact that all the communities within the activity map could be characterized by the academic subject shows that it is rare that a teaching activity switch between academic subjects. In the activity maps where a mixed-subject community appears, i.e. a switch between academic subjects, the mixed-community only occurs once except for Teacher F implementations where there were two mixed communities. Again this suggests that it is rare that such switch happen within a teaching activity.

If one looks at how the three academic subject types of communities were distributed in the six different teachers' activity maps the following table is obtained. Where ISD stands for individual science discipline, GS stands for general science and Mixed indicates that the community is a mix of two or more academic subjects.

TEACHER	ISD	GS	MIXED	TOTAL
Teacher A	2	5	1	8
Teacher C, c2	4	3	1	8
Teacher C, c3	3	3	0	6
Teacher D	4	2	1	7
Teacher E	6	3	0	9
Teacher F	4	1	2	7

Table 25: Division of the different communities when focusing on the academic subject in the teachers activity maps

Table 25 shows that Teacher E's implementation and Teacher C's implementation in class 3 each has a clear tendency to focus on either individual science disciplines or general science. Therefore the degree of interdisciplinarity could have a tendency to be low like pluridisciplinarity where the disciplines works in parallel with each other. From Table 25 one also notices that the activity maps of Teacher C in class 2, Teacher D, Teacher E and Teacher F primarily focus on an individual science discipline. In contrast, Teacher A primarily focuses on the general science element. Hence, the interdisciplinarity might be of a higher degree for Teacher A compared to the rest. Teacher C's implementation in class 3 is hard to put a specific interdisciplinary category on as the communities are evenly distributed. Nonetheless, the clear division between the two types of communities still indicates a lower degree of interdisciplinarity.

In order to investigate the interdisciplinarity of the different implementations further, the PageRank score was calculated for the different subjects within each activity map. The PageRank score is a measure which indicates a node's (through the subject code) involvement and relative importance in relation to the other nodes in the network, here the activity map. From these calculations, it was very clear that either the general science code "bsc" or one specific discipline had the most importance. These numbers changed the classification of the degree of interdisciplinarity which was based on the modularity measurements. If the results from the modularity are combined with the PageRank measures for the different subjects it become easier to say something about the degree of the interdisciplinarity in the different implementations.

Teacher C's implementation in class 2 and Teacher E's and Teacher F's implementations had clear pluridisciplinary features and the time spent on general science (indicated be the code "bsc") was limited. When the two teachers were asked about the degree of interdisciplinarity in the interviews, they are both aware that their implementations are of pluridisciplinary character according to Jantch's definition[1972]. Teacher D's and Teacher C's implementations in class 3 also had some pluridiciplinary features. However, at the same time the PageRank score on the general science code was relatively high in both implementations. In Teacher C's case the code "bsc" actually had gained the highest score. Nonetheless, due to the clear division of communities, the degree of interdisciplinary which describes the two implementations in class 3 most aptly is still pluridisciplinarity. In Teacher A's implementation the degree of interdisciplinarity is different. Here most communities focus on science in general, and the highest PageRank score was the general science code "bsc". From the modularity measurement, Teacher A's implementation is still very divided. This implementation could therefore be an example of Jantch's [1972] category interdisciplinarity, where the disciplines are subjected to a common higher-level concept. Thus, in the implementation of Teacher A, the individual science discipline was only addressed if the students required them in relation to their group work.

The activity maps together with the modularity and the PageRank calculations have been useful in relation to characterizing the degree of interdisciplinarity in the different BSC implementations. However, one should beware of the fact that the code "bsc" is defined as an interdisciplinary code on the assumption that science in general is interdisciplinary. This code was predefined prior to the classroom observations as the curriculum many times states the word "science" as the one thing that should be in focus of the implementations. If the code should have been defined in another way or if this code should be excluded from the study is hard to say. It is clearly that the results are heavily influenced by the codes used. These code are based on my interpretation of BSC program curriculum documents. It would have been preferable if this code definition could have been discussed with other researchers in order to make a validation of the codes being used in this study.

The visual activity maps revealed two tendencies in the way the teachers taught the BSC implementations. Either the teacher uses a lot of time on staging one science discipline, often their own, in order to put the specific science discipline into a more general science perspective. One could call this tendency: looking from an individual science discipline into the perspective of general science. Otherwise the teacher uses a lot on time focusing on general science in order to create a setting for talking about individual science disciplines. One could call this tendency: looking from a general science perspective into the individual science disciplines. The first tendency appears in the activity maps of Teacher C in class 2, Teacher D, Teacher E and Teacher F. The second tendency is visible in the activity maps of Teacher A and Teacher C in class 3. It is hard to say if one or the other of these ways is more suitable for gaining a high degree of interdisciplinarity.

The activity maps also showed different ways of teaching. In some of the teachers' activity maps, a clear dialogue structure was revealed. Some of the other teachers' activity maps were more characterized by a lecturing approach to teaching. This could indicate that activity maps such as these also can be used to say something about the teaching style of the teacher. These maps therefore might be helpful when discussing different ways of teaching in a classroom. Another thing which the activity maps revealed was the importance of classroom management. This might have relation to the fact that the BSC is an introductory program. Hence, it is one of the first things the students meet when they start at Stx. The students might need guidance in relation to the rules, regulations, which expectations they are met with when they start USS as well as how to behave in a classroom. Therefore the activity maps have also contributed to expose other parts of the teaching situation.

8.3 THE INTERDISCIPLINARITY IN THE REALIZED CURRICULUM

I this proof of concept study, dialogue maps of BSC exam situations were produced using network analysis. The exam situations had been observed, and the dialogue maps were produced on the basis of field notes and audio recordings of the exam situations. From the dialogue maps the network properties modularity and PageRank, were calculated in order to investigate the degree of interdisciplinarity at the exam situation.

The modularity calculations were used in the same way as with the activity maps. Hence, the modularity indicates if the dialogue maps have a tendency to be divided into communities. In the dialogue maps the nodes are represented by different dialogical aspects and their relation to the student and teachers, the subject of interest and finally the learning aim which the dialogical aspect supports. In both Student 1's and Student 2's dialogue maps the modularity was larger than 0.5. This indicates that both dialogue maps have a tendency to be divided into communities. In the dialogue maps, it was expected that the structure of the exam might be visible in the dialogue maps. This structure is that the exam was built on a student presentation followed by a dialogue between the student and the teachers. This division was clear in both of the dialogue maps. In addition to this type of division, the communities also revealed a tendency to be divided into academic subjects; the same three community types as found in the activity maps. Hence, the communities are classified as either; an individual science discipline, general science or a mixed-subject community. This indicates that it is rare that the student presentation and the dialogue between the student and the teachers switches between disciplines.

If one looks at how the three academic subject types of communities were distributed in the dialogue maps, following table is obtained. Here ISD stand for individual science discipline, GS stands for general science and Mixed indicates that the community is mix of two or more academic subjects.

STUDENT	ISD	GS	MIXED	TOTAL
Student 1	0	3	2	5
Student 2	3	1	1	5

Table 26: Division of the different communities when focusing on the academic subject in the dialogue maps from the exam situation

As mentioned in Section 7.3 it may be hard to classify the mixed communities in the dialogue maps when some communities only consist of 4 nodes, when is a community characterized as mixed? Is it when one node is different from the three others, or is it when we have a half-half situation? This division in relation to academic subject can be influenced by the way the students structure the presentation and in which order the teachers ask their questions as the teachers had a tendency to ask question within the same subject. If one assumes that the division by academic subject is valid, then these two exam situations can be characterized as having different degrees of interdisciplinarity. Student 1's exam could be classified as interdisciplinary according to Jantsch [1972] as the dialogue map mostly had general science communities. Furthermore, in the two mixed communities of the dialogue map the general science was used as a setting for talking about the individual science disciplines. Student 2's exam could be classified as pluridisciplinary according to Jantsch [1972]. The exam had a clear focus on the individual science disciplines and it was rare that the different subjects were intertwined. However, it should be said that more exam situations need to be analyzed in order to determine whether the academic subject division is valid.

The PageRank score of the different subjects was also calculated for two dialogue maps. The PageRank is a measure which indicates a node's (in this case the subject codes) involvement and relative importance in relation to the other nodes in the network, here the dialogue map. The PageRank calculations for Student 1's dialogue map show that it is the general science subject which has the most importance. This supports the classification of Student 1's exam situation as being of interdisciplinary character. The PageRank calculations for Student 2's dialogue map show that the individual science disciplines have a higher importance than the general science subject. Again the PageRank scores are supporting the classification of Student 2's exam situation as being of pluridisciplinary character.

The two dialogue maps represent the high and the low end of the grading scale. Whether the grade is related to the degree of interdisciplinarity or the dialogue structure of the map cannot be said from these two trial maps. Nonetheless, it is definitely worth investigating by analyzing additional exam situations.

The dialogue maps together with the modularity and the PageRank calculations have been useful when charactering the degree of interdisciplinarity of the two BSC exam situations. As with the activity maps, the code for the dialogue maps is based on my interpretations of the BSC. Thus, it would have been preferable that these codes had been validated by other researchers. Since this part of the study has been a proof of concept study, a lot more data needs to be analyzed in order to determine if this in general is a valuable way of analyzing interdisciplinarity in exam situations. These two trial dialogue maps show some tendencies which indicates that dialogue maps could indeed be a viable method to analyze exam situations.

8.4 NETWORK ANALYSIS - USEFUL OR NOT WHEN INVESTIGATING CURRICULUM ALIGNMENT?

The last research questions related to investigating the degree of interdisciplinarity through the three curricula; the intended, the implemented and the realized curriculum. The aim was to see if there was alignment regarding the interdisciplinarity between the three curricula in the BSC program. In addition to the interdisciplinarity, the learning aims for the BSC program were also investigated in each of the three curricula in order to study if these were aligned through the three curricula. In this section I will discuss if the three curricula are aligned; first in relation to the interdisciplinarity and then in relation to the learning aims of BSC program. Finally I will discuss if these three types of network analysis can be used when investigating curriculum alignment.

From the thematic discourse network analysis (TDNA), three thematic maps of the BSC curriculum documents were obtained. All three thematic maps showed very few structural demands regarding how interdisciplinarity should be coordinated in a BSC implementation. The structural demand is explicit mentioned in the BSC curriculum documents. The demand states that the BSC implementations must be of pluridisciplinary character [UVM, 2005,2007,2010]. It is debatable whether the BSC curriculum overall can be characterized as being interdisciplinary (according to Jantsch's [1972] categories) since the primary focus is on general science as a higher level concept. Based on the analysis of the intended curriculum, a BSC implementation must at least be of pluridisciplinary character. The implemented curriculum was exemplified by six teachers' part of the BSC implementations. These implementations were observed and then made into activity maps. These activity maps showed that five out of six could be characterized as being pluridisciplinary and one could be characterized as being interdisciplinary acoording to Jantsch[1972]. The investigation of the realized curriculum was a proof of concept study where two observed BSC exam situations were transformed into dialogue maps. The dialogue maps revealed that one BSC exam had interdisciplinary characteristics and the other BSC exam had pluridisciplinary characteristics.

These three types of network analysis have provided three different kinds of maps; thematic, activity and dialogue. From these different maps, it have been possible to give a categorization of the degree of interdisciplinarity in the three different curricula. Based on these characterizations of interdisciplinarity I will argue that an alignment between the three different curricula takes place regarding the interdisciplinarity. However, this study can only comment on the interdisciplinarity in the specific BSC implementations and the two BSC exam situations. Therefore the curriculum alignment found in this study cannot be generalized to cover all BSC implementations and all BSC exams.

As mentioned in the beginning of this section, the learning aims for the BSC were also investigated as another way to study the curriculum alignment of the BSC program. The learning aims were constructed from the academic aims in the BSC curriculum plan [UVM, 2013b]. The idea was to trace what was taught in the specific BSC implementation and compare this with what was learned when the student was at the BSC exam. After the thematic maps were constructed from the intended curriculum, it became clear that all eight learning aims could be found within the thematic map, see Section 5.4 for a further description. The thematic maps were then used as a way of validating the learning aims. From the thematic maps, the size of the different modules which had a clear relation was used as an indication of how the different learning aims should be distributed in a BSC implementation. Hence, the science identity should be given more importance than the other learning aims. The learning aims were included in the code procedure in both the analysis of the implemented and the realized curriculum. This was done as a part of the label on the nodes in both the activity maps and the dialogue maps. The network property PageRank was then calculated for each of the eight learning aims in both the activity maps and the dialogue maps in order to see if all eight learning aims were present. In addition it was done to investigate the importance that each learning aim had in the BSC implementations and the two BSC exam situations represents the implemented and realized curriculum, respectively.

For the six teachers' part of the BSC implementations, the activity maps and the PageRank calculations showed that all eight learning aims were present in all implementations. The PageRank calculations also revealed that the identity of science had the highest importance of all the learning aims in all the BSC implementations. The PageRank scores showed that the rest of the learning aims were not evenly distributed in any of the implementations. Some of the BSC implementations focused more on models, others on practical work and a third implementation focused on the scientific method. This indicates that the eight different learnings aims are not evenly distributed in a BSC implementation as the teachers might choose some of the learning aims to be more central or important in relation to the topic of the specific BSC implementation. Therefore some learning aims will receive higher importance than others in a specific BSC implementation. Regarding the realized curriculum and the two BSC exam situations, the dialogue maps and the PageRank calculations showed that six out of seven relevant learning aims were covered at both exams. However, it was not the same learning aim which was left out in the two exams. In that way one could say that teachers manage to examine in most of the learning aims during the exams. Again the PageRank showed that the identity of science had the highest importance in both exam situations and that the rest of the learning aims were not evenly distributed.

The three different kinds of maps (thematic, activity and dialogue) combined with the network property PageRank have made it possible to trace the learning aims of the BSC program from the intended curriculum all the way through the implemented curriculum to the realized curriculum. Based on the fact that all eight learning aims can be found in the two former curricula and all but one in the latter, I will argue that the three different curricula are aligned regarding learning aims. When it comes to how the different learning aims are distributed, it looks like that there is alignment regarding the learning aim identity of science since it receives the most importance in both the implemented and realized curriculum. In addition, this learning aim was visualized with the largest node in the thematic map of the intended curriculum. Whether there is an alignment between the other learning aims cannot concluded. Although the analyzed data indicates a lack of alignment this does not give the full picture. As I was not able to be present at all the taught modules in the different implementations and only two exams were analyzed, additional observations might change the picture. Furthermore, this study can only comment on how the learning aims were prioritized in the specific BSC implementations and the two BSC exam situations, therefore the curriculum alignment found in this study cannot be generalized to cover all BSC implementations and all BSC exams.

Based on these two examples I will argue that it have been possible to investigate the curriculum alignment of the BSC through the three types of network analysis. Network analysis in education research is an emerging field [Bruun, 2016]. This makes this thesis an exploratory study of the method of network analysis. The successful description of the BSC curriculum as a thematic map and characterization of interdisciplinarity and the learning aims indicate that the method of thematic discourse network analysis TDNA is a viable candidate for curriculum analysis. The activity maps were used to describe the implemented curriculum through classroom observations. This method combined with different network properties made it possible to characterize the degree of interdisciplinary in each of the implementations as well as obtaining an indication of how the different learning aims were prioritized in the different BSC implementations. This demonstrates that activity maps can be useful when analyzing classroom observations. Finally, the dialogue maps of the exam situation made is possible to get an overview of how an exam is structured in a dialogical perspective. From the two dialogue maps, it was possible to obtain knowledge about the degree of interdisciplinarity as well as how the different learning aims were prioritized in the two exam situations. This way of analyzing exam situations shows great promise and is definitely worth investigating further.

8.5 FUTURE RESEARCH WITH THIS DATA

This thesis contains a lot of data and various data types; one for each of the three curricula. In general for most of the data types more research is needed. For the intended curriculum, future research could include a TDNA of the new BSC curriculum from 2017 [UVM, 2017b] in order to investigate any changes regarding the interdisciplinarity of the course, as well as other changes in the BSC curriculum have been made as a consequence of the new USS reform [UVM, 2017a].

For the implemented curriculum, future research could include a transformation of the activity maps into thematic maps as in [Bruun and Andersen, 2017]. This might contribute to further or better characterization of the degree of interdisciplinarity in the different BSC implementations. In addition to this, the transformation of the activity maps into thematic maps might also reveal if the tendencies about how the different BSC implementations are taught are valid. These were either looking from an individual science discipline into the perspective of general science or looking from a general science perspective into the individual science disciplines. Then there are the interviews which could be further analyzed in order to uncover the perceived curriculum as many of the questions targeted the teachers' interpretation of the BSC.

For the realized curriculum, future research could include an analysis of the remaining 12 exam situations from class 4 in order to confirm whether the observed tendencies from the two trial dialogue maps are valid or not. Furthermore the 7 group exams could be analyzed. Maybe it would be possible to analyze the group exams in the same way as the rest or maybe a new method needs to be developed in order to analyze the group exams. This new way might include the use of bipartite networks. As these exams represent the entire grade scale, it could be interesting to investigate if the grades and structures in the dialogue map are correlated in any way.

9 CONCLUSION AND FINAL REMARKS

The aim of this thesis was to investigate the phenomenon interdisciplinarity in the Basic Science Course (BSC) in the upper secondary school USS. The study explored the interdisciplinarity, through the lens of network analysis, in the three different curricula:

- The intended curriculum
- The implemented curriculum
- The realized curriculum

The intended curriculum in this study consisted of three thematic maps which were made using a thematic discourse network analysis on the BSC program's curriculum documents. The thematic maps of the BSC curriculum, together with the alluvial, provide an insight to how the curriculum of the BSC program has evolved over time and which learning aims the BSC program targets. It was difficult to characterize the degree of interdisciplinarity from the thematic maps as the demands for how the interdisciplinarity should be implemented in a BSC implementation was only to be found within one out of eight themes in the thematic map. Within the theme *Structural demands to the BSC* the degree of interdisciplinarity was shortly described to be of *pluridisciplinary* character.

The implemented curriculum was represented by six different teachers' specific BSC implementations. These six BSC implementations were transformed into activity maps. From these activity maps, the network properties modularity and PageRank were calculated in order to characterize the degree of interdisciplinarity in each of the six BSC implementations. All six implementations were highly modular and could therefore be characterized as divided into separate disciplines. Five out six implementations were characterized as being pluridisciplinary meaning that subjects worked mostly in parallel to each other. The implementation of Teacher A was different as the general science discipline got the most relative importance, and from the activity map it was clear that most of the time were spent on science in a general perspective. However, the high modularity still classifies the disciplines as being divided. Therefore Teacher A's implementation was categorized as being interdisciplinary meaning that the disciplines are coordinated by a higher level problem which cannot be properly explained by one discipline. From the activity maps, the PageRank of the different learning aims were obtained in order to study what was taught and learned in the specific BSC implementations. These numbers showed that learning aims about the identity of science gained the most importance in all six BSC implementations.

The realized curriculum consisted of two BSC exam situations from the same BSC implementation. These exam situations were transformed into dialogue maps. This was a proof of concept study which tested if the dialogue maps together with the network properties modularity and PageRank could provide a way to characterize the degree of interdisciplinarity in the exam situations. Like with the activity maps of the different implementations, the dialogue maps also showed high modularity and could therefore also be characterized as divided into disciplines. One BSC exam had pluridisciplinary characteristics and the other BSC exam had interdisciplinary characteristics. As with the activity maps the PageRank the of different learning aims were obtained from the dialogue maps as well. These numbers showed that the learning aim about the identity of science also gained the most importance at the BSC exam situations. Since this was a proof of concept study, more investigations are needed in order to validate the results presented above.

The supplementary aim with this study was to explore if the application of three different types of network analysis could be used to describe the alignment between the three curricula. In this thesis, three types of network analysis were used to construct three types of map; thematic, activity and dialogue. From each of these maps, it have been possible to determine the degree of interdisciplinarity in relation to the three different curricula. The thematic map also allowed an insight in the learning aims of the BSC program. In addition by using the network property PageRank, it have been possible to compare the importance of the different learning aims in the implemented and realized curriculum. Based on these two examples, the three different types of network analysis could be used as a tool in the investigation of curriculum alignment in educational research.

9.1 OUTLOOK - WHERE CAN THESE NEW METHODS BE APPLIED?

This thesis is an example on how different types of network analysis can be used in qualitative research in relation to science education. In this section I would like to make two suggestions to new research projects where these methods can be applied.

In the upper secondary program Hf- higher preparatory examination, all science disciplines are gather in the course: Science (in Danish: naturvidenskabelig faggruppe) [UVM, 2017c]. The overall aim with the course is to provide a coherent insight in issues with natural science content [UVM, 2017c] hereby indicating that some degree of interdisciplinarity between the individual science disciplines must take place. By using the same methods as in this thesis, it might be possible to investigate the interdisciplinarity in the course in relation to all three curricula.

In 2016 a new science exam were implemented in the lower secondary school. Here all four science disciplines: physics, chemistry, biology and geography have one joint exam, also called the science exam (en Danish: den fælles prøve i naturfag) [UVM, 2016]. The exam is based on a minimum of four interdisciplinary topics. These four topics should have provided a basis for interdisciplinary science teaching in the lower secondary school. By using the same methods as in this thesis, it might be possible to investigate the interdisciplinarity in this new exam form and the teaching prior to the exam.

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Colophon

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DECLARATION

Put your declaration here.

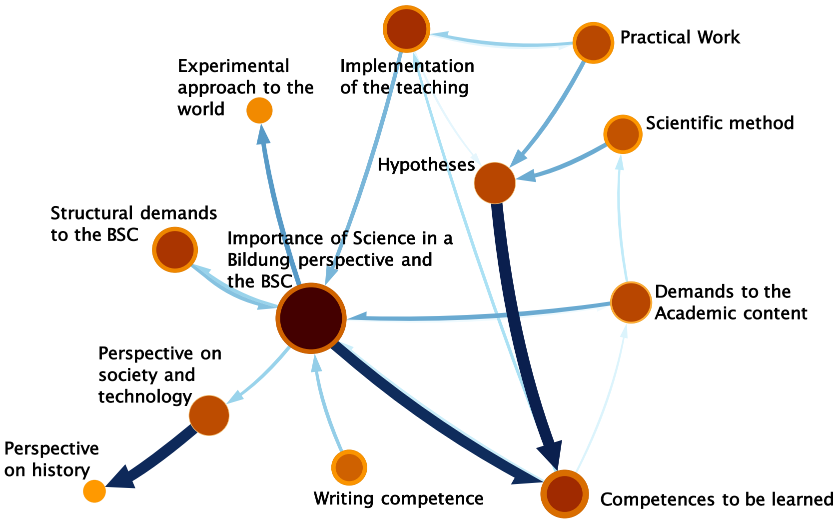
Copenhagen, July 2017

Ida Viola Kalmark Andersen

APPENDIX

INTERDISCIPLINARITY IN THE BASIC SCIENCE COURSE

IDA VIOLA KALMARK ANDERSEN



A study of how network analysis can be used in Science Education

Niels Bohr Institute
&
Department of Science Education
Copenhagen University

July 2017

A QUOTE TRANSLATIONS

A.1 CITATIONS FROM CHAPTER 2

Original citation:

> Det er systemets krav til, hvad eleverne skal lære gennem undervisningen, (...) Det er det ønskeværdige.[Dolin, 2013b, p. 131]

Translation of citation:

> It is the systems requirements for what the students should learn through the teaching(...). It (the intended curriculum) is the desirable" [Dolin, 2013b, p. 131]

Original citation:

> - Opnåelse af transfaglige kompetencer (dvs. faglige kompetencer, som indgår i flere fag), fx analysemetodik, rapportskrivning osv.
>
> - Opnåelse af personlige/sociale kompetencer, fx selvstændighed, gruppearbejdskompetencer osv.
>
> - Dybere (fag)faglig viden om emnet herunder øget forståelse for fagnes muligheder og begrænsninger i den givne problemstilling. [Dolin, 2013a , p. 240]

Translation of citation:

> - Achieving trans disciplinary competencies (i.e professional qualifications which are included in several subjects) such as analytical methodology, report writing, etc.
>
> - Achieving personal/social competencies e.g independence, teamwork skills, etc.
>
> - Deeper (subject) knowledge of the topic including an increased understanding of the opportunities and limitations of the given problem. [Dolin, 2013a , p. 240]

Original citation:

> at forbinde den lingvistiske analyse med en intertekstuel analyse for at slå bro mellem tekst og sprog på den ene side og samfund og kultur på den anden. [Norman, 2008, p. 130]

Translation of citation:

> to link the linguistic analysis with an intertextual analysis to bridge the gap between text and language on one side and society and culture on the other side. [Norman, 2008, p. 130]

A.2 CITATIONS FROM CHAPTER 3

Original citation:

> Det naturvidenskabelige grundforløb udgør den gymnasiale introduktion til naturvidenskab gennem et arbejde med grundlæggende elementer af naturvidenskab, hvor der lægges vægt på det sammenhængende i naturvidenskaben. I naturvidenskabeligt grundforløb inddrages eksemplariske og aktuelle problemstillinger kombineret med en oplevelsesorienteret og eksperimentel tilgang til omverdenen. [UVM, 2013b]

Translation of citation:

> The basics science course represents the introduction to natural science in upper secondary school Stx through working with the basic elements of natural science with emphasis on the coherences in natural science. BSC consists of exemplary and current issues combined with an experience-oriented and experimental approach to the outside world. [UVM, 2013b]

Original citation:

> Eleverne skal gennem undervisningen i grundforløbet indse betydningen af at kende til og forstå naturvidenskabelig tankegang, og de skal kunne forholde sig til naturvidenskabelig videns styrker og begrænsninger. Eleverne skal opnå viden om nogle centrale naturvidenskabelige problemstillinger og deres samfundsmæssige, etiske eller historiske perspektiver, så de kan udtrykke en vidensbaseret mening om forhold og problemer med et naturfagligt aspekt. Endelig skal elevernes nysgerrighed og engagement inden for det naturfaglige område understøttes og fremmes. [UVM, 2013b].

Translation of citation:

> Students should through the teaching of BSC realize the importance of knowing and understanding scientific thinking, and they must be able to relate the scientific knowledge to its strengths and limitations. Students should acquire knowledge about some key scientific problems and

> their social, ethical or historical perspectives so that they can express a knowledge-based opinion on issues and problems with a natural sciences aspect. Finally, students' curiosity and commitment towards the natural sciences should be supported and encouraged. [UVM, 2013b]

Original citation:

> Eleverne skal kunne:
>
> – gennemføre praktiske undersøgelser og iagttagelser, såvel i laboratoriet som i naturen, blandt andet med henblik på at opstille og vurdere enkle hypoteser
>
> – anvende modeller, som kvalitativt og kvantitativt beskriver enkle sammenhænge i naturen, og kunne se modellernes muligheder og begrænsninger
>
> – formidle et naturvidenskabeligt emne med korrekt anvendelse af faglige begreber
>
> – perspektivere bidrag fra naturvidenskab til teknologisk og samfundsmæssig udvikling gennem eksempler
>
> – demonstrere grundlæggende viden om naturvidenskabens identitet og metoder.
>
> [UVM, 2013b]

Translation of citation:

> The students should be able to:
>
> - perform practical studies and observations both in the laboratory and in the field (of nature) in order to create and evaluate simple hypotheses.
>
> - apply models which qualitatively and quantitatively describe simple relations in nature and see the models' possibilities and limitations.
>
> - communicate a scientific topic with proper application of academic vocabulary.
>
> - put into perspective the contributions of science to technological and social development through examples.
>
> - demonstrate basic knowledge of science identity and methods.
> [UVM, 2013b]

A.3 CITATIONS FROM CHAPTER 4

Original citation:

> Et semistruktureret livsverdensinterview forsøger at forstå temaer fra den daglige livsverden ud fra interviewpersonernes egne perspektiver(...) Det nærmer sig en hverdagssamtale, men har som professionelt interview et formål og indebærer en særlig tilgang og teknik; det er semistruktureret - det er hverken en åben hverdagssamtale eller et lukket spørgeskema [Kvale and Brinkmann, 2009, p.45].

Translation of citation:

> The semi-structured lifeworld interview is an attempt to understand themes from daily life from the perspectives of the informant (. . .) It approaches ordinary conversation, but has as a professional interview a purpose and entails a certain approach and technique; it is semi-structured – it is neither an open conversation nor a closed questionnaire [Kvale and Brinkmann, 2009, p.45].

A.3.1 *Sentence used for illustrating the procedure of splitting sentences*

Original citation:

> Eleverne skal kunne gennemføre praktiske undersøgelser og iagttagelser, såvel i laboratoriet som i naturen, bl.a. med henblik på at opstille og vurdere enkle hypoteser. [UVM, 2010]

Translation of citation:

> The students should be able to perform practical studies and observations both in the laboratory and in the field (of nature), in order to create and evaluate simple hypotheses. [UVM, 2010]

The procedure done on the danish text gives following eight sentences:

Eleverne skal gennemføre praktiske undersøgelser i laboratoriet med henblik på at opstille enkle hypoteser.

Eleverne skal gennemføre praktiske undersøgelser i laboratoriet med henblik på at vurdere enkle hypoteser.

Eleverne skal gennemføre praktiske undersøgelser i naturen med henblik på at opstille enkle hypoteser.

Eleverne skal gennemføre praktiske undersøgelser i naturen med henblik på at vurdere enkle hypoteser.

Eleverne skal gennemføre iagttagelser i laboratoriet med henblik på at opstille enkle hypoteser.

Eleverne skal gennemføre iagttagelser i laboratoriet med henblik på at vurdere enkle hypoteser.

Eleverne skal gennemføre iagttagelser i naturen med henblik på at opstille enkle hypoteser.

Eleverne skal gennemføre iagttagelser i naturen med henblik på at vurdere enkle hypoteser.

A.4 CITATIONS FROM CHAPTER 5

Original citation:

> "... intoduktion til de naturvidenskabelige fags fællestræk og forskelligheder, gennem arbejdet med grundlæggende elementer af fagene biology, fysik, kemi og naturgeografi"[UVM, 2005,UVM, 2007]

Translation of citation:

> "... an introduction to natural science commonalities and differences through working with fundamental elements of the disciplines biology, physics, chemistry, and natural geography" [UVM, 2005,UVM, 2007]

Original citation:

> "introduktion til naturvidenskab gennem et arbejde med grundlæggende elementer af naturvidenskab"[UVM, 2010]

Translation of citation:

> "the introduction to natural science (...) through working with the basic elements of natural science with emphasis on the coherences in natural science."[UVM, 2010]

Original citation:

> "Det naturvidenskabelige grundforløb bygges op omkring tematiske, fortrinsvis flerfaglige forløb. "

Translation of citation:

> "The BSC implementation should be based on thematic topics which are <u>preferably</u> pluridisciplinary" [UVM, 2005]

Original citation:

> "de (eleverne) kan udtrykke en vidensbaseret mening om forhold og problemer med et naturfagligt aspekt. [UVM, 2005,2007,2010]"

Translation of citation:

> they(students) can express a knowledge-based opinion on issues and problems with a natural sciences aspect.

Original citation:

> " vise relevansen og anvendelsen af naturvidenskab i samfundet" [UVM, 2005,2007,2010]"

Translation of citation;

> "show the relevance and the application of natural science in relation to society "[UVM, 2005,2007,2010]

Original citation:

> "at kende til og forstå naturvidenskabelig tankegang" [UVM, 2005,2007,2010]

Translation of citation:

> "to know about and understand scientific thinking ..."[UVM, 2005,2007,2010]

Original citation:

> " (eleverne skal kunne) demonstrere grundlæggende viden om naturvidenskabens identitet og metoder"[UVM, 2010]

Translation of citation:

> "(the students should be able to) demonstrate basic knowledge about scientific identity and methods"[UVM, 2010]

Original citation:

> "praktiske undersøgelser skal udgøre en væsentlig del af udannelsestiden"

Translation of citation:

> "practical investigations must constitute a significant part of the education time"[UVM, 2005,2007,2010]

Original citation:

> Eleverne skal arbejde med forskellige former for skriftlighed, der tilrettelægges med en klar progression i kravene frem mod et afsluttende skriftligt produkt.[UVM, 2005,2007,2010]

Translation of citation:

> "The students must work with different kind of written assignments, which should be planned with a clear progression in the demands towards a final written product"[UVM, 2005,2007,2010]

Original citation:

> "(Eleverne skal kunne) perspektivere de naturvidenskabelige fags bidrag til teknologisk og samfundsmæssige udvikling gennem eksempler".[UVM, 2005,2007,2010]

Translation of citation:

> (The students should be able to) put into perspective the contributions of science to technological and social development through examples.[UVM, 2005,2007,2010]

A.5 CITATIONS FROM CHAPTER 6

Original citation:

> (NV) lægger op til at man kan udforske og man kan lege lidt, og man (som lærer) er ikke bundet op af at eleverne skal have et bestemt pensum. Så er det også i NV hvor der er to lærer, hvor vi kan få lavet noget samarbejde på et højere plan end hvad man ellers får gjort. Så er det (NV) jo vigtigt fordi det ligger i starten og derfor vigtigt for elevernes forhold til faget naturvidenskab. (*Teacher A*)

Translation citation:

> (BSC) suggests that one can explore and one can play a little, and you (as a teacher) are not bound by the students to have a specific syllabus. It is also in the BSC, where there are two teachers (to cover at course) where we (teachers) can make some cooperation on a higher level than usual. It (BSC) is important because it is placed at the beginning and therefore important for the students' relation to the subject of science. (*Teacher A*)

Original citation:

> I det første forløb(klasse 2), så tænker jeg at det har været 2/3 fysik teori, eller 2/3 fysik-fagbegreber der blev introduceret og 1/3 naturvideskabelig metode begreber. Hvor

> jeg syntes at det minimum var spejlet i det andet forløb (klasse 3), vi(lærer og elever i klasse 3) brugte ikke særligt meget tid på fysik- fagbegreber i det andet forløb. Og der syntes jeg tilgengæld at mange af de her NV begreber fik lov til at stå stærkere. (*Teacher C*)

Translation of citation:

> In the first implementation (class 2), I think that there have been 2/3 theory, or 2/3 physics vocabulary introduced and 1/3 scientific method concepts. Where I thought that the minimum was mirrored in the second implementation (class 3), we (teachers and students in class 3) did not spend much time on the physical concepts of the second implementation . And I found that many of the BSC concepts were allowed to stand out.(*Teacher C*)

Original citation:

> Hvad der fungerede og hvad der ikke fungerede, handler også om de konstellation (lærer konstellationer) er var og noget af det om handler om klassen. (*Teacher C*)

Translation of citation:

> What worked and what did not work is also about the constellation (teacher constellations) and some of it is about the class.(*Teacher C*)

Original citation:

> Jeg syntes at det(det tværfaglige samarbejde) er udmærket. (*Teacher D*)

Translation of citation:

> I think that it (the interdisciplinarity of the implementation) is very good. (*Teacher D*)

Original citation:

> F.eks kan jeg se at nu kan jeg kører emnet fordøjelsen ret hurtigt i denne klasse (klasse 3), fordi jeg kan bygge ovenpå de forsøg vi allerede har lavet.(*Teacher D*)

Translation of citation:

> As an example, I can see that I can teach the subject about digestion rather quickly in this class (class 3) because I can build on the experiments we have already made.(*Teacher D*)

Original citation:

> Tiden gør at det bliver parallel forløb, vil jeg mene. Der er ikke nogen fælles plan. [...] Men stumperne passer jo sammen (til det overordnet emne), det ved jeg. (*Teacher E*)

Translation of citation:

> Time does that the implementation becomes a parallel course, I would think. There is no common plan. [...] But the pieces fit together (for the main topic of the implementation), I know that. (*Teacher E*)

Original citation:

> Jeg synes ikke fagene imellem hænger godt sammen, fordi det ikke er noget vi har planlagt sammen. [...] Så det hænger ikke sammen så et fag (faget NV), men som 4 parallelle fag, det kigger på samme emne med forskellige øjne. (*Teacher F*)

Translation of citation:

> I do not think that the different disciplines play together because it was not something we've planned together. [...] So it did not work to together as an integrated implementation (the BSC). Instead it was 4 parallel disciplines that looked at the same topic with different eyes. (*Teacher F*)

Original citation:

> [...] så handler NV om at skabe nysggerighed og en interesse for naturvidenskab.(Teacher E).

Translation of citation:

> [...] The BSC is about creating curiosity and interest in natural science

Original citation:

> De (studerende) skal have begreb om hvordan man arbejder med naturvidenskab, og det skal de også selv afprøve ved at lave eksperimenter mm. (*Teacher D*)

Translation citation:

> They (the students) should have an idea of how people work within natural science, and they (students) must also try it out by doing experiments, etc. (*Teacher D*)

Original citation:

> Det syntes jeg at de rent faktisk godt kan. Det kloge af dem (de studerende) kunne godt se det. Jeg tror, de har forskellige opfattelser af om de syntes det var sjovt, men jeg tror sådan set godt de kunne forstå det. Altså at det (de forskellige fag) hang sammen.(Teacher E)

Translation of citation:

> I think that they really do. The wise of them (the students) could see it. I think they have different views of whether they thought it was fun. But I think that they could understand it. That it (the different disciplines) was connected. (Teacher E)

B

DEFINITIONS NEEDED FOR TRANSFORMING A SCIENTIFIC LITERACY TEXT TO A LIST ON ONE STATEMENT SENTENCES

These definitions are made by Bruun in [Bruun, 2009]. These definitions are taken directly from the blog.

Sentence
Normal definition from grammatical theory.

Parsed sentence
A sentence which has been extracted from the text using the rules and procedures described below.

List comma and list *and*
A list comma is used to list a number of different features or properties which all belong to a set of actors, contexts, and/or concepts. They can be identified by the following rule: If you replace a list comma with an "and" the meaning is unaltered. The list commas and "ands" can separate list items. A list can be placed in the beginning of, in the middle of or at the end of a sentence.

List items
Items of a list: single words, groups of words or even sentence structures.

Sentence splitting
A sentence containing a class of list commas and list "ands" can be split in to sentences, each of which contains one of the list items. The parts of the sentence which do not belong to the list are reused in each of the split sentences.

Active and passive forms
Active form: The student uses a mathematical model.
Passive form: A mathematical model is used by the student.

Nouns derived from verbs
Awareness may be viewed as a derivative of being aware. Knowledge as a derivative of to know.

Comment: So "The student has awareness of" can be changed to "The student is aware of". In the same way "having knowledge of" could be changed in to “know (of)”. The rule of thumb we use here, is that if we can reduce the complexity and still keep the same level of information in the text, we make the change. This is why a sentence like "Students should achieve scientific knowledge" would not be changed.

C

OBSERVATION PROTOCOL

Observationsprotokol: Aktiviteter i NV- timer

Lærer: ______ Dato: ______ Modulets tema ______

	0-2 min	2- 4min	4-6 min	6-8 min	8-10 m	10-12m	12-14m	14-16m	16-18m	18-20m	20-22m	22-24m
Tavle UV												
Hel-klasse fælles												
Pararbejde												
Gruppearbejde												
Gruppe ved tavle												
Elev ved tavle												
Gennemgang												
læse												
Regne opgaver												
Se demo-forsøg												
Lave forsøg												
Faglig diskussion												
Holdnings diskussion												
Fremlægge												
L. spørger												
L. svarer												
L. statement												
E. spørger												
E. svarer												
E. statement												
Faglig dialog												
Fag, F,G,K,B, NV												

Antal lærer spg: Antal elever der vil svare:

Elev spg:

Note that this only page 1 off the protocol, as it covers the first 24 minutes of a module, for a complete observation protocol four similar pages are add where only the minute bar in the top are changed to cover a 100 minute module.

D INTERVIEWS GUIDES

D.1 INTERVIEW GUIDE 1 PRIOR TO THE BSC IMPLEMENTATION

NV- generelt

- Hvis du skal sætte nogle ord på hvad NV er for en størrelse helt generelt?

- Hvad er det for en rolle NV udfylder/ er det overflødigt? (Kan de enkelt naturvidenskabelig fag ikke udfylde dette?)

- Hvad er det eleverne skal have ud af et forløb som NV?

- Er der så nogle særlige kompetencer eleverne skal træne/ have stiftet bekendtskab med efter NV?

- Hvilke ting/kompetencer er så mindre vigtige eleverne for trænet.

Overordnet om NV på det specifikke Gym

- Hvordan er NV struktureret hos jer?

  • Tid
  • Lærerfordeling
  • Fagfordeling
  • Delforløb
  • Skrive/elevtid
  • Prøve/eksamen

- Hvad er fokuspunkter/læringsmål i jeres NV forløb?

- Hvor meget tid går der til praktiske undersøgelser/eksperimenter?

- Når I som lærer laver et forløb, hvad tager I så udgangspunkt i?

- Vil der så være et spørgsmål, der driver forløbet, og ikke mindst kan de spores tilbage til et specifikt fag?

- Bliver der så tale om forskellige fag der indgår i et forløb eller bliver fagene udvisket?

Samarbejde med mat

- I lærerplanen står der beskrevet at der skal være et samarbejde med matematik, har i det her?

- Hvad kræver det ekstra eller?

Afslutningsvis

- Til sidst hvad synes du om NV, helt generelt?

- Fungere NV som en introduktion til naturvidenskab som det er til tænkt eller ?

- Har NV som sådan et særligt potential som ikke finde andre steder eller burde det blive skrottet til fordel for flere enkeltfags timer?

D.2 INTERVIEW GUIDE 2 POST TO THE BSC IMPLEMENTATION

Forløbet

- Hvis du skal sætte nogle ord på hvordan det NV-forløb, som vi lige har været gennem er struktureret?

