NFSUN Trondheim 2017

Nordiske Forskersymposium om Undervisning i Naturfag

Paper presentations – posters – symposia – workshops

Paper presentations

Symposia

Posters

Workshops

12. TO FLIP OR NOT TO FLIP – STUDENTS' USE OF THE LEARNING MATERIAL IN A FLIPPED UNIVERSITY ORGANIC CHEMISTRY COURSE

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Abstract

University chemistry courses have had a similar approach to teaching for a long time, with chemistry professors lecturing in a traditional manner. Today, flipped learning approaches have found their ways into higher education and positive results from for example the US have been spread and made Swedish university chemistry teachers interested and curious to develop their courses. The rationale of flipped learning is to incorporate an active learning approach in the lecture halls and thereby hopefully both increase student engagement and learning outcomes. In this presentation, an implementation project where an organic chemistry course has changed focus from traditional teaching to flipped learning will be presented.

1 Introduction

To make students' learning environments more active and thereby improve learning outcomes as well as student engagement, flipped learning approaches have emerged since the beginning of the 21st century (Seery, 2015). In the US, several projects have focused university chemistry courses, general and organic chemistry in specific, and as Pienta states „lecturing in general or organic chemistry is easy. Doing the things to make sure everyone in one's class learning is far more challenging" (Pienta, 2016, p. 1). In this project, we follow an organic chemistry university course when changing from a more traditional teaching method to a new pedagogical approach emanating from an objective to develop chemistry courses and to learn from previous educational research.

Flipped learning, or inverted teaching, relates to blended learning where activities in class and at home are shifted, i.e. lectures are moved from university lecture halls to something students do at home and where problem solving and "homework" is done at university lessons (Christiansen, 2014). To flip a classroom is not a fixed and regulated methodology with explicit rules, several different approaches have been presented in previous research (e.g. Christiansen, Lambert, Dadelson, Dupree, & Kingsford, 2017; Eichler & Peeples, 2016; Mooring, Mitchell, & Burrows, 2016). However, three big ideas portraying flipped learning are highlighted by Schnell and Mazur (2015); (1) to achieve deeper learning, prior knowledge is required, (2) engagement makes student learn better, and (3) flipped classrooms influence students' learning outside the course frame and thereby affect their future self-regulated learning. The importance of prior knowledge as a foundation for higher order thinking has been stated since many years by several scholars (cf. Ausubel, Novak, & Hanesian, 1968; Zohar, 2004) and within the flipped learning approach, this is often intended to be achieved through on-line lectures students watch before coming to the classroom. Nevertheless, flipped classroom approaches do not depend on technology, they focus the pedagogy or philosophy in general and are therefore seen as a new mind-set where learning and the learner is emphasised, not teaching and the teacher (Schnell & Mazur, 2015; Seery, 2015).

2 Theoretical framework

Flipped learning approaches emanates from several different theoretical frameworks, depending on aspects explored. Seery (2015) presents in his recent review on flipped learning in higher education chemistry connections to constructivism, cognitive load theory or different motivation theories (e.g. self-determination theory). In this study, students' use of the pre-lecture assets, that is the on-line lectures and the quizzes, relates to the constructivism paradigm, whereas students' collaboration in the group work in class and peer instruction relates to a more socio-cultural paradigm (Mooring et al., 2016).

3 Research methods

This study uses the format of a previously applied structure of a flipped organic chemistry university course (Eichler & Peeples, 2016). The structure is similar to most published university chemistry flipped learning projects according to Seery's (2015) review. In the pre-lecture learning step, on-line lectures are available to the students who are supposed to look them through before coming to class. After watching the lectures, short quizzes are given that the students are supposed to solve the evening before the scheduled class. The teacher looks through the results from the quizzes before going to class to be updated on students' responses and thereby their potential misconceptions. In the second step, during the scheduled lessons, in-class collaborative group learning focuses difficulties and ambiguities students have observed in their preparations. Students work with problem solving and peer instruction is observed and explored (Schnell & Mazur, 2015).

In Sweden, flipped learning approaches are uncommon compared to the US and a Swedish university chemistry department had intentions to develop their teaching approaches, with the aim to improve students' learning outcomes and increase students' engagement in chemistry. A half-term organic chemistry course with 28 students was chosen as the first chemistry course to implement a flipped learning approach. The course professor (i.e. second author) developed the course and produced all learning material, including 23 screencasts half-an-hour each, handouts and quizzes. The professor had taught this and similar courses more than 25 times previous to this occasion and we could therefore use his competence and experience in the process.

Questionnaires with both open and closed questions were given to the students in the beginning and after the course to collect their experiences on how they plan to use the teaching material and how they perceive their use of it. The actual use of the teaching material (the on-line lectures, handouts and quizzes) was also monitored through the university's learning and collaboration platform, Cambro. Besides quantitative empirical data, classroom observations were made by first author to evaluate the in-class group work discussions.

4 Results

The empirical data is under analysis but will be presented at the conference; however, one apparent result already seen is the language of the course. Most students have Swedish as their first language, however the course is available for foreign exchange students and therefore the course material is produced in English. This is something that students state as complicating for the learning process, even though students always are used to chemistry textbooks written in English. In class, the group discussions were always done in Swedish if no none-Swedish students were in the group. The teacher also responded in Swedish if everyone in the group were Swedish-talking.

We will present how the students tackled both the on-line lectures and quizzes at home and the in-class chemistry problems with peers in relation both to constructivist and socio-cultural theories. Different groupings within the class will be presented, for example, how different group of students (e.g. students on the Master of Science Programme in Biotechnology, future chemistry teachers or chemists) used the course material. Both quantitative results describing students' perceived experiences as well as qualitative observation data will be explored in the presentation.

4 Discussion and conclusion

To follow an implementation of a new teaching and learning approach, i.e. flipped learning, in a university course that has been taught in the same way for more than 30 years will be elaborated and both advantages and challenges will be discussed.

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13. COLLABORATION BETWEEN UNIVERSITY AND SCHOOL – HOW DO WE MAKE USE OF EACH OTHER'S COMPETENCIES?

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Abstract
Through design-based research, two collaboration projects between school and university are presented to illustrate how science education research can both inform practice and at the same time learn from practice. Evidence-based practice has been elaborated for more than 25 years, however several aspects still need more consideration. How can we achieve a win-win situation for both research and practice, how can we make use of both parts and not only try to implement research in schools in a one-way manner? In this study, two different collaboration projects concerning teacher education and in-service teacher training will be used as examples to highlight the possibilities for a collaboration where both parts benefit from each other. Through the lens of design-based research, the development of the projects will be emphasised in the presentation.

1 Introduction
Collaboration projects between science education research and the surrounding society have become more and more important today, partly with intentions to spread educational research to practitioners, partly to find new research areas relevant for practice. But how can we collaborate to develop and improve science education research and make use of experiences from teachers? How can a research-practice partnership be valuable for both parts? On the other hand, one foundation for schools is to rely on a scientific foundation as well as be evidence-based (Ryve, Hemmi & Kornhall, 2016). How can practice develop from educational research? Two ongoing projects, one emanating from a larger project from Vinnova (Sweden's innovation agency) and one project developed through a position as a NATDID-ambassador (NATDID, the Swedish National Centre for Science and Technology Education) will be presented and experiences from the first rounds of the projects will be elaborated. For a research purpose, this collaboration will be analysed from a theoretical point of view.

The first project presented is named "Möjligheternas möte" (the meeting of possibilities) and is a part of a large Vinnova project "Samverkanssäkrade utbildningsprogram". "Möjligheternas mote" is a meeting between university teachers/researchers and school teachers to develop ideas with the aim to produce examples for students' project degree course (master thesis), a one-term project that teacher students do in the end of their teacher education to connect practice with research. Previous experiences from these project degree courses are that students choose topics mostly similar to projects done by students before and with little value for school and explicit influence from school practice. The intention with "Möjligheternas möte" was to connect school teachers with university teachers/researchers to develop concrete ideas for students to work further with. In this study the focus is on the part where science (i.e. chemistry, physics, biology and science studies) is involved.

The second project is a "book club" realised within the larger project of NATDID, a national centre with an aim to make science and technology education research available to teachers in a valuable format. After contact with headmasters and teachers in a Swedish municipality, a group of upper secondary science teachers applied to participate in a book club where I, as a NATDID-ambassador and a chemistry education researcher, helped the teachers to find suitable research to read concerning areas the teachers requested (e.g. ICT in science education, assessment of open-ended chemistry problems) and then acted as a discussant when meeting to discuss the research together with their experience from practice.

The aim of the study is to learn from the collaboration between school and university and develop it further to make use of each other's competencies. The research question in focus is: How can two collaboration projects between practice and research develop both teacher education and teachers' in-service training?

2 Theoretical framework

Interventions to analyse and improve the activities within the two projects are designed in a cyclical process, according to the paradigm of design-based research, DBR (Bell, 2004; Edelson, 2002; Juuti & Lavonen, 2006). Bell (2004, p. 251) highlight that *Design-based research is focused on the development of sustained innovation in education*. The first project, "Möjligheternas möte", has been accomplished two times whereas the book club has a cycle of one year and is still on the first round. The main idea of DBR is to make teaching and learning research more relevant for educational practice. Wang and Hannafin (2005, p. 6) define DBR as "*a systematic but flexible methodology aimed to improve educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real world settings, and leading to contextually sensitive design principles and theories*". The intentions for using DBR as a means of framing the two projects are mostly to be thorough in the process and to evaluate all steps in the cycles and thereby develop the design further for the next cycles. Besides DBR, affective frameworks as the Häussler et al. (1998) framework will be applied to explore the teachers' interest in participating in the projects. Interest from teachers to participate in collaboration projects is seen as a foundation for further development and interest as an affective construct will be elaborated in the presentation (cf. Krapp & Prenzel, 2011).

3 Research methods

From both projects, all written correspondence from the teachers involved in the project and experiences from meetings between research and practice have been collected as empirical data and is analysed using the DBR cycle. In the first project, "Möjligheternas möte", two rounds have been carried out and in total four science teachers and three university researchers/educators have participated. In the second project, five teachers and one researcher form the book club. Besides the teachers participating in the projects, interviews with the teachers and the researchers about their experiences about the two projects have recently been conducted and will be analysed and presented at the conference. All teachers and researchers have voluntarily agreed to participate in the projects and appropriate ethical guidelines have been applied (Swedish Research Council, 2011).

4 Results

One overall result is that the teachers involved in the two projects are positive to participate and engaged in the project. One exemplary quote from the interviews with a teacher in project 1 (Möjligheternas möte): *I see clear possibilities from us in school to help the teacher students to guide them to their project degree, and then it is so much easier, and more valuable, for us to take part in the project and help the students to collect empirical data. Not as today where students all the time ask me to do surveys and interviews where I'm not really interested.* The interviews about the book club show more focus on the teachers' own training: *It's great to have the possibilities to ask for concrete help from a science education researcher to find good texts to read about something we have chosen and then to take time to discuss it with my colleagues.* Different interest aspects have been stated by the teachers and will be presented. Difficulties are also emphasised, then almost always mentioning the time-issue, that teachers feel they do not get enough time to work in projects valuable for both themselves and for school practice.

In the first project where two cycles are finalised, the final written texts presenting project degree examples to the students will be analysed together with the correspondence between teachers in schools and the university and will be elaborated in the presentation.

4 Discussion and conclusion

This study focuses evidence-based practice and how collaboration projects might improve both practice and research. The first project concerning teacher education and the second on in-service training.

Teachers' own interest to participate in these projects are found important for engagement and the use of the DBR cycle as a means to emphasise the assessment of the project have clearly influenced the results. This spiral DBR cycle is applicable now moving into the next round of the projects.

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14. DEVELOPING A LEARNING PROGRESSION FOR STUDENTS: FROM EVERYDAY TO SCIENTIFIC OBSERVATION IN GEOLOGY

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Abstract
This study addresses how students use observation to identify rocks – a key activity for geologists. This is carried out by investigating how an intervention – a tool for rock identification – proposed in a recent study can support students to identify rocks in line with a scientific perspective. Data consists of videos of 19 small student groups from three schools (55 students aged 16-18) who identified rocks. Drawing on the Observation framework by Eberbach & Crowley (2009), we analyze how students observed rocks: how they noticed features of rocks and how they connected the features to geological processes. Findings revealed that three student groups used everyday observation to identify rocks, 13 groups performed rock identification on a transitional level, while three groups performed in line with scientific observation. This indicated that the "tool for rock identification" enabled most students to achieve a more scientific understanding of rock identification. Based on the findings, we argue that scientific observation is critical for engaging in scientific practices that support scientific understanding of rocks. We also propose that the findings can be used to develop an Observation framework for rock identification that can be used by teachers to support and assess students' understanding.

1 Introduction
This study investigates how students use observation to identify rocks. Previous research reviewed by Francek (2013) document students' difficulties with rock identification. Yet rock identification is included in many countries' curriculums, because rock identification is a key activity for geologists. They observe specific features of rocks to determine whether the sample is magmatic, metamorphic, and sedimentary, and then make inferences about the rock's geological history. Hence, the purpose of this study is to discuss how students can identify rocks in line with a scientific perspective.

2 Theoretical background
Students develop understanding by participating in activities requiring application of scientific content and practices (Duschl & Grandy, 2013). Scientific practices are specified in the US framework for science education as: asking questions, developing and using models, planning and carrying out investigations, analyzing an interpreting data, using mathematics and computational thinking, constructing explanations, engaging in argument from evidence, and obtaining, evaluating and communicating information (NRC, 2012).

However, none of these practices include the word "observation", despite the fact that scientific observation is a prerequisite for the aforementioned scientific practices. Scientific practices such as "planning and carrying out investigations" cannot be done without knowing what to observe or how to do it (Duschl & Bybee, 2014). Therefore, scientific observation has a key role in science education (Hodson, 1986).

Eberbach and Crowley (2009) proposed a framework of four components of scientific observation: *noticing, expectations, observation records, and productive dispositions*. Within each component, Eberbach and Crowley distinguish between different levels: *everyday*, *transitional* and *scientific*. On an everyday level, students cannot distinguish between relevant and irrelevant features and cannot connect features to scientific theories, whereas the scientific level involves an ability to notice relevant features and interpret them in a scientific framework. This implies that teaching need to support students to develop scientific observation skills (Hodson, 1986).

In a recent study (Authors & Colleague, 20XX), we investigated how scientific observation was emphasized in the teaching of rock identification in one elementary class and one secondary class. When the teaching focused on naming rocks without using observations, the students were unable to identify rocks consistent with a geological framework. By contrast, the students demonstrated a *scientific understanding* of rocks when the teaching emphasized geological observation by using a “tool for rock identification” (henceforth: RID-tool).

The RID- tool consists of the pattern of rocks as a relevant feature to be noticed. The pattern denotes which main group the sample belongs to: Dotted pattern =magmatic rocks, stripes = metamorphic rocks and layer-on-layer with fossils = sedimentary rocks. Each pattern is linked to the geological process explaining how the rock gained its feature: Dotted pattern is created by solidification of melted rock, stripy patterns form when rocks are changed due to high pressure and temperature in plate collisions and layer-on-layer are formed when materials are deposited by water and wind.

The present study addresses how the RID-tool can support secondary students’ rock identification more effectively. Our research question is: *How do students use observation to identify rocks?*

3 Research methods

55 students (aged 16-18) from three different schools in Norway participated in this study. Their teachers told that they had implemented the RID-tool in their teaching.

We collected video data (using head-mounted cameras) by asking the students to sit in small groups (2-4 students), and asked them to identify a collection of rock samples (Figure 1). 55 students resulted in 19 small groups, producing 19 videos of 5-10 minutes.

Figure 1. Rocks to identify

Viewing the videos we used the two components – *Noticing* (noticing relevant features of an object) and *Expectations* (interpreting features in a scientific framework) – from Eberbach and Crowley (2009) to analyze how students used observation (*everyday, transitional or scientific*) to identify the rock samples as evident in their talk and actions.

4 Results

Almost all student groups reached a correct conclusion: they sorted the rock samples into three groups and explained the associated geological processes. However, the analysis of how the students reached the conclusion revealed that they used observation in different ways to identify rocks: three student groups used everyday observation, 13 groups used transitional, and three groups used scientific observation. Further details are presented below.

Everyday observation

Noticing: In three groups, the students tried to memorize whether they had seen a similar sample before – as exemplified by Tom’s utterance:

> Tom [About a magmatic sample]: This is not basalt, but what was it called, I can’t remember…

Expectations: When the students could not remember the name, they began noticing both relevant (i.e. bands, dots, layers) and irrelevant features of the samples (i.e. shape, roughness, smell). However, the features did not enable them to identify which main group the sample belonged to. When asked by the researcher, the students recalled simple definitions of rock formation – e.g., “high pressure and temperature” – without linking to plate tectonics or to observable features in the sample, which reflected everyday observation.

Transitional observation

Noticing: In 13 groups, relevant features (dots, stripes, layers) prevailed in the students’ noticing. However, many students spent a long time discussing whether a rock was “stripy” or “layer-on-layer”. This indicated that they focused on relevant features, without being to see the difference.

Expectations: When connecting the features (patterns) to geological processes, confusions and misunderstandings emerged – for instance:

> Georg: These are magmatic because they are dotted and have been under high pressure and temperature. And that influences the consistence of the rock [pointing at specific features of the sample].

Georg referred to the formation of metamorphic rocks when explaining how the magmatic samples gained a dotted pattern. This indicated transitional observation.

Scientific observation

Noticing: Three student groups sorted samples by noticing the patterns (dots, stripes, layers). Next they proceed to notice additional relevant features to identify the samples. For instance – identifying slate, the students tried to “draw” on a sheet of paper to determine whether the sample was an alun or clay slate. This showed that they were able to name rocks based on noticing features at a more specific level.