- Hvilke progression skal eleverne igennem?

- Kunne eleverne følge denne progression, løftede de sig eller faldt de igennem?

- Var det på et tidspunkt hvor du /i måtte korrigere i tidsplanen (progressionen)? Hvorfor?

- Hvis du skal vælge noget der fungerede rigtig godt eller slet ikke fungerede?

- Hvordan synes du at eleverne håndterede elever NV?

- Hvilke timer eller hvornår mødte eleverne essen af NV? (Eller hvilke elementer i forløb opfattede du som, afgørende for at eleverne fik /ikke fik indfriet de faglige mål)

- Hvis du skal kigge tilbage på forløbet hvilke ting blev så prioriteret højest i undervisningen? (værktøjshåndtering , It –værktøjer, modeller, formler, enkelte fags metoder/identitet, fag begreb og anvendelse af disse korrekt, skriftlig/ mundtlig formidlings, praktiske undersøgelser, data opsamling, perspektiv)

- Deres sidste afleveringen/eksamen; hvad består det af er der flere elementer? (tester de forskellige elementer forskellige ting)

- Er eleverne blevet bedre til at udtrykke sig om forhold og problemer naturfagligt (hvor og hvornår)?

- Har NV været med til at skabe større nysgerrighed og engagement på det naturvidenskabelige område? (hvorfor, hvorfor ikke?)

- Efter NV er eleverne blevet i stand til at forholde sig til naturvidenskabelig videns styrker og svagheder? (henvis evt. til modul)

- Kan eleverne overføre den/de naturvidenskabelige kompetencer de har opnået i NV til de enkelte naturvidenskabelige fag?

Tværfaglighed

- Hvordan og hvornår vil du sige at der var tværfaglighed i jeres nv-forløb, og hvordan vil du beskrive det?

- Er der samarbejde med andre fag?

- Vil du karakterisere NV som et tværfagligt forløb? (Hvorfor, hvorfor ikke?)

- Forstår eleverne at det er tværfagligt?

- Inddragelse af matematik, når du tænker tilbage blev der så inddraget matematik?

Samarbejde mellem lærer

- Har der været samarbejde med de andre lærer som du har afholdt forløb med?

- På hvilken måde har det påvirket din undervisning?

- Går det en forskel at være to lærer tilstede?

Opfattelse af NV

- Passer ambitionen fra ministeriet til forløb, størrelsesmæssigt, stofmæssigt (Visionsmæssigt)?

- Er det mugligt at opnå de kompetencer/ læringsmålene i lærerplanen?

- Fungere NV som Introduktion til de naturvidenskabelige fag?

E
INTERVIEWS TRANSCRIPTIONS

E.1 TEACHER A, TA

I: Mit speciale handler om at undersøge tværfagligheden i naturvidenskabelig grundforløb (NV). Jeg vil forsøge at undersøge om tværfagligheden ændres fra lærerplanen intentioner, til lærernes fortolkning af lærerplan, og til hvad der egentlig sker i undervisningen. Den måde jeg gør dette på er ved at bruge netværksanalyse, så jeg får et netværk der illustrere hvad lærerplanerne siger, nogle netværk for hvad du siger, og til sidst et netværk over hvordan aktiviteterne i undervisningen hænger sammen. Hvis du nu skal sætte nogle ord på NV generelt, altså hvad NV er for en størrelse?

TA: Jeg synes at NV er, i hvert fald den ordning der er nu, det er et sted hvor man har bedre tid, og dermed så også lægger op til at man kan udforske lidt og man kan lege lidt, og man ikke ligesom er bundet op af at de (eleverne) skal have et bestemt pensum og den salgs. Så er det også NV hvor der ligesom er to lærer, hvor man kan få det til at lave noget samarbejde så ... på et højere plan end hvad man ellers får gjort. Så er det jo også fordi det ligger i starten vigtigt for elevernes forhold til naturvidenskab, at det bliver gjort som noget der er sjovt og interessant. Og det er jo heldigvis ikke noget som er sådan modstridige ting, for det kan jo godt lade sig gøre de her ting. Samtidig er det også fra lærermæssig side hårdt, fordi det er mange timer og det ligger ret kompakt og her har vi det oveni købet to gange, så på den måde er det lidt hårdt. Også har vi gjort det at vi har lagt rigtig meget omlagt skriftlighed, så vi har haft endnu flere timer. Til gengæld har vi så ikke skulle rette så meget, fordi det kan heller ikke... du kan heller ikke nå at rette noget, eller ret meget. . . fordi det (NV) ligger rimeligt kompakt. Så det er den måde vi har gjort det på. Det har virket godt... men også hårdt for lærerne syntes jeg. Men man kan sige at så har der også været den fordel, at den måde vi har arbejdet på der har det været meget op til eleverne... eller at arbejde meget projekt orienteret, så det har jo så også hjulpet lidt til hvordan det har været som lærer at kunne hjælpe på en anden måde.

I: I gør meget det at I er sammen to lærer i flere moduler, hvad gør det af forskel at man er to lærer på? Også har der været enkelte virtuelle moduler, hvor der har siddet en lærer i det skjulte, mere eller mindre til at stillet instrumenter frem.

TA: Ja, det har vi haft noget af (virtuelle moduler), men man kan sige at vi har egentlig gjort mere det, at vi i stedet for afleveringer så har vi haft... og i stedet for at det skal blive virtuelle moduler, så har vi jo så været der i stedet for. Så de har ikke haft så meget hvor de selv har arbejdet, hvor de har haft udstyret. Altså man kan sige at i det ene forløb var det lidt specielt fordi at vi var to lærer, men tilfældigvis viste det sig at halvdelen valgte, noget biologisk og den anden halvdel valgte noget fysik, og så var det jo oplagt at sige at den ene halvdel går der hen den anden der hen. På den måde resulterede det jo bare i at vi havde færre elever, der var ikke noget samarbejde på den måde. Men det har været meget fint for vi kunne også få noget fagligt ind på den måde. Men man kan sige at de steder hvor vi har haft to lærer ellers har det været noget med at de har fået noget tilbage, også har vi sådan begge to kunne forklare ud fra hvert vores synspunkt var, og noget optakt til science dagen hvor vi kunne være to lærer på, både så de(eleverne) forstod at det hang sammen men også at vi begge to fik lidt ligesom pointeret hvad der er vigtigt for vores fag. Så de kunne se forskellen på fagene og på måden at arbejde på. Så det har været bedre i form af at kunne vejlede dem og lidt mere tid til hver enkelt elev, og så har det jo så også hvis man skal lave et samarbejde, så er det jo rart at være to lærer for det er nemmere at få det samarbejde op og kører, men også for eleverne, det at de kan se at vi faktisk er fælles om dette forløb, hvis aldrig at de møder os sammen så tror de... så oplever de ikke det her sammenspil, og at det er det samme vi arbejder for, så ser de det som meget adskilt. Så jeg tror det er vigtig for eleverne at opleve det, og det er jo som minimum så skal det ske i starten og i slutning en af forløbet, her er det så også sket i løbet af forløbet.

I: Hvad er det for nogle kompetencer i træner i jeres NV-forløb? Altså hvilke ting skal eleverne have med for dette forløb?

TA: Jamen her det været meget med sådan variabel kontrol, meget med at ud tænke sine egne forsøg, finde ud af hvad er det for nogen variabler man skal variere, så har det været meget med grafer, og det at forholde sig til en graf, og få lavet en eller anden problemstilling om til nogle variabler, der så lave om til en graf, og man kan så bruge den til at sige noget om den oprindelige undersøgelse. Det at gå, fra at man har en eller anden diffus problemstilling til at man skal snakke om at en graf er lineære, der er utroligt langt for de her 1.gere, og det er det som har været i fokus og så at forholde sig kritisk til hvad man laver, har også været i fokus. Men sådan grundlæggende hvordan er det man argumentere for noget i naturvidenskab, og hvordan er det man kan bruge det til noget der er interessant og giver mening for dem, det har været det vi har arbejdet med.

I: Så har de i dette forløb brugt rigtigt meget tid på at lave eksperimenter selv, jeg har været meget imponeret over, at I som lærere bare sagde: Nu skal I selv gøre det. Og så gjorde eleverne det. Jeg tænker, at arbejde så projekt orienteret må kræve meget af eleverne, fra første dag de er på gymnasiet. Hvordan får man sådan et forløb til at spille?

TA: Jamen... øhh... man kan jo sige det... jamen man skal få dem til at blive motiveret, og det hjælper at de har valgt det selv og vi har brugt langtid på at de vælger noget selv altså hvordan de når frem til selve den her myte, det er jo sådan et større arbejde. Der har du været og set.

I: Ja, i lavede sådan nogle innovations øvelser

TA: ja og det tager sin tid, men jeg tror det er med til at de når frem til noget der er værd at arbejde med, men også at de føler at de selv er nået frem til det, så de faktisk er interesseret i det vi nu laver, og får ejerskab, det er nok en væsentlig ting. Og så handler det jo grundlæggende om at det ikke skal være uoverskueligt for dem, fordi hvis det er det så gør de ikke noget, så er der i hvert fald nogen som har den måde at arbejde på at de så bare bryder sammen, i stedet for at klø på. Så hvis det er overskueligt og de føler ejerskab for det, så gør eleverne det også. Så... udfordringen ligger i at det er så tidligt i forløbet, der er jo lige startet, så derfor er der jo nogen grupper der virker bedre end andre, men alle nåede i hus med det her. Det handler også rigtig meget om at lave klare mål, kan man sige, det skal være, de sådanne kompetencer de skal bruge, der skal de lige som trænes lidt i det først, så de ved hvad det er, og der har været sådan en cirkel, den har du ikke?

I: JA

TA: Den har i hvert fald været med til at gøre det klart for dem, nu er jeg her og jeg skal der over, så jeg skal den her vej rundt osv. Og i stedet for at have en liste, hvor de så har glemt listen, så kan man ligesom referer til den her cirkel som hedder guldvejledningen eller sådan noget som så er med til at gøre det... det handler om at have nogle små skridt som de kan se og forklare hvad de ska. For de vil alle sammen gerne, så det er sådan set det.

I: Men har du nogensinde, når du har kørt de her forløb, simpelt måtte gå ind og korrigere en gruppe, fordi ellers kørte de simpelthen i grøften?

TA: Ja man kan sige, at man skal fange de der håbløse projekter, i opstarten og det er den der innovations fase, at det er der hvor man virkelig skal være vaks som lærer, for man skal dels få... for hvis man har en gruppe der har gang i et eller andet, som man kan se det bliver rigtigt svært at gøre kvantitativt, altså hvordan får vi en graf ud af det her, og hvis jeg allerede på det tidspunkt ser at de bliver rigtig svært, så skal jeg få eleverne til at vælge noget andet, samtidig med jeg skal få dem til at føle at de selv har fundet på det. Så der kræver noget snilde, at man ligesom skal få dem til selv og dreje det ind så de stadigvæk føler at de er deres emne. Og det er bare rigtig vigtigt i starten, så det... hvis man har gjort det før, hvis du selv kan se hvor det skal hen osv. så ved vi jo, hvad vi kan gøre. Så skal vi samtidig også være lidt vovede, så vi skal også prøve noget der er nyt og sådan noget, og jeg havde der også nogle, hvor jeg ... vi blev nødt til at dreje det lidt men grundlæggende så har jeg det i hvert fald sådan, at jeg bliver nødt til at have noget, jeg ved virker. Jeg vil ikke springe ud i noget som jeg ikke er i stand til at kunne se virke, bare noget af det. Så må vi dreje det om.

I: Undervejs slog I ligesom ned og lavede nogle breaks, hvor i tog forskellige mere værktøjsmæssige ting, fx. hvordan funger en graf mm. Hvordan fungerede det at tage skiftevis projekt orienteret arbejde, og fælles moduler med mere teori?

TA: Det virker godt, også fordi der er jo det der gruppearbejde, hvor der er nogen grupper der ligesom går lidt død på et tidspunkt, ikke fordi de nødvendigvis er svært eller et eller andet, men bare den der moral for at fortsætte den kan godt blive lidt slidt på et tidspunkt, også tror jeg det er rigtig godt med en pause. Så i stedet for at man starter med at lære alting, så ligesom få det ind der hvor de har brug for det. Også få solgt det her, det kan I bruge til jeres projekt senere og de kan se det, og det hjælper også på det. Men det tror jeg grundlæggende er en fin struktur.

I: Og så præsentere de deres projekter for en anden klasse, hvad tror du der gør af forskel? OG hvorfor har i valgt at implementere det element?

TA: Jeg tror det gør en stor forskel, de havde... der var i hvert fald en masse der havde nerver på, og det syntes jeg var godt. Man kan sige at de tager det... det bliver ligesom en begivenhed, dels så bliver det en konkurrence og det er jo sjovt i sig selv, også er det bare det der med at man skal stå overfor en anden klasse, så bliver det bare lidt mere alvorligt, og de sådan automatisk vil gøre sig mere umage, ja også bliver det en begivenhed og det er jo sjovt. Og så er det nogen, der skal stemme på dem og den slags ting. Så det bliver en happening på sin vis.

I: Jeg var personligt meget imponeret over at de kunne fremlægge, men man kunne også godt se at der var de eleverne der havde øvet hele morgen og så var der også den anden ende af skalaen, hvor eleverne måske lidt havde tænke, vi kan det jo godt. Sådan som jeg så det fra en observatør, så lærte de rigtig meget af at se på hinanden fremlægge.

TA: Ja, fordi det jeg har snakket med nogle af grupperne om der er at det dermed... jeg snakkede med nogen fra klasse 1, der var det helt klart det de sagde de havde fået mest ud af var at se hinanden, og der var en gruppe der ikke havde klaret sig sådan super godt, men de som så bare havde set jamen ok alt det jeg havde sagt, dem der gjorde det, de vandt. Og det var ikke fordi at vi ligesom havde ... dem der skulle stemme havde ligesom hørt nå så skal man gøre som lærer A siger, men bare at der er bare nogle universelle ting som spiller ind, hvis man kan fange opmærksomheden, hvis man kan lave de der breaks, hvis man kan bruge rummet osv. Det virker og det kunne de se, og det tror jeg er rigtig rigtig fint at de får så tidligt ind, at selve den der sådan performancedel sammen med det faglige det faktisk har meget at sige, det var de overrasket over, og det syntes de var sjovt.

I: Syntes du at det her forløb har været med til at skabe mere nysgerrighed og engagement omkring naturvidenskab?

TA: Klasse 1, har samfundsfag og naturgeografi

I: Så de har lidt naturvidenskab inde i studieretningen.

TA: Ja de har valgt noget til, jeg tror grundlæggende at de syntes at det har været sjovt, jeg har også spurgt dem ad og lavet nogle evalueringer, de har været glade for det, og den anden klasse jeg havde, havde været helt vilde med den der science dag... helt åndsvagt vilde med den.

I: Den dag hvor de selv skulle lave eksperimenter?

TA: ja, de syntes bare at den der afslutning, der hvor de... jeg tror måske bare at de havde haft en succes oplevelse med at de kunne løse den udfordring, og at de kunne klare det selv uden lærere og at de ligesom kunne se, hold da op jeg har faktisk lært noget. Det var helt klar en meget klar melding, at de kunne rumme den opgave der blev stillet. Ja jeg tror de blev lidt stolte, og det er jo fedt, at det var sådan det sluttede.

I: Ja, for man skal være effektiv som lærer på den science dag, man skal sætte dem i gang og så lige så snart de første elever er ved at være igennem, så skal man i gang med at holde afsluttende samtaler, løbende mens eleverne fortsætter med at arbejde.

TA: ja der er meget som lærer at holde styr på, og så kan man sige at det der så er udfordringen, det er at der så er en del splidtid for eleverne eller i hvert fald pause. Det er så det eneste der ikke spiller 100%, men så må de jo bare lave noget, og det gjorde de så også, men ja, man er rundt og man snakker, men jeg kan sådan set godt lide den form. For vi kan få spurgt ind til noget og hvis de ikke formulere det rigtig første gang, så har vi tid nok til at spørge ind til noget, så det virker fint.

I: Jeg synes, det var nogle meget fine øvelser de kom igennem i løbet af dagen. Der var både hypotetisk deduktivt, induktivt, og det dermed at de selv skulle koble alle ordene på de enkelte forsøg.

TA: Ja det virkede fint, man kan sige at det vi så gjorde forskelligt til den næste science dag jeg kørte... man kan sige at det første forløb i klasse 1, det var meget fysik ting de lavede, det blev det hurtig og det var det også på science dagen. Mens med den anden klasse der var det opdelt, så de fik helt klart noget biotek eller noget biologi artigt, noget med nogle petriskåle, også noget med kraft hvor de målte noget på sig selv, på science dagen var det noget med sammenhæng mellem længden mellem armene og hvor høj man er, også fik de ligesom set er der en sammenhæng, og den slags ting, også fik de lov at måle lidt på sig selv, også noget med at puste og se hvor meget lungekapacitet de havde og sådan noget. Så på den måde blev det mere opdelt i fag til dem, og det var jo fint nok for så kunne man sammenligne fagene og sådan noget.

I: hvordan fungerede det så, fik I så sammenlignet forsøgene da I var rundt og snakke med dem?

TA: Ja, men det var helt klart noget af det de havde sværest ved. Men det gjorde vi, og fik ligesom snakket lidt om hvad man kan se af forskelle når man måler på mennesker og når man måler på en kugle der falder ned, og få det element ind i det også, men man kan sige sådan karaktermæssigt at den ene klasse er der blevet givet 4 tal og resten over og i klasse 1 der var 7 og op over. Så det var som om alle har været med og havde fået en del ud af det.

I: Når de så er færdige med NV, tager eleverne så noget med sig over i de naturvidenskabelige fag? eller er det bare nu er NV-slut, vi smider det hele ud af hovedet og starter nye fag?

TA: Jamen det tror jeg de gør, altså den her måde at... at de kan se ligesom hvordan man laver et forsøg og hvordan man udtænker det, hvad der er bag. Vi kan også bruge det her med grafer i andre sammenhæng. Så forhåbentligt at de syntes det er spændende og at det er overkommeligt, at de ikke er for svært, men man kan sige at man kan godt gøre mere for at få det til at hænge sammen, det kunne man godt gøre. JA det kunne man sagtens, altså fx at få lavet noget mere med grafer i 1.g og sådan noget og få det til at spille, det ville være noget jeg godt kunne gøre mere ud af. Men næste gang er noget andet.

I: Hvad med samarbejdet med matematik?

TA: Ja, vi har jo lavet regressioner og den slags, og har snakket lidt med matematiklæren om at de også skal lave regression og sådan noget, man kan sige det der ligesom er ... det der ville være fint at gøre er at bruge de samme målinger i det program som matematik bruger, så eleverne kan se at det er det samme, men jeg må indrømme, at det samarbejde har ikke været det helt vilde. Og det tror jeg helt klart er noget som den nye reform vil styrke, eller bliver gjort klart, at nu må vi ligesom få gjort noget ved det. For selvfølgelig kan man det. Så det bliver der mere af. Men man kan sige, når man ser på hvad de har som udkast til den nye reform, så ser det jo ud til at det er det vi bare har lavet, altså det ser ud som at de er lineære sammenhænge det hele handler om i NV, og der kan man sige at de var det vi gjorde, så jeg tror hvis det er muligt vil jeg gerne fortsætte med det her med for at gøre det realistisk i tid, så ... at man så måske nedtoner eller bliver nødt til at droppe den der innovation og selvstændige del hvor de vælger noget og så kan de så i stedet vælge mellem nogle ting eller sådan noget. det er selvfølgelig lidt ærligt, men det er nu de rammer der er. Det er nok den vej jeg tror det går.

I: Fungere NV som den her introduktion til naturvidenskab eller kunne man ligeså godt have haft fysik eller biologi til at starte med og så fået det samme ud i sidste ende eller giver NV noget ekstra?

TA: Ja jeg syntes helt klart at man får noget andet, og det gør vi fordi vi har arbejdet på den måde vi gjorde, hvis vi nu bare havde haft om et eller andet emne og lavet det på samme måde som vi plejede, så havde det ikke været noget andet, men her der er det at vi har gjort det, at vi har fokus på det legende element og det undersøgende element og fordi vi har de rammer og der er tid osv., og ikke noget pensum, så har det givet noget andet.

I: Er det godt eller dårligt, at I har den her mulighed for at lege lidt mere?

TA: Jeg syntes det er godt, men det er en luksus man slet ikke er vant til, så derfor kan det også være lidt overraskende, men jeg syntes at det er godt. Jeg syntes også at når de er nye, så syntes jeg at det er rigtig rigtig fint at de får den oplevelse af at man kan bruge det her til noget der giver mening for dem og som... og får noget selvtillid med at de kan faktisk snakke videnskabeligt og bruge videnskaben til noget, som det selv har gjort.

I: Men du siger at du frygter at det er det man kommer til at pille af med den nye reform, altså at de selv skal komme frem til et emne men at de i stedet skal melde sig på nogle emner. Hvad tror du det vil gøre af forskel?

TA: Jamen det kommer til at blive mere ligesom det andet (mere lærerstyret forløb), problemet er jo også... og det er jo også det vi gør... man kan siger der er en bedømmelse i NV allerede nu, og det vi gør er jo også lidt... at vi tager højde for det i den struktur vi har lavet, på den måde at de får en karakter, som er basseret på det de fremlægger overfor den anden klasse også til science dagen og så til den afsluttende aflevering de laver basseret på science dagen. På den måde er alt det arbejde de har lavet og knoklet for, er kun en lille del af bedømmelsen, altså science dagen tæller rigtig meget. Der har vi jo valgt på science dagen, det kunne vi jo også have gjort anderledes, men der har vi valgt på science dagen at det er noget andet (andre forsøg), og det er simpelthen fordi hvis man nu er i noget der gør galt og hvis de skal vurderes sådan... hvis retfærdigheden handler om at de skal vurderes ligeligt, så vil vi risikere at det ikke bliver ligeligt ved at de laver et projekt hvor de kan gå i alle mulige retninger og de skal have lov til at lave noget der ikke virker. Og det har vi taget højde for at det arbejde ikke tæller med så meget. I den nye ordning, der bliver det en medtællende karakter, og det bliver en eksamen mere, og hvis det skal være en sammenlignelig sådan vurdering, i de samme sådanne kriterier, jamen så vil det være unfair for dem hvis de fik så åbne opgave. Man kan sige at hvis selve vurderings tingen er svær at få med i den der. Så derfor skal der være plads til begge dele og når de så skærer ned på tid, så bliver det den der del, projektdelen, den vilde del som vi bliver nødt til at tone ned. Hvis de skal evalueres på samme måde. Så nu må vi se hvor mange timer der er og sådan noget.

I: Det ligner at det kommer til at lande på 45 klokketimer.

TA: Ja og så er det også det der med hvor mange lærer er der inde over, for hvis det er 3 lærer i stedet for to lærer, Så er det i hvert fald noget andet. Men her er det mig der er med til at være NV-ansvarlig og mine tanker er, med hensyn til det nye er at vi laver et overordnet ramme, som egentlig bare er en overskrift, jeg tænker at det kunne fx være Liv og vand. For så kan man få en del fag med og vand det gjorde man meget da man startede reformen, så der er i hvert fald noget materiale og man kan lave forsøg med vand og det er jo nemt og til at have med at gøre og godt. Så det tænker jeg kunne være et over emne, også er der ikke mere end det overemne og så skal der være nogle fælles kompetencemål, som vi på vores gymnasium vælger at det skal de vurderes efter, og det er sådan noget med grafer og ting og sager går jeg ud fra. Så det ikke hedder at man skal have om drivhuseffekten og alle mulige fagspecifikke ting, så vi får noget fokus på kompetence i selve bedømmelsen og noget frihed til at lærerne kan lavet det, samtidig skal det også være muligt at lærerne kan lave det samme hvert år, også selvom de arbejder sammen med en anden. Det er jo et spørgsmål om lærer ressourcer eller hvor mange kræfter vi skal bruge på at lave det, så hvis lærerne skal overleve så skal det ikke være skræddersyet hver gang. Det er der jeg tror gym1 lander.

I: Jeg tænker er det muligt at kunne lave NV med alle klasser på en gang?

TA: Jamen det skal det jo være så. . . udover det skal vi lave noget ud af huset artigt, og det giver jo også mindre tid til den her ting, hvis vi bare skulle kører det samme som nu. For vi har ikke plads til at have dem her og hvis vi skal kører ud af huset og det skal hænge sammen med noget. Så skal de jo være et sted, så det giver mening, så der skal bruges noget tid på at det skal give mening... og problemet er at der næsten ikke er nogen steder der kan tage så mange klasser, for vi har jo nærmest 1000 elever. For hvis der er et sted fx Vest forbrændingen, de kan måske godt tage os men hvis de tager os, så er der lukket for andre gymnasier, for det hele er på samme tid.

I: Tak for at du ville deltage i mit projekt.

I: Mit speciale handler om at undersøge tværfagligheden i naturvidenskabelig grundforløb (NV). Jeg vil forsøge at undersøge om tværfagligheden ændres fra lærerplanen intentioner, til lærernes fortolkning af lærerplan, og til hvad der egentlig sker i undervisningen. Den måde jeg gør dette på er ved at bruge netværksanalyse, så jeg får et netværk der illustrere hvad lærerplanerne siger, nogle netværk for hvad du siger, og til sidst et netværk over hvordan aktiviteterne i undervisningen hænger sammen. Hvis du skal sætte nogle ord på hvordan det her NV forløb er strukturret og hvad I har gjort med klasse 1?

TB: Forløbet er strukturret omkring... sådan helt overordnet tænker jeg, at vi har valgt at have fokus på at vække noget nysgerrighed omkring naturvidenskab, det vil jeg sige. Og det som lærer A og jeg har tænkt var det centrale, var at eleverne selvfølgelig skulle, med udgangspunkt i nogle forsøg og noget viden, skulle oprette nogle færdigheder, man kan bruge naturvidenskabeligt. Men virkelighede skulle fokus være at få dem til at syntes at naturvidenskab er sjov og noget som man sådan kunne se sig selv i også fremadrettet, fordi jeg tror måske at vi begge to, det har jeg i hvert fald selv været... altså haft forløb hvor der er eleverne der melder sig ud fordi at de ved inden de starter at naturvidenskab er noget som de ikke kan finde ud af. Også tænker de at det er ikke noget for mig, det har jeg altid haft svært ved og det kan jeg ikke finde ud af, også så har de svært ved at applicere sig selv på det. Så fokus har været at få gjort det sjovt og få vækket deres interesse, og så sige at der er en masse ting som sådan almindelig underen som man kan omformulere, så det bliver naturvidenskabeligt interessant at arbejde med. Og det som vi sådan har gjort, er at vi typisk starter med at lave sådan nogle klassiske teambuildings øvelser og sådan nogle(øvelser) fra sådan noget innovativt undervisning, hvor man sådan løsner op for deres innovative kompetence, så de tør at begå fejl, faktisk, det er det som de handler om.

I: Så emnet var Myth Busters, og så skulle eleverne finde en nytte også kører eleverne selv og får vejledning undervejs. Og så laver I nogle få stops, med nogle enkelte undervisning gange både dig og lærer A, hvad bruger I de stops til?

TB: Vi bruger den jo til... fordi vi ved hvad de skal lave på den der science dag, så siger vi, vi vil godt give dem nogle færdigheder. Man kan sige at der kører to parallelle spor, der kører det spor der hedder at de skal være med til en science dag, hvor de skal lave noget, de skal lave nogle forsøg og de skal udarbejde en rapport(video) på baggrund af forsøgene. Hvor der så bliver mulighed for at give dem en bedømmelse. Hvor det andet spor er jo, at de skal arbejde med deres egne myter undervejs, men for at man ligesom siger at de bliver lidt klædt på til deres science dag, så det ikke er første gang at de fx. møder en vægt og første gang de møder termometeret til LoggerPro eller LabQuest, så laver vi nogle små øvelser med dem undervejs. Og noget af det vi sådan har fokuseret på, for lærer A er fysiker og jeg er naturgeograf, så det som vi har fokuseret på er nogle af de ting som jeg laver det er dem som handler om naturvidenskabelig metode, fordi det er sådan lidt af praktiske årsager at på science dagen er det meget praktisk at man er i et laboratorium, fordi så kan man komme rundt til eleverne, i stedet for hvis man nu bare sendte dem ud på en eller anden mark, så ville det tage en krig at komme rundt og tale med alle. Så det vi har lavet eller nogle af de øvelser jeg har lavet, det er nogle af dem hvor man arbejder med observationer og kommer med forudsigelser på baggrund af de her observationer, sådan som de i virkeligheden arbejder induktivt, når de bearbejder de her data. Så har de også noget hvor de arbejder, hvor man laver mere et laboratorie forsøg, hvor de arbejder hypotetisk deduktivt, sådan så man ligesom har set hvordan man arbejder der (i lab). Det bruger de jo selvfølgelig på science dagen, de her ting, men vi forsøge at få flettet det ind i deres egne myter, så de bruger begreberne undervejs. Men det er godt at have nogle øvelser, som ligesom danner et bagtæppe for at man kan tale om naturvidenskabelig metode og på samme måde for lærer A's vedkommende, så er det godt at der er nogle øvelser, hvor eleverne faktisk har prøvet at bruge noget af det her udstyr, som de skal bruge til science dagen. Så det er egentlig det der er ideen med de her små øvelser undervejs. Selve det faglige vi putter på er ikke... NV er jo ikke et fag hvor de skal oparbejde en kompetence indenfor hver fag. Så det er egentlig bare sådan hvad vi sådan tænker jeg. Medhenblik på hvad de skal lave til science dagen, tænker jeg at det kunne måske være lidt relevant, det kunne fx. have noget af gøre med at opvarme vand, så snakker jeg lidt om havtemperature og havstrømme, så det passer sådan lidt ind i geografi, og der er et naturgeografi forsøg som passer til de der ting, så er det meget logisk at sætte det ind i den ramme for mig. Men i virkeligheden kunne man jo godt af koble de to ting fra hinanden.

I: Nu sagde du det der med at eleverne ikke får fag specifikke kompetencer, men hvad er det så for nogle kompetencer i gerne vil proppe i dem i løbet af NV?

TB: Altså man kan sige at de skal jo have en kompetence i at arbejde i et laboratorie, de skal have en vis form for innovativ kompetence, og de skal også have en kompetence indenfor at forstå naturvidenskabelig metode. Også er der nogle af de sådan konkrete ting som er relevant at bruge fremover, sådan noget med at de ved hvordan man laver en graf ordentligt, og ved hvordan man opbygger en naturvidenskabelig rapport er også en af de ting vi tænker er væsentlig for dem. Ja, det er vel egentlig det. Så man kan sige at det er nogle af de der helt basis eller fundamentale ting som alle de naturvidenskabelige fag i virkeligheden kan bruge, tænker vi.

I: Hvis du lige skal sætte et par ord på klasse 1, som har været igennem jeres NV forløb som var meget åbent, hvilket betød at eleverne skulle styrer mange ting selv. Kræver det ikke at man har en klasse der kan rumme den udfordring?

TB: Jo, det vil jeg også sige. Altså ofte er det jo sådan at når man starter med 1.gere, og her på gym1 er det sådan at NV forløbene køre med vekslen med de her AP-forløb, så klasse1 de startede med NV og nu har de AP, og så er der andre klasser på skolen som har det omvendt. Til at starte med i 1.g klasser så er der rigtig mange af dem, som man få til at lave stort set hvad som helst, fordi alt er nyt når man starter på gymnasiet. Men jeg vil sige at i den her klasse (k1) har de været rigtig friske på at prøve de her ting, og de syntes at det har været sjovt og de har været gode på den måde at de har evnet den frihed der har været og ligger i forløbet, har de administreret på en rigtig fin måde. Det kan jo ikke undgås når vi er to lærer og nogle gange kun en der er sat på en hel klasse, og når man har sådan noget arbejde i et laboratorium, at der er nogle der står og ikke ved hvad de skal lave, hvad de skal gå i gang med eller er gået i stå eller andre ting. Og der har de været rigtig dygtige til ikke at blive meget frustreret eller begynde at lave alle mulige andre ting, der har de sådan set været ret gode til at koncentrere sig. Jeg har i hvert fald oplevet andre klasser hvor det har været svære for dem, så på den måde har de været en fornuftig klasse. Og man kan sige at den klasse (K1) er en samfundsvidenskabelig klasse, og det betyder jo at de har valgt efter at ikke at have den store pakke indenfor naturvidenskabs fagene. Og det afspejler sig jo også i sådan... den måde man ser det på oftest er at det sprog man bruger i naturvidenskaben er meget præcist omkring begreber, den tankegang har de typisk ikke. De har været gode på det sociale og på at demonstrere deres egen tid, de har været villige til at drive tingene fremad også når de blev frustreret over at der manglede batterier i den fjernstyret bil, som de skulle lave flyve hop med eller når de havde svært ved at finde ud af hvordan du skulle regne massefylden ud af de der balloner, eller hvad det nu var. Så har de faktisk været ret dygtige til at arbejde fremad, det syntes jeg.

I: Jeg tænker at når det er en samfundsfags klasse eller en klasse der ikke har valgt naturvidenskab, og dermed ikke nødvendigvis har en naturlig lyst til naturvidenskab, så kan eleverne nemt blive lidt skræmt af NV, men det syntes jeg ikke man så i denne klasse på nogen måde.

TB: Det tror jeg er rigtig, og jeg tror at der er nogen nu i klassen, og det ved man jo ikke, måske Lærer A ved det mere for han har dem jo i fysik nu, men jeg skal have dem efter nytår i naturgeografi. Men jeg kunne godt forstille mig at der var nogen, som forud for at de startede på NV forløbet, havde tænkt sig selv som nogen der ikke syntes at naturvidenskab er det fedeste i verden. Og jeg ved jo ikke om de så er vendt tilbage til det, for man kan jo sige at når vi så går væk fra NV, så går vi jo også væk fra den der meget legende tilgang. Jeg ved at lærer A har den i fysik undervisningen og jeg forsøger også at fastholde den i naturgeografi, men der skarpes de faglige krav jo i de fag. Men forløbet er super godt til... man kan sige at forløbet er super godt til de klasser som er gode til at sætte sig selv i gang med at arbejde og syntes at det er sjovt at arbejde med deres egne ting. Og det der med at bruge den projekt orienteret tilgang til at løse et eller andet problem. På den måde kan man sige at samfundsfags klasser faktisk er meget gode, fordi de tænker tit det der med at arbejde projekt orienteret omkring et eller andet emne, syntes de er rigtig sjovt. Det er ikke sådan, man kan ikke sige at det passer sammen, men i der her tilfælde gjorde det, men vi har ikke designet forløb så det skulle passe til klassen, det tænker jeg er et sammenfald. Vi har også oplevet klasser hvor det ikke rigtig gik.

I: Hvad gør man så?

TB: Der handler det om at man som lærer er hurtigt. Altså konkret kan man sige at de gange hvor lærer A og jeg har oplevet det før, har der været ting er skred lidt. Det gælder specielt i den der fase hvor de skal afprøve deres myter, der var et hold som havde meget svært ved at få sat skub i tingene, og de udfordringer som de mødte undervejs gjorde at de bare bakkede væk fra det og så tænkte jamen så kan vi ikke. Og så gik det faktisk lidt op i hat og briller. Det handler om at når man oplever sådan noget at man reagerer hurtigt på det, og den enkleste måde at håndtere det på er jo at hjælpe med at omformulere den problemstilling de står i. Der er selvfølgelig rigtig meget hvor man har prøvet at gøre nogle ting, som er ligne før, men man ved jo aldrig rigtig hvad der kommer, når det er sådan at det er helt åbent. Og det her ville lave sådan noget med Star Wars og de her lyssværd, om der var forskellige... jeg kan sgu ikke helt huske det... sådan noget med om flammer på farver har noget at gøre med... men vi kan jo ikke lave lyssværd, så vi fik det omformuleret til noget i retningen af forskellen når de målte på forskellige temperature, om der ændrede flammens farver. Det havde de bare rigtig svært ved at få til at virke, også prøver man ligesom undervejs at hjælpe, også går man videre rundt også i løbet af sådan en dag, hvor man har dem og der ikke rigtig sker noget, så kan jeg huske at vi gjorde faktisk det at vi omformulerede også lavede vi faktisk en konkret myte til dem. På baggrund af en relativ simpel myte, som kunne lave en masse data, så du skulle skyde en kugle ud og så skulle de kigge på vinklen, så det blev lidt katapult artigt, så havde de set en film med en blide som sender en stenblok af sted og så skulle de måle på vinklen. Så brugte vi de der små kanoner der kan skyde med stål kugler nede i fysik, det er sådan det yderste man kan gøre hvor man så siger, nå okay, så parkere vi det andet som I gerne ville, og så for at I får noget data så laver vi det her. Det er også noget med noget krig og ødelæggelse. Og hvis vi når det med flammerne så kan I jo forestille jer at der er ild i kuglen som i sender afsted. Så på den måde kan man sige, at når man oplever det der med at det skrider, så gælder det om at gå ind og styre processen.

I: I var to lærer på i mange timer, hvad gør det af forskel?

TB: Jeg har også prøvet at køre NV forløb, hvor det var meget opdelt. Jeg syntes at det at man er enige om hvor det er man skal hen, de to lærere der er tilstede, og det at man så er der på samme tid i klassen, det skaber en helt anden uformel og mere sådan laboratorie artig stemning, som man måske også kender fra universitets sammenhænge eller andre steder. Hvor det er sådan at man arbejder sådan løbende med sine egne ting, og fordi der måske ikke er så meget spildtid med at man venter på at få hjælp af en lærer, så rykker man ligesom frem i processen. Så får man også en rigtig god mulighed som lærer at komme meget rundt og få talt med eleverne, nogle gange gør lærer A og jeg det at vi går sammen rundt. Andre gange har vi sådan delt det op, så vi sådan set bare er hjælpere der ved hvor tingene ligger henne. Så når de spørger hvor kan jeg finde en lineal eller hvor kan jeg finde en fjeder eller sådan noget så kan man finde det hurtigere end at de selv skal løbe rundt og lede efter det. Så jeg syntes at man kommer på den måde, når nu det er dem selv der har fundet ud af hvad det er de vil arbejde med og det er dem selv der har designet deres forsøg og det er dem selv der også udføre forsøget. Vi sætter selvfølgelig de overordnet rammer, men når det er dem selv der sådan i detaljen bestemmer, hvad vil vi gøre i hvilken rækkefølge og hvordan skal det så ud og sådan noget. Som får man som lærer sådan en god rolle, hvor man sådan er medspiller på de der... og er en eller anden form for ekspert elev eller hvad man skal kalde det, man ved meget og det tekniske og man ved meget om det rent praktisk og man har prøvet en masse ting før og sådan noget, og man kan komme med rigtig gode råd. Det syntes jeg er den store fordel ved at vi er to af gangen.

I: NV har jo det der tværfaglige aspekt, syntes du at det her forløb formåede at være tværfagligt så det var naturvidenskab, der blev præsenteret og ikke fysik og naturgeografi?

TB: Ja det syntes jeg. Eleverne forstå lærer først og fremset som nogle faglige repræsentanter, altså jeg tror at de ikke har tænkt os som repræsentanter for fysik og naturgeografi, jeg tror de har tænkt os som repræsentanter for naturvidenskab eller NV, altså NV faget eller forløbet. Det tror jeg. Også har de godt kunne se undervejs at så kan lærer A nogle ting inden for fysikken og matematikken som jeg ikke kan. Og så der de nogle forskelle, men ellers tror jeg at de tænker at det er meget tværfagligt, jeg tror ikke de vil sige at lige præcist den her del af det var NG-delen og den her del af det var fysik-delen, jeg tror bare de tænker at det hele er sådan lidt NV artigt.

I: Det meget sjovt for jeg lagde mærke til at I stort set aldrig sagde jeres fag, jeg tror måske at det blev nævnt den første dag at lærer A havde fysik og du havde NG, og ellers blev det aldrig nævnt. Så hed det bare NV, tror du det gør en forskel?

TB: Ja, det er i hvert fald i talesat og det er jo også det der er hele intentionen med hele forløbet i sig selv. Så man kan sige at der er heller ikke rigtig nogen anledning til at understrege at den der faglige ting. Så på den måde så tror jeg det er det.

I: Så her kommer NV til at fungere som en introduktion til naturvidenskab?

TB: Ja, det er jo forhåbningen, og det tror jeg også det gør. Ja det vil jeg tro.

I: Der står jo i lærerplanen at de skal have nogle kompetencer, inde for praktiske øvelser, formidling, både mundtligt og skriftligt, syntes du at i når at komme rundt om alle de ting eller har i plukket nogle ud, og siger dem her prioritere vi som de vigtigste?

TB: Jeg synes at vi kommer rundt om tingene, jeg synes at de opfylder kravene, de laver jo skriftlige produkter, de laver jo eksperimentelt arbejde i laboratoriet, de formulere sig på naturvidenskabsk, hvis man kan sige det, specielt til science dagen, hvor de har en hel dag, hvor der ikke er noget skriftligt produkt som sådan men man tegner grafer, og så taler man om hvad de rent faktisk laver. Og hele vejen igennem er... på science dagen, jamen de bliver jo introduceret til tingene og vi gør et nummer ud af at sige: "I for lov at spørge, og vi skal nok sige til når vi taler bedømmelse, det kommer ikke til at være overraskende for jer, det er ikke sådan at I bliver bedømt hele tiden", men under bedømmelsen på science dagen der er det jo den mundtlige kompetence som bliver afprøvet der.