Expectations: The students explained how the rock gained its pattern. For instance, when explaining metamorphic rocks, the students referred to high pressure and temperature due to plate collisions. This indicated an understanding that large-scale geological processes cause changes in rocks, which corresponds to scientific observation.

4 Discussion and conclusion

Our findings indicate that the secondary students had developed an ability to identify rocks using observation, as opposed to previous studies showing that students lack scientific understanding of rocks (Francek, 2013). Hence, the RID-tool seems important for supporting students’ understanding. However, the variation in the level of observation revealed that there are aspects of the RID-tool that needs to be discussed in order to support more students to achieve scientific observation, which would be a prerequisite for scientific practices.

First, students using everyday observation suggested that they had not understood how features are clues in rock identification. Therefore, teaching needs to ensure that students understand the scientific purpose of noticing relevant features. However, it might not be enough to know about the RID-tool. The students at the transitional level confused “stripes” and “layer-on-layer”, suggesting that they had learned what features to notice, but could not really apply it to identify new samples. Thus, students need enough opportunities to practice noticing in different contexts over time (Authors & Colleague, 20XX).

Second, the students at the everyday and transitional levels encountered more difficulties with using the features of rocks as clues for geological processes. Noticing relevant features has little value if students are unable to explain how the features developed within a geological framework (Eberbach & Crowley, 2009). Therefore, our findings indicate that explaining how rocks gained their features is critical in order to identify rocks in a scientific way.

Based on the discussion, we will construct an Observation framework particular to rock identification, proving a tool for teachers to support and assess students' development from everyday to scientific observation. This is critical for engaging students in scientific practices. Therefore, a message to science educators is to emphasize "scientific observation" more explicit in the scientific practices.

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15. ELABORATION AND NEGOTIATION OF NEW CONTENT. THE USE OF MEANING-MAKING RESOURCES IN MULTILINGUAL SCIENCE CLASSROOMS

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Abstract
This presentation reports results from a study aiming at examining multilingual students' meaning-making in science when instructed through Swedish. Focus is on how new content is elaborated and negotiated through various semiotic resources such as written and spoken language, still and moving images, gestures and physical artefacts. Data consist of video and audio recordings and digital photographs from two multilingual physics classrooms (students aged 11-12 and 14-15 respectively) and one biology classroom (students aged 14-15 years). Theoretically, the project takes its stance in social semiotics and pragmatist theory. Data are analysed through systemic functional linguistics, multimodal analyses and Dewey's principle of continuity. The results show that the teachers and the students were engaged in meaning-making activities involving a variety of semiotic resources in ways that sometimes matched both students' linguistic and scientific level. However, some observations indicate classroom practices that might constitute a hindrance for meaning-making. The study has implications for ways of promoting multilingual students' meaning-making in science, including learning science, competent action, that is, norms about how to act in the science classroom, and communicating through different modes.

1 Introduction
We present results from a project funded by the Swedish Research Council, studying classroom interaction and its contribution to multilingual students' meaning-making in science. Our point of departure is the fact that various semiotic resources are used in all meaning-making situations, especially in science classrooms (Danielsson, 2016; Kress, 2010; Kress et al., 2001; Lemke, 1998). Lemke (1998) found that multiple resources were used in an upper secondary physics classroom. He concludes that various semiotic resources need to be used in the science classroom, since each resource can contribute to meaning-making in specific ways, and since a certain level of redundancy can be beneficial for learning. Kress and colleagues (2001) showed that multimodal ensembles were used in a lower secondary biology classroom to present different aspects of blood circulation, such as a 3D model of a torso, gestures, speech, drawings, each resource being used in accordance with their modal *affordance* (Kress, 2010). Likewise, Danielsson (2016) revealed that lower secondary chemistry teachers used gestures, writing, speech and drawings in accordance to their respective modal affordances when introducing the atom as a scientific concept. Gestures (and speech) highlighted dynamic aspects, while images highlighted the different particles, giving a static image of the atom. An implication is that classroom discussions might enhance students' learning, which might be important especially for students learning science in a second language.

Our research question addresses how new content is elaborated and negotiated in classroom activities through various semiotic resources.

2 Theoretical framework
Our theories emanate from social semiotics (Halliday & Matthiessen, 2004; Jewitt, 2016; Kress, 2010) and pragmatist theory (Dewey, 1938/1997). In social semiotics, the choice of resource for meaning-making is viewed as a result of social, cultural and situational factors, including participants and available semiotic modes and resources. A central concept for our analyses is the notion of 'affordance'

(Gibson, 1977; Kress, 2010), here defined as the potential for meaning-making or potentials and limitations of the resources used (Kress, 2010).

Dewey's (1938/1997) principle of continuity implies that earlier experiences are reconstructed and transformed from a purpose, having consequences for meaning-making in the present and future situations. Accordingly, science meaning-making is *continuous*, however, not always taking the route intended by a teacher (Jakobson, 2008; Lave, 1996; Wickman, 2006). Continuity can be seen in how students interact and proceed in situated action, using language and other resources.

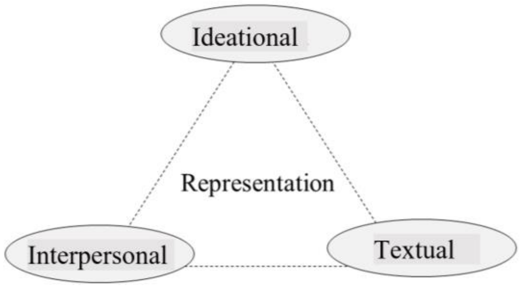
3 Research methods

We present results from three multilingual classrooms in three different schools, two physics classrooms (students aged 11-12 and 14-15) and one biology classroom (students aged 14-15 years). The schools are linguistically and culturally diverse, located in suburbs. Most of the students are multilingual with varied proficiencies in Swedish.

The lessons deal with the units *Sound*, *Measuring time* and the *Human body.* Data consist of video/audio recordings, digital photographs and students' written texts. The project adheres to the ethical principles outlined by the Swedish Research Council (2011).

Data is analysed through multimodal analysis by the use of systemic functional linguistics (SFL) and Dewey's principle of continuity.

We describe the overall design of the lessons according to a number of activities that were noted. For each activity, we specify the semiotic resources used, including *multimodal ensembles*, that is, combinations of resources in different semiotic modes forming an entity (Jewitt, 2016).



Figur 1. Metafunctions in communication (Halliday 1978; Bergh Nestlog 2012).

A basis for SFL (Halliday 1978) is the idea that all communication and all resources used in communication can be described through three metafunctions realised simultaneously in all communicative events (Figure 1): ideational, textual and interpersonal. Regarding disciplinary discourse, all subjects have developed resources in relation to these dimensions: displaying knowledge (field; ideational metafunction), being authoritative (tenor; interpersonal metafunction) and organizing information (mode; textual metafunction). The framework has mainly been used for written texts and needs some adaptation for analyses of classroom interaction (Bergh Nestlog, 2012). Our data is analysed in regard to content (ideational metafunction), how the content is expressed and organised (textual metafunction) and the interpersonal metafunction as to how relations are created through interaction between participants or between participants and the resources used. Regarding the interpersonal metafunction, special focus is on how teachers and students position themselves in relation to the discourse of science, i.e. to what extent they use the authoritative voice of science or more everyday ways of expressing content. Moreover, central to our analyses is to what extent the use of different resources is continuous, or coherent, with the purpose of the activity.

4 Results

Teachers and students used several resources when elaborating and negotiating about content, often in multimodal ensembles. Analyses from all units revealed similar results, although with some difference. The following example is from the *Sound* unit in one classroom:

- Ideational metafunction: content was specialised - sound waves and the wave model to explain how sound travels through different media. This content was explained by connections to students' everyday experiences (throwing a stone in water, which creates waves) or through the scientific wave model.

- Textual metafunction: content was expressed through various resources and could be more or less specialised, such as spoken exposition combining gestures and specialised concepts like compression vs. expansion in multimodal ensembles or an analogy to standing in a line being pushed.

- Interpersonal metafunction: on the one hand students were drawn into the content through questions, inclusive voice and connections to earlier experiences. On the other hand, the teacher used resources in line with science proper.

Moreover, this lesson was continuous with learning about sound, seen in student's actions and discussions. Their earlier experiences were reconstructed and transformed in the new situation in line with the teacher's purpose. Consequently, the students made meaning of the science content.

4 Discussion and conclusion

The students were afforded various channels for meaning-making which can be especially beneficial for students learning in their second language. However, an implication of our study is that teachers might need to enhance their awareness of their use of different resources as well as the ways in which they create opportunities for students to make meaning of the science content through a variety of semiotic modes. Possibly, students can benefit from getting opportunities to reason about their observations in small groups or whole class, and from receiving instructions about both *how* and *what* to discuss. Furthermore, students would also benefit from discussions about modal affordances and how different resources are related in a given situation. Such discussions can promote continuity between the purpose of the activity and the actual meaning-making. Also, through such discussions, students can develop their disciplinary literacy, in this case learning science, expressed through competent action in the science classroom and communicating through different modes.

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16. TEKNIKÄMNET I SVENSK GRUNDSKOLAS TIDIGA SKOLÅR SETT GENOM FORSKNINGSCIRKELNS LUPP

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Abstract
Technology has been a compulsory subject in the Swedish school curriculum since 1980. However, many primary school teachers say that they do not feel comfortable with teaching technology. This often results in a teaching time that is a (too) small part of the total teaching time of science and technology. In addition, studies show that pupils probably are not given equivalent education as the syllabi may be interpreted in different ways. With this as a background, we have conducted three research circles under the guidance of researchers, in three municipalities in the Mälardalen region addressing teachers working in preschool class to grade 6. Each circle had up to five participants and had five meetings during a year. Based on the teachers' own questions and needs we have studied didactic literature connected to the subject technology, discussed the syllabi for technology and different forms of teaching support. Results of the research circles were that the teachers have had time and opportunity to talk technology and find inspiration to try new ideas in their teaching. They experienced opportunities to work with a subject content linked to the syllabi for technology and ways to integrate technology with other school subjects.

1 Introduktion
Teknik har varit ett obligatoriskt ämne i svenska grundskolan sedan 1980 års läroplan. Trots detta har ämnet haft svårt att etablera sig då det ännu saknar tradition som eget ämne och med egen form (Björkholm, 2015). Många lärare som undervisar de lägre åldrarnas elever uppger också att de inte känner sig bekväma med att undervisa i teknik, vilket innebär att ämnet ofta får en för liten del av den totala undervisningen inom naturvetenskap och teknik (Skolinspektionen, 2014). Dessutom visar studier att eleverna med stor sannolikhet inte får likvärdig undervisning eftersom kursplanen tolkas på olika sätt (Bjurulf, 2008; SOU 2010:28; Teknikföretegen & Cetis, 2013). Detta är inte enbart ett svenskt fenomen utan internationella studier påvisar likheter i andra länder (Benson, 2012; Koski, 2014). Detta synliggör ett behov att vidare utbilda lärarna i vad teknikämnet kan ha för innehåll och hur de kan arbeta med teknik i grundskolans lägre åldrar.

I en tidigare genomförd enkätstudie (Nilsson, Sundqvist, & Gustafsson, 2016) med lärare från tre olika grundskolor i tre olika städer i mälardalsregionen från skolans tidigare år (F-6) noterades att de lärarna har en uppfattning om vad teknik är och innehåller, som rätt väl överensstämmer med vad teknikfilosofer och teknikdidaktiker beskriver som teknikens karaktär (Collier-Reed, 2006; DiGironimo, 2010; Mitcham, 1994); teknik är produkter eller artefakter, användning av dessa, deras utveckling över tid, kunskap att kunna utveckla och tillverka produkterna samt en lösning på ett problem. Men en något svagare respons erhölls för att teknik är själva produkten eller artefakten, något som även noterats tidigare (Engström & Häger, 2015). En tendens är att uppfatta produkten som teknik först när den används.

Med syfte att fördjupa kunskapen om hur lärare ser på teknikämnet i skolan, hur de arbetar med det och samtidigt tillsammans utvecklar vår kunskap om teknik i skolan startades tre forskningscirklar i tre olika kommuner i mälardalsregionen med lärare från skolans tidigare år (F-6).

2 Bakgrund

Etableringen av teknik som ämne i svensk skola är relativt nytt. Även om ämnet blev obligatoriskt i och med läroplanen 1980 fick det inte egen kursplan förrän 1994 och kommer få en egen timtilldelning först under 2017 utifrån ett lagt regeringsförslag.

Även om teknik som praktik följt människan sedan urminnes tider är det med denna korta historia som obligatoriskt ämne i svensk skola förståeligt att det är i en utvecklings- och etableringsfas. Flera studier har gjorts om teknikämnet och särskilt kring teknik i skolans tidiga år. Resultat från dessa påvisar att undervisningen ofta har ett fokus på görandet, skapandet av produkter och artefakter på bekostnad av lärandemål och att läroplanens beskrivna innehåll av teknik fått liten uppmärksamhet av lärarna (Bjurulf, 2008; Jones, Buntting, & de Vries, 2013; Jones & Moreland, 2004). Detta är särskilt framträdande bland lärare i de tidiga skolåren (Björkholm, 2015; Blomdahl, 2007; Jones & Moreland, 2004; Rennie, 2001) och här framträder ofta svårigheter för lärarna att välja innehåll och forma innehåll i relation till ämnets kursplan. Resultatet kan bli att ämnet inte synliggörs av lärarna och att det av eleverna uppfattas som utan koppling till verkligheten och därför saknar relevans, men även att lärarna inte känner sig kompetenta i sin undervisning och upplever ett tillkortakommande genom bristande kompetens (Skolinspektionen, 2014).

En väsentlig utgångspunkt i arbete med att skapa kvalitet i teknikundervisning är att enas om vad teknik är. Även om någon konsensus inte finns kring *en* beskrivning finns ändå, som beskrivits, en stor samstämmighet bland teknikfilosofer och teknikdidaktiker (American Association for the Advancement of Science, 1989; DiGironimo, 2010; International Technology Education Association, 2007; Mitcham, 1994). Det är också viktigt att kunna identifiera teknikens karaktär i kursplanen för teknikämnet och då både i centralt innehåll och i förmågor (Skolverket, 2011). En annan central utgångspunkt är de didaktiska frågorna för undervisningens praktik. Varför man ska undervisa i teknik, där aspekter kopplade till samhället, dess komplexitet och teknikberoende, men även demokratiska perspektiv är viktiga. Men även frågan om vad man ska undervisa, där läroplanens tre rubriker om tekniska lösningar, arbetssätt för utveckling av tekniska lösningar samt teknik, människa, samhälle och miljö ger en utmärkt grund och vägledning. Slutligen hur man ska undervisa, där den didaktiska triangeln, som kan ha olika beskrivningar (Clément, 2006), kan vara en bra utgångspunkt och beskrivas som relationen mellan lärare, elev och teknikämnets innehåll i detta fall.

Som stöd för lärare i Sverige som arbetar med teknikämnet har Skolverket ett pågående arbete att ta fram material som en insats för fortbildning (Skolverket, 2016). Ett annat sätt där båda parter kan lära är samverkan mellan skola och högskola och vår studie är ett sådant exempel. Som metod för samverkan är forskningscirkeln vald och denna studie undersöker huruvida den genererar resultat som gör den användbar för kompetensutveckling av yrkesverksamma lärare i tidiga skolår i svensk skola.

En fråga vi ställer oss för denna studie är om forskningscirklar är ett funktionellt arbetssätt för att påverka skolans praktik? I så fall, hur förändras lärarnas syn på och arbete med teknik och teknikämnet i skolan genom forskningscirklarna? En delpresentation av våra resultat från forskningscirklarna har tidigare gjorts (Jonsson, Gustafsson, & Nilsson, 2016), men här ges en fylligare beskrivning av metod och resultat.

3 Forskningsmetod

Studien bygger främst på forskningscirkeln som metod. Denna är en inriktning inom deltagarbaserad aktionsforskning, där man genom kvalitativt forskningsarbete söker att nå ökad klarhet och förståelse inom en frågeställning (Stringer, 2007, p. 19). Svaren som erhålls med metoden är knutna till den didaktiska frågan hur, snarare än vad, och kan ge förståelse hur deltagarna uppfattar, tolkar förhåller sig till den fråga man har i fokus (Stringer, 2007, p. 19). Att en forskning är deltagarbaserad beskriver att den bygger på delaktighet där forskare och praktiker ser processen som gemensam (Andersson, 2007, p. 36). Detta innebar att de som berörs av forskningen är involverade i det utforskande arbetet under hela processen och på likvärdiga villkor. Vid deltagarbaserad forskning samverkar forskaren nära praktiken, i detta fall lärarna i forskningscirkeln. Ett växelspel sker där alla parter bidrar till kunskapens framväxande.

Två skolor valdes ut baserat på de finansieringskrav som fanns för studien. Detta innebar att skolorna måste ingå i det nätverk av övningsskolor som Mälardalens högskola har för sina lärarutbildningars verksamhetsförlagda del. Efter kontakt med berörda rektorer startades tre forskningscirklar, var och en med sin egen forskare från högskolan som cirkelledare. Två var lokaliserade på de utvalda skolorna med av rektor utsedda deltagare. Den tredje cirkeln bedrevs med deltagare från flera skolor på en tredje ort utifrån lärares eget val och engagemang. Varje cirkel hade mellan tre och fem deltagare och planerades för fem möten under ett år. För att dokumentera skeendet och processen vid mötena i forskningscirkeln valdes att göra fältnoter och minnesanteckningar. Att spela in mötena som ljudfil eller videofilm hade kunnat vara ett alternativ, men valdes bort då vi ansåg att det kunde påverka stämning i arbetet och därmed innehållet vid mötena. Cirkelledarna ansvarade för att ta noter under mötena och dessa har distribuerats till cirkeldeltagarna efter varje möte, så de har kunnat verifiera att innehållet i dessa motsvarat vad som avhandlats vid mötena i forskningscirklarna.