I: De der fremlæggelser du laver for den anden klasse, hvad bidrager de med?

TB: Et godt sådan pædagogisk fif, didaktisk fif er jo at man etablere et sådan forhold at der er en autentisk modtager til det produkt som eleverne skal lave. Og en måde at gøre det på det er at sige at de skal præsentere for en anden klasse. Man kan sige at det mest optimale ville være at de samarbejde med en eller anden virksomhed eller en organisation, og havde lavet et der lå i forlængelse af hvad den her organisation arbejdede med og der så sad nogle fagfolk på den anden side, som ligesom tænkte det er da interessant at høre hvad jeres bidrag er til det her. Så det er jo et eksempel på en autentisk modtager. Men en autentisk modtager er jo også en anden 1.g klasse som skal i gang med at lave et NV forløb efterfølgende eller når de selv skal sidde der, og så sige at hvad er det de rent faktisk selv har fået ud af det, for nu har vi selv været igennem det her. Så formålet med at modtageren sider der, og at de holder oplæg for hinanden, skifter jo selvfølgelig alt efter som man er dem der er først eller i anden omgang. Men de ændre ikke ved det faktum at der sidder nogen som ikke er ens lærer. Og så sker der også det at når man skal præsentere for nogen, så igen ikke er ens lærere, altså hvor det bliver præsenteret i det offentlige på en eller anden måde, det offentlige rum, så anstrenger man sig. Altså man ser... og det kender man jo fra sig selv, hvis man skal holde et eller andet oplæg foran nogle andre, og at man meget gerne vil give dem noget viden på en eller anden måde, så anstrenger man sig rigtig meget med præsentationen og med det arbejde. Og hvis det i gåseøjne er en enkelt person der ser på det på et kontor hvor døren er lukket også bliver det lagt i skuffen bagefter, så er det bare en anden kontekst. Så intentionen med at de holder oplæg for hinanden det er at få dem til at gøre deres ypperste for at den her afprøve deres myte og deres efterfølgende formidling er så god som overhovedet muligt. Fordi man kan sige at det er det der måske mest af alt minder om en eksamens situation, så står de selvfølgelig i grupper, for vi vil jo helst ikke kaste dem ud på for dybt vand. Det ville jo også være angst provokerende, hvis de skulle stå helt alene første gang foran en anden klasse, jamen så gør vi det i grupper hvor det er noget de er trygge i, de har selv arbejdet med det så de er godt inden i det og det er nogle jævnaldrende de står overfor. Men de har selvfølgelig nogle evner til at se med kritiske øjne og vi har lavet den der liste den anden klasse kan følge når de bedømmer dem, så til sidst bliver eleverne bedømt og så får de noget chokolade, alt efter om de vinder på formidling eller interessant undersøgelse eller hvor videnskabeligt det er. Så vi prøver ligesom at bygge nogle didaktisk greb ind. Så det er det der er intentionen.

I: Til sidst kan Nv noget særligt som vi ikke kan med de enkelte naturvidenskabelige fag eller skulle vi bare have haft flere timer til fysik, NG, Kemi og Bio?

TB: Det ved jeg ikke... i princippet ville man kunne de samme ting inde for de enkelte fag. Men jeg er stor tilhænger af tværfaglig tilgang til problemstillinger og jeg syntes at det giver rigtig godt mening at introducere dem for naturvidenskab, og naturvidenskabelig tankegang på den måde som det bliver gjort i hvert fald i det her tilfælde med det her forløb. Jeg kan godt lide at man forsøger at vække den innovative tilgang til problemløsning og ikke have så meget fokus på at det er nogle faglige begreber, selvfølgelig skal der være en ramme som handler om at vi er indenfor naturvidenskaben, så vi skal være præcise i vores håndtering af data og i vores anvendelse af begreberne, vi skal forstå metoderne og vi skal vide hvad det er vi taler om, vi skal forstå hvad en hypotese er og hvordan vi kan sige noget er falsificeret og så skal vi have nogle redskaber til hvordan vi behandler de her data. Og det tænker jeg at det kunne man lige så godt gøre i enkelt faglig sammenhænge, men f.eks. det der med at prøver at kigge på en problemstilling der har rod i en virkelig kontekst, nu var der så også nogen af myterne der var hentet fra film selvfølgelig, det kan man jo godt diskutere hvor virkeligt det er, men ikke desto mindre er det noget der optager dem fra den virkelige verden. Det syntes jeg giver rigtig god mening og det vil ikke altid være relevant at kigge på enkelt fagligt. Så det syntes jeg giver meget god mening, og jeg kan meget godt lide det selvom det er noget andet. Jeg syntes at det er fint.

NOTE: lærer X var lærer i klasse 2 (C2) og ville ikke deltage i projektet.

I: Mit speciale handler om at undersøge tværfagligheden i naturvidenskabelig grundforløb (NV). Jeg vil forsøge at undersøge om tværfagligheden ændres fra lærerplanen intentioner, til lærernes fortolkning af lærerplan, og til hvad der egentlig sker i undervisningen. Den måde jeg gør dette på er ved at bruge netværksanalyse, så jeg får et netværk der illustrere hvad lærerplanerne siger, nogle netværk for hvad du siger, og til sidst et netværk over hvordan aktiviteterne i undervisningen hænger sammen. Det her interview er det første i en række af tre og dette interview kommer til at handle om NV mere generelt og hvilket rolle NV har. Så kan du ikke sætte et par ord på hvad NV er for en størrelse?

TC: Ja, så det naturvidenskabelig grundforløb er et fag der introducere de forskellige naturfag og introducere til de metoder og den tankegang der er i fagene, sådan sagt helt overordnet. Så er der jo altid to fag der indgår, det betyder at det jo ikke på den måde er en introduktion til fagindholdet af alle 4 naturvidenskabelige fag. Så de to fag skal gerne være eksempler på hvordan er det man arbejder med naturvidenskab og så er der jo fokus på hvordan er det man arbejder på det metodiske osv.

I: Kan de enkelte naturvidenskabelige fag ikke lige så godt udfylde NV's rolle, så der er tale om enkelt faglighed som introduktion til naturvidenskab eller er NV så specielt eftersom der er flere fag der spiller sammen?

TC: Jeg syntes at fagene hver for sig hver især er eksempler på hvordan man arbejder naturvidenskabeligt og der er jo mange steder hvor fagene har nogle fællestræk og så er der nogle steder hvor fagene har deres egen art. For eksempel er de fleste af de ting vi arbejder med i fysik har en anden karakter end de ting man arbejder med i naturgeografi. Jeg syntes at det at man på den måde parrer fagene og holder dem op imod hinanden er med til at illustrere både nogle af de steder hvor der er overlap og nogle af de steder hvor fagene adskiller sig fra hinanden. Og principielt kunne man nok godt "bare" lade fagene være hver for sig. Hvis man som lærer er opmærksom på det, så facillitere elevernes overvejelser over hvordan de forskellige fag ligner hinanden og hvor de adskiller sig fra hinanden. Jeg synes egentligt at det er en god ide at man ... at man laver nogle nedslag hvor der er noget tvunget flerfagligt eller tværfagligt samarbejde, som der er i NV og i AT også. Jeg kan se at der er nogle lærer der prioritere det og nogle lærer som ikke prioritere det, og synes at det er vigtigt.

I: Er det nemmere for eleverne at se, at når man er 2 lærer, at de lærer hænger sammen med fag til en vis grad, at der så kommer, det her med der er 2 forskellige indgangsvinkler til naturvidenskab. Selvom vi i naturvidenskab snakker om at der er en metode, er der måske alligevel nogle forskelle tilgange til naturvidenskab. Så for at opsummere er det nemmere for eleverne, at der er 2 lærer i stedet for 1 lærer?

TC: Ja det tror, ja det tror jeg... jeg tror nemlig at når eleverne kommer at se er den skelnen svær. Den er ikke åbenlys, og det at de kan koble det til en lærer, så bliver det lettere for dem at skabe de kategorier der nu er. Men det afhænger jo også lidt at hvilken tilgang man har til det, der er nogen som gør meget ud af at præsentere deres eget fag primært og egentlig bare arbejder to enkelt faglige forløb også har vi et samlet emnet. Og så er der nogen der mere nedbryder grænserne imellem, og tager udgangspunkt i problemstillingen... og lidt afhængig af om man gør det ene eller det andet, så tror jeg at eleverne får et meget forskelligt udbytte af NV.

I: Hvad er det for nogle ting eleverne ligesom skal tage med sig fra NV, nu har du jo lidt hentydet at det ikke er enkelt faglig som fx et kernestof i fysik, men hvad er det så for nogle ting eleverne skal tage med når der som sådan ikke rigtigt er noget kernestof for NV?

TC: Altså det som jeg gerne vil ... jeg syntes det vigtigste er at de (eleverne) bliver introdukseret til naturvidenskabelig tankegang og sige hvordan er det vi arbejder naturvidenskabeligt. Og det er både i forhold til hvordan arbejder vi metodisk, at vi inddrager teori på en bestemt måde, at vi stiller nogle krav til hvad er en god teori og hvad er den dårlig teori, at de på en eller anden måde forholder sig til hvordan er det vi argumentere når vi arbejder natur fagligt, og at de har indsigt i at det både er et kvalitativt og et kvantitativt fag. Vi vil gerne regne på problemstillingerne, vi vil gerne kunne ... danne nogle entydige data sim vi kan behandle matematisk, at det er et empirisk fag, så at hver gang der er noget vi er i tvivl om at så håber vi på at vi på en eller anden måde kan opstille et eller andet form for eksperiment eller at vi kan hente noget empiri på anden vis, som kan afdække problemstillingen. Så det syntes jeg er en del af det faglige felt. Så ... vil jeg gerne have at de er motiveret for naturvidenskab, så det må også gerne være sjovt, og det må også gerne vise at faget kan være relevant og det er jo obligatorisk for alle studieretninger, og der kommer jo rigtig mange elever som ikke nødvendigvis er naturvidenskabeligt interesseret eller som ikke ser sig selv som en der arbejder med naturvidenskab, og der syntes jeg at det her er et af de første fag som de møder og de møder det ret massivt det fylder en stor del af deres skema i en periode, så syntes jeg at det er der vi skal gøre en indsats for at vise at de her faktisk har en relevans også selvom at man... at eleven ser sig selv som en der vil arbejde i en humanistisk retning eller i en kunstnerisk retning, eller i en samfundsfaglig retning eller ... vi har en hel del elever der også er på nogle idræts linjer og så har vi jo nogle elever der bare er fuldt med for nu gik kammeraterne på gymnasiet og det er jo det man gør, og måske ikke rigtigt har gjort sig en overvejelse om hvad de vil gøre med det. Dem vi jeg jo også gerne vise at det her fag, kan noget relevant for dem.

Så er der en ting som slet ikke ligger (står) i læreplanen, men for en stor del elever så kommer de til gymnasiet og så skal de til at finde ud af hvordan fanden er det at man arbejder som elev i gymnasiet. Og det handler ikke en skid om ... jo det handler jo også om noget fagligt, men rigtig meget handler om hvad er det for nogle forventninger der er til en elev, hvordan er det man arbejder i timerne, hvordan er det man ... hvad er det for nogle forventninger vi (lærerne) har til deres arbejdsindsats i timen. Fagene har jo tit nogle lidt andre vinkler end det de er vant til fra folkeskolen, fx er naturfagene langt mere matematiske og fysik og kemi nu er det splittet op, så hele det dermed at finde ud af: nåh ja men vi (elever) trorede egentlig godt vi vidste hvad det var at gå i skolen, men nu er det bare en lille smule noget andet. Og det skal.... skal de lige lære, og nogle falder meget hurtigt på plads og der er nogle som bruger i virkeligheden det mest af 1.g på at finde ud af hvad fanden vil det egentlig sige at være gymnasieelev, og er det i det hele taget noget som de skal. Så nogle af de mål som jeg har .... nu bliver det en lille smule fabulerende og overordnet. Men det vil være nogle af de ting jeg putter ind eller nogle af de overvejelser jeg gør når jeg laver min læreplan og når jeg laver min undervisning.

En anden ting som også handler om noget andet end undervisning, det handler om teambuilding, det handler om at få en klasse til at fungere, og hvad hedder det ... det fylder bare virkelig meget for elever, jeg syntes at man kan godt som gymnasielærer have en tendens til at syntes at fagene jo er det vigtigste i gymnasiet og jeg tror at hvis man spørger de fleste elever så er det vigtigere at man er en del af fællesskabet og at øh... det her er jo en stor del af deres liv i den her periode og for dem er det vigtigere at deres liv fungere end at de lige nødvendigvis bliver dygtige til naturfag eller noget andet. På den tror jeg engang imellem så er fagene mere en kulisse, hvor det mere er den personlige udvikling der foregår og det er det der er vigtigst for eleverne i den periode. Det syntes jeg som lærer at man bliver nødt til at forholde sig til og at ... hvis jeg sørger for at mit fag er en god kulisse for det liv og at det stiller nogle rammer hvor de kan blive en del af et fællesskab og hvor de kan have det fornuftigt sammen, at så er det meget nemmere for mig at undervise eleverne end hvis min undervisning hele tiden er i konflikt med det projekt. Og jeg syntes at hvis man... hvis jeg lykkedes.... det gør bare altid meget lettere, og den forbindelse så kan jeg se for nogle elever, så bliver fællesskabet rent socialt, at det bliver et frikvarters fællesskab og at timerne bare bliver et afbræk for det der er det vigtige, og dermed bliver det en barriere for at lære noget, hvorimod at hvis ... når det lykkedes, så kan jeg sørge for at det fælleskab også bliver et fagligt fælleskab og at fagene på den måde og undervisningen bidrager til at de kan have det godt sammen og de kan have nogle gode relationer og at de kan udfordre hinanden osv. Jeg tror på at det også er sjovere og mere givne at være sammen om noget der er fagligt også, end hvis man kun er sammen om noget der er rent social. Giver det mening.

Hvis jeg skal gå ned og være sådan helt konkret med nogle af de ting jeg gerne vil have, så syntes jeg at for mange elever så handler det om at kunne se en sammenhæng mellem et fagligt begreb og så de data som det på en eller anden måde er relateret til og den virkelighed vi prøver at beskrive. I NV fx. lige nu snakke vi om at vi skal tage et tema der handler om kroppen og energi, så for mig så handler det jo om en forståelse for hvad ligger der i energi begrebet og at vi kan gå helt ned til at sige at nu kan vi måle på energi, vi kan måle på den kinetiske energi af noget eller på den termiske energi der er noget. Det kan vi ... bruger nogle symboler til at sige at nu er det energi det handler om, vi an sætte det op på en formel og vi vil gerne hen til hvor vi kan pege den enkelt parameter ud og give den parameter en talværdi og en enhed. Hvis de kan forstå, at vi kan gå ned på det der helt konkrete plan og rent faktisk stadigvæk siger noget om den overordnede faglige problemstilling de arbejder med. Så syntes jeg at det har lykkedes rigtig godt.

I: Nu skal vi til at snakke lidt om hvordan I kører NV på gym1, så hvordan er NV strukturret på gym α?

TC: Sådan som vi strukturret det her på gym1, er at NV ligger i løbet af det først halve år og at vi kører det i 2 faser, hvor halvdelen af 1.g har det i september - oktober, i et intensiv forløb, og den anden halvdel har det i fra slutning af oktober - midten af december.

I: så er der forskel, kan du mærke der er forskel, på eleverne i de to omgange?

TC: Ja klart, hvad hedder det ... fx. så er energi jo noget af det jeg tager meget tidligt i fysik undervisningen, fordi det er sådan et overordnet begreb, så .... hvis jeg har det andet hold, så har vi som regel arbejdet med energi i forvejen i fysik, og det betyder jo at jeg kan arbejde videre, også har de jo en forståelse for nogle af de fagbegreber vi arbejder med og har også allerede lavet eksperimenter. Så der arbejder vi jo videre for det udgangspunkt. Hvorimod når jeg har det først hold så skal de jo introduceres til det, så rent konkret så er der jo nogle af de elementer, som jeg ellers ville smide i et fysik modul, som bliver en introduktion til hvad er energi i fysik, og vi skal også lære at sætte en formel op, vi skal lærere hvad er forskel på symbolet og talværdien, og enheden. Så man kan sige at det er en lille smule et andet startsted og så er det klart at når jeg har det først hold, så bliver hele det her sociale, endnu mere væsentligt at få styr på.

I: Ja, der er måske nogle flere ting på spil i starten, end i de klasser der har haft 2 måneder til at blive rystet sammen på.

TC: Så... vi deler det op i to faser, så bliver det jo et intensivt forløb, hvor de har ... tror jeg en 34-36 moduler, som er afviklet over 2 måneder så det betyder jo at det har et ret stort volumen og cirka 4 moduler om ugen omkring det her. Så kører vi men to lærer på det, der har forskellige naturfag. så de på den måde... altså afsættet er jo tværfagligt, men på en eller anden måde bruger man jo sit eget fag, som eksempel på nogle af de naturvidenskabelige tankegange, eller det ser jeg i hvert fald 95% af lærerene gøre. Som regel tager vi udgangspunkt i et tværfagligt tema, og vi har arbejdet lidt frem og tilbage med nogle forskellige... der er blevet lavet såkaldte standard forløb hvor der er lavet et udkast til en problemstilling og problemformulering, og hvad er det nu det hedder... helt overordnet en modul plan, og nogle gange også nogle udkast til slides eller ... som man kan bruge.

Der er blevet lavet et NV hæfte som, lærer A, har arbejdet med som introducere til nogle af de ting der ikke er fag-faglige og dermed handler mere om det metodiske eller det mere overordnet omkring den naturvidenskabelige metode. Så gør vi som regel det at de arbejder med at holdet har en midtvejs evaluering undervejs, sådan så at først er der en introduktion til den faglige problemstilling, der bliver præsenteret nogle begreb, der bliver tit også lavet et par eksperimenter, der bliver gjort nogle overvejelser over hvad vil det sige at arbejde eksperimentelt, der vil være nogle introducerende tekster til hvad er naturfag og naturvidenskab og så får de(eleverne) en eller anden form for projektopgave som de skal arbejde med i gennem, tit de sidste 60 % af forløbet. Og når de har arbejdet lidt med det er der tit en midtvejs evaluering, hvor de præsentere hvad de re nået frem til og arbejder de videre frem imod en aflevering. Og der gør vi (lærerne) det lidt forskelligt, nogen ender med at de har en science-dag hvor de har en hel dag hvor de skal gennemføre eksperimenter og ende med at fremlægge, og bagefter laver de en skriftlig rapport.

Jeg har eksperimenteret en lille smule med at deres science-dag ligger lidt tidligere i forløbet og at de på science-dagen arbejder med det afsluttende produkt de skal lave. Og jeg har tit ... eller tit, nu har jeg gjort det tre gange, arbejdet med at de skal lave en poster, og at de skal lave nogle eksperimenter... så de skal lave en poster med deres egen lille undersøgelse som de så formidler gennem posteren. der er nogle krav til at de skal præsentere noget teori, de skal præsentere et eller to eksperimenter, de skal præsentere deres resultater og nogle konklusioner og en diskussion af deres resultater, og den arbejder de så med på deres science dag, og så kommer de til en afsluttende mundtlig prøve hvor de fremlægger deres poster, hos begge lærere. Og det syntes jeg egentlig giver meget god mening, fordi jeg syntes at ... jeg syntes at det er mærkeligt at man afslutter og så bagefter lavet en projektrapport efterfølgende, hvad fanden ... det bliver sådan lidt en form for appendiks, syntes jeg. Det bliver koblet fra på en eller anden måde. Er det sådan ok forklaret, eller er der mere omkring strukturen du gerne vil vide?

I: Ikke andet end at jeg tænker; hvor meget tid går der med eksperimenter, eller sagt lidt anderledes hvor mange eksperimenter kan I nå at lave i de her forløb med 34-36 modul?

TC: Det kommer an på hvad du lægger i ordet eksperiment?

I: Jeg tænker det kan være alt fra et demo-forsøg til eleverne laver noget selv mm.

TC: Som regel arbejder de i laboratoriet, to gange hos mig og så en eller to gange hos den anden lærer, også er der nogle som fysiske øvelser også hvis der er tid til det. Sidste år lavede jeg en øvelse, der skulle de have en introduktion til hvad er kinetisk og potentiel energi og så fik de en øvelse hvor de skulle filme sig selv, hvor deres krop havde en potentiel energi på X antal joule eller at kroppen havde en kinetisk energi på x antal joule og det ved jeg ikke om det tælle som et eksperiment, der er jo mere sådan en øvelse hvor der er en eller anden praktisk dimension også. Så på den måde... laboratoriearbejde vil der typisk være to eksperimenter i første del og så skal de selv udvikle og gennemføre en undersøgelse hvor der ligger et eller to eksperimenter i. Så det er måske i alt omkring fem eksperimenter eller undersøgelser. Eller en eller anden form for praktisk arbejde.

I: Nu siger du at I vælger et emne er det så skolen der vælger et emne eller er det jer som lærer?

TC: det er os som lærer team, med der er en paletten af ting vi ligesom kan trække indefra, og vi er principielt fuldstændig frie til at lave noget fra bunden af hvis vi vil, men det er bare også ... det er et godt sted at starte som udgangspunkt.

I: så når i sidder der og skal vælge emne er det så en problemstilling i tager udgangspunkt i eller er det fagene?

TC: Det er som regel temaet, og hvad hedder det... i år arbejder jeg sammen med to biologi lærere og så var vi egentlig ret hurtigt blevet enige om at vi tager noget med krop og energi, så er det et tema hvor vi let ser vores egne fag og hvor vi kan se et naturligt sammenspil, og hvor af fagene dermed også supplerer hinanden til at belyse en problemstilling som er relevant, og nu er den ene klasse en klasse med en idræts studieretning, så tænker vi at det forhåbentligt også er et tema, så appellere til eleverne, vi kan se at der jo traditionelt kommer mange af de der røre gøre elever på nogle af de studieretninger og vi kan se at mange af dem bare jo også vælger sådan en retning, fordi de er krops og idræts interesseret , og hvis de kan få lov til at måle noget på deres egen krop, så kan det godt være en måde at motivere dem på, også spiller det jo ind i forhold til den studieretnings identitet.

I: Hvad med sådan noget som matematik? Nu står der jo i lærerplan at der skal være et sammenspil med matematik, har I det?

TC: Ja det er en sindssygt svær øvelse og i praksis så er det noget vi hvert eneste år siger det skal vi blive bedre til. Og det har vi også sagt til os selv i år og det er bare ... det er svært syntes jeg, og jeg har endnu ikke fået det til at lykkedes.

I: Jeg kan se på Lærerplanerne gennem tiden at det er blevet et mere og mere specifikt krav, som er gået fra at der skal være et samarbejde med matematik til eleverne skal behandle et data sæt fra NV i matematiktimen, til det skal have relation til lineær regression. Det stiller dermed rimeligt store krav til et NV-forløb, hvis eleverne skal tage data med i matematiktimen, og den data skal ende ud med en lineær regression?

TC: Ja og man kan jo sige at ... jeg syntes ikke at den største udfordring er at daten skal ende i en lineær regression... udfordringen er/bliver at koordinere det med matematiklæreren, så at han er nået lige præcist der til, på en meningsfuld måde hvor at de kan lave lineær regression og jeg kan se i praksis at ... de rammer der er i gymnasiet kan godt en gang i mellem gøre samarbejde på tværs af fag vanskelige, at samarbejde 2 lærer jaja der kommer man fint igennem men at skulle koordinere det med en tredje lærer er i praksis rigtig svært... fordi han eller hun skal få det indarbejdet i sin progressionsplan og så ... nåede vi sku ikke lige at få lavet det data den dag fordi eleverne syntes det var svært at lave eksperimentet eller jeg kunne se at vi blev nødt til at gå dybere ned i begreber energi for eksempel, fordi det var bare vanskeligere for eleverne at forstå det end hvad jeg først havde forestillet mig. Så på den måde bliver vi nødt til også at have en eller anden form for fleksibilitet i forløbet så vi kan gribe hvad der nu opstår både af muligheder og problemer. Og det er bare sindssygt svært hvis vi så også skal kunne levere et data sæt til en lineær regression på en bestemt dato. Så vil jeg hellere lave det selv, hvis jeg skal være helt ærlig.

I: Sådan tror jeg mange lærer har det, så dække de det ind i deres eget fag altså matematik del.

TC: På de naturvidenskabelige fag eller dem der er på de naturvidenskabeligretninger de kommer til at lave lineær regression lige meget hvad. Så hvis de ikke når det i NV, så er jeg slet ikke bekymret for at det skal de nok nå i deres studietid. Og så er dem som arbejder med de andre fag(studieretninger), der har vi som regel noget der minder om lineær regression som de(eleverne) møder når de kommer i AT. Og det løber jo ud... så man kan sige at jeg er ikke bange for at eleverne ikke når at snuse til lineær regression i løbet af gymnasiet. Og hvis jeg nu skal være helt ærlig, så tror jeg at vi kommer til at arbejde med det så overfladisk i NV alene, at hvis de ikke arbejder med det senere hen så er den indsats vi gør lige gyldig. Så skal eleverne så ... de skal have kendskab til at vi er et kvantitativt fag, og at vi arbejder med matematik som sprog og at vi arbejder med data og det tror jeg er det som de for med sig, og at de har siddet og kæmpet med en lineær regression, så tror jeg at de eneste de får med sig er; at så lavede vi et eller andet underligt med et computerprogram, og det gør man åbenbart i naturvidenskab, så gave computeren der her og så var læreren glad. Og jeg tro simpelthen ikke at man når der hen, hvor man får en klar forståelse af hvad er det egentlig der sker. så bliver det noget løsrevet... hvor jeg tillader mig at syntes at så vil jeg hellere give dem en dybere forståelse for nogle af de andre ting.

I: Nu kommer vi lidt ind på hvad der er lidt mindre vigtigt i NV-sammenhæng, for der er jo mange ting de(elever) skal nå at for kompetencer inden for i løbet af NV; de skal have trænet den mundtlige kompetence, og den skriftlig kompetence, de skal lave noget eksperimentelt/praktisk arbejde, og de skal have fundet ud af hvad den kvalitative og den kvantitative metode er. Så der er rigtig mange ting/kompetencer eleverne skal kunne efter det her NV-forløb. Men tænker du om der er nogle ting der er mindre vigtige at for trænet under NV, tænker du? Måske nogle ting man skyder lidt over i de enkelte naturvidenskabelige fag, som de møder efter NV.

TC: Jeg vil sige at... jeg synes NV er introduktion og at jeg syntes at ... det som jeg syntes er svagheden og der hvor jeg syntes det kan virke er hvis der er en fornuftig progression mellem det de arbejder med i NV og det de arbejder med i AT. For hvis der ikke er en progression og sammenhæng mellem de ting, mellem de fag, så er det meningsløst. Jeg syntes ikke at vi på et intensivt kursus i starten af 1.g kan give dem... en blivende forståelse af hvad naturvidenskab er, det kan introduceres og eleverne kan snuse til det, men det bliver nødt til at blive taget op igen. Og på den måde syntes jeg også... føler jeg mig også egentlig ... jeg kan godt sige at jeg føler mig nødsaget til det, jeg syntes også i et læringsperspektiv helt fornuftigt at sige: vi vælger ud og vi skal sørge for at vi samlet set for dækket de ting ind, og heldigvis er der jo en sammenhæng mellem lærerplanerne både i de enkelte naturfag, og i NV og AT, så at hvis vi bare er nogenlunde fornuftige som kommer vi rundt om tingene og at ... så kan jeg også se at de fleste lærer flekser lidt, så ligger de lidt over i NV fra de enkelte fag også er der nogle af de ting der ligger i NV's lærerplan som vi jo alligevel arbejder med i fagene, så hvis vi ikke når det hele i NV, jamen så laver vi ... eller så lægger vi lidt mere vægt på det når vi så har faget eller når vi skal laver eksperimenter i fysik eller biologi , eller andre fag. Eller vi kom ikke så dybt ned i induktion eller deduktion så samler vi lidt mere op på det og lader der fylde lidt mere i AT. Og det tænker jeg er den pragmatiske løsning på den praktiske udfordring det er at komme i mål med den lærerplan.

I: Så her til sidst, hvad syntes du sådan om NV generelt, fungere det, fungere det ikke? Så når du står midt i det fungere det så, udfylder NV den rolle den skal eller?

TC: jeg syntes at der er nogle ting i NV, som ikke helt fungerer, noget er det handler om lærerplanen og noget andet handler om ... gymnasiet. Jeg syntes, at der er en tendens til at nu handler det om metode blandt andet, og at så er der mange som tænker, jamen så skal de jo have noget om naturvidenskabelig metode og det handler om hypotetisk deduktiv og det handler om induktion og det handler om kvantitative analyser og kvalitative analyser. Og det betyder at de kommer meget hurtigt op på et videnskabsteoretisk niveau og det kommer meget hurtigt op på et Meta plan. Og ... hvis skal tale om taksonomier for eksempel jamen hvis vi tager hele Meta niveauet, jamen så er det der hvor vi arbejder på de allerhøjeste taksonomiske niveau. Og det syntes jeg er hul i hovedet, at starte der. Og jeg kan de at det er der hvor eleverne bliver fuldstændigt fjerne også lærer de et par ord som de kan lirer af til eksamen. Og det videnskabsteoretiske niveau har de ingen ide om hvad fanden betyder. Og det syntes jeg dels at lærerplanen ligger en smule optil, og syntes især at det er sådan lærerne tit kommer til at tolke det, og hvis man skal gøre det til den der videnskabsteoretiske overvejelse over faget, så syntes jeg at det ligger helt forkert. Så syntes jeg hellere at de skulle ligge i 2.g eller 3.g, hvad ved jeg, hvor de havde nogle konkrete erfaringer med de forskellige naturfag også kan det her være en overbygning der samler op på hvordan er det vi anvender fagene i sammenspil med hinanden, kan vi trække nogle generelle træk ud, i forhold til hvad er de naturvidenskabelige fag og hvordan kan vi anvende dem til at belyse konkrete problemer. Det ligger også en lille smule i AT, hvis man tænker det på den måde, det gør man bare ikke i praksis, fordi AT jo ikke kun forholder sig til naturvidenskab men til hele paletten af fag. Så på den måde syntes jeg at hvis man har den vinkel på det, syntes jeg at det ligger forkert placeret.

Jeg syntes at hvis man ser naturvidenskaben som en introduktion, så skal man gå hardcore den vej, også syntes jeg at det er vanvittig meningsfuldt og så ligger det lige præcist på det rigtige sted. Så syntes jeg man skal trutte ren røv og sige lad os præsentere nogle fag... og selvfølgelig skal vi snakke om metode, men vi skal ikke gøre det i et videnskabsteoretisk perspektiv, vi skal gøre det i et fuldstændigt lav praktisk perspektiv, de skal vide, jamen vi bruger empiri, vi går ud og undersøger ting og den viden samler vi sammen, så hvis vi har et spørgsmål som vi ikke kan besvare teoretisk, jamen så går vi ud og undersøger det empirisk, og tilsvarende bruger vi vores teori til at tolke når vi får data, altså hvad fanden kan vi lægger i de her data, vi bruger vores teori til at inspirere også til at sige hvad kunne være interessant at undersøge. Så syntes jeg at når man taler om naturvidenskabelig metode, for mig der ligger i begreb metoder; hvad er det vi gør når vi lave naturvidenskab, så der ligger jo ikke kun hvordan er det vi bedriver naturvidenskab når vi går ud og laver front forskning, der er jo helvede meget rugbrødsarbejde som... altså som går hele vejen fra det helt overordnet videnskabsteoretiske til laboratorie teknik, hvordan er det vi arbejder hensigtsmæssigt i et laboratorium... vi bruger jo også tid på bare at samle viden ind, ikke hvor vi skal danne nu viden, men hvor vi bare skal bruge vores viden og metoder, jamen vi ved godt ... vi har en masse teorier om arternes udvikling og hvad ved jeg, det ved vi jo godt, vi skal ikke ud og lave frontforskning og blive klogere på den side, men nu bruger vi bare den viden vi har nu til at undersøge et helt specifikt vandhul for hvad vi har af arter her. Der er vi jo ikke ude at bruge hypotetisk deduktiv metode overhovedet, der er vi bare ude og lave nogle observationer hvor vi laver en form for rugbrødsarbejde.

Jeg syntes at det ville være en langt mere fremarbejdende at gå også sige at vi er lav praktiske, og det er den praktiske del af metoden vi lægger vægt på, vi er langt tættere på fremgangsmåden og det eneste overordnede de skal vide det er noget om at vi meget gerne hvis vi kan vil sætte... lave kvantitative data, vi vil ud og lave empiri, vi vil se en sammenhæng mellem teori og data, engang imellem kan vi opstille et eksperiment hvor vi laver variable kontrol, vel og mærket hvis vi kan, og engang imellem gå vi ud og laver observationer. For mig så er det, det niveau vi kan tale metode i 1.g i hvert fald i NV. Og det prøver jeg at overbevise mine kollegaer om... og det er også der hvor... hvis jeg skal have sådan min læringsteoretiske baggrund, hvor jeg siger er det her meningsfuldt, ud fra en konstruktivistisk tankegang, så er det der hvor vi kan bygge videre på det de ved i forvejen og det er der hvor vi er inden for zonen af nærmeste udvikling, det er vi ikke når vi taler et Meta perspektiv på fagene i 1.g som det første som de møder efter 14 dage i gymnasiet.

Det er der hvor jeg både syntes at vi som gymnasie, skal gøre os mere umage, og det er også der hvor jeg syntes at man i designet af lærerplanen skal gøre sige mere umage, det er at tænke fagene ikke kun som enkelte fag men se en progression fagene imellem, også se en progression i hvordan er det eleverne udvikler sig gymnasiet igennem. Der er jo en bred menneskelig udvikling igennem gymnasiet, noget af det er fagligt noget af det er socialt, og noget af det er rent personligt også skal vi jo sørge for at de(eleverne) bliver dannet bredt at de opnår faglige kompetencer og at de bliver studie parate og studiekompetente. Og hvis vi taget udgangspunkt i det projekt så syntes jeg jo sagtens at man kan opstille en progressions plan, også finde ud af hvordan er det at de enkelte fag bidrager til den samlede udvikling. Hvor jeg syntes at der er en tendens til at gøre det fragmenteret og det betyder at der bliver... at der mangler en logisk sammenhæng ind imellem og at jeg syntes at der engang imellem bliver opstillet nogle... fatamorganaer for hvad vi kan nå i de enkelte fag, som er urealistiske og som ser super godt ud på papiret, og som både kan være politisk ambitiøse og.... hvis man arbejder for et fagligt afsæt også kan se super relevante ud, men som mangler den der fuldstændig lav praktiske ting med hvordan er det vi får eleverne fra de møder i 1.g til de er færdige i 3.g. Hvordan er det vi skaber et sammenhængende forløb for dem. og den eneste vej vi som undervisere har er at tolke lærerplanerne meget fleksibelt... (grin)

2. runde

I: Nu har vi jo været igennem NV og jeg har været i to klasser (K2 og K3) hos dig, men hvordan vi de to forløb strukturret, for de var lidt forskellige?

TC: Hvad mener du med hvordan de var strukturret? Man kan sige at vi har jo begge to haft en tanke om at der er et endemål vi skal møde, ende ud i. Så der skal være en eller anden form for afsluttende projekt hvor de selv har skulle gennemføre nogle små undersøgelser som de har skulle fremlægge og at de i fremlæggelsen så skulle dokumentere de faglige mål der er for NV. det med at de skal kunne gennemføre små naturvidenskabelige undersøgelser, de skal kunne reflektere over hvad det er for en metode de har valgt, de skal kunne redgøre for om de har valgt en induktiv eller deduktiv, eller hvad hedder det en induktiv eller hypotetisk deduktiv fremgangsmåde, de skal kunne sætte ord hvilken type data de har fået lavet, og hvad hedder det... og der har skulle fremlægge et naturvidenskabeligt emne med brug af teori osv.

Så på den måde har det for begge to været endemålet, og i begge forløb har de skulle producere en poster, hvor de fremlægger deres undersøgelse eller to små undersøgelser for klasse 3 vedkommende hvor i klasse 2 var det en undersøgelse. Så man kan sige at det har været det endemål de har arbejdet frem imod, og så har vi jo så hver især forsøgt at få tingene nigaleret på plads, således at der var en fornuftig progression i forløbet. Jeg syntes, at det er lidt pussige, at i det sidste forløb (K3), det mindst planlagte forløb, blev måske det forløb der var strukturret bedst. Hvor det først (K2) er jo også bærer præg af at det var lige efter de var startet så der var nogle helt grundlæggende ting som hvordan fanden er det lige vi går i gymnasiet som også kommer til at fylde i et sådan forløb, hvor der i forløb (K3) nummer 2, har jeg også kunne... har vi bedre kunne udnytte at de har haft noget forhåndsviden som vi har kunne trække ind. Så vi har ikke behøvet at præsentere dem for særligt meget viden før de kunne gå i gang med at lave undersøgelser, hvor på det første så var der noget basis viden som de blev nødt til at have før de kunne stille de rigtige spørgsmål, ellers så blev det bare... ikke bare men ellers er der risiko for at de ikke kan få en interessant undersøgelse, fordi de simpelthen mangler noget faglig viden eller nogle fagbegreber til at forstå det de ser eller kvalificeret stille de rigtige spørgsmål. Var det sådan noget du tænker i struktur?

I: ja og så tænker jeg sådan noget med at klasse3 fik lov at teste at lave deres egen undersøgelse inden den endelige undersøgelse der gjaldt til eksamen. Hvor imod klasse 2 virkede lidt mere usikre, måske også fordi de ikke havde prøvet at arbejde selv før.

TC: Ja og man kan sige at det var jo også at ... forløbet i klasse 3 blev jo også en reaktion på at jeg kunne se på klasse 2 at de var for svært for dem på science dagen, og de var for famlende nogle af dem. Så derfor lagde vi det element ind tidligere, altså at de fik... ja at science dagen egentlig blev en gentagelse af hvad de havde lavet før.

I: Og fungerede det bedre? Fik eleverne en anden form for tryghed.

TC: Ja, jeg syntes at det fungerede væsentligt bedre, og jeg syntes at ... vi lavede jo også en pilot test på hel fremlæggelses delen. Og er syntes jeg, at jeg kunne giver dem noget konkret feedback på...

prøv at se nu fremlagde I det på den her måde, til science dagen kunne jeg godt tænke mig at I ... vi kunne jo se af mange af dem ikke brugte deres teori, så at sige at på science dagen vil vi gerne have at I gør lidt mere ud af at inddrage jeres teori, og forklare hvordan jeres teori har kvalificeret jeres undersøgelse og hvordan I ... vi lavede også en lille ændring i problemformuleringen, hvor at vi havde skrevet ... hypoteser efter formål, hvor i den første test sagde hypotesen efter teorien, så de i højere grad inddragede teori i deres hypotese dannelse, eller det var i hvert fald tanken, at det skulle være tydeligt for dem at det var det vi gerne vil have dem til.

I: Så det fungerede markant bedre måske?

TC: Ja det syntes jeg, men man kan sige at det er jo også en... hvor meget at det handler om at det var et bedre undervisningsforløb og hvor meget det handler om at de var nogle bedre elever, eller hvor meget det handler om at forløbet lå 3 måneder senere i deres gymnasieforløb, det syntes jeg er svært at vurdere. Men forhåbentligt har det været en kombination af de tre faktorer.

I: Hvordan syntes du at eleverne håndterede NV? Hvis vi nu kigger på klasse 2 først.

TC: Nu ligger det jo lidt tid tilbage, så jeg bliver nødt til at tænke tilbage ... hvad hedder det... jeg syntes at ikke du kan sige at de håndterede det på en måde, fordi at jeg syntes at der er relativ stor variation i klassen. Og der er ... jeg syntes at der var nogle grupper af elever, som jeg bare må sige at de håndterede det sku ikke særligt godt det blev for u-konkret for dem. Og de var for uambitiøse og der var en gruppe på tre drenge, som gik op og lave 2-taller hele bundtet og som havde brugt hele deres science dag på at lave et fuldstændigt minimalt forsøg, som de ikke helt havde gennemskuet og til eksamen slog de bare lidt ud med armene og sagde at det er jo fint nok... nå ja så er vi jo bestået, hvor jeg tænker, at der kunne jeg jo godt have ønsket at de bare havde hævet deres eget ambitionsniveau, fordi så havde de fået mere ud af det. Og tilsvarende var der en anden gruppe hvor den ene dumpede og den anden bestod med et 4 tal, men de havde lavet et forsøg, hvor de bare overhovedet ikke havde nogen sammenhæng mellem de resultater de havde lavet og de konklusioner de gjorde. Og at… de skulle lave et forsøg med en bold som hoppede og på en eller anden måde havde de fået stillet udstyret forkert op så deres resultater ikke gave nogen som helt mening, og fx konkluderede de at bolden blev ved med at hoppe med samme højde for det vidste deres udstyr, og når man så spurgte dem, jamen var det, det I så? så svarede de at det var det ikke, nej for når de så på det så kunne de jo godt se at bolden ikke hoppede på den måde. De havde på en eller anden måde været så lidt nærværende at det havde bare ikke slået dem som et paradoks og at det ene af dem er ret skarp og meget uambitiøse og den anden har virkelig svært ved det, så jeg tænker at de to grupper håndterede det meget dårligt.

SÅ syntes jeg at der var nogle andre grupper, der faktisk fungerede rigtig godt i den afsluttende del, nogle som startede med at være meget usikre men som bare havde en arbejdsdisciplin der bare gjorde at endte med at lave nogle gode resultater og lave nogle gode fremlæggelser og egentlig vise at de havde forstået fint hvad de kunne, og det syntes jeg at der især var to grupper som jeg syntes bonner meget ud på den. Og så syntes jeg at der var nogle grupper der lå der i mellem. Så hvis jeg kigger på hvordan de har arbejdet undervejs i forløbet, så syntes jeg... så kan jeg se at der var nogle der havde lidt svært ved at finde formen, jeg havde nogle del afleveringer undervejs hvor halvdelen af klassen kun havde svaret på halvdelen af spørgsmålene og at jeg syntes også at der var nogle timer hvor at jeg kunne se, at så længe at det var fuldstændigt strengt strukturret og de vidste hvad de skulle lave de næste 5-10 minutter så kunne jeg holde de til ilden og så snart at jeg gav lidt slip, så flimrede de ud. Så det kan man sige ... jeg tænker også at det er udtryk for at det er svært at håndtere processen undervejs. Så har jeg jo snakket med nogle af dem et par gange i forløbet, og der flere af dem der har givet udtryk for at det er meget meget svært ved at se hvordan de to fag spillede sammen.

Det må jeg sige at det kan jeg meget godt forstå, fordi det syntes jeg ikke blev særligt elegant håndteret af lærer X og mig. Og jeg tror at vi kom til at støde på at vi underviser på meget forskellige metoder, hvor lærer X har en stor træng og lyst til at være spontan og se hvad er det der rører sig i timen nu og hvad er det der giver mening at lave lige nu og her. Hvor jeg har en præference for at have en klar plan, og sige at vi har nogle delmål som vi skal nå undervejs og så kan det jo engang imellem blive en lille smule forceret, der er nogle ting der bliver ændret med jeg syntes det er svært at skabe et overblik for eleverne, hvis man ikke selv har lagt en plan. Og jeg tror at det clashede lidt, og jeg tror, at det også betød, at for mig var det svært at spille fornuftigt op af lærer X, fordi jeg vidste ikke hvor lærer X ville hen. Jeg havde svært ved at samle op på det eleverne lavede i lærer x timer, for jeg vidste det faktisk ikke rigtig. Så det syntes jeg også at vi må tage på os, at der fik vi ikke nødvendigvis vist hvordan fagene spiller sammen på en elegant måde. Hvis jeg skal se på resultatet så kan jeg også se at i det første forløb(k2) der blev der lagt mere vægt på, det at komme formidle et emne med brug af teori end der gjorde i det andet forløb.

For i det sidste forløb(k3), der syntes jeg at NV læringsmålene... stod meget skarpere og at de begreb, problemstillinger, som der ligger i NV, fyldte væsentligt mere. I det første forløb, så tænker jeg at det har været sådan noget 2/3 teori, eller 2/3 fagbegreber der blev introduceret og 1/3 metode begreber. Hvor I jeg syntes at den var minimum spejlet på det andet forløb, vi brugte ikke særlig meget tid på fagbegreber i det andet forløb. OG der syntes jeg til gengæld at mange af de her NV begreber fik lov til at stå stærkere.

I: Fordi Klasse 3 havde en faglig ballast, eftersom de havde haft noget fysik først?

TC: Ja altså både fordi at de havde en lidt større faglig ballast og fordi ... det var en anden lærer konstellation. Og lærer D, som var med i det sidste forløb, også havde en større forberedelses præference, og det betød at vi kunne bedre spille op af hinanden. Og jeg tror også at lærer D tillægger NV læringsmålene en større betydning end lærer x. Og så er det en anden klasse (K3), som har et højere abstraktions niveau, det er nogen som har valgt den studieretning, hvor det er naturvidenskabeligt orienteret. Hvor de andre der er naturvidenskab ikke det de har valgt studieretning på, det er noget der følger med. Og jeg synes at det er en klasse (K2) som vokser og som bliver dygtigere og dygtigere, men det hat også været en klasse, hvor der skulle bruges lidt længere tid på at falde til. Og jeg, og jeg ved andre undervisere, har skulle bruge tid på at finde ud af, hvordan er det lige præcist vi griber denne klasse, det er en meget fragmenteret klasse, hvor at der er rigtig mange kloge hoveder og der er også en ret stor gruppe der er umodne og umotiveret, som i starten fik lov til at sætte en dagsorden som de andre hoppede med på. Hvor nu er det de kloge hoveder, som sætter dagsorden. Men jeg tænker at det var en udvikling der ikke helt var slået igennem i starten af NV forløbet.

I: Ja det er en udfordring når NV ligger så tidligt. Har du haft begge klasser efter NV?

TC: Jo

I: Er eleverne blevet bedre til at udtrykke sig naturfagligt? Eller bruge nogle af de ting der har lært i NV eller vi nu gået ned i fysik?

TC: Hvordan er det, jeg syntes at i klasse 3, der syntes jeg jo faktisk bare at de er dygtige og at de er dygrige til at tænke naturvidenskabeligt, og at det er naturligt for den at inddrage de perspektiver. I den anden klasse (K2) syntes jeg også at der er eleverne der bare er dygtige, hvor jeg kan se at her der bygger vi bare videre på de her ting. Og så er der nogle andre steder hvor man kan sige, at der nogle der syntes det er svært og stadigvæk kæmper med noget af det basale, som stadigvæk syntes at det er mærkeligt at der er en enhed bag på et tal. Og hvor jeg syntes at... at de kæmper både med abstraktions niveauerne i fysik og de kæmper med det i NV, og det kan godt være at jeg også skal være mere skarp på at inddrage og bygge videre på i højere. Det bliver jo i højere grad når vi arbejder eksperimentelt for alvor, og det ved jeg ikke helt om er rigtig for der er jo nogle grundtankegange som vi henviser til i løbet af, men jeg syntes da...jeg synets bestemt ikke at Klasse2 er en dårlig klasse, og de får nogle udmærket karaktere i fysik de fik også nogle udemærket karaktere til NV- eksamen. Jeg kan måske syntes... nu er vi jo to der skal give karaktere, jeg syntes at karakter niveauet var lidt højere end hvis jeg skulle have givet dem selv.

Men jeg syntes ikke at det er en dårlig klasse, så på den måde syntes jeg jo at NV har hvert en del af den progression de(eleverne) har været igennem, og en del af den progression som de har rent fagligt, og jeg syntes at der hvor jeg har haft det største udbytte, det har været der hvor jeg har kunne henvise til nogle at de ting vi har arbejdet med i NV, når vi så har arbejdet videre med det. Men jeg syntes faktisk at det er mere... jeg syntes faktisk at det er lettere at gøre det (henvise) på de faglige begreber end det er på det metodiske. For det første forløb vi skulle arbejde med bagefter det har været energi, og det er de jo blevet introduceret til før, så har jeg kunne henvise til nogle af de oplevelser de har haft og nogle af de temaer de har arbejdet med undervejs. Så er der jo nogle lav praktiske ting, når nu at I (eleverne) laver eksperimentelt arbejde, hvad er det så for nogen ting som vi lægger vægt på. Sådan rent lav praktisk vi har noget teori som vi bruger til at kvalificere en problemstilling, vi arbejder med en fremgangsmåde hvor vi skal overveje de metoder vi bruger, når vi får et resultat så skal vi diskutere gyldigheden af de resultater. En gode måde at diskutere pålideligheden af det eksperiment og det eksperimentelle resultat, jamen det er ved at sammenligne dem med andre. Får de noget der minder om eller får de noget helt anderledes. Og hvad... og hvorfor er det relevant at forholde mine egne resultater til andre. Vi snakker noget om gyldighedsområdet, de data jeg har lavet hvilken gyldighedsområde har de, hvad kan jeg bruge dem til og hvordan kan jeg konkludere ud fra det data jeg har lavet.

Men jeg syntes jo svagheden i NV er at det ofte er et ... at nogle af de fag mål der er ligger på et for højt abstraktionsniveau for eleverne, og det bliver et Meta perspektiv på faget før eller fagene, så bliver præsenteret på et tidspunkt før at eleverne har et erfaringsgrundlag at lave Meta refleksioner ud fra, så jeg syntes, og det kan jo godt bare være at det er sådan min præference, men jeg vil meget gerne gøre det ned til nogen nærværende diskussioner som for eleverne, så at ... jeg syntes at det er lettere at diskutere fx, nu har I lavet de her resultater, nabogruppen de har de her resultater, I har lavet det samme forsøg, hvordan kan I... hvad siger forskellen på de resultater om kvaliteten af de undersøgelser I har lavet. Det syntes jeg er at bringe nogle overordnet naturvidenskabelige Meta perspektiver og overvejelser om empiri og empirisk metode, sammenhæng mellem data, teori og konklusioner ned på niveau, hvor det er nærværende og meningsfuldt for eleverne. Så det er jo sådan noget som fylder mere i min undervisning end en drøftelse af er det her en induktiv eller hypotetisk deduktiv metode, det bruger jeg ikke super meget tid på i NV heller ikke i min fysik undervisning. Også kan det godt være at jeg i et enkelt forsøg, hvis der er nogle elever der syntes, at det er interessant eller at jeg har nogle elever der skal udfordres ekstra, beder dem om at tage sådan nogle refleksioner ind også. Men ... ja... det er ikke sikkert at det fylder super meget.

I: Hvad med deres nysgerrighed, deres motivation og deres engagement for naturvidenskab er den blevet større? Man sige at klasse 3 har valgt det til på forhånd.

TC: Jeg ved simpelthen ikke...(tænke pause)

TC: Jeg ved simpelthen ikke hvordan det har bidraget, fordi jeg syntes at for mig har det jo handlet om en løbende progression på tværs af fysik og NV, og hvad hedder det... og jeg oplever... jeg syntes at der er to forskellige historier i de to klasser. Jeg oplever at i Klasse 2, at der er de, der syntes jeg at de langsomt er blevet mere og mere motiveret, men jeg tænker også at noget af det handler om at jeg har fundet en form og jeg har lært eleverne at kende, og jeg har opbygget nogle relationer til eleverne, og de har fået nogle erfaringer med faget og de har fået, for nogen af dem noget selvtillid og for andre så var det der i forvejen. Men jeg tror heller ikke at eleverne skelner, jeg tror også at de se det som en ... nå men vi har fysik, og i en periode var det i regi af NV, hvor der også var en anden en inde over. Men jeg tror de ser det som fysik undervisning og de ser det som min undervisning. Og det er der heldigvis mange af dem som godt kan lide og der er nogle enkelte som har svært ved at gribe den. Men det at jeg har haft dem i NV, syntes jeg det betyder, at jeg har haft dem nok til at jeg har kunne finde ud af hvordan er det den her klasse skal håndteres på fornuftigvis.

I: I starten i klasse2, var der et par piger det virkede sådan lidt halv bange for naturvidenskab, har NV været med til at pille det af dem?

TC: Mit indtryk er i hvert fald at der var nogen der fik nogle succes oplevelser, jeg ikke om du kan huske eleverne, men Pige 1, Pige 2 og Pige 3, de virkede sådan at de syntes godt nok det her var svært og at de var meget forvirret og udtrykte mange frustrationer i starten, men fik bare på et tidspunkt grebet det, du så dem jo arbejde med deres egen undersøgelse, der havde de bare taget konsekvensen og de havde slået et brød op som var overskueligt for dem, og de endte med at få rigtige fine karaktere tilslut og få følelsen af at hov det her det kunne vi faktisk godt. Så jeg er da helt sikker på at for dem har det både givet dem en selvtillid og givet dem en måde at arbejde med faget på, og opdaget at det faktisk kan betale sig, og de arbejder med det på den rigtige måde og det de er... det betaler sig for dem at ligge den energi i det, for det betyder faktisk at de rykker sig. Det tror jeg har været positivt for dem og det syntes jeg også at de tager med over i undervisningen efterfølgende når de arbejder med fysik.

Så er det jo sådan nogen som Dreng1, dreng 2 og pige 4, og tildeles pige 5 og pige 6, der bare er dygtige og de har også den der arbejdsomhed, til gengæld tror jeg at det havde været stor set lige gyldigt, fordi de havde det drive i forvejen også har det til gengæld bare betydet at de har haft noget mere. . . lejlighed til at arbejde med det og derfor er de kommet mere i dybden med det. Men på den måde re det ikke sket sådan et skifte i deres tilgang. Så er det den der gruppe med drenge, Dreng 3-7, og der oplevede jeg faktisk at de fik manøvreret sig selv ind i en blindgyde, hvor de kom sku ikke helt med på vognen og de endte ud med at lave noget lort. Og der har jeg oplevet at det faktisk har været en kvalitet, at vi har kunne starte på en friske efterfølgende, fordi det har betydet at... i det første forløb (i fysik efter NV) der var Dreng 3-5, bare på og jeg fik lavet nogle ændringer i måden at arbejde på, jeg lavede nogle faste markerer og hvad hedder det... placeret dem sammen, netop for at få dem ud af deres indbyrdes fællesskab og få den til at arbejde sammen med nogle andre som ... og det betød bare at i starten af det næste forløb der var de... der fik de lov til at starte på en frisk og der holdt dreng 6 og 7 lidt fast i nogle dårlige vaner, men det ser til gengæld ud til at juleferien og den første karaktergivning har gjort at de i hvert fald lige nu er opmærksomme på at der er noget der skal ændres. Og det ser faktisk ud som om de forsøger at gøre det. Så man kan sige at der ... at der har NV måske ikke gjort... men det kan man jo ikke sige, for det kan jo også være at NV har givet dem, nogle af de erfaringer, som sagt "Okay, den her strategi, den virkede sgu ikke, vi bliver nødt til at gøre noget andet ", men der har skiftet faktisk været godt, men det tænker jeg, at det handler jo mere om nogle dynamikker elever imellem end det handler om NV. Så jeg ved ikke om det er interessant for dig?

I: Det er jo meget interessant at høre hvad du synes driver det frem. Er det, det faglige eller er det klassekonstellationen og de elever, hvordan de ligesom møder hinanden. Jeg er efterhånden ved at være overbevidst om at det handler et om lærerne er strukturret og de laver et forløb som eleverne kan griber, altså om eleverne kan være med, og rigtig meget om hvordan eleverne ligesom sidder sammen, hvilken strategi er det eleverne vælger at ligge for dagen. Altså sidder der to i en gruppe der er hårdt arbejdende og trækker resten af gruppen op, eller sidder der to der måske fører på den sociale front, men måske ikke lige har en læringsstrategi og så får trukket nogle andre med ned.

TC: Men man kan sige at det er den sindssygt sjove i den klasse (K2), det er at de er faktisk meget følsomme overfor den struktur de bliver præsenteret for og at jeg syntes at de begynder at vokse og blive bedre, men især i starten at der kunne det være dag og nat. Man kan sige at noget af det handler også om at nu kender jeg jo eleverne godt nok til, at jeg ved hvem er det der er følsomme og hvem er det der kan manøvrere rundt i det og hvor er det at der er nogle lokomotiver der kan trække nogle andre med, og hvor er det at der er nogen som jeg skal være lidt ... hvad hedder sådan noget... hvor er det nogen der skal skærmmes, for hvis de får et puf i den forkerte retning, jamen så ryger de i den, hvorimod hvis de får et lille træk i den rigtige retning jamen så ryger de i den retning. Så det er jo interessant at arbejde med sådan en klasse. Og jeg syntes at lige nu har vi en klasse(k2), hvor 75% arbejder rigtig godt og så er 1/4 af klassen der har brug for noget opmærksomhed, men der er faktisk ikke nogen elever der melder sig ud. Det syntes jeg er en god succesrate og der er 2-3 elever, som virkelig kæmper og som får det hårdt, og jeg syntes ikke at det er givet at de kommer igennem gymnasiet, men det er som om at de virkelig begynder at ... altså den ene har hele tiden kæmpet og bare haft det svært, men dreng 6 og 7, virker som om de begynder at indse at det er vigtigt at få rykket og det virker som om især dreng 6, at han vil gerne gå på gymnasiet og han kan mærke at han faktisk bliver nødt til at gøre sig umage ellers er det ikke givet at han bliver der. Hvor at det kendetegnede de første 3-4 måneder at han virkede som om han faktisk ikke rigtig gad. Og dreng 7 har det også virket sådan faktisk lidt længere end dreng 6, at der virkede som om han gad faktisk ikke.

I: Du var lidt inde på det før da du kort berørte tværfagligheden, hvordan har det fungeret i de to forløb?

TC: Jeg syntes at det fungerede rigtig godt i Klasse3 og jeg syntes at det fungerede mindre godt i klasse2. Jeg syntes der var ... en blanding af at vi var skarpere på det sidste og jeg syntes at jeg kunne bruge nogle af de erfaringer for hvad der fungerede og hvad der ikke fungerede, og noget af det handler jo også om de konstellationer (lærerkonstellationer) der var og noget af et handler om klassen og tidspunk i forløbet. Så jeg syntes at alt pegede på... og det var også et nemmere forløb det sidste, fordi der syntes jeg at der lykkedes vi faktisk med det vi ville, og jeg syntes at vi lykkedes med at få fagene til at spille sammen på en måde hvor metoderne kom til at så i centrum, og hvor eleverne kom til at arbejde selvstændigt med metoderne og vi brugte metoderne til at belyse nogle problemstillinger og nogle emner.

I: Så i klasse 3, der fik elever også en forståelse af at der var en tværfaglighed og at fagene spillede sammen?

TC: Ja, det syntes jeg. I begge der syntes jeg jo at vi valgte tværfaglige problemstillinger at arbejde med, men de udtrykte også hele tiden, at det var svært at se sammenhængen i klasse 2. Hvor det syntes jeg, eller det biller jeg mig ind at de i højere grad oplevede et sammen spil i klasse 3. Og netop det at de arbejdede med... at hele sidste halvdel blev lidt mere tværfaglige projekter de arbejde med, som de selv styrede, tror jeg fik metoderne til at stå tydeligere frem. Og det at de hurtigt fik gennemført deres eget projekt og at vi kunne give en mere konkret feedback, og sige "det du har lavet her er et godt eksempel på en hypotetisk deduktiv undersøgelse fordi osv." eller "her kan vi godt diskutere om du har arbejdet hypotetisk deduktiv eller hvad du har" eller "denne her problemstilling egner sig måske mere til en induktiv undersøgelse og du kan få det induktive frem ved at arbejde på den her måde". Så er der jo nogen steder hvor jeg også bare må sige at jeg er en lille smule uenig i den måde man tænker induktiv undersøgelse på, både som der bliver lagt op til i vores NV-temahæfte og den måde som lærerne i talesætter hvad hypotetisk deduktiv og hvad induktiv metode er og hvad vi bruger dem til. Jeg hører jo rigtig mange lærer som siger" nå men induktiv undersøgelse, det er dem vi laver når vi ikke ved noget i forvejen", det syntes jeg er det værste omgang bræk, jeg nogensinde har hørt. Det er det godt nok ikke (henvisning til tolkning af induktiv metode).

Der er ikke nogle naturvidenskabelige mennesker som går ud og lave en undersøgelse om noget de ikke ved noget om i forvejen, tværtimod så bruger man i den grad sin viden, men det er jo netop metoderne og måden man angriber undersøgelsen der er forskellig, og jeg oplever faktisk at dem som arbejder med naturvidenskab laver en lang mindre skarp skelnen end det der bliver lagt op til i bøgerne. Så jeg syntes faktisk at det er et eksempel på, at der er et misforhold mellem den undervisning praksis og den videnskabs praksis der er. Og det som jeg har forsøgt, og som jeg syntes, at jeg lykkedes bedst med i NV, det er at sige; hvad er det vi skal bruge viden til og hvad er det for en... hvornår er det at det er oplagt at lave den ene type undersøgelse og hvornår er det oplagt at vi laver den anden type undersøgelse, og så er der nogle gange hvor modsætningerne blive forceret en lille smule, og jeg ved ikke... nogle steder har det jo givet lidt mere mening for mig at gøre det på den måde. Jeg tror ikke nødvendigvis, at det gør undervisningen dårligere, at læreren i lidt højere grad kan stå ind for det han underviser i.

I: Det er sjovt du siger det, for der er en der lige nu sidder og skriver speciale om det der er videnskabsfagenes metode er det, det sammen som metoden i gymnasiet.

TC: Men det er det ikke, og jeg har sjældent hørt andre end filosoffer der har været meget optaget af om det er hypotetisk deduktiv tiv eller induktiv. og at når jeg ser... hvad hedder det... videnskabelige artikler, så er jeg ikke stødt meget på, at man overhovedet har redegjort for om man har valgt en induktiv eller hypotetisk deduktiv metode i sit metode afsnit, det er som om at her der er virkeligheden som kun giver mening i et videnskabsteoretisk perspektiv på et niveau som er for højt for det som eleverne arbejder i, og som faktisk ikke afspejler sig i den naturvidenskabelig praksis, og hvor at det kan være interessant i et historisk perspektiv og selvfølgelig er det noget hvis man nørder metode hvor der er nogle nuance forskelle. Men jeg syntes lidt der er et missing link i det der er de faglige mål.

I: Hvad tror du der kommer til at ske nu her, med de elever der skal starte næste år, og ikke skal have AT men skal have naturvidenskabelig metode i NV?

TC: Pas... nu har jeg ikke gjort mig klog på undervisningsbeskrivelsen, men jeg håber jo at de lav praktiske får lov til at fylde mere og at jeg syntes at det der står stærkest det er... eller det jeg syntes er det vigtigste at tage med sig det er jo en nysgerrighed og så en viden om at der er et sammenspil mellem vores teori og de metoder. Og at naturvidenskaben ligesom meget er defineret ved sin metode som ved det videns grundlag vi arbejder ud fra og den er defineret ud fra det der er målet, det er at aflure, søge ny viden om naturen, rigtig anvendelse kunne være nogle andre perspektiver. Og at man forholder sig lidt kritisk til de resultater, både dem man selv lave og dem man bliver præsenteret for.

I: Hvordan med næste år når alle skal NV samtidig?

TC: Ja det drøfter vi, og det bliver et helvede for os, hvis vi skal. For det vil give os nogle overskuelige flaskehalse. Men hvordan vi i et 3,5 måneders forløb skal kunne lave to heat, det bliver også svært ikke, så bliver det nogle meget intensive forløb. Så jeg tror at det bliver en praktisk udfordring, som vi ikke helt har fundet ud af hvordan den lander bedst.

I: Her til sidst syntes du at NV, i Klasse 2 var det jo det første de mødte og klasse 3 der havde de haft fysik først, kom til at fungere som en intro til naturvidenskab eller blev det bare begyndelsen på de enkelt fag?

TC: Ja tror det kom til at... altså selvom jeg syntes at vi havde et stort fokus på metode, så tror jeg at et i elevernes bevidsthed er en introduktion til de enkelte fag. Og det handler ligeså meget om at jeg har den i fysik og dermed tager dem videre i fysik. Nu får de vist også kemi, som de er startet med her efter årsskiftet og jeg kan ikke huske om de også starter med at have biologi efter årsskiftet eller om det først er i 2g. Jeg syntes jo at der hvor det giver mest mening, det er at jeg syntes jo de skal møde en fælles progression i deres undervisning og derfor tænker jeg jo progression i min undervisning og i NV og tilbage til min egen fysik undervisning i en fælles progression. Det betyder måske også at de (eleverne) tolker det ind i den sammenhæng i højere grad end at de ser det som noget bredt naturvidenskabeligt.

Det syntes jeg er et åbent spørgsmål. Jeg syntes lidt, og det har vi jo snakket om før, jeg syntes at der er nogle gode intentioner og jeg syntes det er fantastisk at få lov til at lege naturvidenskab, og det syntes jeg er kvaliteten i NV, men jeg kunne godt tænke mig at det var en lærerplan der var bygget op om det. Altså den legende tilgang, hvor eksperimentet står stærkt og at de der Metaperspektiver bliver nedtonet. Og at de til gengæld... ja det er jo tabet ved at AT ryger ud, fordi jeg syntes at der hvor det for alvor giver mening for eleverne at tænke i nogle af Metaperspektiverne, det er i 3g, hvor de har erfaringer med fagene og hvor de kan bruge deres egen erfaringer til at modstille fagene og holde dem op imod hinanden, og drøfte nå ja men i biologi har vi arbejdet sådan her og i fysik har vi arbejdet sådan her, og i kemi har vi arbejdet sådan her, hvad fortæller det os om naturvidenskaben? Hvor er der fælles træk i de metodiske tilgange. Kan vi putte nogle begreber på som beskriver de fællestræk og kan vi også sætte nogle ord på hvad er så forskellen, og hvad er det i det genstandsfelt som de fag arbejder med som gør de forskelle naturlige osv. Det syntes jeg ville være fornuftigt, men jeg syntes at den form som det(NV) havde ikke var den skarpeste.

I: Mit speciale handler om at undersøge tværfagligheden i naturvidenskabelig grundforløb (NV). Jeg vil forsøge at undersøge om tværfagligheden ændres fra lærerplanen intentioner, til lærernes fortolkning af lærerplan, og til hvad der egentlig sker i undervisningen. Den måde jeg gør dette på er ved at bruge netværksanalyse, så jeg får et netværk der illustrere hvad lærerplanerne siger, nogle netværk for hvad du siger, og til sidst et netværk over hvordan aktiviteterne i undervisningen hænger sammen. Hvis du skal sætte nogle ord på hvad NV er for en størrelse helt generelt, altså hvad er det for et fag?

TD: Det er jo generelt en introduktion til naturvidenskabelig tankegang og begreber, metoder. Så vi prøver at gøre os umage med at det skal være en appetitvækker. NV skal altså være noget der giver os nogle elever, som ikke nødvendigvis troede at de var dygtig eller interesseret i naturvidenskab lyst til at beskæftige sig med et af de naturvidenskabelige fag. Så det er sådan en helt basis introduktion, men vi prøver også at gøre det lidt som en form for legeplads, hvor man kan interessere sig og undersøge nogle helt sjove og skægge ting, for der igennem at få metoderne i højsædet. I princippet kunne vi jo godt have et emne som sten, eller papirs fly, eller bølger. Det er jo lidt lige meget med emnet som sådan, så vi plejer bare at tage et emne som vi lærere syntes er sjovt. Så det ikke kun er eleverne men også os lærere der har det lidt sjovt.

I: Er der nogle særlige kompetencer, I som lærer gerne vil nå at træne eller udstyrer eleverne med i løbet af NV-forløbet?

TD: Jeg har lidt en kæphest med at jeg vil gerne lære dem(eleverne) at kunne indsætte tal i Excel ark, og lave nogle fornuftige grafer og dermed tænke over hvordan aksen skal deles, og hvorfor vi skal have enheder ud af akserne. Så sådan helt basis hvordan man præsentere data og forskelige præsentationsformer. Også lige så stille begynde at lugte til at formidling i naturvidenskab er lidt noget andet end formidling i sprogfagene. Det med at vi genre vil have det kort og præcist i naturvidenskaben, og at det er bygget op på en meget struktureret måde. Ikke fordi eleverne skal kunne lave en helt fantastisk fyldestgørende rapport efter NV, men bare lige begynde at lugte lidt til genren, det er også en af mine kæphest.

Kort afbrydelse af telefonopkald

I: Hvad er så mindre vigtigt at eleverne lære i NV?

TD: Det er netop så noget med at kunne skrive en helt rapport, jeg synes det er vigtigt at der er en progression, måske har de (eleverne) en ide om hvad resultater vil sige i en rapport, men det der med at vide, hvad en komplet fyldestgørende rapport er og kunne lave en, samt at have en masse faglig viden, det syntes jeg er meget underordnet. I forhold til det at gøre naturvidenskaben sjovt og hvad kendetegner naturvidenskab, det er noget med fakta, det kan være noget om naturen, kroppen eller sådan noget. De skal have et begreb om hvilken del af virkelighed naturvidenskabsfolk beskæftiger sig med og sådan lidt om hvordan man arbejder med naturvidenskab, det skal de lugte til. Den der dybe faglige viden ligger jo i fagene, og den store forkromede måde at formidle på det ligger også i fagene der kommer efterfølgende.

I: Hvis du skal karakterisere det NV forløb vi har været igennem, fx tema og klassen mm?

TD: hmm... hvad var det nu vi havde om ...

I: Jeg mener at det var energi og kroppen.

TD: Tjoh... altså... det skal jeg lige tænke over for jeg havde jo flere NV-forløb der kørte samtidig. Det jeg havde med lærer C, jeg kan først og fremmest huske at det var en dejlig lille klasse de var jo kun 22 og vi er jo vant til 28. Øm. . . Jeg lagde mig lidt i slipstrømmen, for jeg havde egentlig planlagt noget lidt andet, og så syntes lærer C at vi skulle gøre det på denne her måde. Og så sagde jeg egentlig bare Ja til det, fordi jeg ville også gerne være inspireret af hvordan lærer C plejer at køre NV. Så der var måske lidt bredere rammer, hvor de (eleverne) selv kunne vælge hvad de ville undersøge.

I: Ja, for de (eleverne) nåede vel at lave 2 undersøgelser selv?

TD: ja de lavede en hvor de præsentere en poster, hvor det ikke "gjaldt" men var en gratis omgang havde jeg ikke prøvet før. Jeg kan huske at lærer C skrev egne undersøgelser inde på 10 moduler i træk og det syntes jeg var voldsomt meget. Men det forløb jo rigtig godt, og jeg tror også at jeg lidt havde forstået at de (eleverne) kun skulle lave en undersøgelse, men de fleste nåede 2 og nogle nåede endda 3. så det fungerede egentlig fint, det der med selv at lade dem (eleverne) vælge og dermed have noget valgfrihed.

I: Det var en science klasse... så vidt jeg husker?

TD: Jo de var nemlig en science klasse, de var havde både fysik, kemi og biologi på B-niveau og så har de mulighed for at hæve det.

I: Gør det en forskel, at have en science klasse til NV end en anden type klasse?

TD: Ja det gør det, for de fatter jo pointerne hurtigere og de er naturligt mere interesseret fra staren. På den anden side elsker jeg også at have de sproglige klasser, hvor der ofte er en masse forvirret piger der går mere op i at se godt ud, som egentlig har en ide om at de slet ikke syntes at naturvidenskab er noget for dem, og så bruge NV til at fange dem, og se ind i deres store brune og blå øjne og se at de faktisk syntes at det er spændende det her naturvidenskab. Og der er også utrolig stor flittighed blandt de her sproglige piger, for når de lære et nyt sprog så sidder de jo virkelig og knokler med det, og det der iver og engagement tager de jo tit med over i biologi. Jeg ved jo ikke hvordan de vil have det med fysik kemi. Men I NV har jeg haft de der sproglige klasse hvor de har været vældigt engageret, så måske vil de føle sig lidt snydt hvis de tager fysik A niveau. Hvor det måske bliver mere hverdag igen, og ikke så meget lege som i NV. Men jeg har haft et rigtigt godt samarbejde med lærer C, men det er nok også fordi jeg rigtig godt kan lide lærer C personligt. Jeg har også talt med ledelsen om, at man måske godt kan lege lidt med, at man som lærer selv kan melde ind hvem man gerne vil være makker med, fordi jeg tror at kemien mellem de to lærer der har NV, betyder også noget.

I: Det der samarbejde man har med den anden lærer er det vigtigt?

TD: JA, altså det andet NV-forløb jeg havde var også godt, der var vi blandt andet i Tivoli og lave en masse sjove ting for de havde faglige dage. Så jeg var måske lidt negativ i forhold til at starte et forløb med lærer C, for vi kan jo ikke komme i Tivoli... det var så sjovt at være i Tivoli. Men det blev jo godt alligevel, det syntes både jeg og eleverne.

Kort afbrydelse telefon ringer.

I: I det forløb du har været igennem, lavede eleverne rigtig mange undersøgelser selv, men i de timer I nu havde kan du huske cirka hvor mange forsøg i lavede der?

TD: Jeg tror vi nåede at 2 eller 3 som jeg bestemte. Der var et med fordøjelsen, et med mikroskoper med røde blodlegemer. Så fordøjelsen lavede vi en del om, så to fordøjelses forsøg og et med mikroskop. Og jeg er så vant til at nå at lave 5-6 hvor det er mig det bestemmer hvilke forsøg det er. Men her fik de jo selv lov at vælge fra en lang liste, så jeg tror at antallet at forsøg eleverne lavede var nogenlunde det sammen som jeg plejer at nå. Men her var det mere eleverne selv der valgte, måske var lærer C lidt hurtigt til at skrive en masse fysik forsøg op, så det blev måske lidt meget fysik præget, men det var fint for mig, for jeg synes jo netop at metoderne skal være i højsædet.

I: Det var tydeligt at der var en progression i forløbet, det var mere bundet i starten og senere fik eleverne lov til selv at vælge undersøgelser. Kunne eleverne som sådan følge denne progression og de brede rammer eller var de helt på herrens mark?

TD: Ja, det syntes jeg egentlig godt de kunne, der var som sådan ikke nogen gruppen der vildt forvirret. Jeg tror også det vi gjorde (lærerne), som måske var en fordel var at vi havde meget eleverne med, vi havde udvalgt 2-3 elever der var med til at lave grupperne, så vi som lærere havde sat nogle skrabe kriterier op for hvordan grupperne skulle sammensættes, så vi på den måde sikrede os at der var nogle styrker i hver gruppe og samtidig noget kemi der passede lidt sammen. Altså der var måske en enkelt gruppe der haltede lidt men de fleste var meget gode til internt i gruppen at overveje fordele og ulempe ved at lave den undersøgelse fremfor den undersøgelse, også selvom den ene undersøgelse måske var nemmere at lave end den anden, men så kan man måske ikke få vist de begreber man gerne vil. For vi havde de der 8 begreber som eleverne gerne skulle vise, bl.a. kvantitativ og kvalitativ, modeller, hypoteser, som vi gerne vil have de skulle komme inde på. Min fornemmelse er at de (eleverne) tog begreberne med i deres overvejelser når du skulle vælge hvilke forsøg der var fordelagtigt og hvilke ting de skulle præsentere der til science-dagen og fremlæggelserne (eksamen) bagefter.

I: Så eleverne havde en science dag, hvor de skulle arbejde videre med den/de undersøgelser de nu var i gang med ?

TD: ja, og det var også noget nyt for mig, jeg har været vant til at science dagen, har været sådan at vi går rundt og interviewer eleverne mens de arbejder i sådan en form for værksted. Men her var det primært at de gjorde deres forsøg/undersøgelser færdige og så lavede deres postere. Så det var mere en ren arbejdsdag, hvor bedømmelsen så lå dagen efter.

I: Hvad var det så de lavede der skulle bedømmes til eksamen?

TD: Det var deres poster og så var de inde og fremlægge deres undersøgelser i de grupper de havde lavet dem i. Hvor de fik 5 min hver til at sige noget, så hvis de var 3 i en gruppe så fremlagde de sammenlagt i 15 min og så var der spørgsmål bagefter til dem alle sammen så det tog cirka en 30 min.

I: Hvordan fungerede det at have sådan en gruppeeksamen?

TD: det fungerede rigtig fint de supplerede hinanden rigtig godt, og især den der er lidt angst for at gå til eksaminer, de havde hinanden at støtte sig op af så det får noget mere tryghed. Ja jeg synes det var godt teamwork og jeg synes at de var gode til ikke... jeg var lidt bange for bag efter når der skulle stilles spørgsmål at elev 1 hele tiden vil svare, men vi formåede at spørge de forskellige elever, eftersom vi rettede spørgsmål til den enkelte elev. Og der var resten af gruppen god til at stå pænt og tænke sig om mens de ventede på deres spørgsmål. Så jeg syntes det gik fint og der var en afslappet stemning, mit indtryk var at eleverne var glade for det. Og at de også kunne forstå at de fik forskellige karaktere.

I: Var der mange grupper hvor de fik forskellige karaktere?

TD: Ja det var der faktisk, det var jo en kombination af hvad de sagde til fremlæggelsen og svarede på vores (lærernes) spørgsmål. Ja, og selvfølgelig hvad de havde skrevet på posteren, det havde de nemlig delt fint op i grupperne. Så det var faktisk ikke så svært at bedømme dem enkeltvis. Jeg tror faktisk at vi havde en gruppe oppe der fik fra 02-12 i samme gruppe.

I: Var eleverne forstående overfor den spredning?

TD: ja det var de.

I: Hvis du skulle vælge en måske to ting der fungerede rigtig godt i det her NV-forløb med lærer C, hvor du måske tænkte det her var nyt eller interessant det kunne jeg godt tænke mig at prøve igen?

TD: jeg kunne godt lide den ide at de selv kunne vælge hvilke forsøg de ville lave, fordi, som jeg også startede med at sige, at emnerne er som sådan underordnet og den specifikke faglige viden er ikke så vigtig, det er derimod metoderne og deres begreber der er vigtige. Så de (eleverne) kan lige så godt vælge noget der interessere dem, ligesom vi(lærerne) vælger det overordnede emne hvor vi synes at der indgår nogle sjove ting. Så det at eleverne selv havde mulighed for at vælge hvad de syntes var interessant ud fra en liste på 8-10 undersøgelser, og der fra valgte 1-2 undersøgelser ud fra listen. Syntes jeg var positiv. Jeg kunne faktisk også godt lide det der med at det var eleverne der var med til at lave gruppedannelsen, for de kan se noget dynamik i klassen som vi(lærerne) ikke selv kan se. Jeg kunne også godt lide at det endelig produkt var en poster så vi (lærere) ikke skulle sidde og rette de mange siders lange rapporter eller hvad vi nu vælger af opgaver. Og det er også meget fint at blive trænet i det der med at formulere sig ULTRA kort, altså ultra ultra kort fordi man har jo ikke meget plads med en sprit tusch på en poster, men alligevel er det vigtigt at man får sat det ordenligt op fx i en tabel eller et eller andet, og der var jo også mulighed for at printe grafer ud, så vi kunne få nogle ordentligt akser og sådan noget.

I: Så eleverne blev måske nødt til at tænke mere over hvordan de præsenterede deres undersøgelse(r)?

TD: JA, for det var jo meget begrænset plads de havde. De grupper der havde mange postere de havde 3 eller 4 med ind til fremlæggelsen. Det lyder måske af meget, men det er jo ret begrænset plads at beskrive alt det de(eleverne) havde undersøgt. Så de tre ting er nok det jeg ville pege på.

I: Har du haft klassen i biologi efter NV?

TD: Jeg skal have dem i den her uge, så jeg har slet ikke set dem siden.

I: Så må jeg trække lidt på dine erfaringer. Tror du, at eleverne tager noget med sig fra NV og over i de andre naturvidenskabelige fag bagefter?

TD: Både ja og nej. Der sådan lidt en tendens til at sige: NV nu er det afsluttet med en karakter, nu glemmer vi (eleverne) glemmer vi alt om det. Men når man som lærer alligevel graver i det så kan de jo godt huske både emner og metoder. F.eks. kan jeg se at nu kan jeg kører emnet om fordøjelsen ret hurtigt i denne klasse, fordi jeg kan bygge ovenpå de forsøg vi allerede har lavet, og det er jo meget sjovt, for det er jo også at arbejde lidt induktivt. Så kan jeg sige i klassen: kan I huske at vi lave de her forsøg i NV, nu kommer teorien. For hvad var det egentlig der skete med alle de her væsker i forsøgene. Så jooo, man kan godt bygge videre på det ... jo det skal jeg kunne sige og sådan skal det også helst være. Det er jo noget med netop at kunne begå sig i et laboratorium. Men det er mini fordi det(NV) skal jo være en appetitvækker og en legeplads ik', så det er jo ikke fordi man som sådan får en form for fundament i NV, sådan vil jeg ikke karakterisere det. Så det er lidt... forhåbentlig en form for positiv energi og lyst til det(naturvidenskab).

Sidste år eller forrige år havde vi et forløb om mysterier som vi havde fundet på, jeg ved faktisk ikke hvor det kom fra men det handlede om at Peter Pedal var død, og så skulle vi undersøge hvordan aben var død, og så havde vi alle mulige undersøgelser(forsøg) man skulle igennem, fx ballistisk pendul, altså man skulle se på nogle skudhuller, for vi har faktisk nogle "skydevåben" ovre i fysik eller luftpistoler. Så kunne man se hvordan de der patroner var gået ind og så undersøge hvor høj personen var der havde skudt, og på hvilken afstand personen havde skudt fra og sådan noget. Og det der med de der mordgåder, hvor de skulle finde DNA og lege efterretningstjeneste, nå ja og vi var også ude i sandkassen udenfor, altså sandgraven hvor de hoppen længdespring, for at se hvor dybe fodspor sætter man, så bar de hinanden på ryggen og sådan noget for at ændre vægten. Det var også et rigtig fint forløb, og der tog de meget det med at det var sjovt at have NV, og det kunne godt være lidt nedtur når de(eleverne) så skulle tilbage og have de enkelte fag. (citat elev): Nåh skal vi bare have biologi nu, vi (eleverne) syntes NV var sjovere. Der var noget i story tellingen der inspirerede dem, så det er altid godt med noget story telling. Jo så det er noget de(eleverne) tager med fra NV, men noget vi kan bruge til eksamen (i de enkelte naturvidenskabelige fag) er ikke så stort, i forhold til hvad de bringer med fra NV.

I: Hvis vi nu skal snakke tværfaglighed i NV, så er det jo fra ministeriets side pålagt at NV skal være tværfagligt. Syntes du det er muligt af opfylde det krav for NV? Eller er NV for kort til at det overhovedet kan lades sig gøre?