Utöver detta har data samlats in genom en avslutningsenkät efter att forskningscirklarna genomförts. Frågorna i dessa formulerades för att fånga in de deltagande lärarnas egna upplevelser av om och hur deras kunskap om teknikämnet i skolan och arbete med undervisning av teknik påverkats av forskningscirkeln.

4 Resultat

Sammantaget har cirkeldeltagarna en erfarenhetsmässig bakgrund med stor spännvidd, allt från ännu ej examinerade lärare till de som har mångårig erfarenhet. Detta gäller även formell utbildning i teknik. Detta parat med att de betonar olika behov gör att deltagarna på ett bra sätt kunde bli varandras resurser, när de själva ringat in behov, som litteraturstudier för att öka teoretisk kunskap om teknikämnet och dess didaktik, material att använda i undervisningen, så väl färdigt material som egna förslag, progression i ämnet, bedömning och betyg, samt koppling till andra ämnen.

Lärarna upplever det som positivt att de har fått tid och möjlighet att diskutera sina frågor i cirklarna och att fått inspiration att prova nya idéer i undervisningen. Dessa har även kunnat kopplas till läroplanens innehåll och beskrivna förmågor. Upplevelser av prövade idéer i undervisningen har sedan diskuterats i cirklarna. Lärarna har beskrivet att litteraturbaserade diskussioner har tydliggjort teknikämnets innehåll, även om en god kunskap fanns inledningsvis.

Viljan att arbete utvecklande även efter forskningscirkels slut är påtaglig. Detta i diskussioner hur deltagarna lokalt kan sprida sina kunskaper till kollegor på skolorna, hur man kan organisera material att använda i undervisning och göra det tillgängligt för fler, men även en gott exempel där man startat upp en egen intern bokcirkel med teknikdidaktisk litteratur.

5 Diskussion och slutsatser

Bland de risker vi förutsåg för projektet ingick svårigheter att kunna planera in träffar i forskningscirklarna på grund av problem att frigöra tid för lärare för deras medverkan. Det visade sig att i alla cirklarna har vi haft svårt att kunna planera in mötesdagar med lärarna. Inbokade möte har också fått ändrats.

Skälen för att planeringen av träffarna i tiden fått ändras har varit högst legitima; andra skolaktiviteter som måste prioriteras eller sjukdom, men ger samtidigt en bild av en pressad situation i skolan där tid som resurs för kompetensutveckling inte har så hög prioritet som lärarna kanske skulle önska.

Vi har också förstått att fler lärare skulle önskat kunna delta i forskningscirklarna, men det har varit svårt att frigöra tid för dem för deras medverkan. Flera följde fortbildningskurser i andra ämnen upphandlade av Skolverket eller har andra kompetensutvecklingsinsatser som har fått förtur.

Sammantaget är dock upplevelsen från både skola och högskola att forskningscirklarna bidragit till en ökad trygghet för undervisning av teknikämnet bland medverkande lärare och en önskan bland medverkande lärare att sprida detta till sina kollegor på sina skolor. Detta är mer framträdande än att deras syn på ämnet och undervisningen ändrats.

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18. STUDENT RESPONSES TO VISITS TO RESEARCHERS' NIGHT EVENTS

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Abstract
Activities around the world aim to stimulate students' interest in science, technology, engineering and mathematics. The European *Researchers' Nights* are one such example. This study investigated how seven students aged 15–19 responded to visiting such events. The study is based on interviews with the students and the results showed that they were all positive to the visit, in most cases experiencing it as better than expected. The results were categorised under the themes: expectations versus experiences, interest in research context and relevance of research. Most of the students were positive about being a scientist and could even imagine a future science career. The context of event presentations sparked the interest of the students who could relate it to their daily lives, or found it to have societal relevance. This study is a pilot and will be followed by a future study including more students.

1 Introduction

The European *Researchers' Nights* have been organised every September since 2005. In 2015 about 1.1 million citizens and 18,000 researchers took part in the scientific events organised in over 280 cities (Ec.europa.eu, 2016). *Researchers' Night* events are dedicated to popular science and learning in a fun way. They serve as an opportunity to meet researchers, talk to them, and find out what they do for society**.** The events include hands-on experiments, science shows, learning activities for children, guided visits of research labs, science quizzes, games, competitions with researchers, etc. (Ec.europa.eu, 2016) and are supported by the European Commission as part of the Marie Skłodowska-Curie Actions, an EU programme to boost European research careers.

Researchers' Nights have been arranged since 2006 in Sweden, with the organisation Vetenskap & Allmänhet (VA) acting as national coordinator. The aim of the Swedish events is to create opportunities for researchers to show citizens how exciting research can be and how it relates to everyday life. In 2016, events were held in 31 cities, attracting almost 16,500 visitors (VA, 2016).

This study regards the *Researchers' Nights* as STEM (science, technology, engineering and mathematics) activities aiming to stimulate students' interest in future studies and careers in these fields. VA has provided the European Commission with evaluations of the event through questionnaires completed by visitors. To study the events qualitatively, this pilot study was performed after the 2016 *Researchers' Nights* in Sweden, in cooperation with VA.

Research questions:

How do students respond to visiting Researchers' Night *events?*
How do the Researchers' Night *events affect students' view of scientific research?*

2 Theoretical framework

Several reports discuss the decline in students' interest in future studies or careers in STEM (e.g. Fitzgerald, Dawson & Hackling, 2013; Hofstein, Eilks & Bybee, 2011; Osborne & Dillon, 2008). Improving and stimulating students' interest in STEM has long been a concern (Osborne, Simon, & Collins, 2003). Examples of activities aiming to stimulate interest in STEM are summer schools, STEM clubs, science museums, competitions, science fairs, etc. (Potvin & Hasni, 2014). As mentioned, *Researchers' Nights* similarly tries to stimulate interest in STEM.

3 Research methods

Seven students between the ages of 15 and 19 were interviewed after visiting *Researcher's Night* events. The interviews were conducted by phone the week after the events and were recorded. An interview guide with structured questions was used, ensuring that similar interviews were conducted after events in different cities. The students consented to voluntary, anonymous participation. They were also informed about the purpose of the interviews and that recordings were being made. Six of the respondents visited the same event; four girls and three boys were interviewed. The girls are coded as G1-G4 and the boys as B1-B3.

The interviews were transcribed verbatim and were analysed using content analysis (Robson, 2011).

4 Results

The results from the interviews were categorised under three themes: Expectation versus experience; Interest of research context; Relevance of research. Some examples from the themes are presented below.

Expectation versus experience

Some of the students who visited *Researchers' Night* expected events to include experiments. These expectations were met since visitors were given the opportunity to do hands-on activities. A nineteen-year-old student expected to have the opportunity to present her own ideas of for future research to a researcher. Her expectation was also met.

However, students' expectations about researchers and research also seemed to be slightly changed due to their *Researchers' Night* visits: they reported that research, or being a researcher, was more positive than they had expected.

To be a researcher seems more fun than I expected. Well, it was actually more positive. (G2)

Another student mentioned that the visit had given her more insight in what it is like to be a researcher.

One of the boys explained that he learnt that when one does research, one needs to conduct several tests before obtaining a result.

The nineteen-year-old student referred to research as being something quite difficult and this impression was unchanged by the visit to *Researchers' Night.*

Interest in research context

The interviews revealed that the students became interested in some of the research fields and wanted to know more. They were curious about robotics, DNA and emergency medicine.

Two of the girls explained that they found the activity about robotics research the most interesting.

The most interesting thing was what you can do with robots. That you can help older people. It is an important thing. It seems fun to do research. (G3)

The nineteen-year-old girl was interested in research about “saving the world”. She explained that Malala was her role model and she wanted to do similar things to what Malala had done.

One of the boys did not find anything particularly interesting during the visit, but still enjoyed it. He explained that he liked science, but did not want to become a scientist anyway.

With the exception of the boy mentioned above, the younger students were positively disposed to the idea of becoming researchers.

Relevance of research

The students had different impressions of the relevance of the research presented at *Researchers' Night*.

I could not find any connections to my everyday life in the research I heard about, not in any way. (B1)

However, some of the students found connections between the research they heard about and their daily lives, and some though that the research was important for society.

Connection to my daily life, well, the activity with the researcher on young people's health and the research in robotics seemed to be very relevant for society. (G2).

I visited an activity linked to my everyday life, it was about colour blindness and I am colour blind. (B2).

4 Discussion and conclusion

The results indicate that the students experienced *Researchers' Night* as positive. Some of the students could even imagine becoming researchers. Hence, the *Researchers' Night* events studied could be considered successful in stimulating student interest in STEM.

Most of the students were interested in the contexts presented during the events. Gilbert (2006) discussed the importance of context in science education and in the *Relevance of Science Education* (*ROSE*) study it was also shown that girls' and boys' interest are context-dependent (Sjøberg & Schreiner, 2010).

Most of the participating students were interested in issues relating to society. This is in line with the results by Newton (1988). He reported that students who are older are more interested in the world around them.

Finally, it is important to consider that this study only included a small group of students. It could therefore serve as a pilot for a future, more comprehensive study.

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19. RELEVANCE OR INTEREST? STUDENTS' AFFECTIVE RESPONSES TOWARDS CONTEXTUAL SETTINGS IN CHEMISTRY PROBLEMS

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Abstract

To make students interested and engaged in science, several new teaching approaches have been developed aiming for higher order thinking. Context-based learning approaches emanates from an idea that science content knowledge should be presented in a, for students, relevant context to improve their learning outcomes as well as making them more interested in science. Previous research has shown positive results; however, researchers and teachers need to consider which aspects of the contextual settings young students perceive as interesting and relevant. In this presentation, the notions of 'interest' and 'relevance' will be elaborated further to discuss which aspects of open-ended chemistry problems students prefer.

1 Introduction

To develop chemistry education towards higher order thinking, i.e. beyond recall of factual knowledge, context-based learning (CBL) approaches have in some countries been implemented to improve students' affective responses as well as to develop their cognitive learning outcomes. To elaborate CBL approaches further, Pilot and Bulte (2006) highlight the need to identify contexts that both are appreciated by students and that can be related to the learning of chemical concepts. In some previous research (e.g. Christensson & Sjöström, 2014; Graeber & Lindner, 2008), the contextual setting has sometimes been named 'topics', 'modules' or 'themes', and the definition of the different aspects has not always been explicit. In this presentation, students' affective responses, i.e. their perceived interest and relevance, towards specific aspects of context-based chemistry problems will be presented. The affective responses have been scrutinised by Stuckey et al. (2013) and will be discussed further in the presentation. The research questions for this study are: How do students differentiate between interest and relevance? Which aspects of context-based chemistry problems are found more or less interesting and relevant to students?

2 Theoretical framework

The affective domain of learning can significantly enhance, inhibit or even prevent student learning and is therefore important to consider within educational research. In this study, the affective construct in focus is 'interest', sometimes taken to be almost a synonym of attitudes and sometimes treated as a construct in its own right (Krapp & Prenzel, 2011). Interest has been investigated for a long time, and various interest frameworks have been developed (e.g. Hidi & Reeninger, 2006; Häussler, Hoffman, Langeheine, Rost, & Sievers, 1998; Krapp & Prenzel, 2011). Interest is primarily conceptualised as a relationship between an individual and a topic, object or activity; in other words, it is content-specific (Häussler et al., 1998). Therefore, the perceived interest is analysed in direct connection to the chemistry problems.

Related to interest and attitudes is the notion of 'relevance', which has for example been investigated within the ROSE project (e.g. Jenkins & Nelson, 2005; Jidesjö, Oscarsson, Karlsson, & Strömdahl, 2009; Sjøberg & Schreiner, 2012) among others. The meaning of 'relevance' has been questioned in the same way as other affective constructs, and Stuckey and colleagues (2013) state that it is inadequately conceptualised. Nevertheless, science education researchers, teachers, policy-makers and curriculum

developers frequently use the term by claiming that students find science in general and chemistry in particular irrelevant.
The perceived importance of relevance is readily apparent from its appearance in different curricula, and relevance is a watchword in many CBL approaches (King, 2012). Another similar notion that is often taken to be synonymous with relevance is 'meaningful'; CBL approaches have been implemented in several western countries with the aim of making chemistry relevant and meaningful (King & Ritchie, 2012). Relevance is clearly aligned with interest; some researchers take them to mean the same thing while others separate them, unfortunately often without clearly defining their differences (Stuckey et al., 2013). In this study, the definition of the two constructs will be elaborated from the participating students' responses.

3 Research methods

Context-based chemistry problems were developed according to structured design principles; 15 tasks in five different topics (i.e. medical drugs, soaps and detergents, fuels, energy drinks, and fat) and three contextualized settings (i.e. personal, societal, and professional context). The reasons for choosing these topics and contexts are related to previous research (cf. the ROSE project, de Jong, 2008). In the presentation, students' affective responses to the chemistry problems will be surveyed. Through semi-structured interviews, 20 upper secondary students (age 19) read and assessed these 15 problems regarding how relevant and interesting they were perceived before solving the problems according to think-aloud techniques. The interviews also elaborated the similarities and differences between interest and relevance, according to the students. Thereafter, 175 students responded to the same affective questions, then in a written format. In a third step, to get more and deeper insights into the perceptions and interpretation of interest and relevance, 25 new short interviews were done to explore the constructs of interest and relevance further.

4 Results

One of the first outcomes is that the students found it difficult to distinguish between relevance and interest, a result also highlighted by Stuckey et al. (2013). However, in the presentation, we will elaborate students' qualitative interpretations and perceptions of the two constructs further.

Students' perceived interest and relevance in relationship with topics and contexts are presented in Table 1 and 2.

***Table 1**: Students' (n=175) preferred topic and context in relation to interest, i.e. response to the question, which context the students find more interesting.*

Topic	**Personal context**	**Societal context**	**Professional context**
Medical drugs	**79**	37	54
Fuels	**84**	52	33
Soaps and detergents	60	**76**	31
Energy drinks	**90**	57	23
Fat	49	40	**77**
IN TOTAL	**362 (43%)**	**262 (31%)**	**218 (26%)**

The personal context is in general found most interesting, however regarding soaps and detergents the societal setting is preferred and professional context is favoured in the task concerning fats.

***Table 2**: Mean values describing students' (n=175) perceived interest and relevance towards the topics, a high value (maximum 4) indicates high interest/relevance and a low value (minimum 1) indicates low interest/relevance.*

Topic	**Interest**	**Relevance**
Medical drugs	2.19	1.27
Fuels	2.59	1.50
Soaps and detergents	3.16	2.36
Energy drinks	2.60	2.64
Fat	2.73	2.02

All topics besides one in table 2 show a higher mean value regarding interest than relevance, i.e. all topics are perceived more interesting than relevant. The only exception is energy drinks where relevance and interest are almost equal. These descriptive data will be statistically analysed further and presented at the conference.

4 Discussion and conclusion

Implications for teaching from this study are that students often find chemistry interesting and relevant when it is closely related to themselves; chemistry topics and contexts that have explicit personal connections are perceived both interesting and relevant. In the presentation, students' affective responses will be discussed in relation to their cognitive responses investigated in previous research, i.e. students' conceptual responses (Broman & Parchmann, 2014). Moreover, suggestions for teachers creating context-based learning environments (cf. Taconis, den Brok, & Pilot, 2016) will be given to emphasise interest and relevance for students.

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20. WHY DO PRESCHOOL EDUCATORS ADOPT OR RESIST A PEDAGOGICAL MODEL THAT CONCERNS SCIENCE?

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Abstract
The article examines reasons that preschool educators adopt or resist a pedagogical idea that concerns science. The analysis builds on group interviews with preschool educators that have, during a 1.5-year-period, implemented and developed a pedagogical idea in practice. In the analysis, the reasons that educators adopt or resist this pedagogical idea, are allocated to five different domains; the personal, external, practice, consequences, and community domain. While the results show few examples of resistance towards the idea, they suggest that the idea is reinforced in relation to all five domains. The results suggest that teachers adopt the pedagogical idea because it helps them to discern and build on science content in their everyday practice. Educators claim that they prefer the everyday approach to their previous way of teaching science through occasional experiments. Further the results show that educators balance several external influences on what is good preschool pedagogy, and it is suggested that the particular pedagogical idea eases that balancing act. This since the idea was developed by, and thus likely perceived as approved by, stakeholders from the preschool pedagogy side as well as the science education side.

1 Introduction
Across the world, professional development (PD) initiatives are designed and conducted to support science teaching in early childhood education (ECE). In order for PD activities to successfully change teaching, it is often crucial that they bring about changes in teachers' beliefs, confidence and knowledge (e.g., Clarke and Hollingsworth 2002). Though there are several examples of PD studies showing *that* and *how* ECE teachers change, and how that change leads to improved science teaching (e.g., Roehrig, Dubosarsky, Mason, Carlson, & Murphy, 2011), few explicitly report on *why* teachers change or why they take on new pedagogical ideas. Addressing that gap in research, this article seeks to identify *reasons that teachers adopt, or resist, a pedagogical idea concerning science in preschool.* In this paper, 'preschool' refers to the Swedish pre-primary institution for children from 1 to 5 years, and the concept 'educator' is used to address all staff that work with children in preschool.

In Swedish preschools, the common case is that 3-4 educators work in teams in a preschool unit. The work team's shared view of science teaching (Sundberg et al., 2015) as well as the individual educators' views of the same (Fleer, 2009) matters to how science activities are carried out in ECE settings. When it comes to science in ECE, a common perception is that science should not reproduce school science standards (cf., Siry, 2013), and that science content should not be separated from other teaching content (Klaar & Öhman, 2014).