TD: Jeg syntes at det går udemærket, altså jeg kan godt lide at arbejde videre med den tankegang i fremtiden også nu med den nye reform (reform 2017), at eleverne ikke nødvendigvis behøves at kende hvilke fag vi(lærerne) har, altså at vi dermed bare er naturvidenskabslige repræsentanter, og så hvis eleverne spørger indtil det kan vi (lærerne) jo sagtens sige at kemi er typisk det her, og fysik er typisk det her. For nu vælger de(eleverne) jo ikke fag og studieretning på forhånd, så de skal jo have en eller anden ide om hvad det adskiller fagene, men at vi som lærere bare står som repræsentanter for naturvidenskab. Men at man også kan se at fagene kan give hinanden noget og at der er nogle synergieffekter. F.eks. at i kemi ville man lave denne analyse med i biologi ville vi nok lave det her i stedet for. Så ja jeg synes det går fint.

I: tror du at det gør en forskel at skjule hvilke moduler og lærer der høre til hvilke fag, man kan sige at på denne skole har i valgt at skrive i elevernes skema at de har NV, hvor på andre skoler står der NV-fysik eller NV-biologi osv.

TD: Ja, jeg tror det gør en lille forskel med ved ikke at skrive de specifikke fag på modulerne, men det der for alvor gør en forskel, det der er alfa omega i NV og så i så meget andet blandt andet AT er at lærerne holder en masse møde, man skal slet ikke undervurdere det der med at holde møder, og skrive til hinanden hvad der er foregået, hvordan virkede det overfor eleverne, hvad er vores grundtanke her. Man skal heller ikke "møde sig" ihjel, men lige i sådan noget tæt samarbejde som NV og AT så bliver man altså nødt til at holde nogle flere møder. Rigtig mange møder både under og før forløbet.

I: Har man tid og overskud til at holde alle disse møder?

TD: Ja det vil jeg mene det er jo en prioriteringssag, de har vi da.

I: Når jeg har talt med andre lærer synes de ikke der er tid til det.

TD: Det er lidt en dårlig undskyldning, det er nok ikke så pænt at sige overfor vores fag kollegaer, men det er guld værd, lige at stikke hovederne sammen, også selvom om det bare er 10 minutter, hist og her. Så travle er vi jo heller ikke.

I: Jeg lagde mærke til at i jeres (T Dog T C) forløb bad I eleverne om at skrive logbog, i hver time med hovedpointer for hvad de havde lært. Hvordan fungerede det?

TD: Det fungerede udmærket jeg synes eleverne var glade for det. De var meget flittige de kunne slet ikke stoppe når de først kom i gang. Jeg synes ellers jeg påpeget at det kun var det vigtigste pointer de skulle skrive ned i deres logbog, altså hvad har I lært. Det kan godt være man skal samle lidt mere op på logbogen til sidst og måske bruge dem til Science dagen. Det kom måske lidt til at hænge lidt. Ideen var god, men vi kunne godt have brugt lidt mere tid på det, og få lidt sammenhæng, det er jo deres egene personlige noter, i princippet er det jo ikke noget der skal rettes, vi kan bare lige gå ind for en sikkerheds skyld og se deres refleksionsniveau. Så jeg synes tanken er god.

I: Der står jo i lærerplanen at man skal have et samarbejde med matematik, lavede I det?

Afbrudt af telefon opkald

TD: jeg synes godt det kan være lidt krampagtigt, men det er igen noget med lærer kemi. Når man fx. arbejder med fysiklærer, der har matematik som sidefag, altså det hænger godt sammen med at jeg synes at eleverne skal kunne lave en graf og beregne nogle gennemsnit og tænke lidt over enhederne, jeg synes ikke det er det store. Vi(lærer) har også nogle gange lavet noget om lineær regression og så det jo helt naturligt at man taler om r^2-værdien, den værdi deres(elevernes) lommeregner udregner for dem, hvad vil det egentlig sige og x og y og koordinatsystemer og sådan noget. Jeg er aldrig så glad for når man skal lavet noget der er tvunget, men jeg syntes at de giver god mening når det kommer lidt mere naturligt, men jeg syntes ikke det er noget stort. Også med så noget kvalitativ og kvantitativ data, hvorfor er der en styrke i kvantitativ data, jo det er fordi vi kan lave noget matematik på det. Men som filosofi lærer diskutere jeg også nogle gange med eleverne, er matematik et naturvidenskabeligt fag? Vi kan jo blive enige om at det er et meget meget vigtigt redskab for de naturvidenskabelige fag og for samfundsfag. Så det har jeg ikke noget problem med.

I: Her til sidst syntes du at NV har et særligt potentiale eller kunne vi lige så godt have haft biologi eller et andet NV- fag fra starten?

TD: Ja det er et godt spørgsmål, hvis du virkelig giver mig kniven for struben og trænger mig op i en krog. Så tror jeg desværre at vi lærer heller bare vil i gang med vores fag stille og roligt, og det tror jeg også de fleste elever ville. Så nu når det er der så prøver jeg at få det bedste ud af det, det kan også blive rigtigt sjovt og interessant det der med at man fanger nogle elever, der måske ikke troede at de skulle have biologi eller kemi, det er det fint nok til. Men i forhold til hvor meget tid vi(lærer) bruge på det, netop det der når det skal blive rigtig godt, skal vi rigtig koordinere det, og det er sjovt at få indblik i en anden læreres tankegang og fag og sådan noget. Men i bund og grund ville jeg måske hellere have indlagt noget bundet samarbejde og så hed det biologi. Men jeg skulle samarbejde med en fysiklærer og matematiklærer og sådan noget. Så det var en mere naturlig del af biologi undervisningen. Og jeg ville også meget gerne gå på besøg hos hinanden og supervisere og sådan noget. men jeg syntes ikke tiden er helt nok givet godt ud i forhold til vi bruger rigtig rigtig meget tid på de her NV- forløb. Så det er sådan lidt ja-nej. Men egentlig ville jeg gerne have det indarbejdet i mit fag, mange af de gode elementer fra NV.

NOTE: lærer X var lærer i klasse 4 (C4) og ville ikke deltage i projektet.

I: Mit speciale handler om at undersøge tværfagligheden i naturvidenskabelig grundforløb (NV). Jeg vil forsøge at undersøge om tværfagligheden ændres fra lærerplanen intentioner, til lærernes fortolkning af lærerplan, og til hvad der egentlig sker i undervisningen. Den måde jeg gør dette på er ved at bruge netværksanalyse, så jeg får et netværk der illustrere hvad lærerplanerne siger, nogle netværk for hvad du siger, og til sidst et netværk over hvordan aktiviteterne i undervisningen hænger sammen. Hvis du skal sætte nogle ord på NV hvad er NV så for en størrelse?

TE: Ja hvad er NV for en størrelse... ja jeg er jo nok farvet lidt af det gymnasium jeg var ansat på før. Det handler om at give folk en introduktion til naturvidenskab, for mig er det forholdsvis meget om at de(eleverne) skal kunne se det her med at der er sammenhænge mellem tingene og der skal laves nogen eksperimenter, jeg synes den ide de (eleverne) har om hvad naturvidenskab er når de kommer ind på gymnasiet er for svag. De(eleverne) har nok fået det fortalt, men der er rigtig mange der aldrig rigtig har tænkt over det. Og måske er det fordi man ikke har modenheden til det i folkeskolen til at få det gjort, og når de så får modenheden til det i 8-9. klassen så har man fokus på eksamen også bliver det meget: "Nu skal du lave noget faglige ting" og dermed ikke så meget overvejelser omkring hvorfor og hvad er det. Så det tror jeg som sådan er det NV er (henvisning til hvorfor og hvad spørgsmålene) og det passer også med det materiale jeg bruger til NV, jeg lærer dem jo ikke tonsvis af nye ting, der ikke så meget fagligt, det er mere det at lære mange af de ting og begreber de(eleverne) godt komme i forvejen, og så se på dem på en ny måde fx skydannelse, vands faseform, densitet og sådan noget. De (eleverne) ved jo godt hvad det er, når det kommer til stykket, men måde at over hvordan man kan se sammenhæng mellem de her ting, det er den del jeg nok tænker er den vigtigste. Hvis jeg bare lige skal vælge en ting.

I: Nå men er NV så overflødigt? Kunne man ikke lige så godt have haft fysik i 10 modul mere?

TE: Det er jo et udtryk for et ønske fra nok nogle politikere om at de mener at man kan få folk(eleverne) til at opleve naturvidenskab som noget positiv og dermed få dem til at vælge deres studie-retning om. De (eleverne) skal have en eller anden viden om hvad det er de vælger af studieretning. Og det er jo tildeles rigtig nok at de (eleverne) ikke ved det på forhånd. Spørgsmålet er så bare om man kan nå at give dem et indtryk der er godt nok til de vælger om? Det bliver jo altid en eller anden form for effektivitets shit,der er nogle der vælger om, men min vurdering er at prisen er for høj. Men så kan man jo også sige et stykke af vejen man kunne godt have givet dem 10 fysik moduler mere, men så skulle de fysik moduler jo bare indeholde NV. Det største spild er nok der hvor man ikke får klassen bagefter, eftersom mit NV er jo lagt op til at det fortsætter, jeg tager noget at det jeg skal bruge i fysik og putter i NV. Men jeg vil gå så langt som at hvis man bare fik NV og dermed aldrig fik mere ... jo så har man også stadigvæk lært noget.

Hvis man kigger med effektivitets øjne på det, jamen så er det en underlig størrelse og det er meget forskelligt det de (eleverne) får. Så man kan ikke sige at alle (elever) har lært det og det når de er færdige med NV, det er meget op til den enkelte lærer hvad eleverne skal lære. Det er nok den største anke jeg har ved NV, det havner i en underlig størrelse at det er for småt, altså fysik C er jo heller ikke noget særligt dog har det en hvis størrelse så man(lærer) kan fylde noget i,NV ender med at være sådan noget, hvor man allerede inden man træder ind i forløbet kan se enden på det. Derfor bliver det sådan noget lidt forkrampet ... ik' , hvor der ik' er særligt meget op til en selv, det bliver mere, " jeg skal nå ... og der er den der eksamen og jeg har kun 12 moduler eller 18 moduler og vi skal også lave en masse eksperimenter", og inden man har set sig om så er det 3 ting man kan sidde og pille ved, hvor imod resten er låst, fordi man så let har lagt nogle krav ned om jeg synes godt jeg vil lave eksperimenter, det kraver så og så mange moduler, jeg vil godt have at de skal regne et par opgaver også. Og når man så nævner de ting, som man syntes burde være der, jeg så er man færdig. Og der kan man selvfølgelig sige at det er jo også meget godt, men jeg savner måske stoffet (kernestof). Og måske er det også bare mig der er for stringent og jeg kan jo se at andre lærere laver noget helt andet der peger i en anden retning. Og så er det jo bare hvordan man vurdere NV.

I: så det du siger, er at det er svært at lave et forløb, hvor eleverne for noget med sig, udover de for sat begreber på ting og måske får et overordnet overblik om det enkelte forløb?

TE: Ja, man kan godt få lavet et forløb, men det er bare ... jeg syntes lidt at det ... jeg når ikke der hen hvor jeg syntes at forløbet er rundet ordentligt af, og måske er det bare fordi jeg vælger det for stort, global opvarmning, som jeg jo bruger, er for stort et emne, så jeg sidder altid der når jeg er færdig og tænker du kan godt lige bruge 5 moduler til. Det ville jeg nok også gøre hvis ... ikke fordi man kan nå meget mere end det man gør. men man skal jo skære et eller andet sted og så har man jo skæret der, men problemet er lidt når man står og underviser sådan et forløb, så står forløbet lidt alene. Så står der sådan et global opvarmnings forløb der, hvor de (eleverne) har lært noget metode og godt nok har set problemet belyst, men det hænger jo ikke fast, før de har gjort det et par gange til.

Når man gør det i fysik C, så siger man i energi, så bruger vi nogle modeller, og de har mulighed for at tænke over dem, og så tager vi bagefter solsystemet. Godt nok et helt andet emne, men måden man resonere på er jo den samme, og når jeg så har taget solsystemet, så der lige noget om verdensbilleder, det springer vi lige henover, så tager vi lyd og lys og bølger, så tager jeg endnu engang og trækker dem igennem hele møllen om at det er sådan her du ræsonnere og nu begynder de sådan lidt nåh ok, det er sådan her naturvidenskab arbejder. Og så tager vi den en sidste gang med universet og så har de været det igennem fire gange og den er der... det er jo ikke en faglig gentagelse, det er sådan en ... hvad kan man sige en tankemæssig gentagelse, at man sætter sig ind i et eller andet emne og hvordan griber man det så an. Og det er vel egentlig også det, fysik går ud på, og det sker jo også i NV, men det sker jo kun en gang og en gang er for lidt.

I: Jeg kommer til at tænke på at du spurgte klassen, hvordan forelæsningen om naturvidenskabelig grundforløb havde været nede i salen, og der til svarer en af eleverne: "der var mange svære ord og det gik hurtigt"

TE : Ja og de ord de gået igen, det er vel egentlig også det der er problemet, nogle af de begreber bliver brugt igen i det næste forløb og dermed hænger de ved, men over itteration er der ikke så meget der hænger ved. Det er ligesom at få en skøjte lektion. det bliver man sku heller ikke god til at stå på skøjter af. Måske kan man nå at finde ud af om man kan lide at køre på skøjter, men det er sku ikke en gang sikkert. Så spørgsmålet er om det er en eller anden indikator, jeg kan selvfølgelig også godt se at der er et problem i at vi ikke kan bruge 200 timer på det, fordi så bliver det jo ... så har vi allerede givet dem hele pakken, før om vi kan se om de kan lide det. Jeg har det problem med det her at jeg ikke er sikker på at vi overbeviser nogen til at de kan lide det (naturvidenskaben) på den korte tid vi har. Måske, jeg ser det jo som en eller anden form for propaganda, fysik C er vel også i bund og grund propaganda, det er bare en reklamekampagne for fysik. for ... lidt hårdt sagt, der er få af dem (eleverne) som ikke kan rigtig meget fysik C når de kommer.

Politikerne forestiller sig at de skal hyre nogle folk til at læse naturvidenskab, og til det formål fejler det. Det fejler også til at være god undervisning, ikke at undervisningen godt kan være fin men den fejler i den forstand at sekvens eller mængden af timer er at lille at det ikke kobler til noget. Og det kan man jo selvfølgelig sige at den anke kan man altid have eftersom de jo er noget af det første de har på gymnasiet og at alt det første kobler ikke til noget, jo det kobler lidt ned i folkeskolen. Men det er der trods alt i mange af de andre fag for så fortsætter man jo så, at return of investment (afkast af investeringen) er bedre på de sidste moduler end på de første og detvil sige at afkastet på de første 10 -15 moduler, den får man lavt afkast af og det acceptere man fordi der kommer nogle moduler senere hvor man får noget afkast af at man har afholdt de første moduler, hvor som man ikke fik så meget ud af. Så på den måde er det noget eksponentiel vækst i hvor meget de (eleverne) lære, lidt hårdt sagt.

Problemet med NV er at her betaler vi bare prisen, vi holder disse underlige moduler med vi høster ikke gevindsten af at nu har vi sat dem (eleverne) ind i en eller anden tankemåde. Du forstår hvad jeg mener? jeg forestiller dig kurven, eksponentielt voksende af hvor hurtigt de lærer det og så vælger vi at tage starten og så konstatere vi at vi ikke høster resten. Og man kan så sige at det jeg så ofte gør, det er at min undervisning er planlagt så jeg føler lidt at hvis jeg har dem i NV og derefter i fysik jamen så høster jeg også resten, men hvis jeg har den i NV og det så er en anden der overtager dem i fysik så starter den person jo bare op med at lave en startsekvens hvor niveauet jo er lavere.

I: Så hvad er det egentligt eleverne skal have ud af NV i følge dig?

TE: De skal have en forståelse af variable og sammenhænge, og så noget om det eksperimentelle arbejde og hvordan man arbejder naturvidenskabeligt, og de skal jo ikke forstå det til punkt og prikke, de skal se at det kan lykkedes, lære at beherske nogle af ordene, det ville selvfølgelig være rart hvis de beherskede dem alle, men hvis de ikke gør så fred være med det. Og så se at det ikke er uoverskueligt, der er nogle af den der kommer med en tanke om at det her det kan vi ikke og der skulle NV gerne vise dem at det kan de godt. Det er propaganda-delen ik, og så på den måde... hot noterne er sådan set... og det bærer jo også ned igennem men det er jo fordi at de er materiale jeg har overtaget. Det er dog sjovt at tænke påat læreren jeg har overtaget materialet fra, så er skiftet; ala fint nok vi kan også gøre noget helt andet.

Jeg er bare så indoktrineret, så jeg holder næsen i sporet og siger at det er sådan her vi gør, og det er måske også fordi jeg er doven. Det skægge er at jeg kan godt se at dem der laver de der meget løse forløb giver eleverne nogle andre kompetencer, men jeg er jo bange for at det munder ud i af de(eleverne) ikke får noget ud af det og så fejler jeg på den del der hedder fik de en god oplevelse, hvis oplevelsen bare var de fik vi sku ikke rigtig noget ud af. Og det falder jo tilbage på læreren fordi at et stykke af vejen så grunden til at sådan noget går galt er at læreren ikke er godt nok forberedt, og lige meget hvor godt man er inspireret selv, så stoler jeg ikke helt nok på mig selv til at jeg kan lade de der åbne ting gå, sådan at jeg rent faktisk kan drive den frem, for jeg er bange for at hvis de vil så kunne de nemt undslippe min struktur og så sidder de bare og 16 moduler senere har de lært hat og briller. Så derfor tager jeg tøjlerne rimeligt meget, og det passer det forløb jeg har fået i hånden jo ganske udemærket på.

I: Hvordan er NV-forløbet strukturret her?

TE: Helt overordnet er det strukturret ved at der er ingen fælles struktur, man må altså gøre hvad man vil. De er to lærer på der er 36 moduler, der bliver afholdt et møde hvor man bliver parret op med sin marker og så finder man ud af hvad man har lyst til at lave. Det ligger i hvad lærerne har lyst til... og folk laver noget meget forskelligt, nogen laver noget med lys altså der er ikke noget fælles rent faktisk overhoved i det. Så det er sådan det er helt valgfrihed, jeg ville også tror at man godt kunne lave de der meget eksperimenterende forløb hvis man havde lyst, der er ikke ... det bliver ikke set som ... som noget ... men lidt underligt at forløbene ikke er inkorporeret, jeg var jo vant til fra før at alle var inde over NV(alle 4 fag grupper) og der var det jo sådan lidt at man sagde at vi jo ligeså godt kunne få nogle ting ud af det og der blev der jo lignet op med både matematik og fysik havde jo visse ting de skulle igennem, og NG(naturgeografi), Biologi og Kemi havde nogle ting de skulle igennem.

Så alle fagene havde et eller andet de sagde det vil vi gerne have med og det skulle være en LoggerPro øvelse(data-behandlingsprogram) bare fordi der arbejder man videre med. Men her har man fx. ikke fælles udstyr så nogen har LoggerPro og nogen har Pasco, så der findes ikke på sammen måde noget der for det hele til at gå op. Og det man heller ikke kan... man kan ikke en gang være sikker på at de altid har et fysik lager hvor der er ting, så det er i hvert fald svær at organisere på den måde.

I: Så I er to lærer der skal dækker alle 4 naturvidenskabelige fag eller dækker i kun jeres egne fag?

TE: Så det vist står i lærerplan, så er det noget med at vi må dække alle 4 fag. Det vil sige at jeg som fysiklærer tager mig af fysik og NG, og i mit tilfælde i år tager kemi læreren sig også af kemi. Så der er sådan det er strukturret og det vil jeg sige at hvis jeg skal sammenligne de to måde (her og før) at lave NV på, så er det en forbedring kun at være to lærer. For før havde man jo kun 8-9 moduler, så det blev meget kort og specielt..., men vi gjorde det ikke så meget, for man skulle jo have den i fysik lige bagefter NV, det skal man jo ikke her, her kommer fysik jo først i 2.g.

Men der er det trods alt bedre at have 18 moduler, nu er det også andet år jeg skal i gang med det, jeg synes også der var lidt mere... jeg nåede lidt længere sidste år. men jeg synes rent faktisk at i min verden kunne man ligeså godt smide den sidste lærer ud og så sige til den lærer der var tilbage lavet et eller andet forløb om naturvidenskab og måske behøves vi ikke alle fire fag eller det behøves måske ikke at være en bladning, man skal måske forpligte sig til at det måske ikke kun være et fag, og man skulle trække de andre ind bla bla ... altså trække de andre fag ind på eller anden måde i sit emne. Og så kunne man der med få 36 moduler, og dermed har man vitterligt fået en undervisnings blok som betyder noget.

Men så kan man selvfølgelig blive bange for at det altid er biologi læren, eller kemi læreren eller hvad det end er og så lægger man jo bare undervisningen ud så den forstætter snor lige over i det andet (det enkelte fag), og det var måske ikke lige det der var tanken med NV, men jeg tror at de 18 moduler jeg har med denne klasse er for lidt, jeg kommer højst sandsynligt aldrig til at se dem igen. eller måske ser jeg dem om er lille års tid hvis jeg får den i fysik. Men det ved jeg jo ikke.

I: Så har eleverne dette forløb, skriver de nogle rapporter undervejes går de til eksamen eller?

TE: Der er lagt 15 elevtimer (timer til skriftligt arbejde hjemme) ind, hvor noget af det kommer til at gå til omlagt skriftlighed (det vil sige at de for tid i timerne til at lave det skriftlige arbejde), hvis jeg ikke skal have den bagefter har jeg ikke til gene at bruge alt den skriftlighed. Så tror jeg at de(eleverne) får mere ud af at få respons på det de skriver end at få det rettet. Der er 5 timer til mig, 5 timer til den anden lærer og 5 timer til en afsluttende rapport hvor vi tager en dag hvor de er her oppe (på gymnasiet), hvor de skal lave en planche og svare på nogle spørgsmål. Det er 3 spørgsmål som de skal lave en planche til og så svare på de spørgsmål og så skal de fremlægge det til en form for eksamen. Så man ligesom afslutter forløbet, og det er noget med at de skal kunne svare på noget om kvalitative og kvantitative forsøg de har lavet under forløbet og noget med afhængige og uafhængige variable, og kigge på de eksperimenter de har lavet og så skal de svare på et eller andet spørgsmål om global opvarmning, jeg kan ikke præcist huske hvad det er. Det er fire forskellige spørgsmål, de (eleverne) kan vælge imellem og de erfuldstændigt stjålet fra det materiale jeg fik fra det tidligere gym.

I: Nu har vi jo i det første par moduler siddet meget i klassen, men hvor meget tid bruger du egentlig på eksperimenter?

TE: Lige har jeg ikke rigtig brugt tid på eksperimenter, men det skulle jo gerne starte nu, der skal jo laves eksperimenter i NV, ikke hver time men... indtil videre har de jo ikke lavet noget der har de jo kun regnet og snakket, men vi har også kun kigget på forskellige typer variable, men nu kommer der en densitets øvelse, og vi laver kogning af vand, og vi laver afbrænding af peanut, har jeg stoppet ind i det, det er det også laver jeg nogle få fremvisningseksperimenter (demo-forsøg), golfstrømmen, fordampning af vand og det er det, altså der er ... og så er det jo meget at eleverne arbejder med det der arbejdsark selv. Så der er vel en 3, 4, 5 eksperimentelle gange i dette forløb. Men det er jo det ... Jeg tror måske også selv at jeg er lige på underkanten af det hvor meget eksperimentelt der i forløbet i forhold til hvad der måske burde være. men altså ja... men det er sådan lidt ikke, at lave eksperimenter før man har lært noget, det er også sådan lidt meningsløst. de (ministeret) siger det skal være meget eksperimentelt, men det giver jo ikke mening når man ingenting kan og du skal have lært noget. Også er det også sådan lidtjeg kan... jeg skal passe på med at lave eksperimenter for det ender bare med at jeg laver fysik C- eksperimenter. Eller jeg skal ikke passe på men det ender jo bare med at jeg laver fysik C eksperimenter. Men indtil videre har jeg ... ikke smeltevarme, is og afbrænding af peanut og densitets øvelsen er det jeg har også nogle forskellige demo øvelser.

I: Så i naturgeografi laver de (eleverne) ingen forsøg?

TE: Jeg laver et par demoer, jeg laver det der golfstrømmen, det der med de der rør og farven (hhv. til forsøg om Grønlandspumpen), menjeg laver ikke rigtigt en ægte NG-Forsøg. Det burde jeg jo nok, sætte mig og finde på, du burdemåske være målet for i år. Vi skal ud og lave et forsøg i felten, det kunne jeg også syntes var sjovt. Men jeg har ikke tænkt det ind i året forløb. Nu er det også kun anden gang jeg køre forløbet og jeg tror også jeg har lidt mere tid i år, sidste år var det jo nærmest bare rent kopi fra det tidligere gym.

I: Hvad med matematik, der står i lærerplanen af man skal have et samarbejde med matematik i nv,

TE: STÅR DER DET!!!

TE: nå, ja jeg brude have krydset det hele af for jeg har lavet noget om variable og sammenhænge, så der vil jeg ... nej jeg har ikke lavet lineær regression, men jeg har lavet variable sammenhænge og det må være nok og så har jeg ... matematiklæreren må være mig dybt taknemmelig for at jeg har lavet afhængige og uafhængige variable. Ellers tror jeg ikke som sådan ... eller det er ikke noget jeg har bidt mærke i, og det er heller ikke sådan at matematiklæreren har været henne og prikke til mig. Men det skal sige at dem(eleverne) jeg havde sidste år var jeg selv matematik lærer i klassen, så der spillede det måske mere sammen, men jeg kunne godt prikke deres (de nu-værende elevers) matematiklærer han spiller med på hvad som helst. Men problemet er at det er mat C, så det er sådan lidt, jeg tror han (mat-læreren) har nok at kæmpe med,så jeg har nok ikke tænkt mig at stresse ham med det. Men der burde jo være et samarbejde, men der synes jeg og det er måske lidt pussigt men der syntes jeg at det fungerede bedre på det tidligere gym, at der var hold materiale til mat også. og det syntes jeg var godt. Jeg lider lidt under at man ikke kan få eksperimentel delene til det, men jeg ved ikke hvor man skal få fat i det. Det må du gerne sige til dem at de må de gerne genoptrykke, naturfagenes didaktik, det er fra 2002.

I: jeg mener Århus universitets afdeling der har lavet det

TE: Det kan måske godt være. Men de kunne godt lige genoptrykke kufferten med al materialet, det kunne Mærsk fonden da godt lige betale for, også give alle gymnasier i DK 3 kasser af det, det er nogle gode og sjove øvelser i. Men man har ikke materialet (materialet til at inkorporere Matematik.) Det kunne være man skulle sige det til nogen der kunne gøre noget ved det.

I: Nå men her til sidst for at runde det af, kommer NV til at fungere som en introduktion til naturvidenskab, eller er det mere en sekvens for sig selv?

TE: Den fungere MEN... den fungere som en introduktion men, intentionen bag den er jeg ikke sikker på at de (eleverne) får, altså de får en introduktion men at man forestiller sig at nogle elever skal vælge om på bagrund af NV ...

I: Altså motivationen og at nogle nye elever skal have øjnene op for hvad naturvidenskab kan på en anden måde?

TE: Så tror jeg ikke på det, jo det kan godt være at de får øjne op for det men jeg tror satme det er et fortal der sidder og tænker det er lige det jeg skal... og det har simpelthen noget at gøre med at der ikke er tid nok. Jeg tror ikke der er nogen der... ej et kan også være at det er mig der bare er et gammelt surt røvhul, men jeg tror bare ikke på at der er nogle unge mennesker som ændre sig på 36 modulers undervisning med to forskellige lærer, også at de (eleverne) kan se at der er forskellige typer lærer og den ene svinger de måske med og så siger de at det der er fantastisk, men ham den anden svinger de ikke med også cancellere skidtet sku lidt ud. Ja tror ikke ... jeg er ikke helt sikker på om man rent faktisk får den effekt man gerne vil have... Jeg er sten sikker på at der en nogen der lærer noget af det, og det er også det dermed ... lidt hårdt sagt, men introduktionskurser også selv på universitet giver ikke rigtigt noget, altså jeg fik sku ikke særligt meget ud af diverse intro kurser udover formel safari. Og det er måske nok bare fordi det hedder noget med introduktion, nv er jo sådan et introduktionskursus som man ikke rigtig tager seriøst, og så kan man jo selvfølgelig godt sige at nu prøver man at ligger en eksamen ned i, men fordi... det kan godt være at jeg er gammel og konservativ. Men fordi indholdet ikke er låst og der er så forskellige (fra lærer til lærer, gym til gym) så kommer det til at stå sådan og blafre lidt. Eleverne ved ikkehvad det er, og så siger lærer hvad det kommer til at handle om, men deres kammerater i de andre klasser får noget andet at vide, og så evaluere (bedømmer til eksamen) vi på sådan nogle vilkår(kriterier) vi selv skaber, dem skaber vi bare når vi kommer dertil.

I: Så hvad er udfordringen næste år når det skal til at være eksamensfag (nu reform 2017)?

TE: ja jeg tænker... det bliver.... jeg tænker at det bliver en katastrofe. Det bliver i hvert fald underligt underligt underligt for dem (eleverne), jeg kan jo ikke giver karaktere på baggrund af noget jeg selv har defineret. Altså noget jeg har defineret sammen med min kollega, jo så trække vi et tal op af en hat, det eneste ... mit stærkest argument har været at denne her karakter betyder ikke noget, for hvis de er overbevist om at den(karakteren) betyder noget så vil de (eleverne) gribe det sådan an at den .... ja jeg frygter hvordan det bliver, så bliver sådan noget hvor man kæmper for... og det er nv... og de vil ... de vil kæmpe for at lære noget fagligt for det er det de tror de vil få karakter for ik', hvilke jo også er rigtigt vi kan give karakter for faglige ting, men det er fandme svært at give karakter for naturvidenskabelig forståelse ik', hvor meget Feyman har du i dig?

Det kan man jo ikke måle, det bliver i hvert fald sværtog jeg ser det lidt som dette her give alle, muligheden og præmissen for at undre sig over verden, samt at kigge på verden og sige det her det er spændende og ser interessant ud, men det ikke målbart der er i hvert fald svært målbart også siger til dem (eleverne). det her det er målbart og vi giver karakter og det er fandme vigtigt ik', jamen så alle de ting der ikke er målbart siger vi skråt op til, giv mig noget... som jo er noget af det I (lærerne) lægger vægt når i vurdere til sidst og som åbenbart er det I mener betyder noget, ja så nu ender jeg så med at lære dig noget som ikke var det jeg havde lyst til at lære dig, fordi vi ikke kan evaluere på den naturvidenskabeliges ånd størrelse, som jeg ... og jeg synes i øvrigt et langt stykke af vejen at det er det eleverne syntes ser rigtigt spændende og de kan godt lide den der måde og at man får lov til at undre sig over verden, ikke alle men man kan få de fleste med på den der tanke om at det her det er spændende, men hvis vi bliver ved med at sige at vi ikke evaluere på det, så.... ja det bliver noget underligt noget. Der ligger et eller andet der som vi (lærer) måske er dårlige til at formulere, jeg tror du forstår hvad jeg mener.

Det jeg synes NV skal indeholde er meget svært af evaluere, fordi ... lidt hårdt sagt så handler NV om at skabe nysgerrighed og en interesse i naturvidenskab, det gør man selvfølgelig ved at lære folk noget fagligt men også ved at stille folk nogle steder, hvor man kan sige prøv at tænke over det her, det her og det her. Vi behøves ikke at finde svaret, men lige om lidt så evaluere vi forresten hvordan det her gik, også kommer eleven og siger at hvis du har tænkt dig (lærer) at evaluere og gøre det her seriøst, så vil jeg også gerne have svarene. Men det er jo det at stille spørgsmål og undre sig, det er en proces, det at man skal have svarene det er en anden proces.

Hvis I vælger at evaluere så vil eleverne også kræve at få svarene, og så bliver det lidt sådan...ahr... for det var jo ikke svarene der var det spændende, det var underen og den der fælles underen, som man sådan lidt... de der spørgsmål man stiller, jamen hvor man kan tage virkeligheden og trække ind , se en sammenhæng og sige kan I se det her, og vi når ikke helt til bunds i detaljerne, men det er ikke noget man kan eksaminere i fordi ... det er josådan nogen naturvidenskabs bull shit ik' man står og fyre af. Men de(eleverne) for en eller anden fornemmelse af hvad det er. Og den der begejstring, jeg så en dokumentar om Feyman, hvor en af hans tidligere elever sagde, det man jo skal passe på med... han (Feynmann) var en fantastisk lærer, men det der var, var entusiasme, og der var spændende og det var sjovt, og det blev man grebet mere af og man syntes at naturvidenskaben var helt fantastisk, men så nogen gange når man kom ud af lokalet så havde man det lidt sådan, at hvad var det i virkeligheden der var sket der inde, man havde ikke helt forstået det, men det skægge er og det er det jeg lagt stykke af vejen det jeg gerne vil have og tænker at NV skal opnå.

Vi skal have den der entusiasme ind i det og så skide hul i at de (elever) ikke lige i øjeblikket forstår det. Hvis bare de kan undres, så kan vi jo lære dem det faglige senere, problemet er så bare at når man ligger en skarp evaluering ned, så vil eleverne eksistere på at lære noget og ikke at jeg siger at de ikke skal lære noget.

I: Der er vel også nogle af de elever der igennem deres skoletid har fået af vide at de ikke er gode til naturvidenskab, det bliver vel ved med at være bange for det, hvis de ikke for plads til at blive trygge og tage det stille og rolig. give dem en gratis chance?

TE: JA helt sikkert og vi kan heller ikke lade der gå lige så meget inflation i karakterskalaen som der er gået nu. Når man begynder at tælle kan man jo ik' give den alle sammen 12 altså der bliver nogle gange givet pædagogiske karaktere i store mængder, det er jeg overbevist om. Der ud hvor man tænker: hun får fandme fordi hun knokler, og hun skal have moralen op, så giver vi sku hende 10, i stedet for 4 eller hvad man kunne have fundet på hvis man havde valgt et andet sæt kriterier ik'? Men når det nu kommer og karakteren skal til at tælle bliver det nok mere arhhh... ik'? Så bliver det for systemets bedste og ikke elevens. Og det er da synd. Der er da nogle piger der helt sikkert vil få en dårlig oplevelse, er jeg ret overbevist om. Og så kan man så sige, ja men der er nogen der også vil tage det mere seriøst, ja men de stager det mere seriøst på en sådan måde at undervisning måske bliver ringere, den bliver mindre nysgerrighed og mere faglig specifik, fordi det er det man kan bruge til den eksamen. Det er noget rod syntes jeg, det er i hvert fald det jeg kan sjusse mig frem til. Og det må godt sige til ministeret.

2.runde

I: Jeg skal lige have dig, til at sige et par ord omkring hvordan NV var strukturret her hos dig, altså det forløb du har været igennem?

TE: Ja, hvordan var det strukturret, det var jo stort set bare mit tidligere gym's forløb jeg havde importeret, der var en stump.... jeg tog noget fysik og noget naturgeografi, der handlede om klima og om vand, jeg går ud fra at du har det der vand-materiale, jeg har brugt og tog... hvad hedder det... og den anden lærer jeg samarbejdet med tog noget kemi og noget biologi, og temaet var global opvarmning. Også var det strukturret i en forholdsvis hurtig gang hvor vi laver lidt eksperimentelt, jeg tror måske ikke jeg er oppe på den maksimale mængde af eksperimentelt man kan lave. . . jeg er nok typen der godt kan lide at holde fast i dem (eleverne), menjeg vil da mene at jeg klarer mine 20%. Det kan du jo nok svare på. Også... mest fokus på forståelse ikke så meget på det faglige. Man skal have ideen om at man kan forstå det også laver vi noget om variable sammenhænge og så noget. Det var sådan lidt om hvordan det var strukturret, det startede med vandforløbet (fysik) og så sluttede det af med noget naturgeografi med lidt om klima og så slutter det med noget... hvad hedder det... så ser vi den der "En ubekvem sandhed", også er forløbet sådan set færdigt.

I: Og den afsluttende del består af?

TE: De fik en dag herovre, hvor de fik... lavede en poster eller slideshow som de skulle præsentere og der var en opgave hvor der var to spørgsmål eller var der tre. Der var to eller tre spørgsmål som de skulle besvares ud fra den poster.

I: Også gik de op individuelt bagefter eller?

TE: ja individuelt 10 minutter pr mand.

I: Hvordan håndterede eleverne det at have NV?

TE: Jeg syntes egentlig at de var meget gode. De var interesseret... jeg syntes sådan set at jeg plejer at have rimeligt godt fat i eleverne, det er i hvert fald det indtryk jeg selv har. Og jeg syntes at de plejer at være rimeligt glade for det jeg laver. Jeg er jo nok lidt kontrol freak, jeg er sku nok ikke til at de for lov at løbe rundt omkring i lokalet fordi det... nogle gange så føler jeg lidt at taber dem, og jeg er måske selv for ustruktureret til at få samlet hurtig nok op, det er nok der den fejler, for det kunne jo være rigtigt godt hvis de kunne få lov selv at løbe rundt og lave noget nogle gang, men hvis jeg ikke er hurtig nok til at få samlet op og bringe dem tilbage på banen, jamen så er der lige pludseligt gået et halvt modul på at skrabe folk ind og det er lidt noget rod. Så det er ret styret og der er ikke så meget af det der: "Hej nu skal I selv prøve at finde lige lidt på artig". Det er ideen om at man kan lære et eller andet, hvis man skal koge det lidt ned. Jeg vil gerne have at de gå der fra med fornemmelsen af at de kan lære noget naturvidenskab. Det her, det kan forstås.

I: Og lykkedes det så, blev det skab noget engagement og noget nysgerrighed hos elever i NV?

TE: ja det syntes jeg, man får indtrykket af at de sådan set syntes at det var spændende... jeg ved ikke om der var nogen der decideret skiftede (henvisning til studieretnings skift). Det jeg får fra dem, det er at det er fagligt spændende... så på den måde det tror jeg sådan set er fint, altså der holder de ved. Spørgsmålet er om man for eksempel kan sige at der er nogle af de der hjørne ... eller mindre ting som: bliver de stærke nok eksperimentelt, og det gør de sku' nok ikke, det er der nogle andre der må lære dem, og ... der er sådan nogle små ting hvor man tænker ahrr, og jeg syntes ikke tiden er til det, jeg føler at hvis jeg skal nå at lære dem det faglige og jeg er måske også typen, der lærer dem det faglige flere gange, jeg er vitterlig ikke bange for at sige det sammen 3 gange. Vi går hen over det igen og igen af den simple årsag, at de ikke er vigtigt for mig hvor meget de lærer, altså der er vigtigere at jeg efterlader et indtryk af, at de kan lære noget naturvidenskab, så er jeg sku ligeglad om vi har lært 5 eller 10 cm.

Når de går ud derfra skal de tænke at det kan godt lade sig gøre. Det er jo sådan lidt min personlige propaganda holdning, ej eller selvfølgelig må de jo gerne have lært meget men altså hvis det er således at der er noget de ikke fatter, så går de bare over de, og så gennemgår vi det bare en gang til, så ryger der jo bare noget ud i den anden ende. Jeg har ikke nogen... det skal sige at planen heller ikke er skåret i stål, så hvis det går hurtigt jamen så tager vi bare noget mere, hvis det ikke går så hurtigt jamen så tager vi lidt mindre.

I: Så her på Gym2, er det noget med at de først skal have fysik igen i 2.g?

TE: Jo de her de får først fysik igen i 2.g.

I: Når men hvis du så tænker på de 2.g hold du har, kan de så huske noget fra NV, eller referere du nogensinde tilbage til NV eller kommer NV til at stå for sig selv?

TE: Nu er det rent faktisk således at de fysik hold jeg har i år, der har jeg undervist dem i NV sidste år,og de kan erindre hvad det er jeg siger. for eksempel når vi snakker om fordampningsvarme og smeltevarme og sådan nogle ting.

I: Så de kan godt huske det faglige?

TE: Ja ja de har... det er jeg helt sikker på. Og energi bevarelse og alt muligt. Der er ... spørgsmålet er jo hvad er det, det er som de kan huske eller kan de genkende mig? Man skal lige passe på fordi at hvis du gik ud og spurgte dem om NV-ting, så er jeg sku ikke sikker på at de kan, men når jeg nu stiller mig op i lokalet og siger "kan I huske at sidste år så var det sådan, sådan og sådan" så nikker de alle sammen og siger jaja, eller 18 ud af 20 gør, og nogle siger måske højt ja det kan jeg godt, og det var sådan og sådan, og så kan jeg sige de rigtige ord og så nikker de genkendende. Men hvis der er en anden der spørger dem "hvad fanden er smeltvarme?" så tror nogle af dem ... eller mange af det siger det aner jeg ikke. Døren er nok stadigvæk lukket til mange af de andre fag eller andre lærer, men det tror jeg mere igen er ... det ved jeg sku ikke rigtigt hvordan man skal komme uden om. Altså det ligger jeg stadigvæk og roder lidt med, jeg tror også det gælder for mine 3g hold og man bliver sku lidt bange for hvordan det går dem til eksamen... om det går godt. Jeg har jo lært dem noget, som de kan sammen med mig, men på en eller andre måde skal jeg jo kaste dem ud... og det er jo der at det der arbejd selv er skide godt, for så er jeg der ikke til at tage imod og så skal de jo selv. Selvom jeg på en eller anden måde burde man jo nok gøre det noget mere.