2 The participants and the pedagogical idea
The paper builds on data from a design-based (The Design-Based Research Collective, 2003) project in which a pedagogical idea was developed by five persons working in a pedagogical development centre, and the author. The particular idea was about approaching chemical processes and physical phenomena through colloquial science verbs, for example, rolling and dissolving (Areljung, 2016). The idea will from hereon be referred to as "the verb idea". During a 1.5-year-period several of these verbs were integrated in preschool practice by three preschool work teams, in all ten educators.

3 Research methods

In the end of the project period, the three work teams participated in group interviews, conducted by the author. Each interview lasted for about one hour and revolved around the educators' experiences of working with the verb idea in practice. The educators have been informed, in writing and verbally, about the aim of the project, the use of data, their right to refrain from participating and my efforts to keep individuals anonymous when communicating about the project. One educator did not participate due to illness and one educator asked not to participate in the interview.

The content analysis of the interview transcripts was guided by Clarke and Hollingsworth's (2002) model of teacher professional growth. The model was considered suitable because it takes into account four interrelated domains of change – the *personal, external, practice,* and *consequences* domain (see Table 1) – and thereby provides for a multifaceted image of why preschool educators adopt or resist a pedagogical idea that concerns science. Initial readings of the interview transcripts suggested that also a *community* domain, referring to the work team's shared beliefs about teaching (cf., Sundberg et al., 2015), should be included as a domain in the analysis.

Table 1: *Analytical tool – selection question and analytical question – and example quotes.*

Domain	Personal	External	Practice	Consequences	Community
Selection question	Does the sequence refer to…				
	… changed individual beliefs, attitudes, or knowledge, connected to science teaching in preschool?	…change in influence from external actors, connected to science teaching in preschool?	… changed practice, connected to science teaching in preschool?	... outcomes, connected to the changed practices?	…the work team's shared beliefs about teaching?
Analytical question	In that domain, how is the pedagogical idea reinforced or challenged?				
Condensed example quotes	Now I notice how a ball of yarn, or a pair of rain pants, sound. I can see that this too is physics or chemistry. I see it with other eyes. It [science] is not these test tubes anymore.	There is no one else who has done this much, not that we know of. No one of these persons that everybody talks about. There is no guru in this area. So you are quite free.	If we are in the sand pit, I say: Are you mixing water and sand' Lately I have rather said: 'Okay, you can hit the drying cabinet, but how does it sound if you hit the door or the floor?'	The children now know what dissolves and what does not. We noticed that the children liked rolling the best, so we focused on that verb.	This fits with our way, and not the school way, of working with science. It makes you focus on the processes, and not on where you should reach.

4 Results

The interviews include relatively few examples of resistance towards the verb idea. What does come up is that the science verbs initially were perceived as unscientific or abstract. During the interviews, the educators' resistance is generally moderated by their colleagues and always told in past tense, thus as a critique that does not apply anymore. This can be interpreted as a consequence of interviewer-bias, as the interviewer was also one of the creators of the verb idea.

Below, reasons for adopting the verb idea are presented in relation to the five domains (example interview quotes are presented in Table 1).

Personal domain. The science verbs are portrayed as an eye-opener that helps educators to identify physics and chemistry in everyday situations. Thus, the data suggests that the verb idea is adopted because it empowers educators in their work with science in preschool.

External domain. The data indicates that the educators deal with several external influences, and that the verb idea eases the educators' balancing act of doing preschool pedagogy and science teaching "the right way".

Practice domain. The educators express that they have changed their practice to more explicitly addressing science verbs involved in children's explorations. Further the data suggests that the educators ask more questions that stimulate investigations in everyday situations.

Consequences domain. The educators seem to value the fact that the children produce their own theories, questions and investigations relating to the verbs. Further they seem to value the fact that children repeatedly engage with material, such as material that produce sound or tornado movies.

Community domain. The data indicates that the verb idea fits the work teams' wishes of how to work with science, which includes a less (than before) detached practice that builds on everyday activities rather than specific experiments, and on everyday material rather than 'test tubes'.

4 Discussion and conclusion

The results suggest that one reason that the educators adopt the verb idea is that it helps them to draw science into their ordinary preschool practices, by addressing explorations of everyday material in everyday situations, instead of doing science through occasional experiments, detached from other teaching content (cf., Klaar & Öhman 2014). Thereby the verb idea offers a way to break with perceived school standards (cf., Siry 2013) and instead align science teaching with ideas of children as explorers. One overarching reason that educators adopt the pedagogical idea is that the idea is 'approved' by both the staff of the pedagogical development centre and the author, hence approved by stakeholders representing both the preschool pedagogy side and the science education side.

Further, the results points towards the need to, when using Clarke and Hollingsworth's (2002) model of teacher professional growth to study educator change in preschool, add a community domain to the model.

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22. MAKING THE INVISIBLE VISIBLE ACROSS MODES AND REPRESENTATIONS

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Abstract

The current paper reports on a study of students' interaction and production of various forms of representations, textual and visual, related to the concept of the greenhouse effect. The competent participation in representational practices is at the heart of scientific literacy and several studies have documented positive effects of introducing students to complex scientific concepts such as the greenhouse effect by means of engaging with various forms of representations. However, studies also show that even though the topic is related to everyday experience (weather, light, heat), the concept of the greenhouse effect is challenging for students. This is partly because of its many invisible processes, such as the transformation of sunlight into heat radiation and its absorption by greenhouse gases. This paper extends previous knowledge by analysing a discussion between first year upper secondary students who try to understand the greenhouse effect. The analysis shows how students' representations develop from naturalistic depiction to scientific abstraction. Furthermore, it shows how students' framing, foregrounding and backgrounding relate various naturalistic and scientific aspects in their drawings; connect multiple modes of representation and their affordances in peer and teacher negotiations; and how this enables sustained inquiry. Implications for teaching and learning are discussed.

1 Introduction

An important aspect of learning science involves learning to produce and interpret different representations, such as graphs and diagrams (Airey & Linder, 2009; Evagorou, Erduran, & Mäntylä, 2015; Gunther Kress, Ogborn, & Martins, 1998). In this paper we focus on visual representations, which, for example, focus students' attention, support negotiation of meaning, and make student thinking visible (see, e.g., Fredlund, Airey, & Linder, 2012; Furberg, Kluge, & Ludvigsen, 2013; Strømme & Furberg, 2015).

The paper reports on a study that is part of the REDE project (Representation and participation) at the University of Oslo. The project uses the comprehensive set of research based design principles that Tytler et al. (2013) have developed to enhance the way representations support science teaching. Tippett (2016, p. 730) notes that "comparatively little is known about what happens as students generate/construct their own visual representations". In this paper we shed further light on teacher-supported student engagement with representations by analysing video data from a discussion between first year upper secondary students who attempt to understand the greenhouse effect. The study is guided by the following research questions:

- How do students' representations develop during their interaction trajectories?
- How do the representations become structuring resources in the students' development of conceptual understanding of the greenhouse effect?

2 Theoretical framework

In our analysis we use the construct "mode", which is "a socially shaped and culturally given resource for meaning making. Image, writing, layout, music, speech, moving image, soundtrack are examples of modes…" (Kress, 2013, p. 60). Scientific representations are constituted by "clusters" of modes (see Knain, 2015). For example, a graph figure might include drawn lines, written language, and equations. Student learning involves making connections across the constituent modes, for instance by pointing (gesture) toward a line (drawing) while making claims (talk) (cf., Tang, Delgado, & Birr Moje, 2014).

When students wish to express something, they also need to make a number of choices, for example, which are the most apt modes that are available to them (see e.g., Kress, 2010), what is the “frame” that creates “the boundaries to interpretation” (Kress, 2013, p. 73), and what should be foregrounded and what should be backgrounded (Kress et al., 1998).

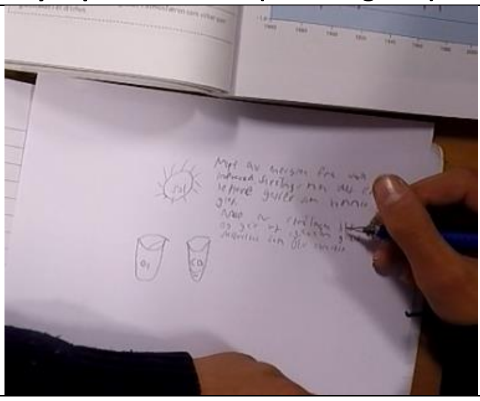
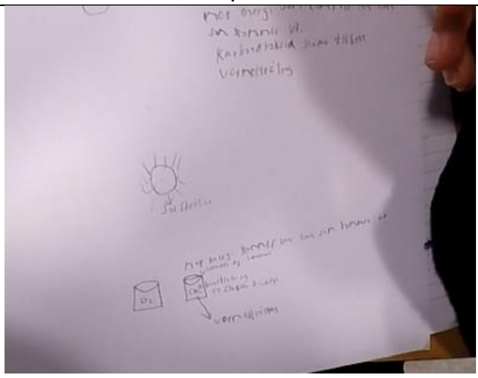
3 Research methods

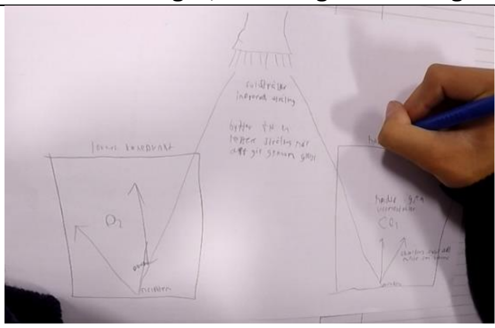
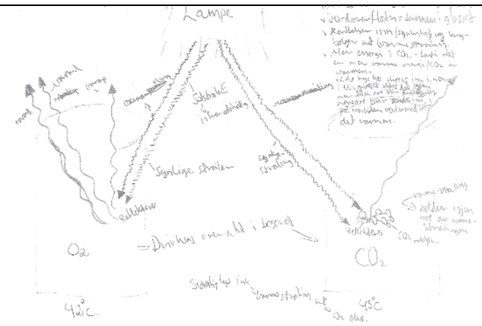
The empirical setting for the study is a science project about climate changes involving 25 upper secondary school students (aged 15-16) and their teacher. The main data material consists of 10 hours of video recordings of teacher-led whole class settings and student interaction during group work. The study used a design based research methodology where teachers and researchers cooperated in designing the teaching, drawing on the design principles presented in Tytler et al. (2013). Three groups used head mounted cameras. In order to explicate and display what can be seen as emerging patterns in students’ development of conceptual understanding while interacting with visual representations, detailed analyses of one student groups’ interaction trajectory is presented in the results section, and compared in brief to the other two groups wearing head cameras.

4 Results

Table 1 presents the trajectory of key events in the development of the group’s drawings to explain the greenhouse effect. In addition to student drawings, key interventions from the teacher are included as key representations. The table also indicates the modes involved, and the additional resources that the students used. A “key representation” we take to differ from “additional resources” by having a constitutive role in the situation.

Table 1. Key events in the students’ sense making of the greenhouse effect.

Event	Key representations (including talk)	Action	Modes	Resources
1		Ole starts by browsing through the textbook. 1st Drawing: beakers and light source. Writes explanatory text.	Drawing and writing.	Textbook and experiment.
2	Teacher talk pointing out that it is important that the drawing is clear, that this is only the first draft, and that the students should expect to revise it.	Teacher whole-class interaction	Talk	
3		Ole starts on 2nd drawing below the first. Knut asks why, and Ole answers “Now I am going to include concepts and stuff”.	Drawing and writing.	Students’ earlier drawing.

4		The students read off the temperature in the two beakers and comment on the heat from the light source.	Experimental setup, gestures, talk	
5	Student discussion about absorption and reflection of light, referring to drawing.	Peer discussion	Talk, gestures	Student drawing
6		Ole looks at the group behind him, says: “They draw so big, we so small. Starts 3rd drawing on the back of the paper.	Drawing	Previous drawings on back side, textbook.
7	The teacher pointing out that they should focus on what goes on inside the beakers, and make a drawing that explains the process to someone who doesn’t know.	Teacher whole-class interaction	Talk	
8	The teacher approaching the group and discussing how to differentiate between short-wave radiation from the sun and long-wave radiation from the ground; how to represent waves and how it is done in the textbook? Asks the students to work on details on what happens to the radiation.	Teacher interacting with Knut and Ole	Talk, gestures, pointing on specific aspects of drawing	Student drawing, teacher talk, gestures (points to drawing)
9		Knut draws the dyad’s 4th and final representa-tion. They discuss intensively different types of radiation during design.	Drawing, talk, gestures	Student drawing, teacher’s explanation (referred to)

The sequence of key events presented in Table 1 develops towards a focus on what goes on inside the beakers. This can be seen in the following ways: (1) labelled arrows are introduced in the student drawings (Event 3), (2) the beakers are drawn larger in the final drawing (Event 6), and (3) the beakers are partly overwritten. A significant shift has thus taken place in what is foregrounded and what is backgrounded. There is also a development in terms of framing: Initially, the piece of paper frames the drawn beakers (Event 1), then the beakers become the framing for the processes that take place inside them (Event 6).

Although we present in detail our findings from a group that we found particularly interesting, other groups showed similar patterns.

4 Discussion and conclusion

Our analysis shows that the students' representations developed from a naturalistic depiction of the situation to the presentation of invisible and theoretical aspects of the scientific model both within and across modes. In essence, the radiation waves and their interaction with CO_2 were foregrounded in the drawing. The development of the students' work shows that authoritative sources (such as the textbook and the teacher) and the students' experience of the experiment setup were interconnected through their drawings. By their sustained inquiry, drawings became increasingly "layered" in the sense that they first related to the experiment only (e.g. the beakers), and developed through relating also to the results of the experiments (e.g. temperature labels), and then ended up as including also the invisible, physical processes inside the beakers.

Educational implications that we see stemming from our results include that teachers should be persistent in guiding the students in what to focus on in their discussions, and how concepts and phenomena should best be represented.

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23. SELF-EFFICACY AS AN INDICATOR OF TEACHER SUCCESS IN USING FORMATIVE ASSESSMENT

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Abstract
In a recently completed project (ASSIST-ME) one goal was to test the usefulness of formative assessment methods in facililitating inquiry based science education. Over four years, teachers in six European countries tested the use of four assessment methods: written feedback, peer-to-peer assessment, 'on-the-fly' feedback and structured assessment dialogue. The study structure intentionally provided opportunities for the teachers to change their self-efficacy capacity beliefs about using theses methods. We hypothesized that one evidence of successful use of these methods would be positive changes in teacher personal beliefs about their capacities to adapt them successfully to their classrooms. We sampled the teacher's self-efficacy capacity beliefs before and after their trials with the formative assessment methods and found no overall changes but significant increases in important abilities in the use of formative assessment in inquiry teaching and learning.

1 Introduction
In a recently completed project (ASSIST-ME) our goal was to test the usefulness of formative assessment methods in facililitating inquiry based science education. Over four years we introduced teachers in six European countries to four assessment methods (written feedback, peer-to-peer assessment, 'on-the-fly' feedback and structured assessment dialogue) and used strategies for enhancing their beliefs about their abilities to use them.We hypothesized that one evidence of successful adoption of these methods would be changes in their personal beliefs about their capacities to adapt them successfully to their classrooms. We sampled the teacher's self-efficacy capacity beliefs before and after using the formative assessment methods. This report will share these results.

2 Theoretical framework
The role of capacity beliefs in changing behaviours
'Self-efficacy' is the capacity belief, which as studied in this project, is based on Albert Bandura's work that posits that such beliefs '… contribute significantly to human motivation and attainments' (Bandura, 1992). Beliefs in one's own ability to manage and implement a given challenge, such as using formative assessment with a class not accustomed to it, are instrumental in meeting the challenge (Bandura, 1992). For example, if teachers attempt to use peer-to-peer feedback for the first time they, based on previous experiences with unfamiliar methodologies, typically will have some doubts about their chances for success. Considering these doubts, positive expectations, and their current teaching environment, teachers will have individual levels of self-efficacy about how successful they expect to be. Contributing to this level of self-efficacy is a teacher's general confidence as a teacher at attempting new methods of instruction. However, general self-confidence is not the same as self-efficacy beliefs, since efficacy beliefs are targeted at specific future behaviours, whereas self-confidence is non-specific. We can simultaneously have a high confidence in our teaching ability yet low self-efficacy when confronted with a specific teaching demand such as using an unfamiliar kind of formative assessment.

Consequently, as teachers implement unfamiliar formative assessment methods, the experiences will either raise or lower their self-efficacies for that type of formative assessment Essential for any change in self-efficacy is authentic feedback about the degree of success for a teaching action. Sources of such feedback include self-reflection, student activation and various indicators of student success as well as perspectives provided by colleagues and or other observers.

Strategies for enhancing self-efficacy beliefs

Albert Bandura (1997) identified four methods for self-efficacy change. He categorized them as ‘enactive mastery experience’, ‘vicarious experience’, ‘verbal persuasion’ and ‘physiological and affective states’ (Bandura, 1997). Mastery experiences are past efforts at the same or similar teaching tasks from which teachers judge for themselves how well they were able to achieve a ‘novel’ teaching method. Their self-reflections about the extent to which they succeed in implementing something different strongly influence their future personal expectations for using this teaching method again. The influence of mastery experiences on future behaviour is high.

Teacher self-efficies are also influenced vicariously through seeing how their peers handle a trial of an unfamiliar formative assessment method. When they work in a teaching group to implement such a method and then discuss with their colleagues the degree of success, they adjust their own self-reflections to those of others with whom they compare themselves.

Similarly, social encouragement that teachers receive from those who they respect such as other teachers, administrators or university faculty, have an effect on their individual perceptions of self-efficacy. These sources of verbal coaching, when valid and not just kindly supportive, influence self-efficacies.

The stresses for teachers attempting unfamiliar teaching methods can have a negative influence on capacity beliefs in that teacher performance may be hindered by stressful messages from their bodies that reduce the positive feedback of their efforts.

3 Research methods

With a goal of testing the usefulness of formative assessment methods, the ASSIST-ME project was constructed around implementations that provided opportunities for all of Bandura’s methods for self-efficacy change (Bandura, 1997) to be used. For each of the trials in all country sites, local working groups (LWGs) of experienced teachers met with one another and project leaders to plan activations and discuss the results. During implementations, LWG teachers tried the assessment methods multiple times and reflected both individually as local groups on the results of their trials. Before and after concluding their project work, all of the teachers in the LWGs as well as teacher colleagues in each country who did not participate in the trials, answered questions about their experiences on standard questionnaire.

The teacher trials with formative assessment methods were designed to provide opportunities for ‘mastery’ of the less familiar methods since they were tried multiple times with intervals between for reflection and feedback. Since the project engaged experienced teachers, their self-reflections after repeated lesson trials are likely to have influenced their self-efficacies for each of the methods they used. In addition, since they met with peers in their LWGs before, during and after trials, the opportunities for vicarious influences from the group were frequent. Concomitantly, there were opportunities for influential members of the LWGs as well as project leaders to affect teacher self-efficacies through social persuasion at meetings where the processes and results of the trials were discussed.

A pre- and post-project teacher questionnaire was administered to all project teachers as well as to a sample of similar teachers from most project countries who were not involved with the study. It contained 12 items whose aim was to assess the self-efficacy of teachers unfamiliar with various formative assessment methods. Since the 12 items in the questionnaire did not represent a standardized instrument to collectively measure self-efficacy, the individual item results were more useful in assessing change than aggregated scores.

Since self-efficacy is an individual’s capacity belief, summative data for all six reporting countries was more useful than individual or country data in judging the potential of these experienced teachers to raise self-efficies while using the formative assessment methods. Individual and country changes in self-efficacy have the potential to inform individual and country success with these methods. Consequently, we chose an overall cross country perspective to gain general feedback on the trials of formative assessment.

4 Results

A hypothesized outcome of the trials of assessment methods was for positive pre to post changes in teacher's self-efficacies to occur when using the given formative assessment methods. Overall there were no changes in self-efficacy for the project teachers (+.06) while the collegial teachers (control groups) who had no exposure to the formative assessment methods of the project reduced their self-reported efficacies (-0.49) over the course of the project. The seven items which most directly asked for teacher expectations when using formative assessment showed an average change of +0.35/5.0 for the teachers who used project formative assessment methods as compared to their control colleagues whose average change was -0.12/5.0.

The same comparison between the three outcome expectation items was +.13/5 and -.34/5 is probably not useful in aggregate since the three outcome item results vary according to the specific contents of each.

5 Discussion and conclusion

The significant difference between the positive self-efficacy changes of the project teachers (+.35) compared to the negative change for their colleagues (-.8) may be due to collegial teachers agreeing with the assertion that 'Increased effort of the teacher in using formative assessment produces little change in some students' achievement in inquiry-based competencies.'. Without any new experience with the project formative assessment methods, but experience with teaching in general, the collegial teachers had a reduced efficacy in the effects of additional effort. The possibility is that experience with formative assessment in the study had a positive effect on project teacher's beliefs about affecting student achievement with formative assessment. Similarly in another question, project teachers had increased self-efficacies for overcoming inadequate student backgrounds when using formative assessment (+.25) while their non-project colleagues, reported lower efficacies (-.31) at overcoming inadequate backgrounds with formative assessment.

Conversely, project teachers' increased experience with using formative assessment may have resulted in a reduced expectation (-0.21) that 'The inadequacy of a student's background can be overcome by the use of formative assessment.' whereas without the project experiences, non-project teacher's self-efficacies remained unchanged (+.09).

The observation that experienced teachers in this project had significant increases in self-efficacy when using innovative formative assessment methods, provided encouragement for further efforts to introduce them into science classrooms.

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24. VEJLEDNING I LÆNGERE-VARENDE FÆLLESFAGLIGE FORLØB I NATURFAG - VÆRKTØJER OG ARTEFAKTBASERING

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Abstract

Periods of interdisciplinary project-oriented studies among the science subjects in grades 7.-9. has recently been made mandatory in Denmark, leading to a new, shared interdisciplinary end examination in the subjects. These new emphases call for teacher capacities to scaffold and supervise students during independent group-work, e.g. facilitating subject integration, managing group processes, and building students' interdisciplinary self-efficacy. Unfortunately, Danish science teachers and teacher trainers are largely unprepared for this challenge. Consequently, in the context of the Teacher Education we have initiated a project to develop tools for supervision in interdisciplinary science education and a conception of artefact-based supervision. Trials have been made with 20 students in an Interdisciplinary Science Teaching course. Here, teacher students have been supervised using various tools, they have tried them out themselves and they have assessed their usefulness for on-going projects and for professional practice. Four specific tools have been devised and trialled. Empirically, the artefact-based trials have been followed through logs of teacher students and teacher trainers, pre- and post-surveys of teacher students, and artefact-based interviews. At the end teacher students could use our tools to identify supervisory problems and to devise supervision strategies themselves. Pre- and post-tests indicate that teacher students' interdisciplinary self-efficacy increased.

Introduktion

Danske elever undervises i et integreret naturfag ("natur/teknologi") til og med 6. klasse, hvorefter undervisningsfagene biologi, fysik/kemi og geografi udskilles. I forbindelse med folkeskolereformen i 2014 i Danmark blev der imidlertid indført bindende krav om, at der i overbygningen gennemføres seks fællesfaglige forløb på tværs af fagene - som afsæt for den afsluttende fælles mundtlig naturfagsprøve. Denne prøve er projekt-organiseret, idet eleverne med afsæt i én af de fællesfaglige forløbstematikker skal formulere deres egne problemstillinger, udarbejde arbejdsspørgsmål og besvare disse på en måde, som inddrager alle fag og viser, at de behersker fire grundlæggende naturfaglige kompetencer. I en periode på ca. 5 uger op til prøven arbejder eleverne selvstændigt eller i grupper i alle fagenes timer med at tilegne sig viden, opstille forsøg, skabe modeller og planlægge deres fremlæggelse. I hele det 3-årige forløb er der tale om krævende faglige og gruppedynamiske processer for eleverne, hvorfor de både må trænes forudgående og stilladseres undervejs. Stilladsering i form af gruppevejledning er essentielt, som hjælp for eleverne mht at tackle faglige udfordringer og støtte faglig integration, styrke deres faglige selvtillid ("self-efficacy") ift. projektarbejdet, samt håndtere problemer i den længerevarende gruppeproces. Problemet er blot, at danske naturfagsundervisere i ringe grad er uddannet til at lave fællesfaglig, selvtillidsskabende procesvejledning. Traditionelt har der ikke været bevågenhed omkring disse aspekter i læreruddannelsen i Danmark. Internationalt ser man et tilsvarende problem, fx konstaterer Hmelo-Silver et *"lack of a sufficient number of skilled facilitators*" ((Hmelo-Silver, 2004, p.261).

I oplægget vil vi præsentere et FUI-arbejde udarbejdet af den samlede naturfagsgruppe ved Læreruddannelsen i Aarhus med fokus på at udvikle værktøjer til og kompetencer udi de aktualiserede vejledningsprocesser. Værktøjerne er blevet afprøvet i kontekst af et specialiseringsmodul om tværfaglig undervisning på 2. årgang af læreruddannelsen i Aarhus.

I sammenhængen her vil vi adressere følgende spørgsmål:

1. Hvordan ser værktøjer og artefakter ud, som kan stilladsere vejledningen ifm længerevarende fællesfaglige forløb?
2. *Hvordan kan man med sådanne artefakt-baserede vejledningstilgange*
    - styrke lærerstuderendes self-efficacy ift. fællesfaglig naturfagsundervisning og vejledning i tilknytning hertil
    - fremme de studerendes refleksion over vejledning
    - modellere og træne elementer af en reflekteret vejledningspraksis

Teoretisk baggrund

Litteraturstudier har godtgjort (se fx (Czerniak & Johnson, 2014), at forskningen i tværfaglig/fællesfaglig naturfagsundervisning ("Interdisciplinary or transdiscisciplinary teaching") er mangesidig, men lidet kumulativ. Der foreligger således ikke nogen autoritativ teoretisk ramme for denne type undervisning. Det teoretiske grundlag for studiet er således stykket sammen af delbidrag:

- Fra social-konstruktivistisk læringsteori (Saljø, 2003) henter vi belæg for, at artefakter og værktøjer spiller en altafgørende rolle som mediatorer for læring. Derfra kommer vores fokus på at udvikle og undersøge artefaktbaseret vejledning.
- Fra litteraturen om PBL og projektorienteret undervisning (fx (Mergendoller, Markham, Ravitz, & Larmer, 2006; Pettersen, 1999)) har vi hentet generel vejledningsstrategi for forskellige faser af problemorienteret arbejde. Som et særligt aspekt fremhæver Mergendoller et al behovet for, at PBL-undervisere også må kunne understøtte de sociale processer i projektgrupperne*: "effective PBL-teachers assess the readiness of their students to work in groups and provide instruction, practice, and remediation of deficient group process skills*" (p. 605).
- Litteraturen om læreres- og lærerstuderendes udfordringer ift. fællesfagligt arbejde indikerer ((Martins, 2012, p.54), at mange lærerstuderende har lav self-efficacy ift interdisciplinær undervisning, og at de typisk angiver manglende fortrolighed med undervisningsformen som væsentligste årsag.
- Forskningslitteraturen om motivation og faglig selvtillid/self-efficacy har først og fremmest informeret vores design af et selvtillidsskabende vejledningsværktøj, hvor en stor del af værktøjets motiverende "self-efficacy-moves" kan henføres til de firekilder til at oparbejde self-efficacy, som Bandura (Bandura, 1997) oprindeligt har identificeret.
- Litteratur om tilgange til faglig integration (fx (Nikitina, 2006) har informeret vores værktøj *Integrations-fokus.*

Metoder og empiriindsamling

Interventioner og empiri-indsamling foregik i tilknytning til et nyudviklet tværfagligt naturfagsmodul på Læreruddannelsen i Aarhus i efteråret 2016. 20 lærerstuderende deltog, 8 med fysik/kemi som undervisningsfag og 7 fra biologi og 5 fra geografi.fra hvert af undervisningsfagene biologi og geografi.

Modulet var opbygget af forskellige delforløb med forskellige læringsperspektiver for de studerende og foci for vejledningen. De væsentligste delforløb fremgår af nedenstående Tabel 1, hvor de anvendte vejledningsværktøjer samtidig er anført med kursiv i den højre kolonne.

	Lærerstuderende arbejder projektorienteret i tværgrupper om:	Vejlednings-Intervention/ (obligatorisk gruppe-vejledning med læreruddanner)	Værktøjer/artefakter
Delforløb 1	En selvvalgt problemstilling inden for et fællesfagligt	• Procesvejledning (ca. 45 min pr. gruppe). • 6 grupper	• Studerende har udfyldt individuelle *ProcesCheck*, som

	fokusområde (centralt formuleret af UVM). Lærerstuderende i rollen som elever		indgår i vejledningen
		• Faglig integrationsvejledning (ca. 45 min) • 6 grupper	• Studerende medbringer gruppe-*Mindmap* over deres projektbesvarelse.
Delforløb 2	Planlægning *og* afvikling af fællesfaglig undervisning i 7.-9. klasse på Syddjurs Friskole. (2 hele dage). Lærerstuderende i underviser-rolle.	• Vejledning - bl.a. med fokus på fællesfaglig self-efficacy (i alt 45 min) • 6 grupper (reelt 3 storgrupper)	• Vejleder bringer præ-valgte elementer af *Selvtillidsskabende vejlednings-moves*, ind i vejledningen
		• Vejledning - bl.a. med fokus på faglig integration • 6 grupper (reelt 3 storgrupper)	• Studerende selvevaluerer deres undervisningsplan i lyset af refleksions-værktøjet *Integrations-fokus*

Tabel 1: Vejledningsfoci og -værktøjer i de mest relevante delforløb af undervisningen

Den indsamlede empiri:
Vejledningsprocessen kan anskues både ud fra et lærende og et vejlederperspektiv, og alt efter perspektivet har vejledningsværktøjet forskellig funktion. Ud fra et lærende-perspektiv har *ProcesCheck* først og fremmest en selvregulerende funktion, mens den fra et vejlederperspektiv vil have både en diagnostisk og en dialogisk funktion. For at indfange værktøjernes anvendelighed fra det dobbelte perspektiv har vi indsamlet tilsvarende dobbeltsidig empiri:

- Studerendes logbogsskrivninger efter hvert delforløb, bl.a om oplevelsen af vejledningen
- Læreruddanneres logbogsskrivning i tilknytning til hver vejledningsseance og afslutningsvist.
- Pre- og post-survey, bl.a. om lærerstuderendes oplevelse af aspekter af fællesfaglig self-efficacy og holdninger til fællesfaglig undervisning.
- Ved afslutningen af modulet blev der tillige lavet tre strukturerede gruppe-interviews, hvor alle fire værktøjer indgik. Strukturen var, at de studerende fik mulighed for at demonstrere:
    - I hvilken udstrækning de kan bruge værktøjer til at identificere vejledningsproblemer i en elevcase-beskrivelse - og til at konstruere en hensigtsmæssig vejledningsstrategi for eleverne i casen.
    - Hvordan de opfatter nytteværdien af værktøjerne - dels for dem selv i det gennemførte forløb og dels i et længere perspektiv for deres egen praksis.

Resultater

Den integrerende analyse er endnu i sin vorden, og pladsen her er trang. Derfor nøjes vi konkret med et enkelt nedslag i hhv. det udviklede materiale og i undersøgelserne af deres funktionalitet. Disse komponenter vil selvsagt blive udfoldet ifm selve præsentationen.

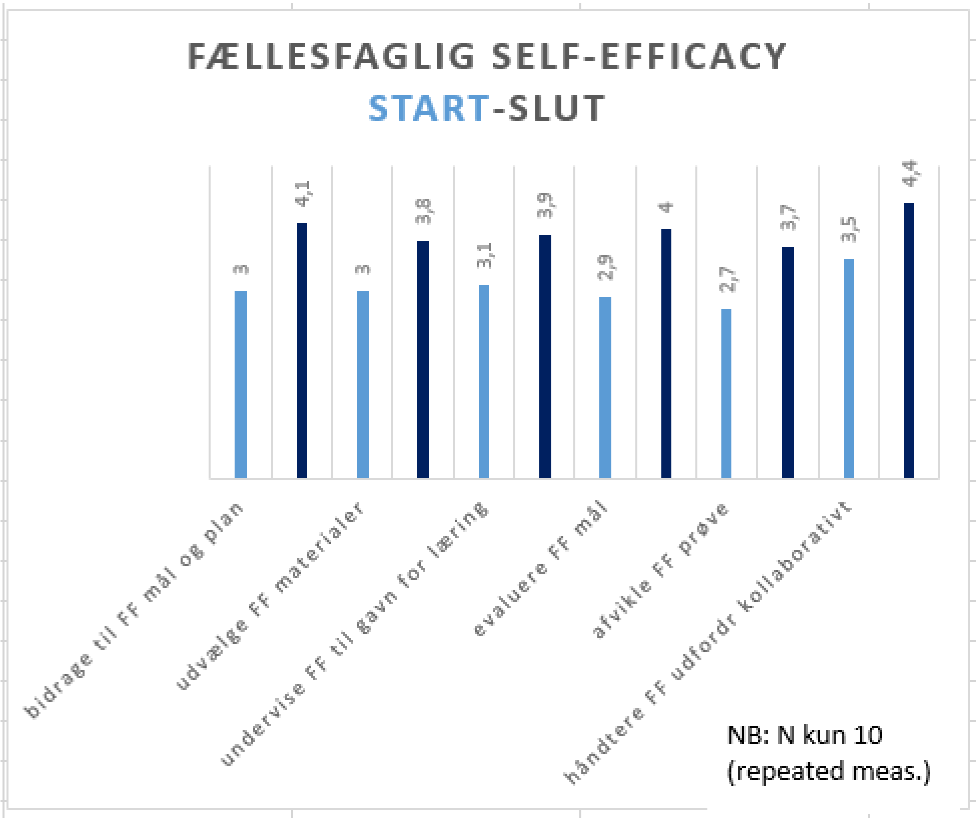
Som svarbidrag til vores første forskningsspørgsmål viser Figur 1 vejledningsværktøjet *Selvtillidsskabende vejlednings-moves*, som er udviklet i projektet.