I: Men det er mest det faglige du vender tilbage til det er ikke metode og sådan noget, eller det snakker man aldrig om igen?

TE: Jo jeg snakker også metode i både fysik og matematik, så jeg snakker om hvordan naturvidenskaben arbejder. I starten af 2005 reform puttede man noget om verdensbilleder ind i fysik , og det har jeg aldrig pillet ud igen, så det er i mit fysik C. Så vi snakker noget om hvordan man bedriver naturvidenskab, bare fordi jeg syntes egentlig talt at det er sjovt. Og det er jo også med til at fange nogle af de der ikke fysik-klasser.

I: Så der kommer der noget metode ind. Hvis du nu skal kigge på om der var tværfaglighed i jeres forløb. Hvad tænker du så om det?

TE: Det kommer an på hvad du mener tværfaglighed... Tiden gør at det bliver parallel forløb, vil jeg mene. Der er ikke nogen fælles plan og der er ikke nogen... vi har ikke sat os og... vi har jo snakket om hvad vi ville gennemgå og nogle gange kunne de (eleverne) også godt se... men det er ikke således at vi har brugt meget lang tid på at planlægge, så siger jeg det, så siger du det. Men stumperne passer jo sammen, det ved jeg. Så på den måde er jeg ikke nervøs, også er det jo kun et spørgsmål om hvilken rækkefølge kommer det i. Jeg var da der henne af, at jeg viste jo godt hvad der var henne i biologi og kemi, så engang imellem har jeg da referret til det, har I ikke set det her i fysik eller i kemi eller biologi. så. . .

I: Men forstår eleverne det at der er et tværfagligt forløb, eller tænker de mere nu er vi hos lærer x og hos dig?

TE: ej det syntes jeg jo nok at de rent faktisk godt kan. De kloge af dem kunne godt se det. Jeg tror at de havde forskellige opfattelser af om de syntes det var sjovt, men jeg tror sådan set godt at de kunne forstå det. Altså at det hang sammen og specielt til sidst når vi kigger på klima i det store hele.

I: Så de havde dannet sig en form for overblik?

TE: ja ja, det vil jeg mene

I: Hvad med matematik?

TE: Ja det har jeg jo nærmest ikke haft med inden over, for jeg har jo ikke ... jeg brugte jo godt... de har jo matematik på c niveau, så de er ikke de stærkeste i matematik, så der var ... jeg tror lidt at jeg... jeg gave dem lidt om variable sammenhænge og det. Men det gør jeg sådan set for fysik skyld, altså de 2-3 moduler kan man måske godt argumentere for at det er matematik der burde betale dem, men nu gjorde jeg det for matematik læren har sikkert travlt med at noget andet... der er nogle problemer med at nogen hverken kan regne eller sidde på en stol. Så tænkte jeg at det kan NV godt tage sig af, og det koster også nogle moduler, når man kun har 30 stk. i alt når eksamen er taget fra og alt det der, så er der jo 15 til hver (lærer) og så skal vi lave lidt dele øvelser og lidt andet også er der jo kun en 10-12 stykker tilbage, når man også har lavet introen (fælles forelæsning for alle klasser). Men altså de fungerede sådan set fint.

I: Hvis vi nu skal hæve os lidt op i et fugleperspektiv, passer ministeriets vision for NV med det man kan nå og det eleverne for med eller er det helt hen i skoven?

TE: Hvis jeg skal være helt ærlig, så kunne jeg godt forestille mig at de skulle laves anderledes. Jeg kan ikke se årsagen til at alle 4 fag skal være med, hvis man kunne skrive en lærerplan som handlede om at de(eleverne) skal forstå hvad naturvidenskab er , de (elever) skal have den ide at de kan forstå en model og de kan lære noget om verden, hvis det er det vi kan få ud af forløbet, og så måske bare sige at de er nok med to fag, altså jeg vil også gå så langt som at sige måske skal der heller ikke være to lærer på jeg kan ikke... der er selvfølgelig alt det der med at man gerne vil have at de kan vælge noget forskeligt og jeg gætter på at ministeriet gerne vil undgå at nogen får en uheldig lærer, det hjælper man jo på når der er to, men stadigvæk... jeg tror ikke at det bliver... det bliver mere forvirrende kort sagt for dem (eleverne)...altså det bliver mindre strukturret og mindre for os (lærer), hvis det var større så ville man også lave noget der var større, altså to 18 modulers forløb er ikke det samme som et forløb med 36 moduler. Det er ikke i nærheden.

Også må man jo sige at der skulle være et andet fag inde over som skulle lave noget, så kunne man lave noget der hed 30:6. Så var der en der var på 30 moduler også var der en der kom 6 moduler og sagde fint nok I skal også have noget kemi, og her kommer lige sådan en basis pakke. Det det behøves ikke engang at være den samme basis pakke, nogle kunne få noget kemi andre noget biologi osv. så var det lidt forskeligt hvad de fik. Jeg er spændt på hvordan de (ministeriet) gør, for de skære jo ned i introforløbet.

I: Ja det skærer time antallet ned, og komprimere det så det vist skal være afsluttet inden efterårsferien.

TE: ja og dem, de skal lave NV sammen med er ikke nødvendigvis dem, de kommer til at gå i klasse sammen med, så mener jeg at det er totalt spildt.

I: Hvad tænker du at det skaber af udfordringer?

TE: Jeg tror ikke det skaber nogle udfordringer, men der er højst sandsynligt ikke noget at overføre mere, for de kommer jo med alt muligt forskelligt. Jeg vil gå så langt som at sige at så skal vi lave det om, så skal det laves om til sådan nogle klumper, altså vi er nødt til...

vi kan ikke bare forære 10 ugers undervisning væk og tænke at de bliver lige så gode. Vi er nødt til på en eller anden måde at... hvis vi blander op, bliver vi nødt til at lave nogle stumper, hvor man kan sige at I har lært det her, det her og det her. Også kan det godt være at ... ja, vi må jo kigge med hårde øjne på den der lærerplan og sige hvordan kan jeg læse den her.

I: Så skal man have et fælles, ens forløb for hele skolen?

TE: ja eller endnu værre, bare sige ok, jamen NV det er det her, men jeg forestiller mig at der i NV skal bruge 6 moduler af specifikt det her, også er der en lærer der bare kører de 6 moduler 5 gange, og en anden der kører 6 moduler af noget andet, og så er der en pose rest moduler, som der er en stakkels tredje lærer der skal prøve at lave et projekt omkring. Jeg vil syntes det er synd at vi bare giver køb på 30 moduler, men på den anden side er der sikkert også bare nogen der siger, "ja det er fint nok, vi tager dem bare som..." ja, men problemet er bare at nu tæller karakteren.

I: Ja og hvordan måler man det? Sidst kritiserede du meget, at det var jer selv som lærer team på forløb der opstillede nogle krav, til hvad vi måler og vejer eleverne på? Der er nogle ting der står i lærerplanen vi skal tjekke om de siger, men ellers var det meget jer selv, der skulle komme med bedømmelses kriterier.

TE: Ja og det er synd for dem, fordi at når vi... hvis vi vælger at deres karakter skal tælle med, så stiller de (eleverne) krav om at det skal være fagligt, og så bliver undervisningen faglig, men den bliver ikke forstås er mit indtryk. Også falder den der del med at hov du skal "bare" lære at forstå en model og jeg er sku skide ligeglad med om du lærer en eller to eller tre modeller, hvis jeg lærer dig en på 30 timer jamen så er det, det du tager med dig fra NV. Men til gengæld så gav jeg dig kernedelen, og så lige pludselig vil de (eleverne) jo tænke får jeg højere karakter hvis jeg kan 2 eller 3 modeller, og så begynder de at kæmpe og masse på for ... og de stærke vil masse på for at vi skal lære noget mere eller får de dårlige karaktere... altså jeg tror det bliver noget lort, eller ikke lort ... det bliver bare et stykke... det bliver bare ikke optimalt, det bliver i hvert fald ikke bedre af at de giver dem den kvarte kararakter. Og hvad pokker vil der ikke også ske... så giver man dem en dårlig karakter der med hilsen "Velkommen til gymnasiet", det er jo ikke særligt fedt.

I: Tilbage til sådan som NV er nu, fungere det som en introduktion til naturvidenskab?

TE: Jeg vil sådan set sige at det er fint som det er nu, jeg tror bare ikke at de ændre noget. Man kan også overveje... ja... måske er det for meget gåen omkring. . . men jeg tror lidt... spørgsmålet er vel om man får nok smæk for skillingen. Giv mig 30 moduler i fysik C ekstra og så skal jeg godt nok lære dem noget. Du kan bare tage fysik c og smide 30 moduler oveni og så tager du NV lærerplanen og stopper oveni fysik C's og det er ikke noget problem. Når du rykker fra 40 til 70 moduler, så bliver det meget bedre, det er rigtig nok at så er introen gået tabt og ideen om at de måske kan vælge om, men så kan vi jo ligger noget af det i starten og sige alle skal have fysik og alle skal være på i starten. De der små fag... fysik C er sådan set fint nok, jeg kan godt liden den, det er et niveau hvor ... ja ... for dem der ikke rigtig vil have fysik så er det et fint fag.

I: Så man kunne ligeså godt lave et forløb i fysik, eller et andet naturvidenskabeligt fag først, for at samle det?

TE: Ja, det kunne man godt. Hvis man vil lave introen, så kunne man sige at fysiklæreren kommer lige og tager 30 moduler i starten, fordi fysik er obligatorisk, også viser man hvad kernestoffet er, og så tager man selvfølgelig noget af det spændende. "Brænder" det ind i deres bevidsthed, så de aldrig kan slippe det igen.

I:Mit speciale handler om at undersøge tværfagligheden i naturvidenskabelig grundforløb (NV). Jeg vil forsøge at undersøge om tværfagligheden ændres fra lærerplanen intentioner, til lærernes fortolkning af lærerplan, og til hvad der egentlig sker i undervisningen. Den måde jeg gør dette på er ved at bruge netværksanalyse, så jeg får et netværk der illustrere hvad lærerplanerne siger, nogle netværk for hvad du siger, og til sidst et netværk over hvordan aktiviteterne i undervisningen hænger sammen. Hvis du skal sætte nogle ord på NV og hvad NV er for en størrelse?

TF: For mig så handler det om, for det første at de(eleverne) skal snuse til faget og lære at skelne de forskellige fag, tænker jeg, de har jo haft kemi og fysik som en samlet pakket i folkeskolen, så en ting er at de skal lære hvad der er fysik og hvad der er kemi, også lære hvordan man arbejder i de forskellige fag, ved sådan at se på samme emne eller tema men med forskellige øjne, og det er jo også derfor vi har haft et overordnet tema: klima, hvor man ligesom har set på det med forskellige øjne. Og nu har de (klasse 5) haft naturgeografi, der er nogen af holdene der har biologi i stedet for. Ja så de har haft fysik, kemi og naturgeografi. Det som det primært har handlet om er ikke så meget at lære noget specifikt fagligt.

I: lige for at opklare her på Gym3, har eleverne 3 fag, med 3 forskellige lærer?

TF: Ja, men de kredser om det samme tema.

I: Hvis du kigger på den rolle NV har, er den så overflødig eller er den brugbar?

TF: Jeg tror at den er måske meget god i den forstand at man sikre sig at de (eleverne) lidt er samme sted når de starter, og det er også fint med den metodebevidsthed de får, forudsat at de får den ... men der er også noget af det, der måske er lidt overflødigt. Det kunne være... det behøvede måske ikke at være så langt i virkeligheden, de samme ting kunne man godt opnå på kortere tid i virkeligheden.

I: Er der nogle særlige kompetencer elever får i NV, som de ikke havde fået hvis det havde været enkelt fagligt?

TF: ja hvad får de... jeg tror at, hvis vi nu tager klima der har været vores emne, altså så lærer de jo på den måde at skelne fagene fra hinanden, altså hvor nogle fag har deres styrker og hvor andre fag har nogle andre styrker. Så hvis det havde været enkelt fagligt... så vil de måske ikke på samme måde vide... men kunne måske også være at man se på mennesket... hvis man kigger på fysik der, jamen så er det som en maskine der optager energi og udføre et arbejde, hvorimod biologi og kemi er noget helt andet, når det har med mennesket at gøre, så jeg tror det er en god måde at lære at skelne fagene fra hinanden på. Og finder ud af hvor de(fagene) hver især har deres styrker, det ville man ikke få hvis det var et enkeltfagligt forløb.

I: Når du kigger tilbage på klasse 5 forløb, er der så nogle særlige kompetencer de har fået trænet i NV?

TF: Vi har gjort meget ud af at træne sådan noget med variabel kontrol, hvilken type forsøg det er og metode. Det er jo også det der står i bekendtgørelsen at man skal. Sådan at når vi så starter på fysik og også de andre fag, så ved de(eleverne) eller burde vide hvad der indgår i det gode forsøg. Altså man skal kunne gentage det, man skal kun ændre en ting af gangen og den slags... og det er jo sådan nogle ting... så behøver man ikke bruge tid på det, så har man gjort det mere generelt og vist dem at det gælder for alle typer forsøg lige meget hvad det er for et fag. Så det er ikke sådan at de har sådan en opskrift på hvordan er det man gør det i fysik, men at de måske mere ved... jamen det er bare sådan man arbejder i naturvidenskab. Men om det er noget ind, det er så en anden sag.

I: Er der nogle ting man lidt nedprioritere i NV? Der står jo i lærerplanen at de skal have nogle kompetencer, inde for praktiske øvelser, formidling, både mundtligt og skriftligt. Kan man nå det på et NV-forløb?

TF: Altså jeg har nedprioriteret det skriftlige, det har vi ikke arbejdet så meget med, vi har lavet en enkelt prøve, hvor de både skulle svare på nogle spørgsmål... altså svare lidt i længere historier og sætning, men det er jo ikke noget der er blevet lagt specielt meget vægt på. Det er jo en klasse der har fysik på C niveau, så de kommer jo ikke til at skulle... selvfølgelig skal de træne det skriftlige, men det er jo ikke det, som det drejer sig om for dem. Så de har ikke få rapporter for eksempel og den slag, der er heller ikke noget elevtid sat af til rapporter i NV overhovedet, så på den måde... rammerne gør at vi prioriteret det ikke. Og de skal heller ikke aflevere noget skriftligt i forbindelse med deres endelig præsentation, der skal de bare uploade deres præsentation. Så det er nok nedprioriteret ret meget.

I: Kan du nogenlunde huske hvor meget tid der gik til at lave eksperimenter?

TF: Åh... altså vi har haft de første to moduler der gik måske en tredje del af tiden med forsøg, og så har vi haft et andet modul hvor det meste gik med forsøg, og så har vi haft to moduler hvor der kun var forsøg, også har vi haft et hvor der var halvt. Måske lidt under 50:50, måske nærmere 40 %, så de har arbejdet rigtig meget.

I: Så da I på gym3, valgte I skulle have om klima er det så kun din klasse der har haft det eller?

TF: Nej det er alle klasser, det er fælles undervisningsmateriale, fælles alt... i hvert fald i fysik, der har vi sådan et kompendium så alle kører efter og temaet ligger ret tæt op af skolens profil, om globale forhold.

I: Så NV-forløbet her er bestemt på forhånd.

TF: Ja, der er ikke nogen fri vilje der. Altså man kan selvfølgelig tone det forskelligt, og det har vi da nok også gjort...

I: I forhold til hvilke typer klasser det er?

TF: Ja ja, der er nogle lærer der kører alle forsøgene igennem, og der er nogle lærer der fokusere på færre forsøg og måske går lidt mere i dybden. Der er nogle lærer der vælger at lave rapporter selvom der ikke er elevtid. Der er også nogle der har haft klasserne med på rensningsanlæg, der tog jeg så og lavede et debat dag i stedet for. Så der er lidt frihed.

I: I løbet af det her forløb havde du så et samarbejde med matematik?

TF: Nej, overhovedet ikke. Der skal jo ikke være nogle formler eller noget svært matematik. Der var en enkelt øvelse som handlede om noget regression, så jeg valgte at hive ud for det er en musik klasse, hvor matematik ikke er deres stærke side, så der har jeg simpelthen bare... det forsøg har vi slet ikke lavet. Så der har ikke været noget matematik henover overhovedet.

I: Hvad synes du om NV generelt, fungerer det eller fungerer det ikke?

TF:hmmm

I: fungere det for dig... er det sparring mellem lærerne?

TF: jeg syntes at der er fint med sparring mellem lærerne. Jeg syntes ikke at fagene imellem hænger det super godt sammen, fordi det ikke er noget vi har planlagt sammen, fordi man måske mere kører noget der er blevet kørt før, og de andre i biologi og kemi overtager jo også materiale fra tidligere. Så det er noget materiale der måske for lang tid siden, er blevet gennemarbejdet af et tværfagligt team, men som nu bare kører parallelt, så vi har rigtig meget sparing fysiklærerne imellem, men ikke klasse kombination af lærer. Så det hænger ikke sammen som et fag, det hænger sammen som 4 parallelle fag, der kigger på det samme emne, med forskellige øjne, mere end det er en sammenhængende enhed. Jo vi kommunikere da om hvis det er en klasse der fx. ikke har naturgeografi hvilken lærer berører så den del, altså hvem der underviser i grønlandspumpen. Vi er ikke tvunget til at sætte os ned og planlægge et forløb sammen, og når vi ikke er det, så gør man det heller ikke. Så den del af fungerer måske ikke 100% optimalt, der må vi bare stole på at dem der har planlagt det i sin tid har tænkt ind af det skal være tværfagligt...

I: Kan man forestiller sig at der blevet lavet et nyt kompendium og et ny forløb?

TF: Ja vi prøvede i år i den NV gruppe, der var det tanken at vi skulle få fagene til at spille meget mere sammen og vi skulle... ja altså tvingen en eller anden form for større tværfaglighed ind i det. Men så var det jo oppe i luften at det jo ikke helt... det var ikke til at vide hvad der skulle ske med NV (henvisning til reform 2017), og så droppede vi det, vi gad ikke at lægge en masse arbejde i det, hvis det hele skal smides ud næste år. Så det gad vi simpelthen ikke, så vi sagde at vi kører som vi har gjort før. Så det vi har gjort er at vi har tvunget folk til at sætte sig ned første dag i skoleåret, for lige at snakke sammen om forløbet og planlægge hvem der gør hvad, og det er det. Så den tværfaglige del kunne måske godt fungere lidt bedre. og så ved jeg måske ikke... nu er temaet klima blevet tvunget lidt ned, selv følgelig, og det er jo også fint nok fordi det er relevant, men selv emnet om vandets kredsløb er ikke det fedeste, fra en fysikers øjne. Og jeg har meget svært ved at sælge faget fysik i det, jeg syntes at det er død kedeligt. Og det er heller ikke det de måske forbinder med fysik, de kunne bedre tænke sig noget med planeter og solsystemet.

I: Så det dermed at NV skal skabe nysgerrighed og motivation.

TF: Det syntes jeg ikke nødvendigvis at det gør. De får jo godt indblik i relevans i og med at det er et problem der er nærværende for dem, altså global opvarmning, men de er garanteret også blevet tudet ørene fulde af det emne i mange, mange år nu efterhånden. Så relevans delen den fylder rigtig meget, men jeg tror ikke de går fra det med en tanke eller følelse at nu skal de ind og læse fysik, så de kan blive klogere på verden. Så det tror jeg ikke.

I: Gør de det i nogle af de andre fag, har du indblik i det, om de møder den slags motivation i biologi eller kemi eller?

TF: Jeg tror at naturgeografi passer rigtigt godt ind i det her tema, fordi det ligesom det som det drejer sig om, har jeg indtryk af. Det er meget det... og nogle af de lærer der underviser i NG er meget interesseret i klima-ting og den slags. Så det ligger rigtig godt til dem. Så de får solgt deres fag godt, det gør fysik ikke så meget, vand, fordampning og massefylde.

I: Hvis du skal sætte nogle ord på klasse 5, og det de har været igennem? Har den progression I/du havde planlagt passede den med klassen eller var det svært at få til at gå op?

TF: Det var en lidt svær klasse at arbejde med, fordi de var meget forskellige og forskellige niveauer og forskellige former for interesse for faget, så... Jeg tror at sådan en klasse som dem, de skulle have haft... for eksempel da vi begyndte diskussions delen af det, så var de på. Så det skulle måske have været... det skulle have været tilrettelagt anderledes for sådan en klasse. Man skulle have startet med det for eksempel og det kunne man måske også, vi har jo en vis grad af friheden til at gøre den slags. Og så nogle kortere og simplere forsøg, vil også have gavnet dem. Og det er jo svært at lave... hvorimod min science klasse de blev bare ikke udfordret nok i det her, det syntes at de var død kedeligt og hvornår skal vi i gang med noget rigtig fysik. Og de andre her, der var nogle af forsøgene simpelthen en for stor mundfuld for dem. Så det der med at lave et generisk forsøg til alle, det ved jeg ikke om er den gode løsning, der skal i hvert fald indlægges ... meget mere fleksibilitet i det.

I: Fordi der er så stort forskel på klasser med forskellige studieretninger?

TF: Ja, og det skal man jo som lærer tage på sig selv. Jeg er jo ny i det, jeg har kun undervist i et år, jeg får min skabelon og jeg kører, fordi der er mange bolde i luften. Det kan da godt være at om 3 år, eller om 2 år har overskud til at skræddersy tingene lidt mere.

I: Hvad tænker du så om næste år, der må eleverne jo ikke vælge retning på forhånd, så der er det lidt mere blandet kuld?

TF: Det bliver også en udfordring, der skal man gøre meget mere ud af håndtering, og det ligger der ikke i det her forløb, her er det lidt mere svar på det her spørgsmål gå videre, svar på næste spørgsmål osv. Det er sådan meget... jeg ved ikke hvad man kalder den form for undervisning, måske et meget styret forløb. Der rammer man bare sådan en eller anden midtergruppe, så der er ikke indlejret super gode muligheder for differentiering, i den måde materialet er bygget op på. men altså skal man jo så arbejde lidt på at gøre.

I: Så sådan som det er nu, så har nogle eleverne nemt ved at følge progression, mens andre har meget svært ved det?

TF: Ja og det oplevede vi også til eksamen, der var kanon stor spredning på, i forhold til hvad vi plejer at have. Altså de klasser jeg havde, science klassen, ja en science klasse jeg havde sidste år, det var sådan en meget homogen klasse de fik næsten alle sammen det samme, og her der var nogle 02 taller, 4 taller og 12 taller. Så det var virkeligt spredt. Så det var tydeligt at der var nogen der havde forstået hvad det handlede om og nogle der bare var stået af på et tidligt tidspunkt i forløbet.

I: Og den spredning så du både i science klassen og i klasse 5? Gælder der også mere generelt for de andre klasser?

TF: Det så jeg primært i klasse 5. Jeg syntes det ser mere spredt ud i år, end det har været før, men eksamensformen har vi også lavet anderledes end den har være før. De har været op individuelt før og der har det måske været lidt nemmere at sidde en til en og hive de rigtige ting ud af dem, hvorimod når de står i sådan et gruppe forum, og de står op ved en tavle også ender det jo med at den der ved noget i gruppe ender med at svare, og det er mere hektisk og det er svære i sådan en gruppe sammenhæng for dem. Så der er nogle af dem der har knækket nakken på det, hvor man måske kunne have hjulpet dem lidt bedre hvis man sad en til en. Så det har været en svære eksamensform for dem, tror jeg.

I: Nu hoppe vi lige tilbage til det med progression, har du på et tidspunkt med klasse 5 måtte ændre i den progression?

TF: Ja det gjorde jeg i forbindelse med forsøgene, sidste år gjorde jeg det, at vi har sådan 2 modul, der går med at de skal besøge forskellige arbejdsstationer og så har jeg egentlig gjort det før at jeg bare har stillet dem op, og så har de selv skulle bevæge sig fra arbejdsstation til arbejdsstation og udfylde i deres kompendier, de spørgsmål der var relateret til hvert forsøg. Og der har jeg simpelthen været nødt til at halvere forsøgene og gøre det mere, nu laver vi det her forsøg, og nu laver vi det her forsøg. Kun de to forsøg, og så tænker vi over dem, for de har ikke kunne forholde sig til så mange forsøg på samme tid, der er for meget uro og der er en del af dem der ikke har knækket den der studiekode, så der har det været nødvendig bare at skære ned i mængden af forsøg.

I: Så der er også en udfordring med at eleverne også skal lære at gå i gymnasiet mens der er NV?

TF: Ja, det skal man også træne med dem, og det har jo heller ikke være det faglige der skulle lægges vægt på, så det er jo også fint nok, men de har simpelt hen ikke kunne rumme det der med at have mange forskellige bolde i luften på samme tid.

I: Når du tænker til er der så nogle timer, hvor du tænker her mødte eleverne virkelig essen af NV?

TF: Det ved jeg sku ikke om jeg har haft med dem, jeg tror at det forløb hvor vi så nogle film og de skulle svare på nogle spørgsmål og forholde sig til nogle ting i filmen ud fra det vi havde lavet i NV, det syntes jeg egentlig fungerede ret godt, jeg ved ikke om det var der, der syntes jeg at de var rimeligt meget på, i forhold til hvad de har været. Og hvad ellers... jeg syntes egentlig også at de første par moduler, de allerførste moduler, hvor det hele var nyt for dem og de ikke havde lært hinanden at kende så godt endnu der var de lidt mere tilbageholdende og måske lidt mere fokuseret på hvad der sket i timerne, så det syntes jeg egentlig også var ok.

I: Det var der de havde om variable sammenhænge?

TF: Ja, det syntes jeg egentlig også var meget fint, men da vi kom til at de skulle lave lidt større forsøg, massefylde forsøget syntes jeg også gk ret fint, men det var også meget stilaseret, i forhold til at de skulle måle sig frem til en forudsigelse og så lave den og så kommer der nogle fine farver ud af det, det syntes jeg også var fint, men de andre lidt større forsøg syntes jeg ikke har fungeret. Så lige i starten hvor de ikke havde så meget andet i hovedet og så til sidst hvor det kom noget samfundsfagligt ind over, og hvor de fil lov til at diskutere som er en af deres spidskompetencer, det motiverede dem. Og det kan man jo også tage med sig til fysik undervisningen, kan man sige. At de kan motiveres der.

I: Deres eksamen hvordan var den opbygget?

TF: De var i grupper af 3 eller 4, tror jeg, de var nogle stykker sammen. også skulle ... de var oppe i 20min hver gruppe og så skulle de lave en præsentation på 8 min og så fik de så spørgsmål bagefter. De var oppe hos to lærer, dvs. de kom op i to af deres fag, og skulle svare på... i fysik, var det ... fortæl om vandets kredsløb og relater det til klima. Og så havde de et andet spørgsmål i kemi og et andet i naturgeografi. Også skulle de perspektivere det hele og til at starte med havde de også et forsøg. Så de havde trukket et forsøg inden i et af de to fag de var op i, hvor de skulle komme ind på metode sammenhænge og sådan noget, beskrive det forsøg også spurgte man til, har du udført variable kontrol hvordan kan du se det du har gjort det, er det et induktivt eller destruktivt forsøg, er det kvalitativt eller kvantitativt og sådan. Der har de skulle bruge metode delen, og så de faglige ting og så den sidste del var så perspektiverende til globale ting eller dit GCP land.

I: Så de kom ind fremlagde i 8 min og så fik de nogle spørgsmål?

TF: ja og så spurgte man dem så enten i gruppe eller man udpegede enkeltvis, hvis man syntes at der var en der manglede at sige noget. Og så sad vi to lærer sammen, så man/jeg skulle ikke sidde og bedømme om de var stærke nok i kemi. Men det gjorde jo så nok også at karakterende blev en lille smule lavere, fordi der kom måske mere fokus på det faglige end der ellers ville være gjort. Fordi man kunne.

I: For man ikke også mere sikker med som lærer når man sidder to?

TF: Det gjorde jo så også at man ... der var jo nogen der sad og sagde noget volapyk uden lige i biologi, i min anden klasse, og det anede jeg jo ikke. Så jeg ville jo have givet dem 10, hvor biologi læreren sad og sagde hør nu her, det der han lige sagde før var det rene volapyk, jeg syntes han skal have 4, ok så får de så 7. Hvis jeg havde siddet med dem alene så havde, jeg ligesom tænkt... så der var større spredning på end før, hvor det før var mere benefit of the doubt, der lagde niveauet. Før har det måske mere haft fokus på metoden og perspektivering, hvor nu hvor faglærerne var tilstede har der også været lidt større fokus på det faglige, og det går måske lidt imod formålet med NV, så der skal man måske stramme lidt op selv.

I: så man skal huske at spørge om metode ting?

TF: Det har man jo så også gjort, men for eksempel hvis de ikke har kunne afstemme en ligning i kemi, jamen så er det trukket gevaldigt ned. Og det er måske ikke helt fair, for det er jo i virkeligheden ikke det som det drejer sig om. Men det er jo uafhængigt af ...

I: Har du haft fysik med dem efter?

TF: Vi har haft et fysik modul, eller vi har haft intro i fysik. Så vi har downloadede deres e-bog og sådanne ting, men med min anden klasse har jeg haft et par enkelte fysik moduler.

I: Så er det måske lidt svært at svare på, men syntes du at de er blevet bedre til at se på naturvidenskab?

TF: Uh... det ved jeg sku ikke... det tror jeg sku ikke, nej. Jeg tror sådan noget som hvad man skal tage hensyn til når man laver et eksperiment, og den slags, det tror jeg de kan tage med sig. Og måske også noget metode. Jeg lave et spørgeskema til en af klasserne, hvor jeg spurgte til hvad de tager med sig fra NV, der var det sådan noget med: inden jeg kom her vidste jeg ikke hvad forskellen var på fysik og kemi. så det er jo noget de tager med sig. Men i forhold til nysgerrighed og interesse så tror jeg ikke det har den store effekt. Jeg kunne forestille mig at de tog nogle metode ting med sig. Eller i hvert fald få i tale sat, at det de i forvejen gør, det hedder noget.

I: Har NV gjort at de er blevet bedre til at udtrykke sig naturvidenskabeligt, på baggrund af det de har lært om global opvarmning?

TF: Nej det syntes jeg faktisk ikke, der var nogle af dem der var gode til det og der var nogle der var gode til at bruge fagbegreber og faglige argumenter, men der var også mange af dem der kom indtil eksamen og bare besvarede spørgsmålene med almindelige hverdagsord, som de også sagtens kunne have gjort da de startede.

I: så hvis man havde givet dem samme opgave lige da de kom ind af døren...

TF: Så havde det været stort set det samme. Så der kunne måske have brugt noget mere krudt på at fortælle dem om at man skal bruge sit fag til ting. I stedet for at de bare lære en eller anden formel eller sammenhæng udenad. Der var stor forskel på ... der var nogen af dem der gik ind og brugte det faglige i forhold til perspektivering, der var nogen der var inde på at man skulle... man kunne bygge hvide by i forhold til albedo og løse klima problemerne. Altså albedo med at de hvide flader reflektere og de sorte flade absorbere, så hvis man lavede byer kun med hvide tage og med en masse græsarealer så kunne det have samme effekt som isen har, så kunne man måske løse noget. Så de var inde og bruge noget de havde lært til at ... det kan jo også godt være at de havde google sig til det men stadigvæk var der en faglig forklaring på hvorfor det virkede. Men det var langt fra alle. Jeg tror lidt det er for tidligt, at... jeg tror ikke de kan gøre sig de tanker så tidligt, altså de er jo først lige ved at lære at gå i gymnasiet, så det der med at... ja...at have et overblik... det er måske for tidligt... og det samme med AT, lidt samme metode fokusering der er der.

Selvfølgelig de skal have det ind i små bidder, men at lave NV et sådan et stort metodefag i starten jeg ved sku ikke om det... er den gode løsning. Det er fint nok at sørge for de er på sammen niveau og at de ved hvad forskellen på fagene er, og så fortælle dem at man arbejder på forskellige måder, men det kan de jo i virkeligheden først forholde sig til når de har haft fysik i 2 år og har prøvet fem af hver slags, så er det at de tænke nåhhh ... det er det induktiv metode går ud på. Man kan lade dem snuse til det men at forvente at de kan det efter NV, er måske lidt for meget.

I: Var der nogle af deres eksamensoplæg hvor du tænkte her er der noget tværfaglighed eller her er fagene mixet, eller var fagene opdelt?

TF: De fleste havde adskilt fagene, men der var også nogle af dem... der for eksempel snakkede grønlandspumpen, så de havde lært i naturgeografi og som inddragede massefylde begrebet fra fysik. Det skal sige at jeg nok også lige har nævnt for dem at det kunne man gøre... så det er nok ikke noget de selv har tænkt på, men dem der havde den kombination af fag, har vi snakket om... prøv at se om I ikke kan... altså det der fænomen grønlandspumpen fra naturgeografi men der er jo faktisk noget fysik i det. Så nogen havde forstået at der var en kobling der, men den var jo ikke særlig tydelig i de andre fag. Nej, jo måske lidt om strålingsbalancen og albedo men det er ikke noget vi i fysik er gået ind på. Jo altså vandet smelter og så er der ikke så meget is, men det er jo ikke så fagligt.

I: Så hvis du skal karakterisere jeres NV-forløb har det så været tværfagligt?

TF: Jeg tror mere det har været et parallel fagligt forløb, det syntes jeg mere. Men det er måske også okay, jeg tænker måske mere at gøre den sådan rigtigt tværfagligt er måske også for tidligt. Altså når de ikke en gang har lært at skelne fagene endnu, hvorfor skal de så allerede smeltes sammen igen. Medmindre man selvfølgelig er en lærer der bare kører hele NV, også bare bruger ren metode og slet ikke snakker fysik, kemi eller hvad det nu er. Men bare snakker om naturvidenskab basta. Men det dermed at skille fagene ad tror jeg måske næsten er vigtigere og måske også lærer at der er noget overlap, men rigtig tværfagligt der tror jeg er for svært for dem nu. Det tror jeg.

I: Når eleverne kom indtil dig, havde de så fysik brillerne på, fordi du er fysiklærer og det vidste de?

TF: Ja det tror jeg lidt, jeg ved ikke... jeg tror måske at hvis man virkelig havde et forløb hvor emnet passede rigtig godt til alle fag og hvor man havde på forhånd aftalt, hvor man skal perspektivere til de andre fag, så kunne det jo give god mening. Det var måske de man skulle gøre. Så hvis man… kunne have et modul ind imellem fysik/NG hvor man snakkede grønlandspumpen.

I: Så det kræver noget nytænkning af forløbet?

TF: Ja altså hvis det skal være ordentligt tværfagligt, og det syntes jeg ikke helt det har været. Det er jo parallel fagligt kan man sige.

I: Hvis du nu tænker på ministeriets visioner for NV, passer de så med det der sker på gymnasiet?

TF: Man kan sige at den tværfaglige del bliver jo ... de bliver jo ikke rigtig tvunget til at tænke over den... hvis man skulle... man skulle bevidst gøre den en del af det og det kunne jo godt være at det var et besøg på et rensningsanlæg, der kunne få dem til at se her er noget biologi, nogets fysik osv. Der valgte jeg så ikke at tage mine hen... men jeg ikke hvordan man ellers kunne få den tværfaglige del til at spille sammen, udover at det i introen altså de to første moduler, der var det jo ikke fysik det drejede sig om men naturvidenskabeligmetode, hvor vi snakkede om at dette gør man i de fleste naturvidenskabelige fag og der er kvalitativ og kvantitativ metode, så på den måde var det jo tværfagligt, så to moduler ud af de 11 vi havde. Så der har jo været noget tværfagligt, det har bare ikke spillet hele vejen igennem. Og det behøver det måske heller ikke... ja… samle og splitte og så samle igen til sidst, så manglede den der samling igen til sidst måske. Det skriftlige har jo så ikke fyldt overhovedet, de har snuset til metoder ja, jeg ved ikke hvad ministeret eller skriver…

I: De skriver noget om modeller?

TF: Ja det har vi lavet.

I: Det har måske været nogle af de ting der var ens for fagene, at opstille modeller?

TF: tja... f.eks. da vi skulle fordampe vand der har de jo haft... mere end vi har kaldt det modeller har vi jo kaldt det teorier og forudsigelse, hvor der har været en formel og de så har skulle bruge den formel til at komme med en forudsigelse, og så måle det efter. Jeg er ikke sikker på at jeg har i talesat det som modeller, men de har lært det. Og det har der været i mange af forsøgene... nogen af forsøgene. Og nogle af dem har bare været fortæl hvad der sker, og nogle af dem har været med hypoteser og forudsigelser.

I: Med dit synspunkt som lærer hvad skal der så til før NV kan fungere bedre?

TF: øhh... jeg tror... man skal snakke mere sammen lærerne på tværs af fagene... måske lægge lidt mere op til at man laver en eller anden form for opsummerende tværfaglig ting, i stedet for det bliver 100% parallelt. Sådan at de også for en eller anden ide om at hvad formål med NV egentlig har været, nu har vi skulle lære en masse ting men hvad kan vi bruge det til udover den her prøve til slut. Der har vi jo afsluttet det på hver vores måde, så der kunne det måske være meget fint hvis man havde et eller andet... de kunne se en samlet kulmination på projektet, udover bare den prøve, måske et modul hvor lærerne var samlet eller et eller andet. Det tænker jeg kunne være meget fint. ja også... jeg ved ikke... det er jo tid versus effektivisering, altså det kunne være rart og have et emne som de 3-4 lærer der har dem(klassen) finder relevant og kan arbejde med, men det kræver selvfølgelig at man laver meget materiale... og har man overskud til det. Og der har det jo været meget fint at have det her materiale der var gennemarbejdet med forsøg og øvelser og regne opgaver og det hele. Så det har været ret nemt på den måde men der er jo ikke så meget af mig i det. Det er ikke mig det emne overhoved, så jeg har svært ved at sælge det, metode delen syntes jeg var sjov. Men det andet det var svært at sælge.

I: Så fra fysiklærernes synspunkt så vil man gerne have noget der motiverer lidt mere?

TF: Ja, og det bliver jo også nu når det kommer til at ændre sig lidt, og de først skal vælge retning efter NV, så ... der tror jeg der her emne bliver lidt svært for os i hvert fald at overbevise nogen om at fysik det er det sejeste i verden, når de har haft 3 måneder med vand. Men vi må se man får jo også nogle moduler hvor man skal sælge sit fag, altså sådan nogle introduktion til de forskellige studieretnings modul, det er vist noget med 12 moduler til en eller anden bestem studieretning. Så der kan man jo flere mere om hvad ens fag er, fordi det reflektere ikke særligt godt hvad fysik drejer sig om det her forløb.

I: Ja der havde det måske været sjovere at lave noget andet?

TF : ja, hvis det handler om at fortælle den, hvad fysik drejer sig om, hvad faget fysik drejer sig om, men det er jo også noget andet en NV, for NV drejer sig jo om hvordan man arbejder i naturvidenskaben. Så der er det måske okay, men det siger ikke så meget om hvad det (fysik) ellers handler om.

F

CODE CATEGORIES FOR THE IMPLEMENTED CURRICULUM

ACTIVITY		
CODE	TRANSLATION	DESCRIPTION
blt	Teaching at the blackboard	The teacher is teaching at the blackboard
gwr	Group work; reading	Group reading the instructions or assignments
gwc	Group work; calculating or solving small task	Group solving assignments by calculation or other small task
gwad	Group work; academic discussion	Group having a academic discussion.
gwp	Group work; presenting a product	Group presenting work or assignment for the rest of the class
gww	Group work; written assignments	Group making reports, journals, logbook, posters etc.
exp	Doing experiment	The students do experiments in pairs or in a group
dex	Demonstration experiment	The teacher performs a demonstration experiments for the whole class
it	Working with IT-programs	Students install software or work with IT-programs
mov	Watching a movie	The students watch a movie in class
test	Performing a test	The students is given a test in class
sbb	Student by blackboard	A student goes to the blackboard to present work
rev	Review of what is taught	The class is reviewing earlier taught assignments, themes etc.
exe	Exercises	The class/group do exercises like team building, idea generation etc.
sww	Student written assignment	Students writing reports, journals, logbook by themselves

Activity codes, translations and descriptions

	INTERACTION	
CODE	TRANSLATION	DESCRIPTION
tas	Teacher asks	The teacher asks a question.
tan	Teacher answers	The teacher answers a question.
tst	Teacher statement	The teacher gives a statement without asking or answering a question.
sas	Student asks	The student asks a question.
san	Student answers	The student answers a question.
sst	Student statement	The student gives a statement without asking or answering a question.
sd	Student dialogue	The students having a dialogue in pairs or in a group.
sil	Silence	When nothing is said.
tf	Teacher as facilitator	The teacher works as a learnings facilitator/consultant.
gui	Guidance of a project by teacher	When a teacher guides one group in their project and the rest of the groups work by themselves.
nc	No code	When the recordings are too blurred to encode

Interaction codes, translations and descriptions

	Subject/course	
Code	Translation	Description
bsc	BSC	Interaction with BSC in an interdisciplinary content.
phy	Physics	Interaction with physics in an academic content.
che	Chemistry	Interaction with chemistry in an academic content.
bio	Biology	Interaction with biology in an academic content.
geo	Physical Geography	Interaction with Physical Geography in an academic content.
mat	Mathematics	Interaction with Mathematics in an academic content.
inn	Innovation	Working with innovation, following the KIE - Model
nac	Non-academic	Interaction with non-academic content

Subject/course codes, translations and descriptions

LEARNING AIMS		
CODE	TRANSLATION	DESCRIPTION
h	Hypothesis	Working with hypothesis; preparing, reviewing, comparing etc.
pi	Practical Work	Develop, understand, apply, analyze, evaluate practical work which could be lab experiment, demonstration experiment, field experiments etc.
m	Models	Describe, formulate, understand, apply, analyze, evaluate, compare models.
co	Oral communication	Presenting scientific work orally.
cw	Written communication	Making reports, articles, poster in written form.
p	Perspectives	Setting science in relation to the community, technology, ethics and history.
si	Scientific identity	Depends on the program, It is characterized by the subject-specific themes and words students must learn. It could be the water circle and the knowledge in relation to that.
sm	Scientific method	Work with the methods of science: inductive, deductive hypothetical, variable control, qualitative and quantitative investigation. .