Symbolsk	Kort betegnelse	Uddybning af vejledningsadfærden
SE1	Goal-setting	Hjælp gruppen til at formulere lærerige OG opnåelige mål (balancere udfordring ift. gruppens forudsætninger)
SE2	Chunking	Hjælp gruppen med at bide opgaven op i mindre dele, som hver for sig er mere håndterbare
SE3	Modelling	Demonstrerer - tænker højt – hvordan problemet tackles
SE4	Vicarious experiencing	Sørger for, at gruppen får adgang til at se, hvordan andre håndterer en tilsvarende udfordring (microteaching, video…)
SE5	Scaffolding	a. Henleder opmærksomheden på kritiske aspekter af arbejdet (som de så selv forventes at klare)
		b. Hjælper med at holde gruppen fast på deres mål
SE6	Feedback-feeding forward	a. Fremhæver fremskridt og reelle kvaliteter ved opgaven (ift. ekspliciterede kriterier) b. Hints til forbedring – fokus på det væsentligste c. Hints til selvevaluering & selvregulering
SE6	Mindsetting	Signalerer, at hjernen er dynamisk, at læring er incrementel & at alt kan læres
SE7	Attributing	Overbeviser om, at vanskeligheder i arbejdet ikke er udtryk for evner, men om noget der kan gøres noget ved (manglende redskaber, lige at se nogle andre, evt. en ekstra indsats o.s.v.)
SE8	Meta challenging	Får dem til at reflektere: a. hvad de har brug for at vide mere om? b. metodiske problemer ved måden de arbejder c. aspekter af deres igangværende læreproces/strategier – fx med afsæt i observationer af gruppen (vejleder/andre studerende)
SE9	Tooling	Hjælper dem med redskaber til at håndtere den faglige proces

Forskningsspørgsmål 2 belyses eksemplarisk her, idet værktøjet først blev brugt af undervisergruppen, som afsæt for en procesorienteret vejledning i delforløb 2. De lærerstuderende fik eksplicit kendskab til redskabet i tilknytning til en træningssession (delforløb 3, af pladshensyn udeladt i Tabel 1), hvor de vejledte hinanden i at skrive problemformuleringer og arbejdsspørgsmål, som afsæt for et prøverettet projektarbejde. Endelig blev værktøjet inddraget i det afsluttende strukturerede gruppeinterview, hvor deltagerne skulle udvikle en vejledningsstrategi for en bestemt case. Her blev de bedt om at reflektere, hvorledes værktøjet evt. ville kunne bidrage til den påtænkte vejledningsstrategi. Der var således en progression i anvendelsen af værktøjet, fra at indgå implicit i vejledningen, til at være et eksplicit redskab for de lærerstuderende til at blive refleksivt og metakognitivt forankret. For andre af værktøjerne har tilegnelsesvejen for de lærerstuderende været anderledes, men i alle tilfælde er det sket i et vekselspil mellem modellering, praktisk afprøvning og refleksion.

Diskussion og (partiel) konklusion

I forlængelse af ovenstående - og som en slags konklusion på den eksemplariske tråd vi har fået plads til her - så viser Figur 2 pre- og post-målingen af forskellige aspekter af fællesfaglig self-efficacy. Mønstret er konsistent og trods det lille sample er udviklingen mht fællesfaglig self-efficacy signifikant positiv ($p<0.05$) på alle delmål. Der er ikke nogen tilsvarende signifikant udvikling i den monofaglige self-efficacy i perioden.



Figur 2: *Udviklingen i de studerendes self-efficacy (pre: blå, post: sort).*

Eet af de intenderede mål på studerende-niveau synes således at være nået. Dertil kommer den kompetenceudvikling, som vi har opnået som læreruddannere.

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25. STUDENTS AS PRODUCERS OF AUGMENTED REALITY IN SCIENCE - DEVELOPING REPRESENTATIONAL COMPETENCE TROUGH SCAFFOLDED DIALOGUE

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Abstract

The paper presents findings from a 3 year EU-project focusing on the use of Augmented Reality (AR) for science education in lower secondary school. Based on teacher interviews and video/observation from Danish, Norwegian and Spanish classrooms, possibilities and challenges are discussed in relation to how students' inquiries in science can include AR, and how their exploratory talk and representational competence can be supported. An overall aim is that students can be producers of AR animations and representations themselves.

The piloting of the AR-resources shows positive possibilities for supporting students meaning-making related to the science content, however dependent of the teachers' thorough use of scaffolding. Scaffolding is in the project conceptualized as both the pre-planned sequencing of the lessons (macro-scaffolding) and the micro-scaffolding used in teacher-student dialogue. Participating teachers were in general positive in relation to students' learning outcomes, and students reported a high level of perceived outcomes, e.g. by experiencing a sense of presence in the science phenomena and "seeing the invisible". The approach in the third piloting, where students are themselves producing AR-resourses connected to their science inquiries, is promising so far.

1 Introduction

This paper presents findings from piloting augmented reality (AR) for lower secondary science education. AR is defined by the combination of real and virtual objects in a real environment, running interactively and in real time. Smartphones (and tablets) are equipped with sensors such as camera, GPS, accelerometer and gyroscope allowing the smartphone to form a virtual perception of the real world and use this information to add an augmented layer of information. Pokemon-go is an example from the popular-culture.

The use of AR for educational purposes is however still in its infancy and more knowledge is needed about how meaningful learning can be mediated with AR tools.

2 Theoretical framework

International comparative research has identified a need for high-level-use of ICT in education, with students as producers, not just consumers (ITL Research 2011). Students as producers in science denotes activities like creating own representations, multimedia productions and animations (Prain & Tytler, 2012). Resent research in science education likewise emphasize that ICT in particular can mediate learning when students are working inquiry-based in meaningful contexts using ICT for data collection and - analysis, and modelling often complex processes and phenomena (Krajcik & Mun, 2014). In a review on AR in education Radu (2014) found benefits such as increased content understanding and motivation, and challenges, such as usability difficulties and ineffective classroom integration. Wu et al. (2013) point to the following affordances: learning content in 3D perspective, ubiquitous, collaborative and situated learning, learners' sense of presence, immediacy, and immersion, visualizing the invisible and bridging formal and informal learning.

Based on this we consider the major affordance of AR in lower secondary science to be students as producers of AR-animations closely connected to the content in their science inquiries. However, in pilot 1 students tested showcase material developed by the ARsci-team (table 1). From a social constructivist theory of learning we draw on research looking into dialogue, e.g. exploratory talk, in the classroom and how it can be scaffolded by the teacher (Barnes, 2009; Lefstein & Snell, 2014). Scaffolding can be both macro- and micro-scaffolding (Prediger & Pohler, 2015; Pollias, 2016), macro-scaffolding being the planned sequencing of activities and micro-scaffolding the strategies the teacher uses e.g. in dialogue, engaging student perspectives and asking questions (Pollias, 2016, p. 98). Furthermore, we use the conceptualization of students' representational competence from Waldrip & Prain (2012, p.146) as an analytical lens, looking into if students can: a) describe the codes and signifiers in a representation, b) explain the links between representation and the target concept or process, c) compare key features of the concept across representations, and d) point to key features to be emphasized when designing their own representations.

Looking into opportunities and challenges for mediating student learning in science the research questions are:

1. How can students' exploratory talk and their representational competence be scaffolded during science activities where augmented reality is a central element?
2. What do students and teachers emphasize as possibilities, challenges and perceived outcomes from these activities?

3 Research methods

The project operates with an iterative approach to design, testing, re-design and adaptation in both the development of the AR-resources, and over time using a framework developed in the project (Nielsen et al., 2016) and insight from piloting to qualify the next steps. Multiple Data is collected, e.g. interviews and video, both full class and following groups of students (Table 1). Interviews are analysed using thematic analysis (Braun & Clarke, 2006), and dialogues from video looking for elements of macro- and micro-scaffolding exploratory talk, and students' representational competence (Waldrip & Prain, 2012).

Phase	**Research focus**	**Data collection**
Pilot 1, primo 2016	Trying out showcase resources developed by the ARsci-team.	Pre and post interview of teachers and observation (e.g. video) of classroom activities (Denmark, Norway and Spain). Student interviews during activities (Denmark).
Pilot 2, ultimo 2016	Teachers as producers of AR-resources.	Pre and post interview of teachers, observation (e.g. video) of classroom activities, and online questionnaire for students (Denmark, Norway and Spain).
Pilot 3, primo 2017	Students as producers of AR-resources.	Pre and post interview of teachers and online questionnaire for students (Denmark and Spain). Video of classroom activities, and interviews with students (Denmark).

Table 1: Research focus and data collection in pilot 1, 2 and 3.

4 Results and discussion

Findings are focusing on pilot 1 and 2, as we are in the middle of data collection in the final pilot. This will be elaborated in our presentation. Pilot 1 and 2 showed opportunities for supporting students' representational competence in particular with the teacher's thorough use of micro-scaffolding with open questions and ongoing guidance. We exemplify from pilot 1 in a Danish classroom where a 7th grade class of physics and chemistry were working with an AR-app illustrating the chemical reactions in a car's catalytic converter. During the first open inquiries students were engaged and fascinated: "*wauw this is cool*". They commented on the technical possibilities: "*okay you can see what is inside*" – one of the main AR affordances of visualizing the invisible (Wu et al., 2013) - and they tried out features like changing temperature: "*it is hot in there*". But it was the teacher's micro-scaffolding that stimulated the use of science concepts and exploratory talk:

Teacher: *You need to look at what comes in and what goes out*
Student 1: *…oh what is it called…*

Teacher: *you can see if it is the same*
Student 2: *there is both a black and a red*
Student 3: *it is carbon dioxide and oxygen*

The students emphasized signifiers in the representation (Waldrip & Prain, 2012), but they did not refer explicitly to this as a model. Nor did the teacher.

In another 7th grade biology-class trying out an app illustrating processes related to photosynthesis in an activity where they examined a range of models, placing them on different part of a tree in the outside environment, and presented their inquiries, a few of the students experienced this as a too difficult task. After the pilot possibilities for using this AR-resource in differentiated ways have been described.

The AR-resources developed by teachers in pilot 2 were in general close connected to the content, and the students in all three countries reported a high level of perceived outcomes (the questionnaire). But it was concluded as a challenge that the students expressed an expectation for the AR-resources to be of the same technical quality as the ones they meet in their daily live. This leads us to conclude that the approach in the third piloting, where students are presently producing their own AR-recourses connected to individual and collaborate science inquiries, is more important. Here the challenge for the teachers is pedagogical, e.g. related to micro- and macro-scaffolding (Pollias, 2016), shown to be so important in the first pilot, and students are not necessarily so self-critical toward self-produced ICT-representations, if the learning experience is positive.

5 Conclusion

The piloting of AR-resources shows positive possibilities for supporting students exploratory talk and their meaning-making related to the science content, however dependent of the teachers thorough use of micro-scaffolding. It is an important challenge to draw students' attention to the character of a model as a representation with certain codes and signifiers. In general teachers are positive in relation to students' learning outcomes, and students report a high level of perceived outcomes, e.g. experiencing a sense of presence in the science phenomena and "seeing the invisible". The approach in the third piloting where students are producing AR-resourses connected to their science inquiries is promising so far.

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26. ONCE AGAIN? - HOW AN UPCOMING VACCINATION DEBATE IS PORTRAYED IN (SWEDISH) MEDIA

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Abstract
An overarching goal in science education is to educate towards science literacy. The ability of students to examine different information critically from diverse sources has been greatly emphasized by policy makers, educators, as well as researchers and is part of media literacy. This paper investigates the diversity of information in newspapers concerning HPV vaccination. A qualitative content analysis was conducted on the six largest daily newspapers in Sweden from a period of 24 months, with focus on articles about the vaccination against HPV. This vaccination is offered all Swedish girls to prevent cervix cancer caused by the virus. The content analysis of 40 articles resulted in seven categories: facts, scientific knowledge, medical knowledge, risks, worry and alarm, economy and individual versus society. The two most common categories were medical knowledge and worry and alarm. The great diversity of the articles, focusing on many different perspectives, shows that they are a good resource to be used in science education to promote scientific and media literacy.

1 Introduction and purpose
Different kinds of vaccinations are lively discussed in media. This is not a new situation, but has been intensified with break-outs of pandemics or unexpected side effects of vaccinations, such as the swine flu vaccination (Lundgren, 2013). The starting point of this project is the vaccination against human papillomavirus (HPV) that can cause cervical cancer. This vaccination is today a part of the vaccination programme in Sweden and is offered for free to all Swedish girls. Since media is an important way for lay people to receive information on these matters it is important to have the competence to understand media reports when making decisions. Media reports are different compared to many textbooks used in school, since textbooks usually are well structured and objective. The purpose with this study is to investigate how an upcoming debate concerning vaccinations against human papilloma virus (HPV) was depicted in the six largest newspapers in Sweden during 2014-2015. This study is a part of a larger project where argumentation and decision-making related to HPV vaccinations are investigated.

2 Theoretical framework
The ability to use knowledge in and about science as an active citizen has been richly emphasized (e.g., van Eijck and Roth, 2010). Commonly, this knowledge is expressed as scientific literacy (Roberts, 2007) and is in line with the writings in the Swedish (and many other countries) curricula in which the importance of using scientific knowledge as a tool in students' life, supporting decision-making in different situations, is emphasized. The capacity to follow and evaluate discussions about science in media is often emphasized and reported as a deficit in the scientific literacy among students (Jarman & McClune, 2010).

This study focuses on media reports in the risk society (Beck, 1992), since side effects from vaccinations are risks both for the society and the individual. Beck (1992) discusses the contemporary society from a risk perspective and states that civilization today has to face many different types of risk. He defines risk as a ''systematic way of dealing with hazards and insecurities induced and introduced by modernization itself'' (Beck, 1992, p. 21.) When making assessments of risks, which are recognized as a difficult operation, different types of experts are central.

When media reports on scientific issues, such as the vaccination issue, some aspects are highlighted on the behalf of others. It is, for example, not possible for media to describe the whole research process such as the review process (León, 2008). However, this review process is important to valid research results, but may vary in time depending on the issue.

3 Research methods

A qualitative content analysis (Hsieh & Shannon, 2005) was conducted on the six largest daily newspapers in Sweden: Aftonbladet, Dagens Nyheter, Expressen, Göteborgsposten, Svenska Dagbladet and Sydsvenskan. Articles from a period of 24 months, from 1st of January 2014 to 31th of December 2015, were accessed through the database Mediearkivet using the search line "Gardasil OR hpv". The list of articles found were reduced following three exclusion criteria (Bohlin & Höst, 2014): 1) the article was an identical copy of another article, 2) the article comprised less than 35 words, 3) the story of the article was unrelated to hpv vaccine as a vaccine to prevent cervix cancer. The database search retrieved 71 articles, of which 40 articles remained after the refinement process.

4 Results

The distribution of the 40 articles over the 24 months is shown in figure 1. There is a peak in the reports concerning HPV and the vaccine Gardasil in the autumn of 2015. This may be explained by the fact that in July 2015 it was decided that European Medical Agency (EMA) should investigate the suspected connection between Gardasil and the side effects POTS (Postural Orthostatic Tachycardia Syndrome) and CRPS (Complex Regional Pain Syndrome). In November 2015 EMA (2015) released the report that concluded that there is no evidence to support a connection. In media, these two occasions are reflected in the peaks of the third and fourth quarter of 2015.

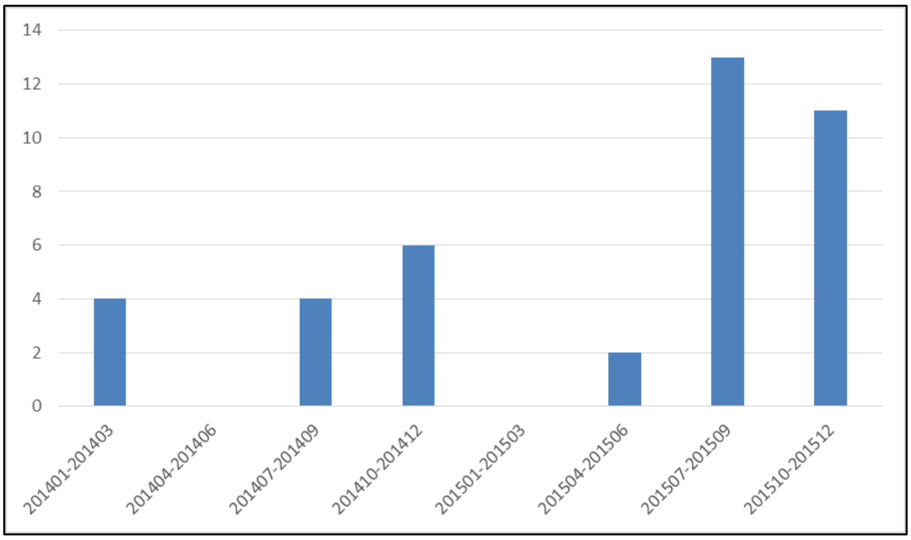

***Figure 1**: Distribution of articles (n=40) over 24 months*

From the 40 investigated articles, 90 different statements were extracted. The statements were sentences, or parts of sentences, that contained information about HPV, the vaccine, or related issues. The categorisation of the statements resulted in seven qualitatively different categories. The categories were *facts, scientific knowledge, medical knowledge, risks, worry and alarm, economy and individual versus society*. The categories and a short description of each category are presented in Table 1. Each article could contain several statements and hence end up in more than one category.

***Table 1:** Categories, number of statements and descriptions of each category.*

Category	Description
Facts n=13	Statements that build on facts. For example, number of vaccinations made, rules for vaccinations, or number of reported side effects.

Scientific knowledge n=7	Statements that demand some kind of understanding of scientific knowledge and how it is produced. For instance, what is possible to describe, causal correlations and possible lack of scientific evidence.
Medical knowledge n=27	Statements concerning scientific medical information. For example, which vaccines that target a specific disease or which side effects that have been reported.
Risks n=15	Statements about risk. Risk can be mentioned explicitly or implicit as when pros and cons are elaborated upon. Here are also statements that mention security and that more investigations are needed included.
Worry and alarm n=21	Statements including peoples' worry and alarm.
Economy n=6	Statements concerning economical aspects of vaccinations.
Individual versus society n=1	Statements where the individual's respective society's best interests are weighed against each other.

4 Discussion and conclusion

The results illustrate the great variety of statements in the newspapers connected to the HPV vaccination. Statements including medical knowledge and worry and alarm are the two most common in the news articles. However, these two categories are fundamentally different; the statements including medical knowledge are often strict with references to authorities, such as doctors and researchers, while the worry and alarm statements are build by mainly emotional arguments that become a part of how media presents a problem. On the one hand, this way of using emotional argument can be seen as irrelevant to scientific problems. On the other hand, emotional arguments can broaden the perspectives when discussing the subject. In addition, the worries and alarms are interesting from an educational perspective, since these can be critically analysed and discussed in science education, which have been asked for by many scholars (e.g. Christensen, 2009; Kolstø, 2006).

The risk category, containing 15 statements, can be related to Beck's (1992) risk society, where he states that individuals have to assess risks in their everyday life. Several of the analysed articles emphasise the importance of more research about the vaccination. Concerning the HPV vaccination and possible side effects caused by it, the newspapers mainly describe that there is a lack of scientific evidence if the vaccination can cause any side effects or not. The risk estimation will from this perspective be hard, especially for a layperson. In summary, our analysis demonstrates the richness of different viewpoints that are reported in media regarding HPV vaccination. The results illustrate how different viewpoints and arguments, which not always are explicit in school textbooks, can be discovered in newspapers. This diversity gives possibilities to use newspapers as one source in science education.

We believe that our methodology and results can be used in two different ways. Firstly, they can be used in further research to categorize and analyse different kind of texts related to risks and uncertain knowledge. We do not claim that our seven categories will be the only possible and cover all kind of texts. However, it will be a guide for this kind of content analysis within science education. Secondly, they can contribute as material for discussions about risks and uncertainty. Newspaper articles can be a good introduction to SSI since our results demonstrate the width of content and claims connected to risks, such as economical, scientific and societal concerns. In this way, students can use our categorization to analyse the content in own found articles. This would meet the demand from Jarman & McClune (2010) and Norris et al. (2003), asking for media literacy among students.

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27. DISCIPLINARY DISCERNMENT FROM HERTZSPRUNG-RUSSELL-DIAGRAMS

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ABSTRACT

This paper aim at investigating what astronomy students and experts discern from the multitude of different disciplinary affordances available in Hertzsprung-Russell (HR) diagrams. HR-diagrams are central to all of astronomy and astrophysics and used extensively in teaching. However, knowledge about what students and experts discern from these disciplinary representations are not well known at present. HR-diagrams include many disciplinary affordances that may be hidden to the novice student, hence we aim at investigating and describing what astronomy students at different university levels (introductory, undergraduate, graduate), and astronomy educators/professors, discern from such representation – referred to as disciplinary discernment (Eriksson, Linder, Airey, & Redfors, 2014). Data from a web based questionnaire were analysed using the Anatomy of Disciplinary Discernment (ADD) framework by Eriksson et al. (2014). Preliminary results show (1) the developmental nature of disciplinary discernment from the HR-diagram by the participants and (2) the large discrepancy between disciplinary discernment by the astronomy educators and their students. We describe and discuss the qualitative nature of these differences and how this can have implications for teaching and learning astronomy.

INTRODUCTION

HR-diagrams are extensively used in teaching astronomy and astrophysics at university level, but very little is known on what understanding students have from encounters with such disciplinary-specific representation (Brogt, 2009). From the literature, it is clear that disciplinary-specific representations harbour many disciplinary affordances which are used to communicate disciplinary knowledge within a particular discourse (Fredlund, Linder, & Airey, 2015; Fredlund, Linder, Airey, & Linder, 2014). *Hertzsprung-Russell (HR) diagrams* are no different in this perspective (Airey & Eriksson, 2014). However, these representations are very specialized and the astronomical knowledge that is present in such a representation could be very difficult for students to discern. For a student to be able to discern the disciplinary affordances of such a representation, (s)he needs to be able to *read* the representation using the *language* of astronomy, which is referred to as *Reading the Sky* (Eriksson, 2014). This is challenging for many students, but very little, if any, research has been identified addressing this issue. In this paper, we present an investigation of how disciplinary discernment from HR-diagrams can be described and addressed.

BACKGROUND AND THEORETICAL FRAMEWORK

In this section, we describe the background of the HR-diagram and the theoretical framework, which this work is based upon.

The HR diagram

An HR-diagram is a graphical representation of stellar luminosities versus temperature, spectral class or colour. It is commonly used in all stellar astrophysics to get a visual representation over stellar populations, and stellar evolution. It was developed in the early 20th century, independently by Ejnar Hertzsprung and Henry Norris Russell. It was not until 1933 that the representation became more commonly accepted as a “Hertzsprung-Russell-diagram”. The history behind the development of the HR-diagram is fascinating and involves many other persons work, which Hertzsprung and Russell built their ideas upon (Nielsen, 1964; Persson, 2012).

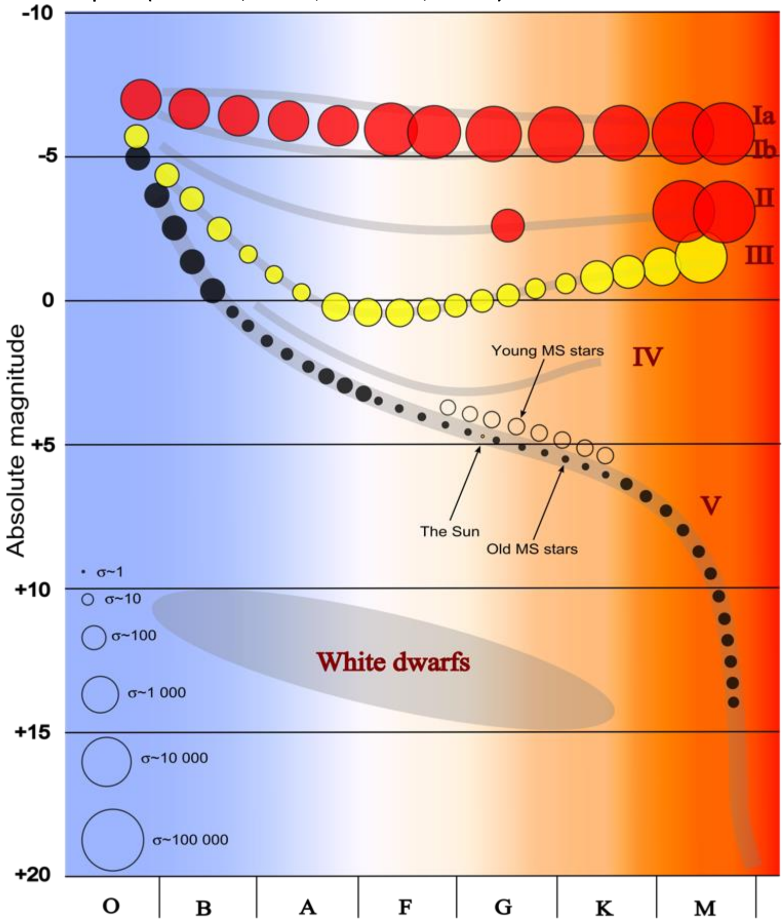

Figure 1. Illustrative example of an HR-diagram representing the astrometric RMS dispersion (σ_{pos}) in different sub-groups of spectral and luminosity classes. The diameters of the circles are proportional to $\log\sigma_{pos}$ and data are from Eriksson and Lindegren (2007). The dispersions are in μ AU.

In figure 1, an example of an HR-diagram is presented, which represents aspects related to stellar astrometric variability (Eriksson, 2007). In such a representation, it becomes obvious that there are many different disciplinary affordances, which may be hidden to a novice or newcomer to the discipline. In the following, we therefore review the literature on the concepts disciplinary affordance, disciplinary discernment, and the ability to read such representation.

Disciplinary affordances

Disciplinary affordance was defined by Fredlund, Airey, and Linder (2012) as "the potential of a given semiotic resource to provide access to disciplinary knowledge" (p. 658). This means that a "semiotic resource", in our case the HR-diagram, has some inherent affordances, defined by the discipline, and those are to be discerned by a student and understood from a disciplinary perspective (Airey, Eriksson, Fredlund, & Linder, 2014). Learning astronomy can then be problematized in terms of coming to appreciate the disciplinary affordances of representations used in the discipline.

The Anatomy of Disciplinary Discernment

Learning astronomy, or any other discipline, involves a process of knowing "*what* to focus on in a given situation and *how* to interpret in an appropriate, disciplinary manner" (Eriksson et al., 2014, p. 168). This process of learning can then be framed in terms of discerning the intended meaning of representations; what is referred to as disciplinary discernment. Eriksson et al. (2014) define disciplinary discernment as "noticing something, reflecting on it, and constructing meaning from a disciplinary perspective" (p. 170). However, this disciplinary discernment depends on one's disciplinary knowledge and can be described by a hierarchy called the Anatomy of Disciplinary Discernment (ADD). The ADD "encapsulates the increasing complexity of intended meaning of representations.[..] It describes the ways in which the disciplinary affordances of a given representation may be discerned" (Eriksson et al., 2014, p. 174), see figure 2. The process of disciplinary discernment is done by the student (Eriksson, 2014), whereas the unpacking of disciplinary affordances of representations usually are done by the educators/professors (Fredlund et al., 2014).

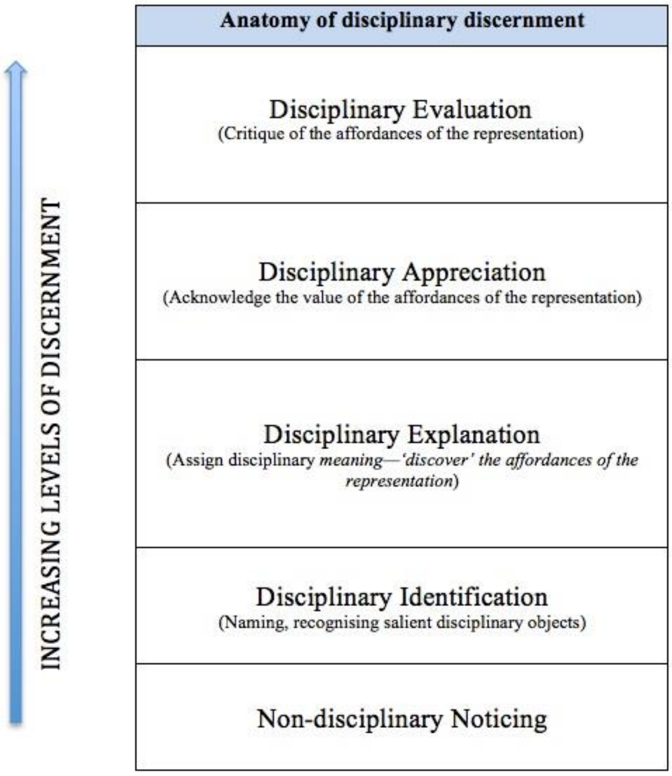

Figure 2. The ADD hierarchy as presented in Eriksson et al. (2014).

Based on the above, the following research questions are addressed:

Research Questions (RQ)

1. What do university astronomy students and lecturers/professors discern from an exemplary HR-diagram?
1) What qualitative differences in disciplinary discernment can be identified between the university astronomy students and the lecturers/professors?

RESEARCH METHOD

Using the framework described by above and in particular the ADD, we constructed a web questionnaire with a number of multiple-choice and open-ended questions in relation the HR-diagram. The questionnaire[1] was developed and tested on a group of astronomy experts for relevance and, after minor refinement, the final questionnaire was launched online and sent to astronomy education institutions in Sweden, South Africa, and the USA for distribution amongst students and astronomers. We have 50 respondents, distributed as follows (table 1):

Table 1. Distribution of respondents

Country	Sweden	USA	South Africa	n.a.
Number	20	20	4	6

[1] See https://hkr.itslearning.com/test/r.aspx?XS=rsyzzasyemoyg

The rich data was analysed using the ADD categories, developed from a standard qualitative hermeneutic method (Eriksson et al., 2014; Seebohm, 2004).

RESULTS

Since the analysis is ongoing, preliminary results are presented here. For RQ1 the ADD-based analysis indicates that most students focus on interpreting the circles on the HR-diagram and they try, erroneously, to relate this to stellar radius, or stellar evolution. The educators/professors generally correctly discern that these circles must represent some form of variability.
For RQ2 preliminary findings are that students struggle to interpret the many disciplinary affordances that the HR-diagram holds. From the ADD-framework indications are that most of the first-year students are found in the first disciplinary discernment category of the ADD (Disciplinary Identification). For post-first-year students' disciplinary discernment are more related to the categories Disciplinary Explanation and Disciplinary Appreciation (categories 3 and 4), whereas the educator/professors are commonly found in the top Disciplinary Evaluation category.

DISCUSSION AND CONCLUSIONS

We find that there are large discrepancies between what students and educators/professors report that they discern for the HR-diagram. This discrepancy may risk affecting teaching and learning in negative ways, leading to less effective teaching and even development of misconceptions by the students, if the unpacking of relevant disciplinary aspects of the HR-diagrams is not done insightfully. Our results confirm earlier research and as an educator one need to consider these aspects in planning and performing teaching sequences. Students need to learn to *read* representations or else they may only see but not discern.

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28. NATURFAGLÆRERES VURDERINGSPRAKSIS, MED ET SÆRSKILT FOKUS PÅ LÆRINGSPROSESSER KNYTTET TIL ARGUMENTASJON

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Abstract

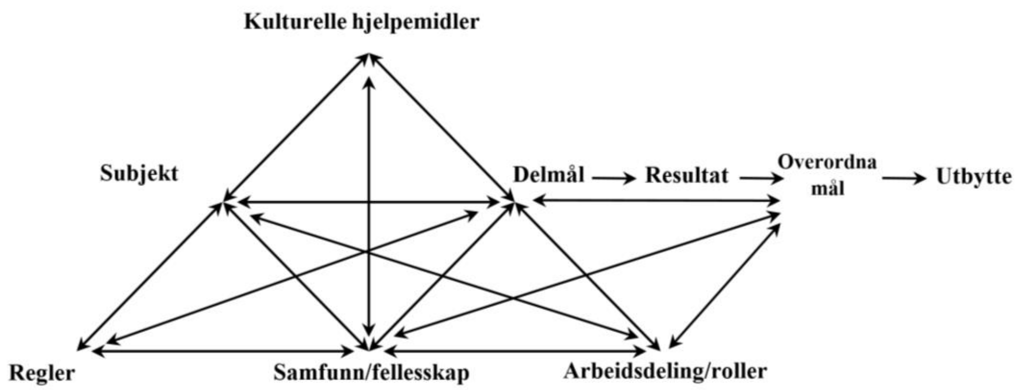
The purpose of this paper is to provide a picture of teachers' assessment practices, with a special focus on learning argumentation in science. The background for this study is several reports indicating that teachers' assessment practice is not in accordance with the intensions of Opplæringsloven and Vurderingsforskriften. Furthermore, the PISA-inquires indicate that Norwegian 15 years old students do not manage to use scientific evidences to argue. Methods to meet this aim are action research as a strategy, and Moustakas phenomenological approach to produce empirical data for the activity system as unit of analysis. Data are based on classroom-observations and semi-structured interviews with four upper secondary science teachers. The theoretical framework is Cultural-Historical Activity Theory (CHAT). Findings indicate that the science teachers' assessment practices is summative, not formative. In addition, they do not know the key concepts of argumentation as a scientific idea. Therefore, they are not able to develop formative assessment tools that can mediate students' learning of argumentation in science.

Innledning

Hensikten med denne studien er å undersøke hva som kjennetegner naturfaglæreres vurderingspraksis, med et særskilt fokus på læringsprosesser knyttet til argumentasjon. Bakgrunnen er forskning som viser at formativ vurdering er grunnleggende for elevers læring (Black & Wiliam, 1998; Hattie, 2009). PISA+ studier viser at det er tradisjonelle undervisningsmetoder som er rådende i norske naturfagklasserom (Ødegaard & Arnesen, 2010). Både FIVIS-rapporten og studier med fokus på læring i naturfag viser at mange skoler og lærere ikke har klart å endre sin praksis i mer formativ retning (Haug & Ødegaard, 2015; Sandvik & Buland, 2014).
Den naturfagdidaktiske litteraturen viser til at argumentasjon kan være grunnleggende for utvikling av elevers naturfaglige allmenndanning (Driver, Newton & Osborne, 2000; Duschl & Osborne, 2002; Kolstø, 2004; Mortimer & Scott, 2003). Samtidig viser PISA-undersøkelser at norske elever skårer sjette dårligst av alle OECD land i kompetanseklasse tre «Kunne bruke naturvitenskapelige evidens til å argumentere» (Kjærnsli, 2013). Den reviderte Læreplan i naturfag vektlegger argumentasjon gjennom et økt fokus på grunnleggende ferdigheter og Forskerspiren (Kunnskapsdepartementet, 2013; Mork, 2013).

Teoretiske rammer

Kulturhistorisk aktivitetsteori (KHAT) er valgt som teoretisk rammeverk for å analysere en situasjon der målet er å utvikle noe kvalitativt nytt (Engeström, 1999, 2001). Som Figur 1 viser er Engeström sin modell av aktivitetssystemet videreutviklet til et modifisert aktivitetssystem (Postholm, Petterson, Gudmundsdottir & Flem, 2004):



Figur 1. Det modifiserte aktivitetssystemet (Postholm et al., 2004).

Det modifiserte aktivitetssystemet består av minimum ni faktorer. Alle disse faktorene har en gjensidig påvirkning på hverandre. For eksempel vil de vurderingsverktøy som brukes ha betydning for hvilke regler som gjelder for vurderingsarbeidet, og hvordan naturfaglærernes og elevenes roller er i arbeidet i naturfag, og hvordan de fungerer i dette fellesskapet (Sandvik, 2011). Engeström (2001) sitt aktivitetssystem synliggjør ikke målrettede handlinger, noe som er vektlagt i Kunnskapsløftet. Jeg velger derfor å ta i bruk den modifiserte modellen utviklet av Postholm et al. (2004).