Learning aims codes, translations and descriptions

G

CODE CATEGORIES FOR THE REALIZED CURRICULUM

	PERSON TALKING	
CODE	TRANSLATION	DESCRIPTION
s	Student	Student talking.
t	Teacher	Teacher talking.

Codes for the person talking, translations and descriptions

DIALOGICAL ASPECT 1		
CODE	TRANSLATION	DESCRIPTION
Inv	Invitation	When the teacher makes a broad invitation to make the student say something, often used in the beginning of a dialogue e.g. "Could you tell me something about ... "
Upt	Uptake	When a teacher incorporates the student responds into the next question hence making the student reflect further about what was said.
Foc	Focus	The opposite of uptake. Focus can be on a specific learning aim, course or topic.
PreV	Precise valuing	When the teacher precise values what the student say. This might not be strictly positive.
PreC	Precise correction	Explicit correction of what is said.
GE	General evaluation	General praise or criticism.
HoQ	Higher order question	Question that aims at the higher levels of new Blooms taxonomy (application, analysis, evaluation, creation).
LoQ	Lower order question	Questions that aims at the lower levels of new Blooms taxonomy (remembering and understanding).
HoA	Higher order answer	Answer that aims at the higher levels of new Blooms taxonomy.
LoA	Lower order answer	Answer that aims at the lower levels of new Blooms taxonomy

Codes for the dialogical aspect, translations and descriptions

DIALOGICAL ASPECT 2		
CODE	TRANSLATION	DESCRIPTION
HoS	Higher order statement	Statement initiated by the student which aims at the higher levels of new Blooms taxonomy.
LoS	Lower order statement	Statement initiated by the student which aims at the lower levels of new Blooms taxonomy.
Sum	Summarizing	When the teacher sums up or repeats what was said by the student without an evaluation or correction.
Qnu	Student questing /non-understanding	When the student explicit asks the teacher to repeat the question. Used as an indication of the student being unsure or unable to answer.

Codes for the dialogical aspect continued, translations and descriptions

	Subject/Course	
Code	Translation	Description
bsc	BSC	Interaction with BSC in an interdisciplinary content.
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bio	Biology	Interaction with biology in an academic content.
geo	Physical Geography	Interaction with Physical Geography in an academic content.
mat	Mathematics	Interaction with Mathematics in an academic content.
inn	Innovation	Working with innovation, following the KIE - Model
nac	Non-academic	Interaction with non-academic content

Subject/course codes, translations and descriptions

LEARNING AIMS		
CODE	TRANSLATION	DESCRIPTION
h	Hypothesis	Working with hypothesis; preparing, reviewing, comparing etc.
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p	Perspectives	Setting science in relation to the community, technology, ethics and history.
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sm	Scientific method	Work with the methods of science: inductive, deductive hypothetical, variable control, qualitative and quantitative investigation. .

Learning aims codes, translations and descriptions

H

CONSENT FORMS

KØBENHAVNS UNIVERSITET

Samtykkeerklæring

I forbindelse med udarbejdelsen af et specialeprojekt ved Institut for Naturfagenes Didaktik (IND) på Københavns Universitet ønskes der indsigt i undervisning af Naturvidenskabeligt grundforløb (NV) ude på gymnasierne (STX). Så en del af dette ønskes så vidt mugligt et interview med hver enkelt lærer, der indgår i undervisningsforløbet, før og efter afholdt grundforløb.

Formålet med observationerne er at få indblik i om der er en rødtråd mellem den beskrevet lærerplan (med tilhørerende vejledning) fra Undervisningsministeriet (UVM) til den undervisning der foregår ude i de enkelte klasselokaler og hvis mugligt det eleverne i sidste ende bliver testet i. Observationerne vil lægge vægt på de aktiviteter, der foregår i undervisningen fx: eksperimentelt arbejde, gruppearbejde mm. Observationerne vil strække sig over hele NV-forløbet. Observationer vil blive optaget på diktafon, således at alt indhold fra timerne kan blive brugt til databehandlingen.
Interviewet, før og efter afholdt NV-forløb, skal bruges til at få indsigt i, hvordan forskellige punkter i prioriteres i de enkelte undervisningsforløb. Under interviewet vil der blive spurgt ind til lærerens personlige holdning til NV og hvordan det bidraget til gymnasieuddannelsen helhed. Hvert interview vil have varighed af 20-40 minutter, hvor der vil blive stillet spørgsmål omhandlende emnet. Interviewet vil blive optaget på diktafon, således at det fulde interview kan benyttes til databehandling

Undersøgelsen vil være tilgængelig for undervisere og studerende ved IND, censor og administration på Københavns Universitet. Derudover er der mulighed for, at der udgives en artikel i forbindelse med projektet, som vil blive tilgængelig for myndigheder dette kunne være relevant for. Optagelserne vil blive behandlet fortroligt og gemmes i 24 måneder fra d.d. og derefter bliver materialet destrueret. I projektet vil dine udtagelser og citater blive anonymiseret, så det ikke kan ledes tilbage til dig.

Ved nedestående underskrifter giver jeg hermed samtykke til, at jeg vil deltage i undersøgelsen med ovenstående formål:

Observationer
Dato: Underskrift:

_____/_____2016 ____________________________
Interviews
Dato: Underskrift:

_____/_____2016 ____________________________

Hvis der er yderligere spørgsmål til undersøgelsen, så kontakt
Ida Viola Kalmark Andersen
Tlf.: 20852657 eller mail:vwt429@alumni.ku.dk

1

Kære elever i 1.XX

I forbindelse med udarbejdelsen af et specialeprojekt ved Institut for Naturfagenes Didaktik (IND) på Københavns Universitet ønskes der indsigt i undervisning af Naturvidenskabeligt grundforløb (NV) ude på gymnasierne (STX). Så en del af dette vil jeg også gerne observere nogle nv-eksamener, men selvfølgelig kun hvis I giver mig lov.

Formålet med observationerne af eksamen er at få indblik i om der er en rødtråd mellem den beskrevet lærerplan (med tilhørerende vejledning) fra Undervisningsministeriet (UVM) til den undervisning der foregået i jeres klasse og det I så bliver testet i til NV-eksamen. Observationerne vil lægge vægt på de hvordan eksamensamtaler foregåre (sprøgsmål og svar fra lærer og elev), samt hvilke områder af jeres NV-forløb I snakker om . Jeg vil altså være tilstede til jeres eksamen, hvor jeg sider nede bag i lokalet og tager notater samt optager det der bliver sagt. NV-eksamen vil blive optaget på diktafon, således at alt indhold fra eksamen kan blive brugt til databehandlingen.

Undersøgelsen vil være tilgængelig for undervisere og studerende ved IND, censor og administration på Københavns Universitet. Derudover er der mulighed for, at der udgives en artikel i forbindelse med projektet, som vil blive tilgængelig for myndigheder dette kunne være relevant for. Optagelserne vil blive behandlet fortroligt og gemmes i 24 måneder fra d.d. og derefter bliver materialet destrueret. I projektet vil dine udtagelser og citater blive anonymiseret, så det ikke kan ledes tilbage til dig.

Hvis du **ikke** har lyst til at deltage i undersøgelsen, skal du skrive en mail til XX (din lærer), også vil jeg ikke være tilstede ved din eksamen. Hvis du syntes det kunne være spændende at deltage skal du ikke gøre merenu. Du vil igen blive spurgt om det er OK, at jeg er tilstede under din NV-eksamen, i døren til din NV-eksamen. Så du kan også nå at sige fra der.

Jeg håber meget at I har lyst til at være med i denne undersøgelse.

Hvis der er yderligere spørgsmål til undersøgelsen, så kontakt
Ida Viola Kalmark Andersen
Tlf.: 20852657 eller mail:vwt429@alumni.ku.dk

I

CODE FOR MODULARITY

This code is made by my academic advisor Jesper Bruun. The code calculates the modularity of the network and the corresponding Z-value.

```
Z_mod3<-function(g,nit){
  g<-simplify(g,remove.multiple = T,remove.loops = T)
  mod<-vector()
  rew<-10*length(E(g))
  imx<-infomap.community(g)
  modx<-imx$modularity
  for (i in 1:nit){
    h<-rewire(g,with= keeping_degseq(niter = vcount(g) * 100))
    im<-infomap.community(h)
    mod[i]<-im$modularity
  }
  X<-modx
  M<-mean(mod,na.rm=T)
  SD<-sd(mod,na.rm=T)
  Z<-(X-M)/SD
  result<-data.frame(X,M,SD,Z)
  return(result)

}
```

J PAGERANK FOR THE REST OF THE CODES FROM THE IMPLEMENTED AND REALIZED CURRICULUM

J.1 PAGERANK TABLES FOR THE IMPLEMENTED CURRICULUM, ACTIVITY AND INTERACTION

Teacher A's PageRank for the activity and the interaction.

TEACHER A, CLASS 1	PAGERANK
Activity	
Blt	0.45
gwr	0.005
gwc	0.010
gwad	0.215
gwp	0.057
gww	0.007
exp	0.016
dex	0.106
it	0.004
mov	0.010
rev	0.003
exe	0.117
Interaction	
tas	0.055
tan	0.098
tst	0.391
sas	0.077
san	0.044
sst	0.003
sil	0.097
tf	0.073
gui	0.160

PageRank of the Teacher A's implementation of BSC

Teacher C's PageRank for the activity and the interaction in class 2.

TEACHER C, CLASS 2	PAGERANK
Activity	
Blt	0.645
gwr	0.053
gwc	0.015
gwad	0.022
gww	0.009
exp	0.011
dex	0.208
mov	0.002
sww	0.002
exe	0.033
Interaction	
tas	0.060
tan	0.126
tst	0.479
sas	0.120
san	0.062
sst	0.013
sil	0.059
tf	0.045
gui	0.002

PageRank of the Teacher C's implementation of BSC in class 2

Teacher C's PageRank for the activity and the interaction in class 3.

TEACHER C, CLASS 3	PAGERANK
Activity	
Blt	0.837
gwr	0.003
gwc	0.017
gwad	0.041
gww	0.011
exp	0.010
dex	0.073
mov	0.006
sbb	0.003
Interaction	
tas	0.074
tan	0.104
tst	0.524
sas	0.084
san	0.078
sst	0.003
sil	0.053
tf	0.049
gui	0.003

PageRank of the Teacher C's implementation of BSC in class 3

Teacher D's PageRank for the activity and the interaction in class 3.

TEACHER D, CLASS 3	PAGERANK
Activity	
Blt	0.727
gwp	0.005
gwc	0.004
gwad	0.023
gww	0.006
exp	0.013
dex	0.041
rev	0.175
sww	0.007
Interaction	
tas	0.205
tan	0.055
tst	0.384
sas	0.049
san	0.231
sst	0.016
sil	0.023
tf	0.027
gui	0.004

PageRank of the Teacher D's implementation of BSC in class 3

Teacher E's PageRank for the activity and the interaction in class 4.

TEACHER E, CLASS 4	PAGERANK
Activity	
Blt	0.617
gwr	0.002
gwc	0.015
gwad	0.011
gww	0.005
exp	0.006
dex	0.040
rev	0.304
Interaction	
tas	0.266
tan	0.072
tst	0.303
sas	0.050
san	0.244
sst	0.016
sd	0.007
sil	0.009
tf	0.032

PageRank of the Teacher E's implementation of BSC in class 4

Teacher F's PageRank for the activity and the interaction in class 5.

TEACHER F, CLASS 5	PAGERANK
Activity	
Blt	0.537
gwc	0.016
gwad	0.011
exp	0.012
dex	0.038
mov	0.012
test	0.003
sbb	0.005
rev	0.358
Interaction	
tas	0.186
tan	0.074
tst	0.418
sas	0.053
san	0.168
sst	0.011
sd	0.011
sil	0.032
tf	0.041

PageRank of the Teacher F's implementation of BSC in class 5

J.2 PageRank tables for the realized curriculum, the teachers PageRank

The teachers PageRank from student 1's exam:

TEACHER	PAGERANK
Teacher talk	0.46
No teacher talk	0.54
Dialogue aspect	
Inv	0.024
up	0.081
foc	0.018
PreV	0.018
PreC	0.036
Ge	0.057
HoQ	0.101
LoQ	0.122
Subject	
bsc	0.384
bio	0.056
Learning aim	
Pi	0.018
CO	0.004
P	0.080
Si	0.337

PageRank of the teachers in student 1's exam situations of BSC

The teachers PageRank from student 2's exam:

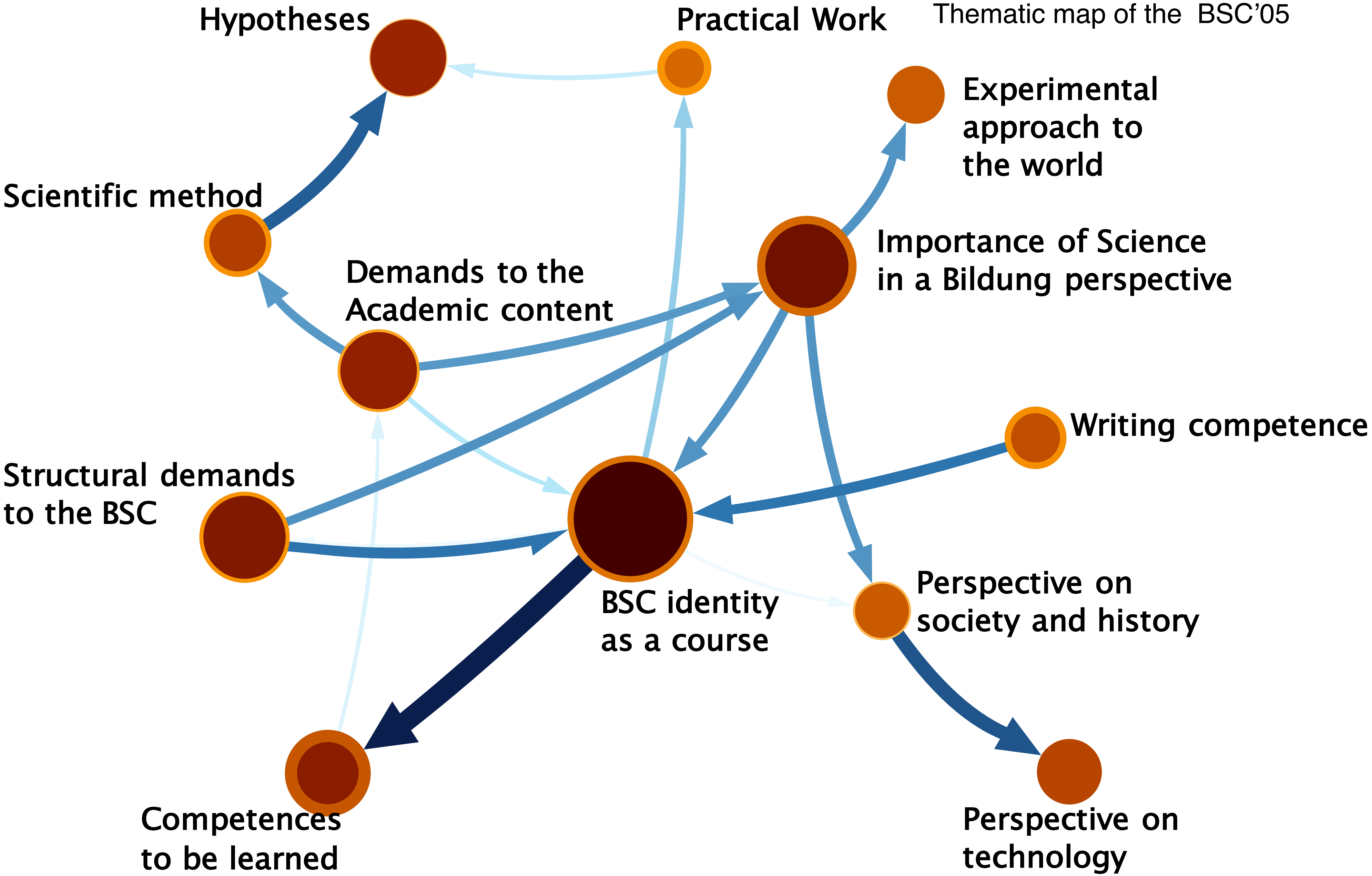
TEACHER	PAGERANK
Teacher talk	0.42
No teacher talk	0.58
Dialogue aspect	
Inv	0.004
up	0.034
foc	0.014
PreV	0.057
PreC	0.020
Ge	0.029
HoQ	0.076
LoQ	0.168
HoS	0.016
Subject	
bsc	0.164
bio	0.130
phy	0.124
Learning aim	
Pi	0.168
CO	0.004
Si	0.246

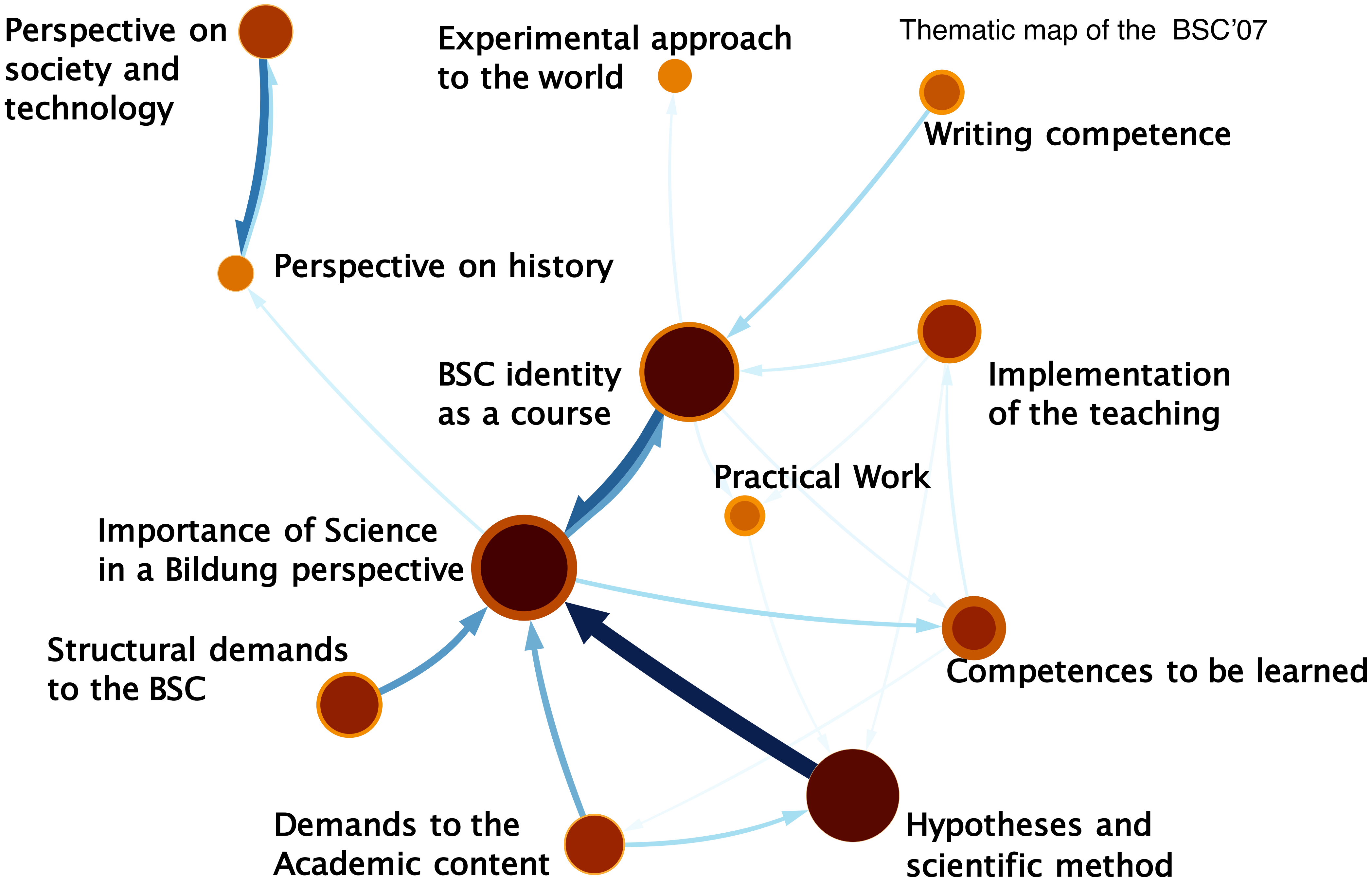
PageRank of the teachers in student 2's exam situations of BSC

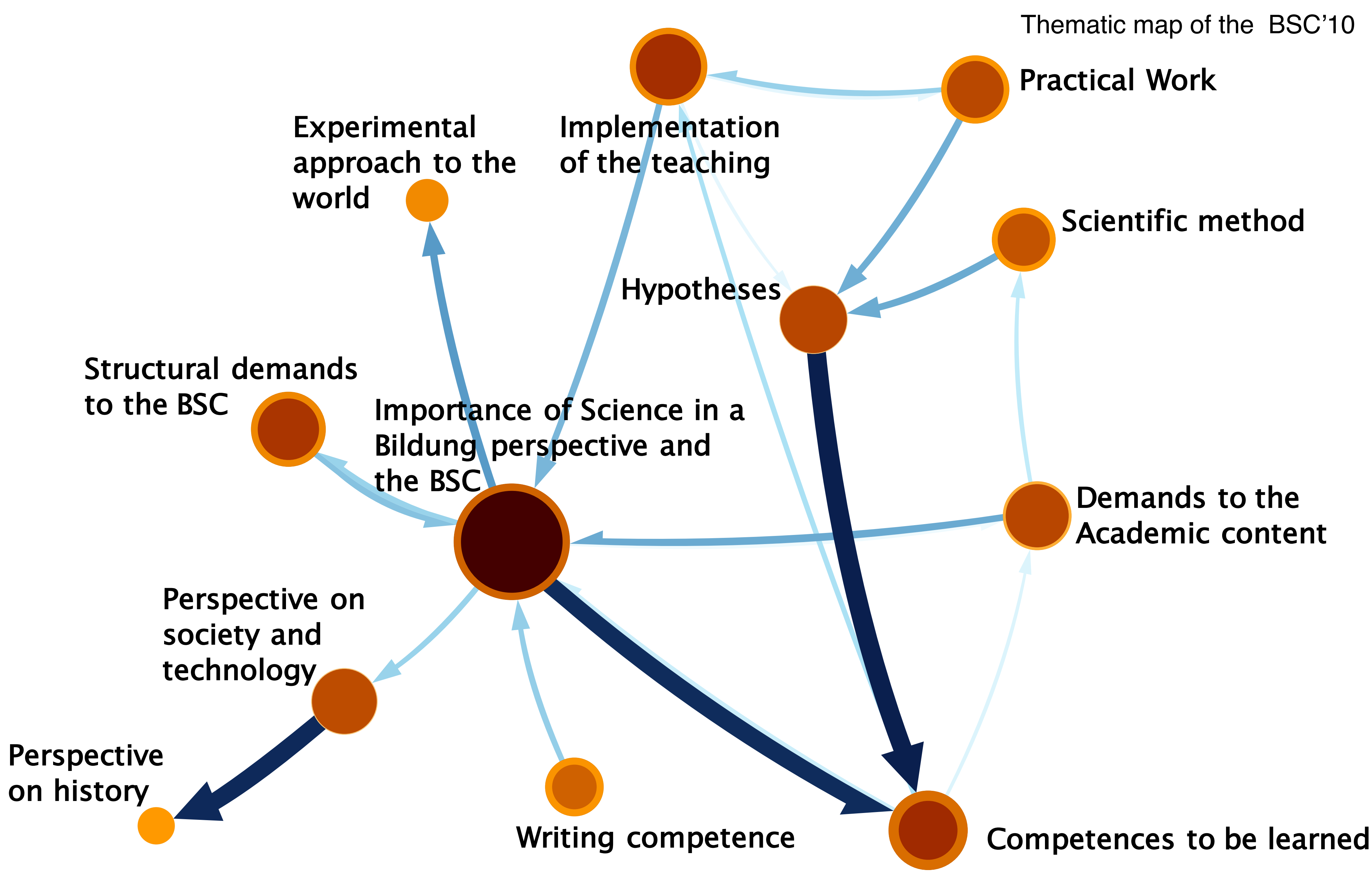
K

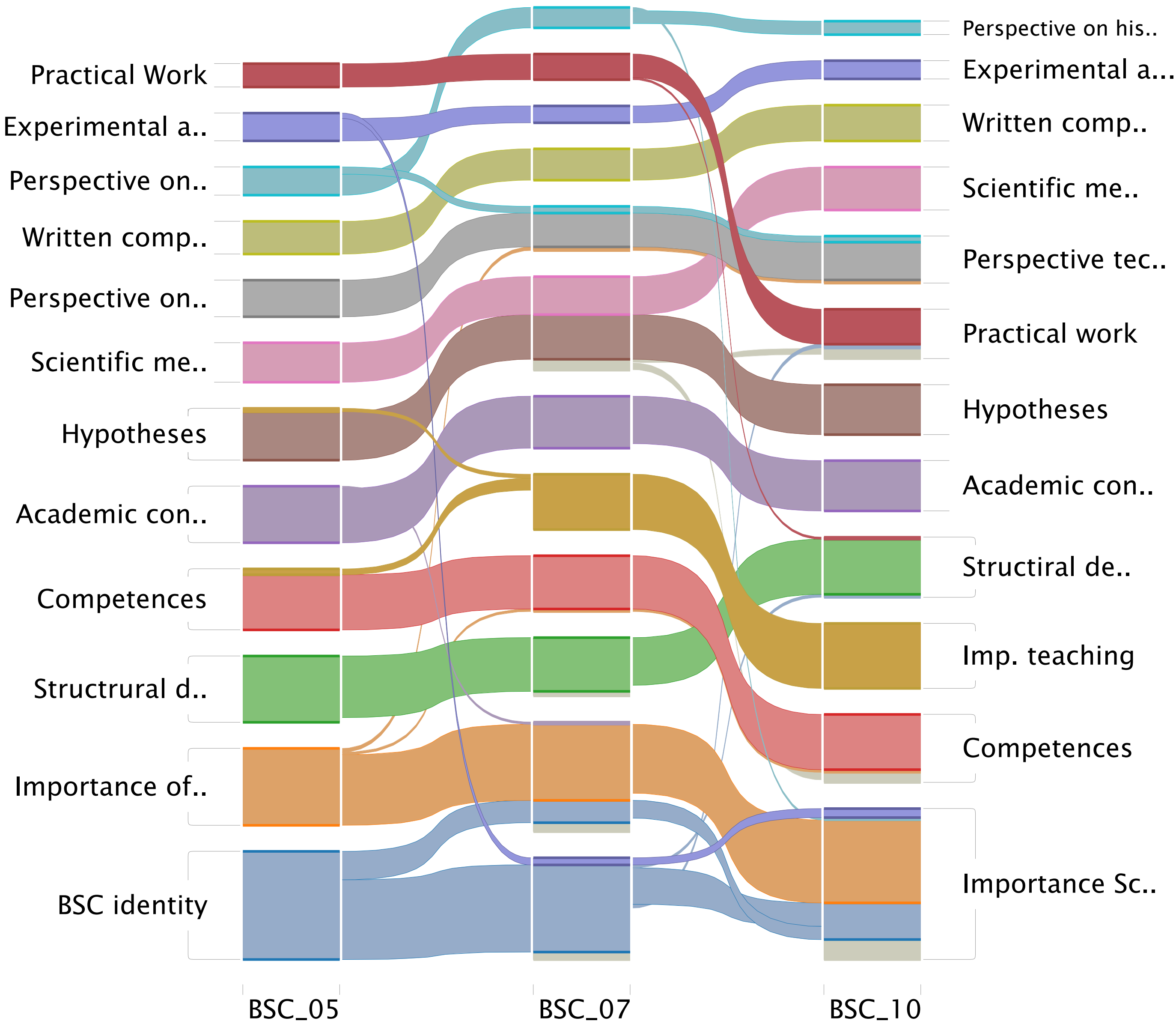
THE NETWORK MAPS IN FULL SIZE

Thematic map of the BSC'05



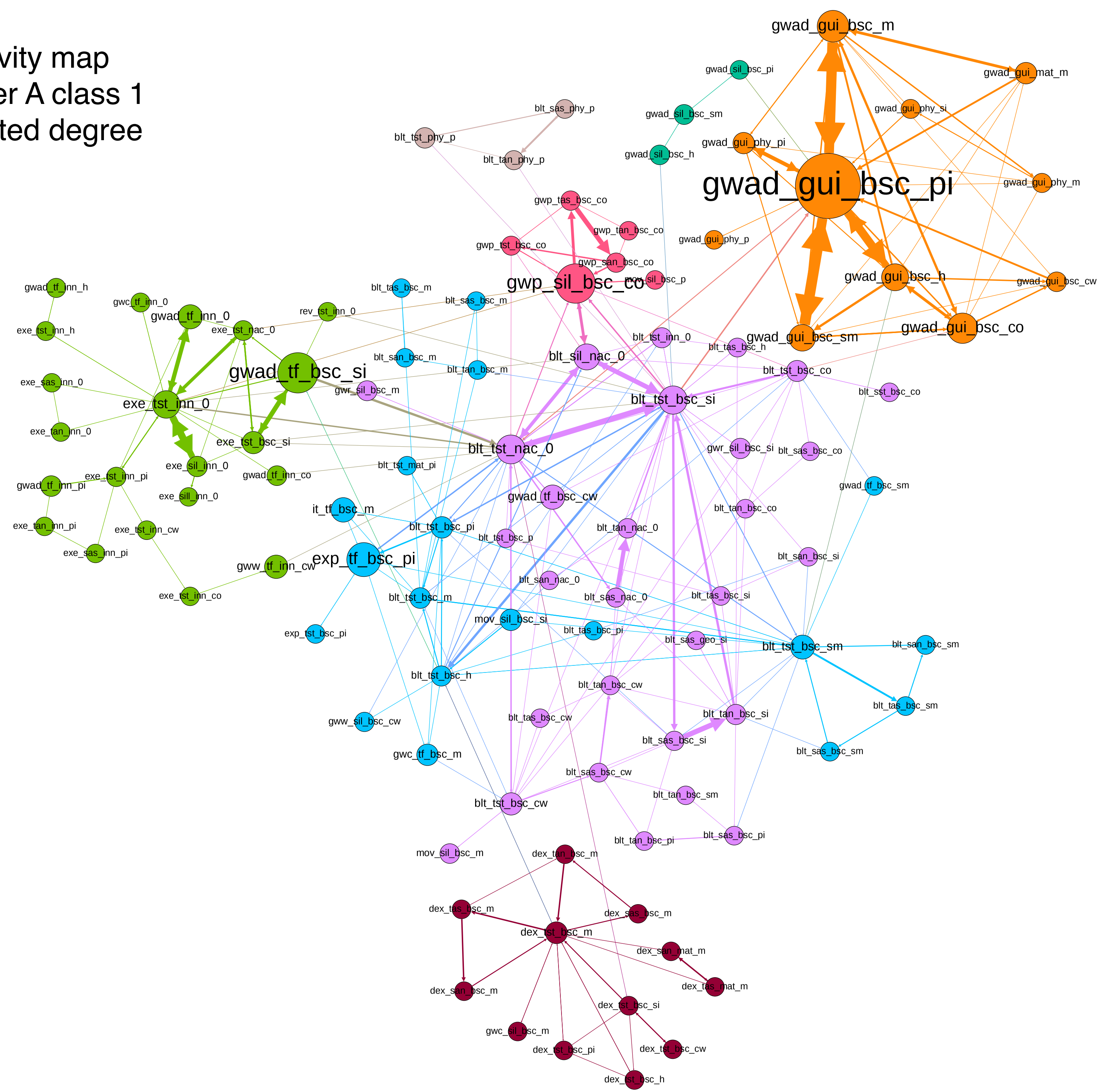

Thematic map of the BSC'07
Perspective on society and technology
Experimental approach to the world
Writing competence
Perspective on history
BSC identity as a course
Implementation of the teaching
Practical Work
Importance of Science in a Bildung perspective
Structural demands to the BSC
Competences to be learned
Demands to the Academic content
Hypotheses and scientific method


Thematic map of the BSC'10
Practical Work
Experimental approach to the world
Implementation of the teaching
Scientific method
Hypotheses
Structural demands to the BSC
Importance of Science in a Bildung perspective and the BSC
Demands to the Academic content
Perspective on society and technology
Perspective on history
Writing competence
Competences to be learned

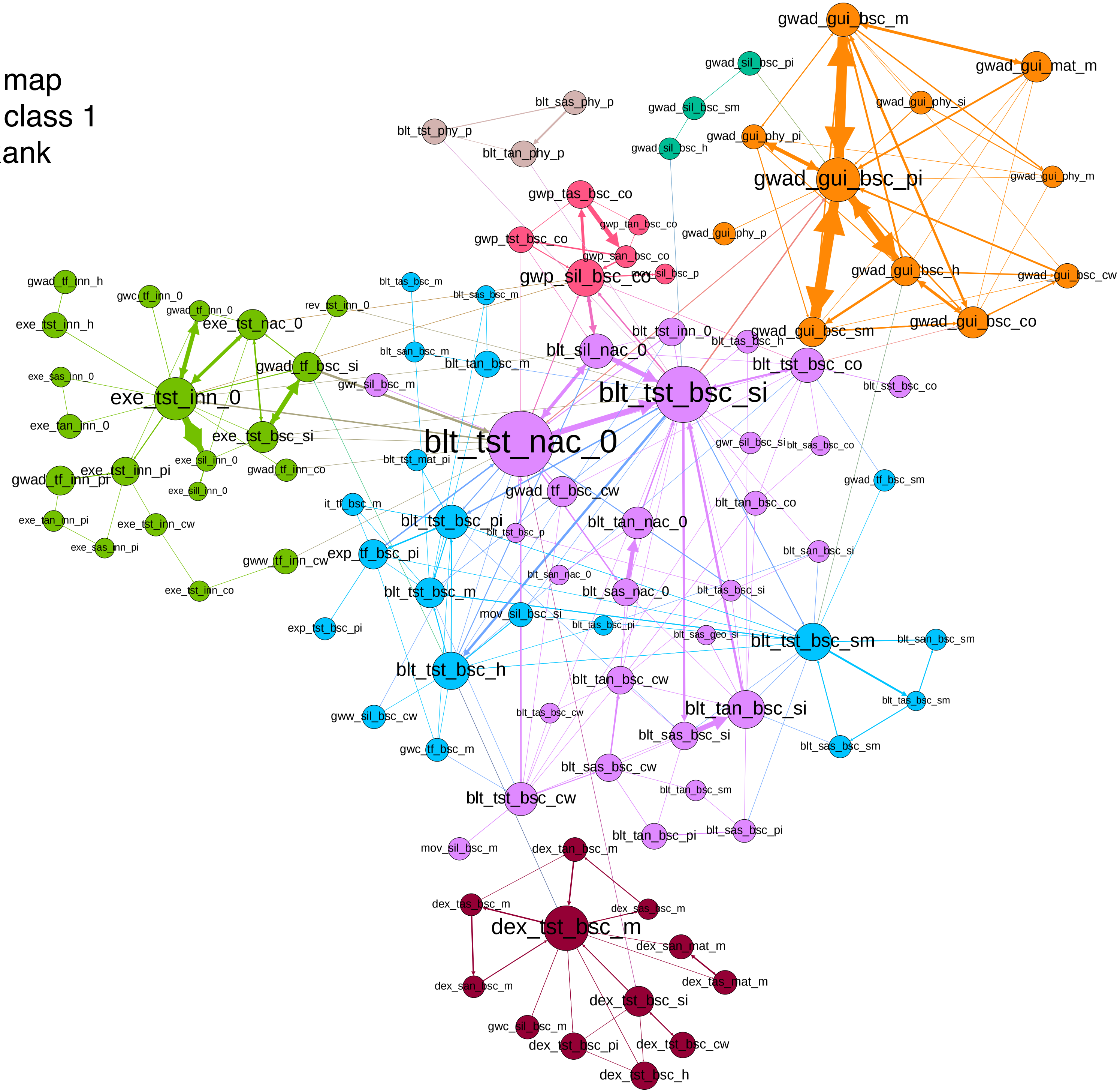


Practical Work
Experimental a..
Perspective on..
Written comp..
Perspective on..
Scientific me..
Hypotheses
Academic con..
Competences
Structrural d..
Importance of..
BSC identity
Perspective on his..
Experimental a...
Written comp..
Scientific me..
Perspective tec..
Practical work
Hypotheses
Academic con..
Structiral de..
Imp. teaching
Competences
Importance Sc..
BSC_05
BSC_07
BSC_10

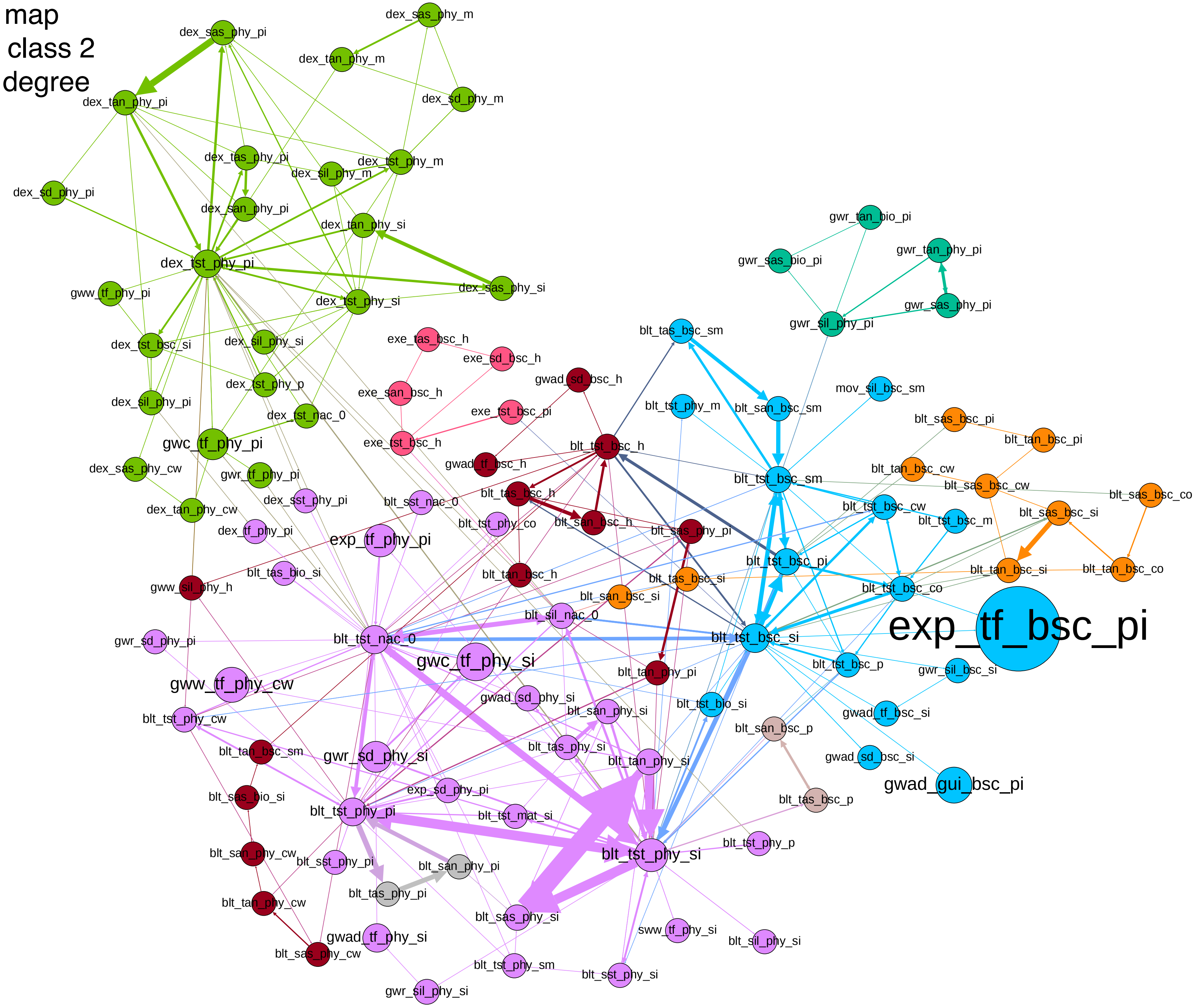
Activity map
Teacher A class 1
Weighted degree



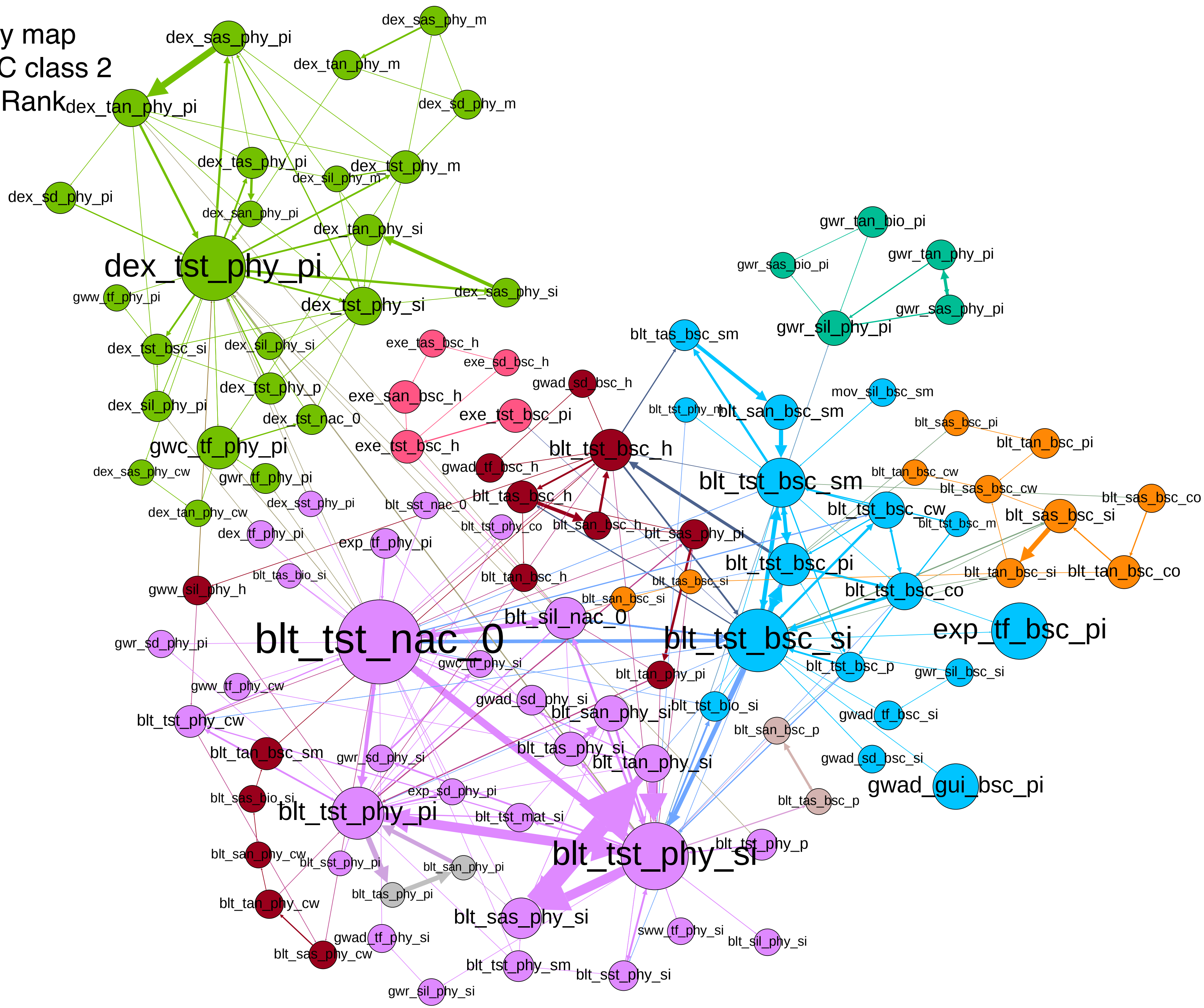
Activity map
Teacher A class 1
PageRank



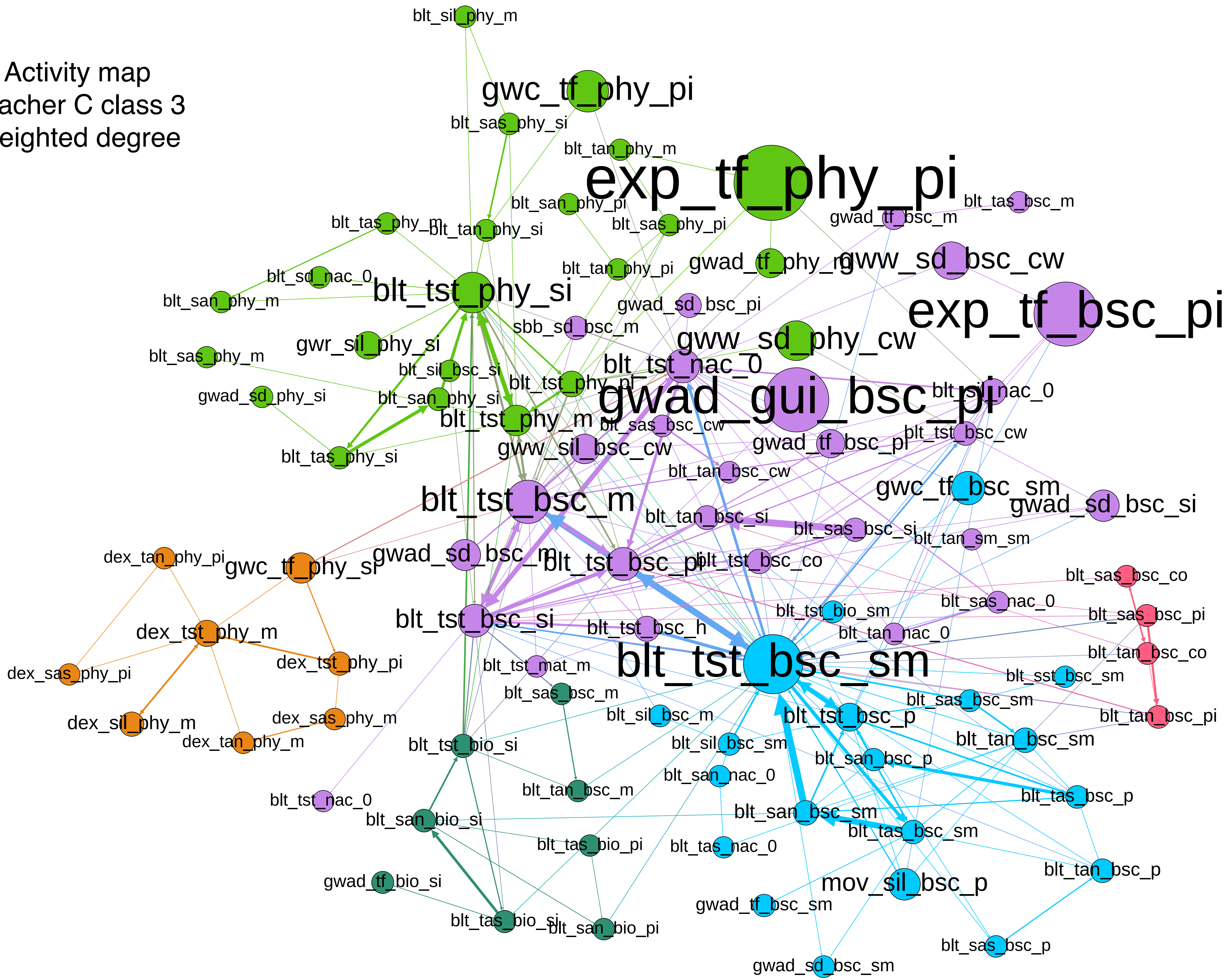
Activity map
Teacher C class 2
Weighted degree



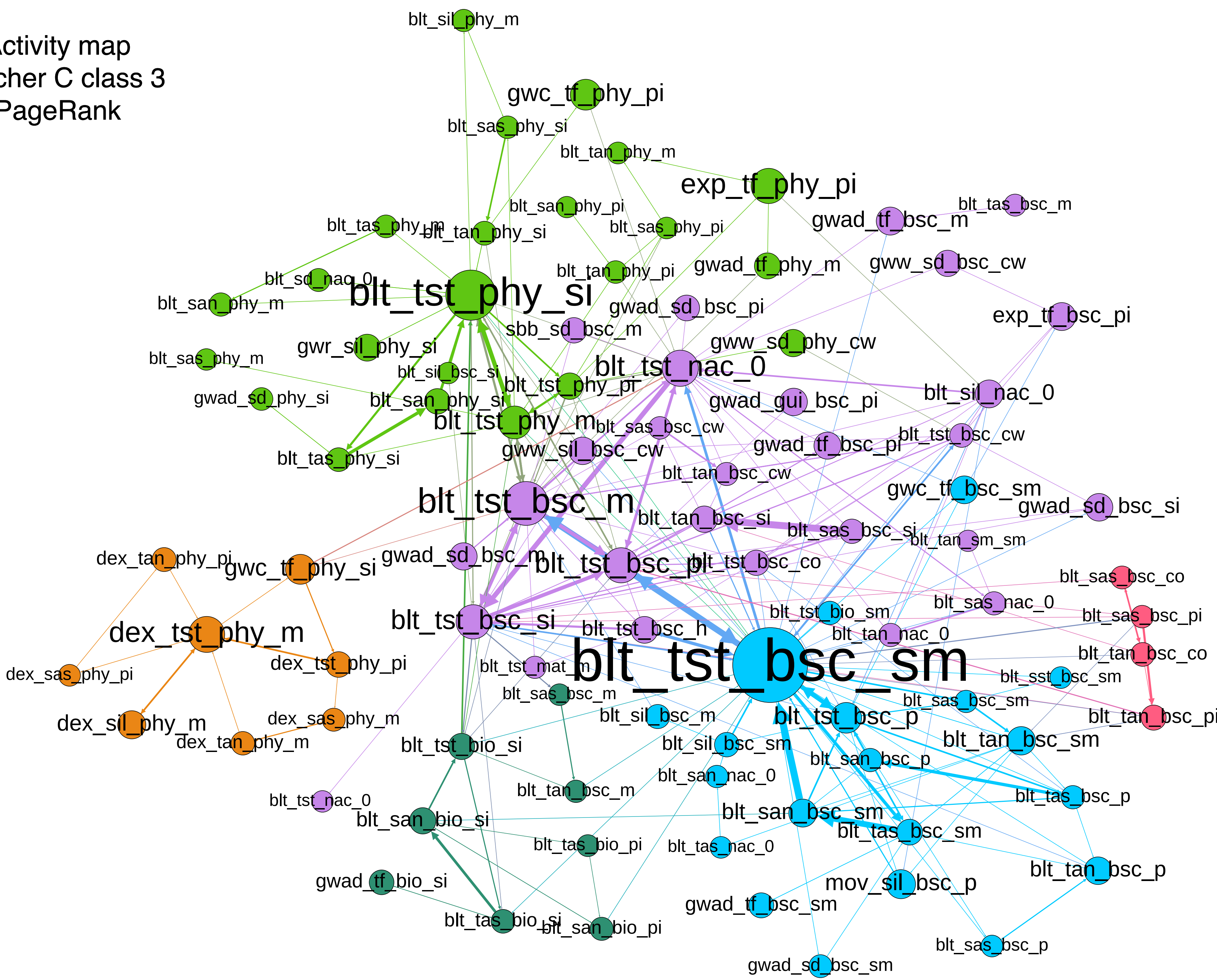
Activity map
Teacher C class 2
PageRank



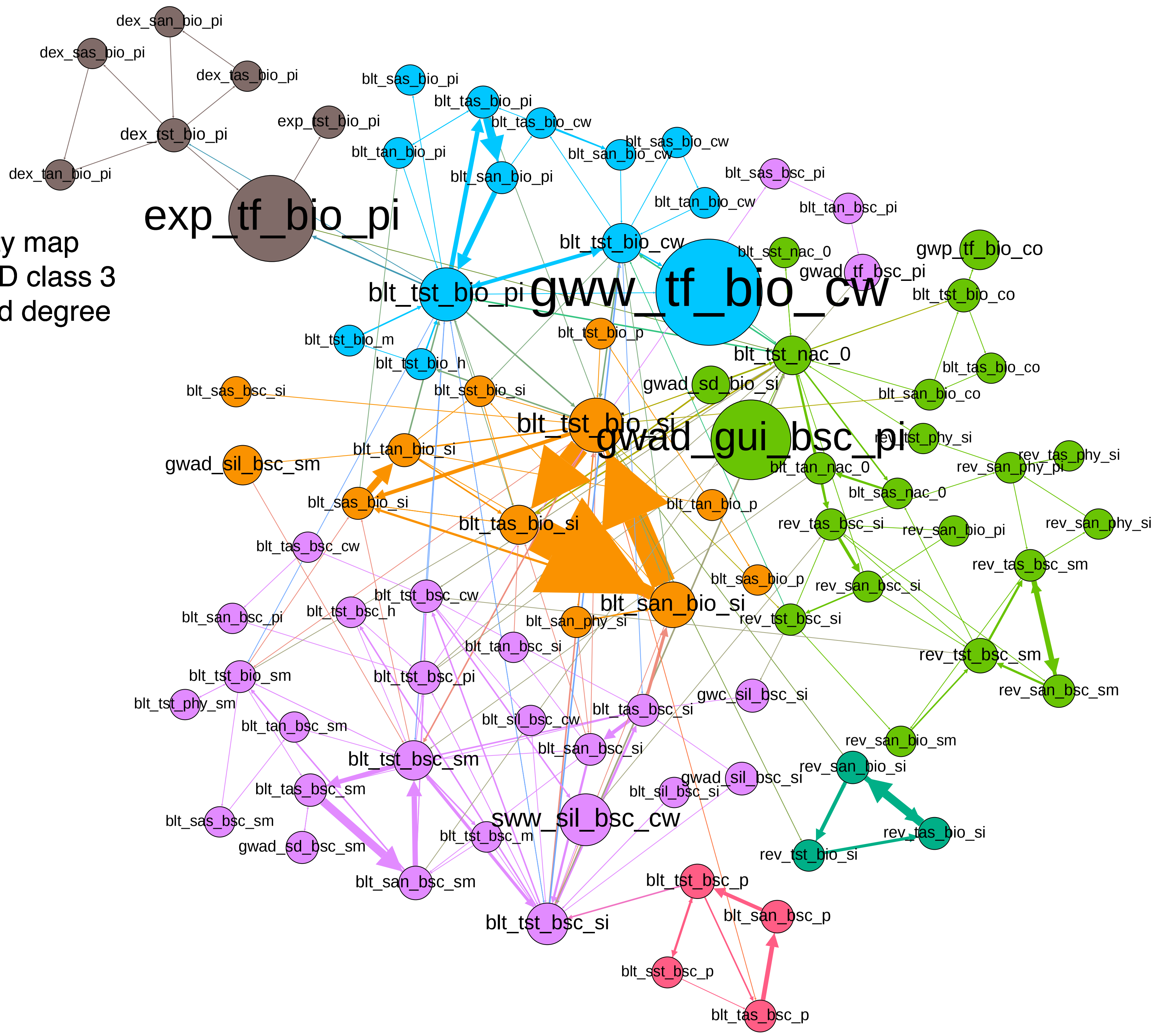
Activity map
Teacher C class 3
Weighted degree

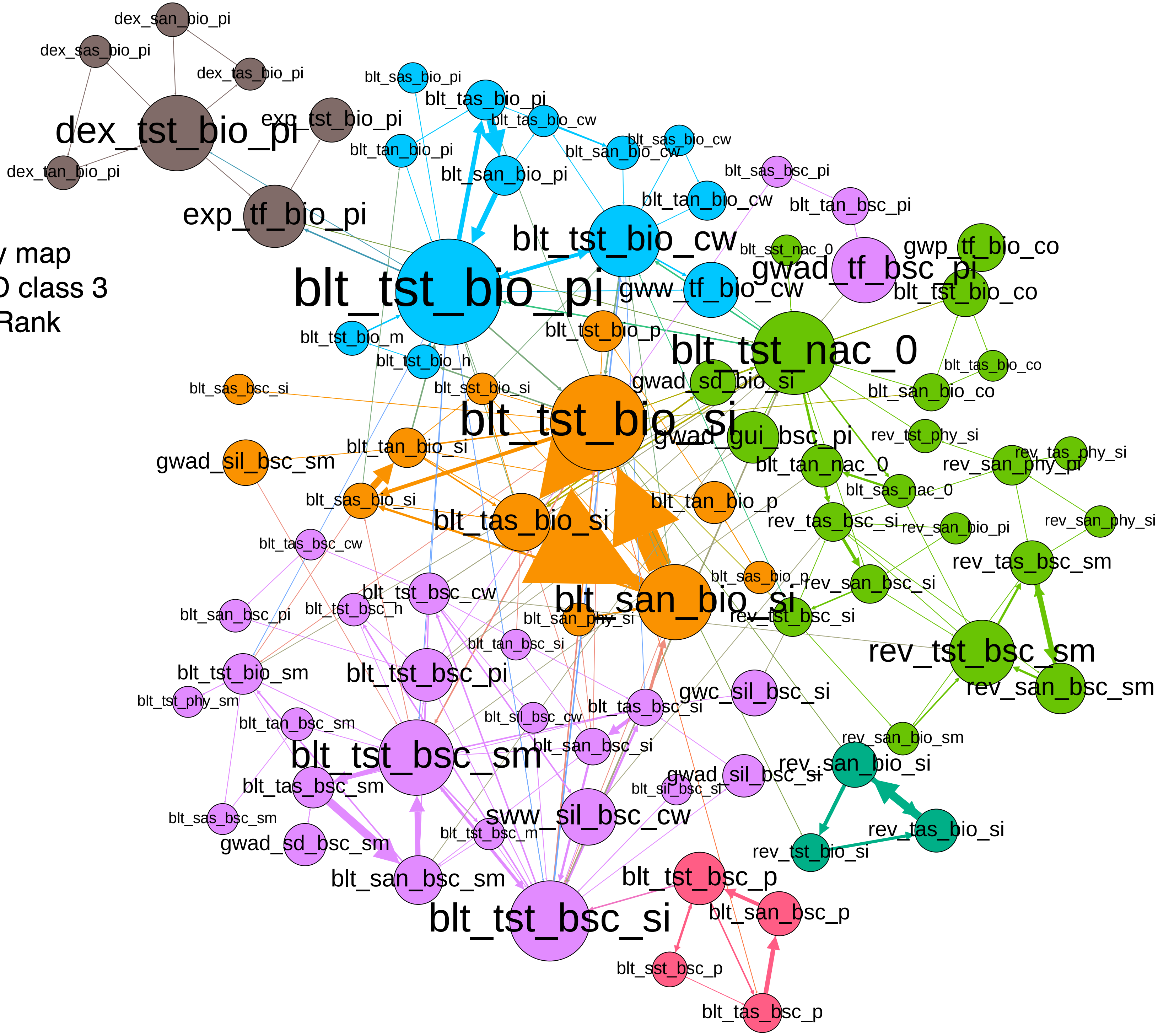


Activity map
Teacher C class 3
PageRank

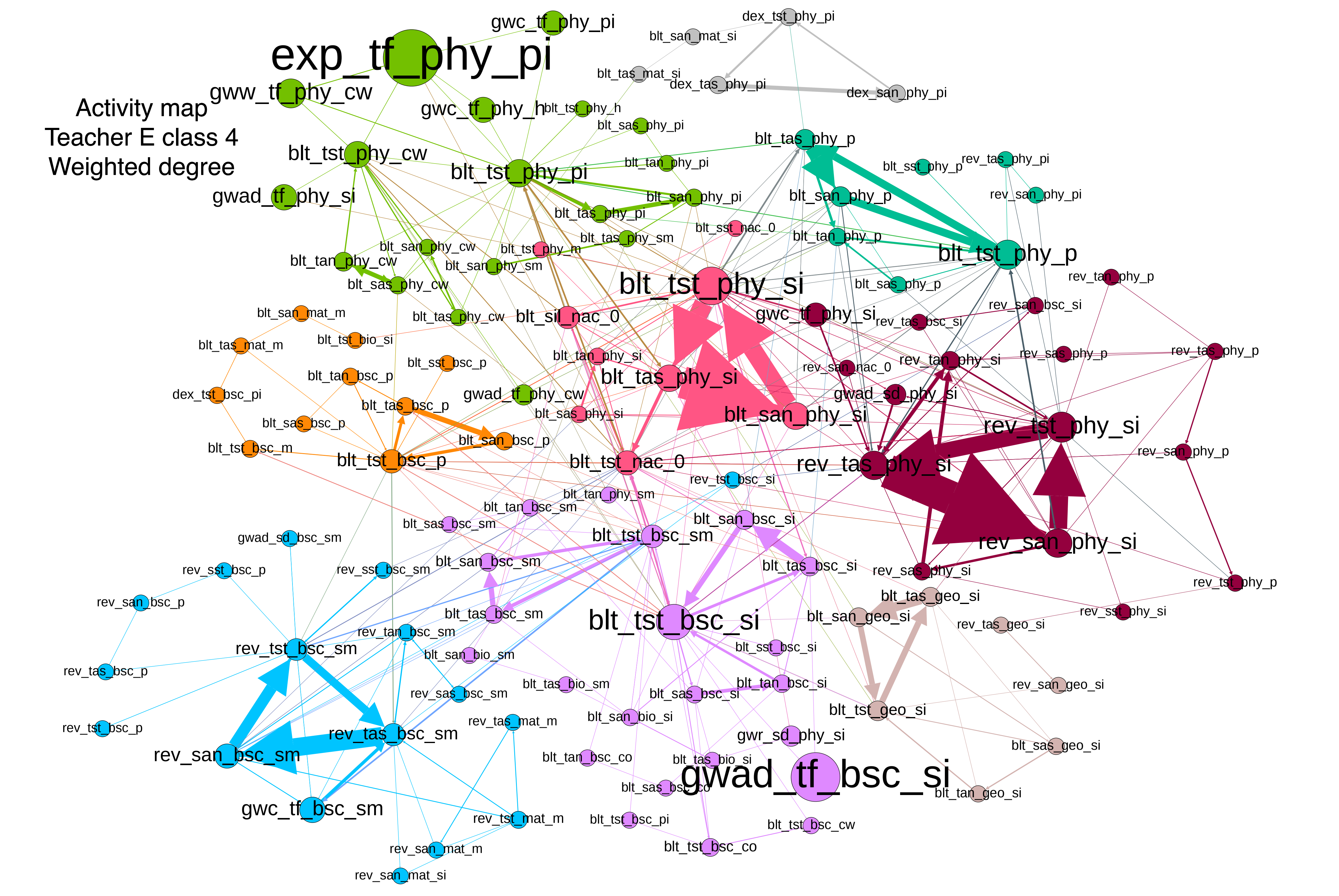


Activity map
Teacher D class 3
Weighted degree



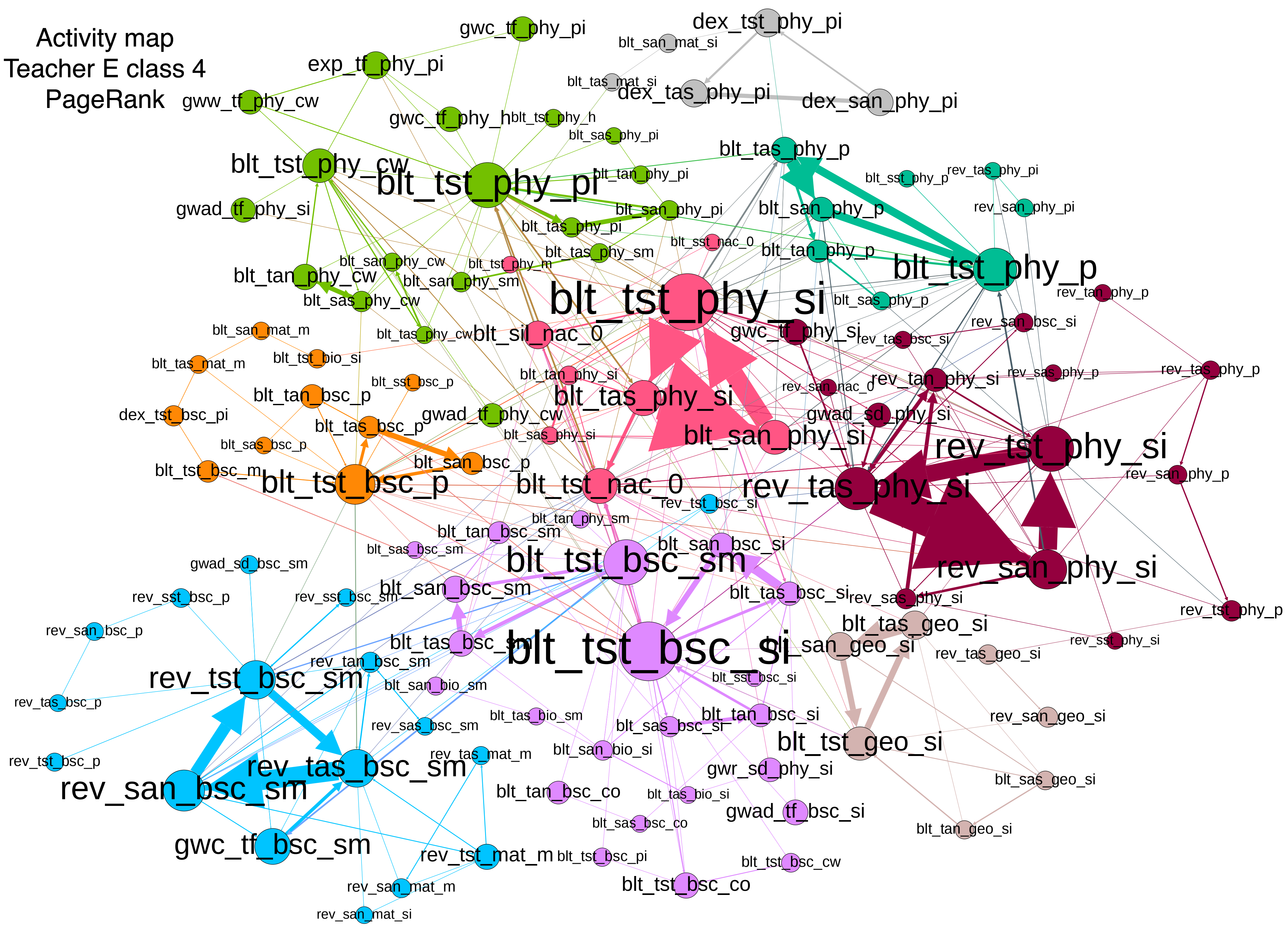


Activity map
Teacher D class 3
PageRank

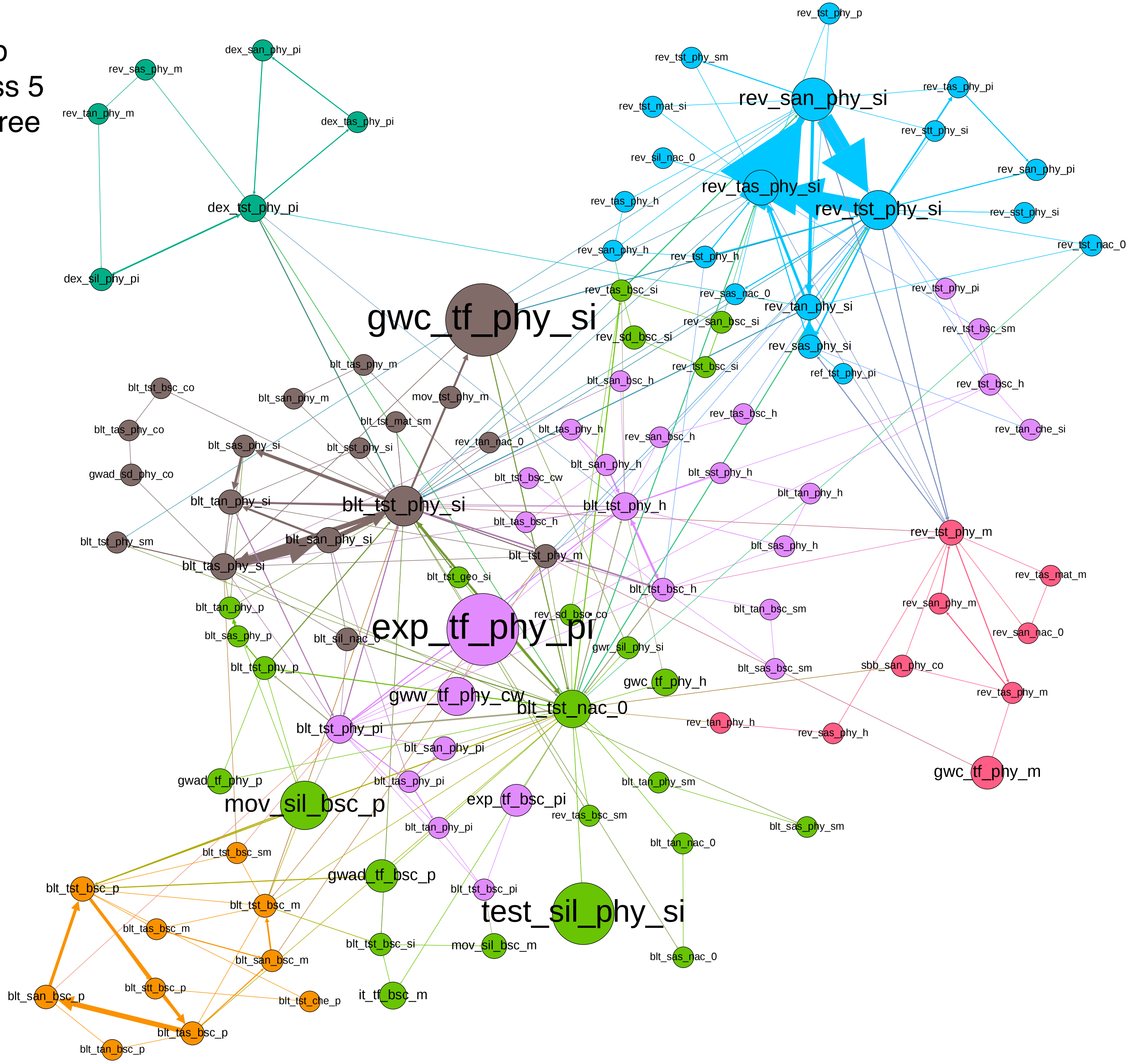


Activity map
Teacher E class 4
Weighted degree

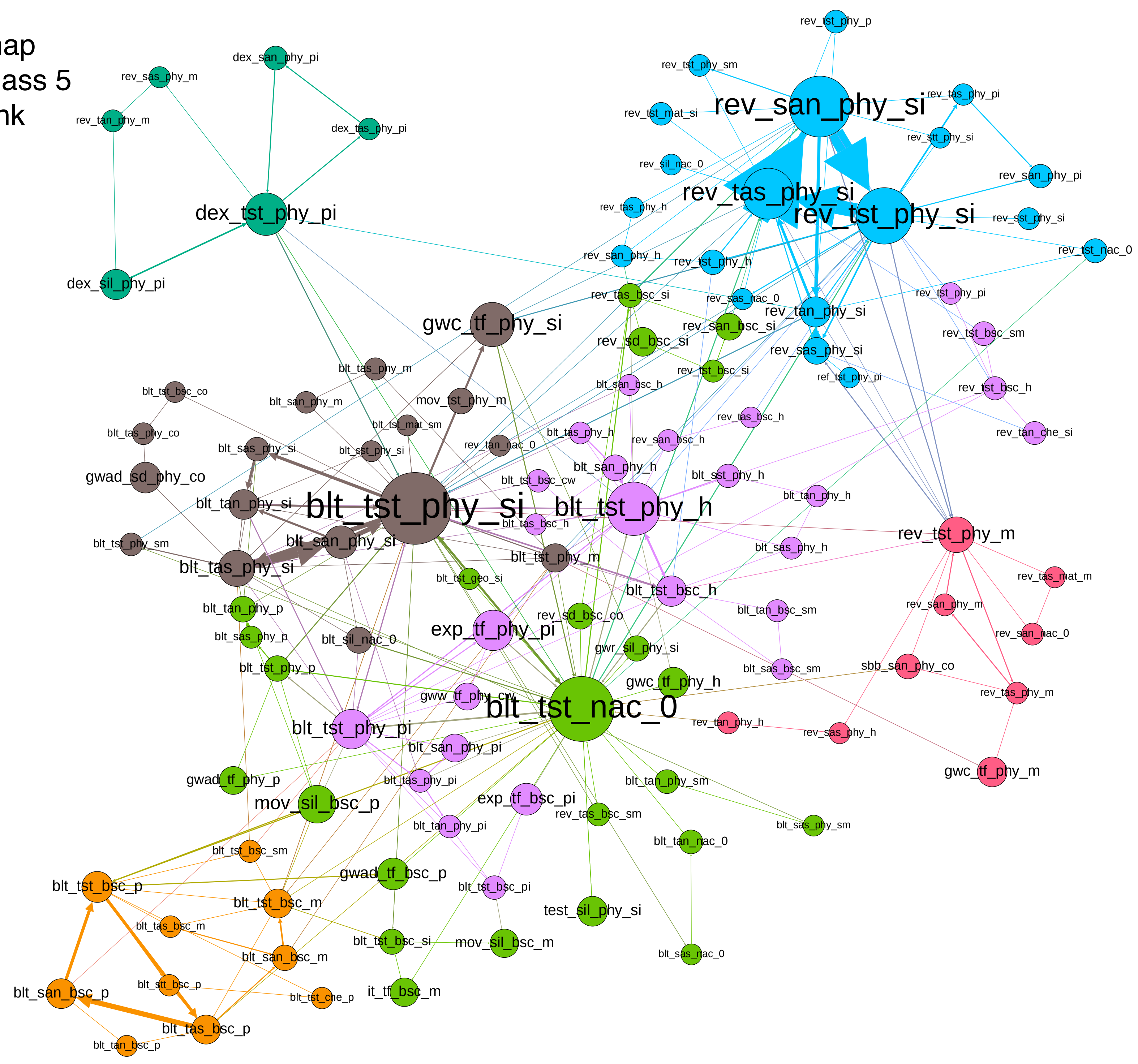
Activity map
Teacher E class 4
PageRank



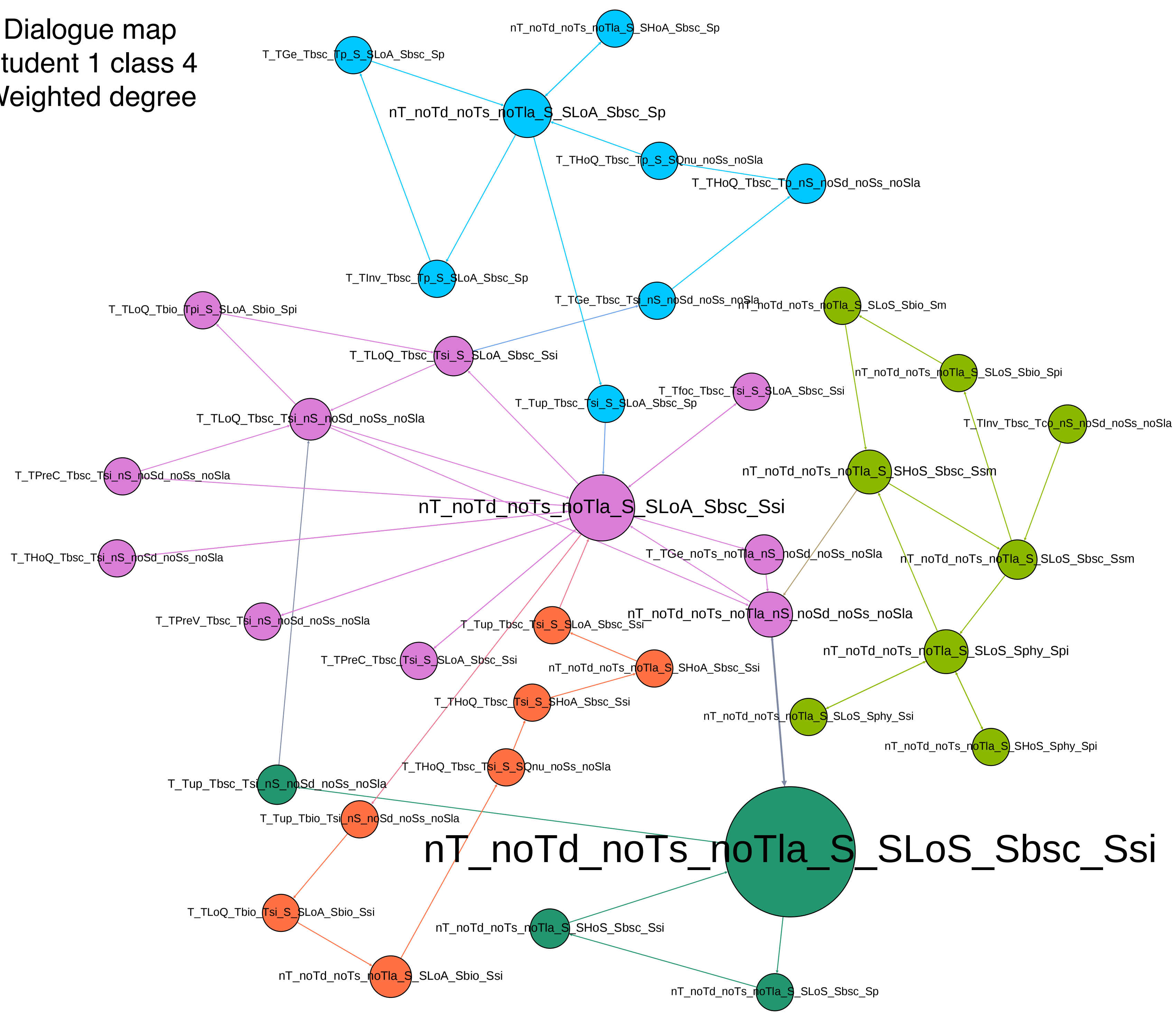
Activity map
Teacher F class 5
Weighted degree



Activity map
Teacher F class 5
PageRank

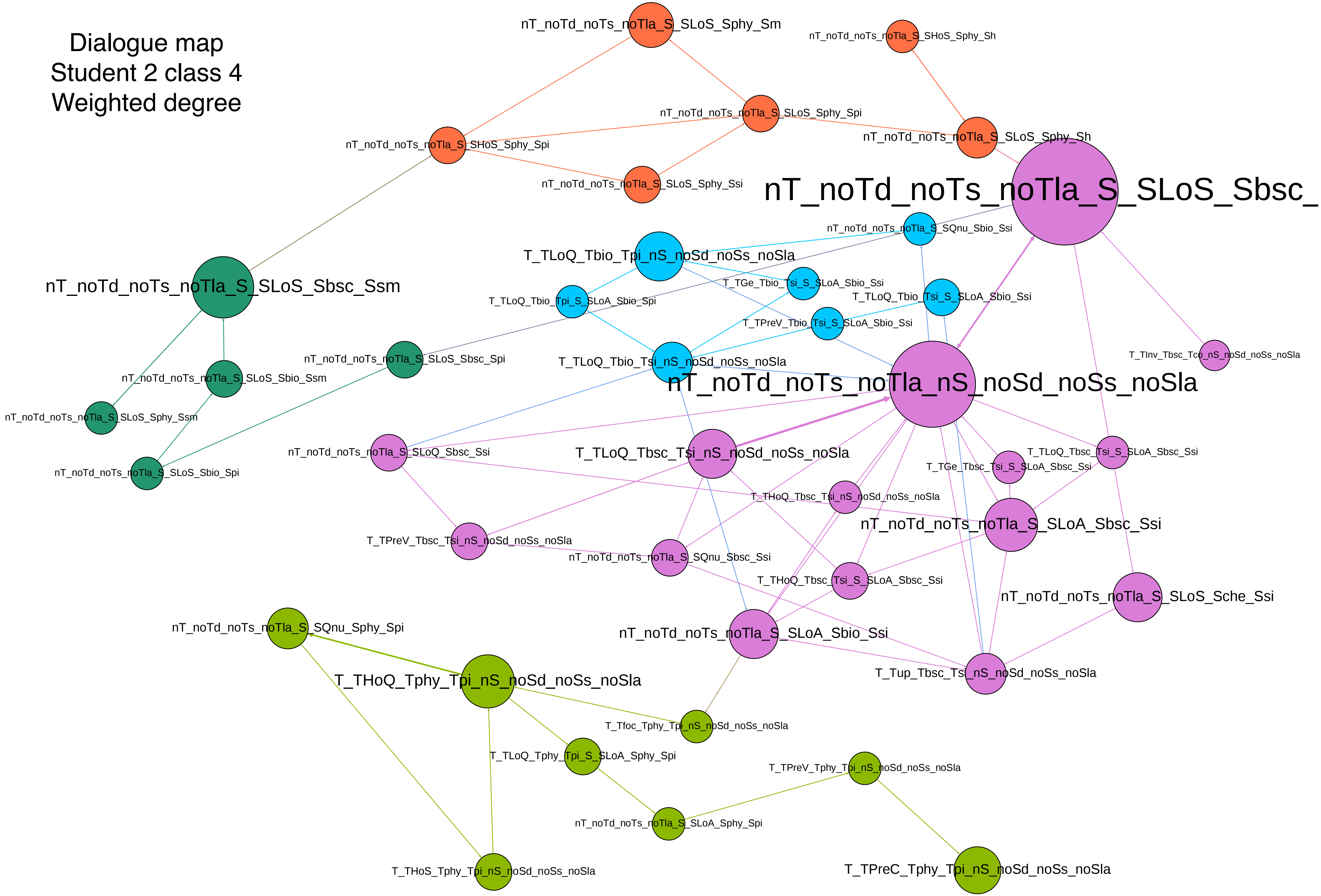


Dialogue map
Student 1 class 4
Weighted degree



Dialogue map
Student 1 class 4
PageRank

Dialogue map
Student 2 class 4
Weighted degree



Dialogue map
Student 2 class 4
PageRank