Forskningstilnærming

Denne studien er del av et kvalitativt Phd-prosjekt som søker svar på problemstillingen: *«Hvordan utvikle undervisningsopplegg som tar i bruk formativ vurdering for å fremme argumentasjonskompetanse hos elever i naturfag?»*. Studien er både pedagogisk og didaktisk forankret i et sosialkonstruktivistisk syn på læring (Quale, 2007; Vygotsky, 1978). Som forskningsstrategi er aksjonsforskning tatt i bruk (Carr & Kemmis, 1986; Postholm, 2007; Tiller, 1999, 2006). I denne teksten rettes fokus mot den eksisterende praksisen før utviklingsprosjektet startet. For å finne svar på hvordan naturfaglærerne erfarer sin praksis er det valgt en fenomenologisk tilnærming (Moustakas, 1994; Patton, 2002). Det fenomenologiske empiriske materialet utgjør dermed grunnlaget for aktivitetssystemet som analyseenhet.

Det fenomenologiske datamaterialet fra de transkriberte intervjuene er organisert, analysert og syntetisert ved hjelp av Moustakas (1994) modifiserte Stevick-Colaizzi-Keen analysemetode. Hensikten med denne deskriptive analysen er 1) å strukturere det empiriske materialet slik at det blir håndterbart, og 2) å synliggjøre på hvilket grunnlag de ulike uttalelsene er valgt ut og inkludert i aktivitetssystemet som analyseenhet (Engeström & Sannino, 2010; Postholm, 2015). Den oppsummerende beskrivelsen er relatert til og samlet i de ni faktorene som kjennetegner det modifiserte aktivitetssystemet. Målet med en slik gruppering er å synliggjøre hvor naturfaglærerne opplever at de har utfordringer i sin praksis i naturfag.

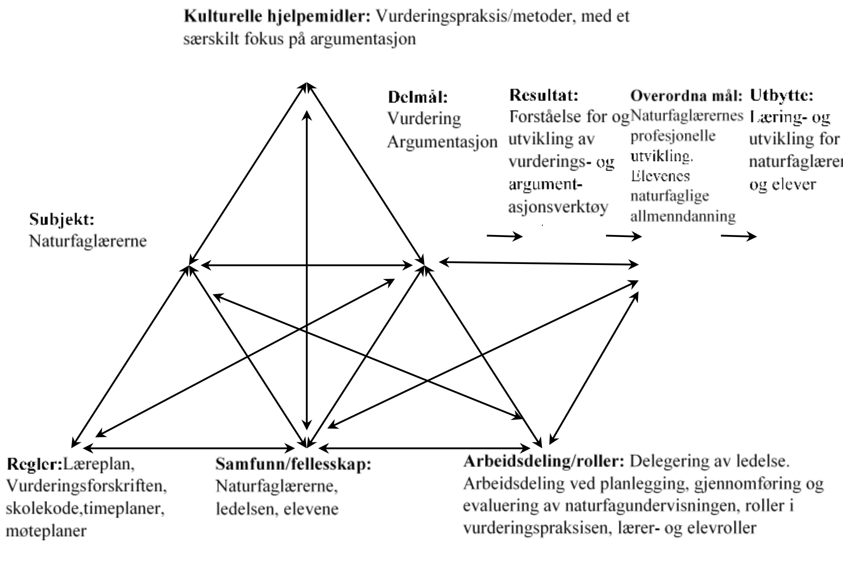
Resultater

Analysen viser at naturfaglærerne opplever at de har et forbedringspotensial i forhold til bruk av formativ vurdering og argumentasjon i naturfag: *«(…)For eksempel når vi skal gjøre et forsøk, så passer det kanskje mer å gjøre forsøket først og så konkludere i lag etterpå. Så, men jeg kan bli bedre på det der fordi det er viktig (…) jeg prøver å tenke på det, men akkurat det der har jeg ikke helt inn i ryggmargen ennå (…).* Uttalelsen tyder på at bruk av læringsmål ved oppstart av timer og oppsummeringer ikke er normen. Praksisen rundt bruk av mal for rapportskriving, vurderingskriterier og kjennetegn på måloppnåelse har summativ hensikt. Det samme er fokuset på karakterer og troen på at kunnskaper kan måles. Med slike rammer beskriver naturfaglærerne at det ikke er tydelig for elevene hva som skal læres: *Altså man gjør forsøk, men jeg synes veldig mye er sånn, at de får ikke med seg poenget. Eller de husker bruddstykker, at det bobla eller (…).* Naturfaglærerne beskriver en usikkerhet i forhold til den idemessige forståelsen av argumentasjon i naturfag: *«Argument, ja. Hva jeg forstår med det? Nå spør du like vanskelig som elevene (…)* og *«Jeg vet ikke om jeg ser forskjell»* på ei forklaring og et argument i naturfag.

Naturfaglærerne opplever at de trives i naturfag, selv om de uttaler at det er et arbeidskrevende fag som krever mye av deres tid. Lærerne opplever ikke at de har den kunnskap/forståelse, de rammer eller verktøy som de trenger for å skape den struktur og støtte som gjør at elevene skal forstå hva de skal lære, og hva som er forventet av dem i forhold til argumentasjon i naturfag: *«Gode ideer til undervisning føler jeg at jeg trenger. Og tilbakemeldinger egentlig, kunne vært. Altså jeg tenker på hvis jeg skal bli en bedre lærer, som jeg alltid har intensjonen om å bli (…).* Det samme gjelder utvikling av tilbakemeldinger som forteller elevene om kvaliteten på arbeidet og prestasjonene, synliggjøring av hvordan elevene skal klare å forbedre seg og ikke minst klare å involvere elevene i eget læringsarbeid (Sandvik & Fjørtoft, 2014).

Naturfaglærerne beskriver sin praksis som styrt av kompetansemålene i Læreplan i naturfag: *«Ja, egentlig litt sånn press i tid og så tenker jeg noen ganger, oi det kunne vært gøy å gjøre, så sjekker jeg om det er på kompetansemål, nei (…) Ja da kjenner jeg at det blir. Blir selektiv i forhold til det».* De beskriver videre en praksis kjennetegnet av en opplevelse av å være alene i Black-Boxen (Black & Wiliam, 1998). Det gjelder både i forhold til kolleger, ledelse og elever. Lærerne opplever ikke at de får den hjelp og den støtte de trenger for å utvikle seg faglig, og de ender opp med tradisjonell tavleundervisning: *«(…) Kan vi ikke gjøre noe gøy? Og det vil jeg jo gjerne, men hva skal jeg gjøre? Ikke sant? Hva er gøy? Så man prøver jo å ha småforsøk og gjøre sånne ting, men ja. Så tenker jeg at man mange ganger kunne gjort ting annerledes, og litt mer elevaktivitet, enn at vi står og skriver på tavla og gjør oppgaver. Altså, ja, at det fort kan bli tradisjonell undervisning».*

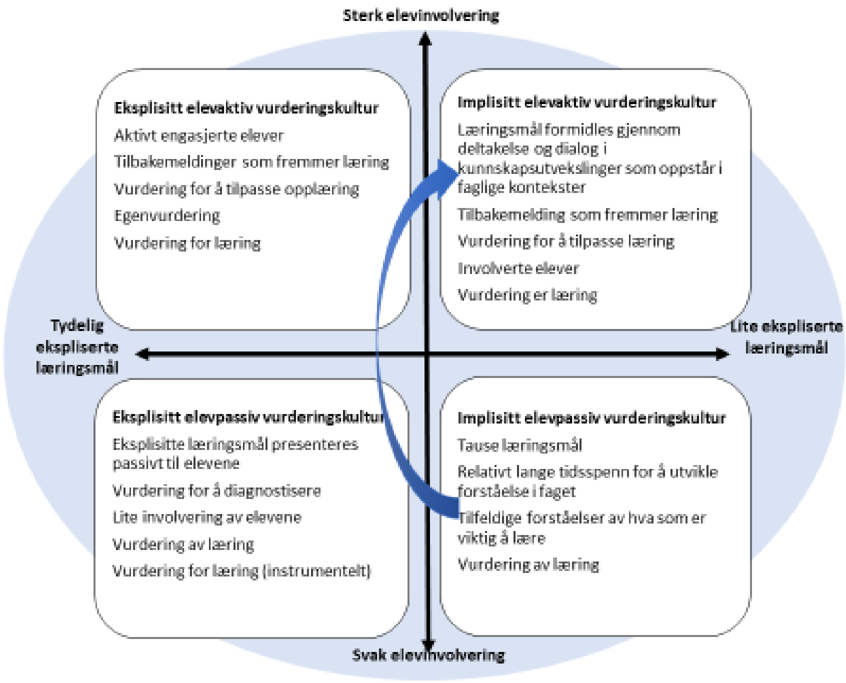
Naturfaglærernes aktivitetssystem kan visualiseres på denne måten, se Figur 2 under:



Figur 2. Aktivitetssystem knyttet til naturfaglærernes vurderingspraksis, med et særskilt fokus på læringsprosesser knyttet til argumentasjon.

Diskusjon

For å forklare og forstå naturfaglærernes vurderingspraksis er det tatt i bruk en modell, se Figur 3 under:



Figur 3. Ulike vurderingspraksiser (Fjørtoft, Langseth & Sandvik, 2014; O`Donovan, Rust, Price & Carroll, 2006).

Naturfaglærernes vurderingspraksis kan beskrives innenfor en implisitt elevpassiv vurderingskultur, med noen forsøk på å bevege seg mot en mer eksplisitt praksis. Naturfaglærerne beskriver at de vet at det er en annen praksis med mere aktive selvregulerte elever som er forventet, men når de ikke klarer å få det til alene så trer forsvarsmekanismer som tid og arbeidsmengde inn (Argyris, 1991): *(...) så har man egentlig ikke tid nok til å finne på noe nytt. Så tenker jeg uff, det her funka ikke helt, også vet jeg ikke hva jeg skal gjøre, også kjører man det igjen, også nei. Nei, det her funka ikke (...).* En slik form for enkeltkretslæring kan forklare hvorfor naturfaglærerne ikke klarer å utvikle seg mot en vurderingspraksis der både lærere og elever kan svare på «Hvor er jeg?», «Hvor skal jeg?» og «Hvordan skal jeg komme meg dit?». Uten tolkningsfellesskap med kolleger og elever om å argumentere for å lære naturfag og lære å argumentere naturfaglig, så klarer ikke naturfaglærerne å bevege seg fra en naiv positivisme (Kind, 2007) og mot et mer sosialkonstruktivistisk syn på hvordan kunnskap bygges og forstås (Kolstø, 2016; Mercer, Dawes, Wegerif & Sams, 2004). Uten en slik idemessig forståelse blir verken utforskende arbeidsmåter med høy frihetsgrad (Knain & Kolstø, 2011) eller sjangeropplæring (Lykknes & Smidt, 2010; Osborne & Patterson, 2011) tatt i bruk i læringsprosessene i naturfag. Vurdering som læring er ikke oppfattet og tatt i bruk av disse fire naturfaglærerne (Hayward, 2015).

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29. CONTEMPORARY SCIENCE IN THE LOWER SECONDARY PHYSICS CLASSROOM

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Abstract
Can contemporary science have a role in the classroom? While many students find contemporary science exciting, they often view school science as boring and uninteresting. Most of the physics taught in school was developed over a century ago and can be seen as well-established consensus science. Including discussions on contemporary research is one way to increase interest and motivation, and is also a way to provide students with possibilities to learn what research today could look like. It is also one way to teach general nature of science (NOS) perspectives, which have been argued to be important for many different reasons. In this presentation we will describe how a group of science teachers developed and implemented teaching sequences focusing on contemporary physics during in-service training. Each teacher chose a research area, interviewed a researcher, and wrote a popular science article aimed at secondary students (13-15 years old). Finally they designed, implemented and evaluated a teaching unit built around the popular science article. During the presentation we will describe the teachers' experiences, the resources developed by them, and the kind of NOS perspectives included by the teachers.

1. Introduction and theoretical framework
There is much evidence from science education research that science classes around the world are focused on established, consensus science. Often, the concepts and models presented evolved some hundred years ago. However, it has been argued that also contemporary science should have a place in the teaching of science (e.g. Tytler, 2007). It has also been shown that although many students view school science as boring and uninteresting, the same does not necessarily hold for contemporary science, which students instead often find exciting and interesting (Jidesjö, 2012). Including discussions on contemporary research is one way to give students possibilities to learn what research today could look like. It is also a way to teach general nature of science perspectives (NOS), which has been argued to be important for a number of reasons (e.g. Lederman, 2007). Getting the possibility to get to know about contemporary research and contemporary researchers could challenge images of science as being no more than a large body of established facts. Furthermore, it could open up possibilities to challenge stereotypical images of scientists (see e.g. Rodari, 2007; Sjøberg, 2010; VA, 2007) through adding human elements of science (such as creative and socio-cultural aspects of science).

Students could meet with contemporary scientists in real life as suggested by Woods-Townsend et al. (2016) or through e.g. films or texts. Meeting possible role-models could improve the possibilities for different student groups (e.g. girls) to identify themselves with science. However it is, as argued by Tytler (2007) necessary to "remember that teachers' professional identities are forged through their experiences of school and university science, with very few having practiced science in a research or professional sense. If we are serious about having school and university science reflect the nature of science as it is practiced in contemporary society, then we need to interrogate directly the nature of contemporary science and how it might differ from schooling versions" (p. 23). One way for pre- or in-service teachers to start examine contemporary science practice is to interview practicing scientists. Such an approach has been described in Tala and Vesterinen (2015).

In summary there are many different possibilities of including not only consensus "Ready-made science", but also contemporary "Science in-the-making" in science teaching. Such teaching could provide students with possibilities to understand research of today; challenge common stereotypical views about the nature of science; and give students more possibilities of finding role models to identify with. Broadening the images of scientists could be important to help students to participate and identify with science (see e.g. Henriksen et al., 2015). In the Swedish curriculum it is also stated that “Current research areas in physics, such as elementary particle physics and nanotechnology” (Skolverket, 2011) should be included in the physics core content knowledge for school year 7-9. However, this is something that is often overlooked in the physics teaching. Since there are most often no traditions to teach about contemporary science, there is a need to develop resources to support teachers.

This presentation describes a case study where science teachers, during in-service training, developed and implemented teaching sequences focusing on contemporary physics. An important part of the development of the teaching sequence was that the teachers met with a researcher, performed an interview, and with the starting point in this interview wrote a text that was used by their students during the teaching sequence. The aim of the presentation is to shed light on the NOS that was included in the texts directed towards the students, as well as to describe the in-service teachers’ experiences from the project.

1. Research methods and analysis

The teachers were, as mentioned above, taking an in-service teaching course, spanning three semesters. NOS perspectives had been taught earlier during the course, and the teachers had also tried NOS activities in their own classrooms. Thus, these teachers had a great deal of NOS-teaching experience, compared to most science teachers in Sweden.

Each teacher identified an area of current research. We, as teachers of the course, supported them by contacting the researchers and scheduling interviews, as well as short presentations by the researchers to the whole group. Each teacher interviewed "their" researcher, wrote a popular science article aimed at secondary students (13-15 years old), designed, implemented and evaluated a teaching unit built around the article, and finally wrote a short report on their experiences from implementing the teaching sequences in their classrooms.

This presentation builds mainly on the analysis of the texts written by the teachers. The popular science articles were examined for different NOS aspects. This analysis used a previously developed framework (Leden et al., 2015) inspired by the Lederman tenets (e.g. Lederman, 2007) as well as the family resemblance perspectives on NOS (Erduran & Dagher, 2014). The final reports were analyzed for challenges and opportunities connected to the inclusion of contemporary physics in physics class.

2. Results

The preliminary results show that the popular science texts include presentations of the specific researchers engaged in the chosen research areas. In the description of the research area and the work and interests of the researcher a number of different NOS perspectives were raised. These include descriptions of scientific processes in different areas including Big Science, research funding, the relation between empirical and theoretical work, research collaborations as well as the peer review system, the relationship between applied and fundamental research, the historical development of research areas, and interdisciplinary research. Some of the texts covered many different NOS issues, while others focused more closely on a few specific aspects. Most often explicit NOS related questions were asked by the teachers in the interviews and the researchers’ perspectives are described in the texts.

The teachers’ experiences from the project were generally very positive. Of course they encountered challenges, such as finding it hard to answer all the questions raised by the students related to the contemporary science topic. They also found it time consuming to prepare this kind of teaching. On the other hand, they found students’ interest and engagement very inspiring. The relevance of physics increases – physics becomes something that happens now and in which people of flesh and blood are engaged, and not something relevant only in the school setting.

4. Discussion and conclusion

At the outset of the project, most of the teachers found it hard to see how it would be possible to include contemporary science in school year 7-9. However, by the end of the project they felt more confident working in line with the intentions of the curriculum. We believe that the teachers' meetings with the science researchers had a great impact on them – researchers became real people. This is something that could serve as inspiration for other pre- and in-service teacher training programs. Another important issue is the necessity for teachers to get the possibility to develop teaching sequences, with support of colleagues and teacher educators, and also implement and reflect on them. In the presentation, we show how it is possible to begin to bridge the gap between research and policy documents on the one hand, and the actual teaching practice on the other, in areas such as teaching contemporary science and NOS to compulsory school students.

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30. DANISH GEOGRAPHY TEACHERS THOUGHTS CONCERNING OWN TEACHER PROFESSIONALISM

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Abstract
The paper presents data from a survey and interviews looking into Danish geography teachers´ considerations about their subject matter knowledge and pedagogical knowledge as well as their considerations concerning their teaching. The survey results indicate that the teachers consider themselves having strong subject matter knowledge concerning socio-scientific issues and strong pedagogical knowledge concerning problem-based work. On the other hand, the geography teachers are less confident with the implementation of practical work, though, other research shows that biology and physics/chemistry teachers typical are more confident with practical work. The interviews show that some geography teachers consider geography as an integrated science subject, whereas others are distancing geography from the other science subjects and are more aware of human geography. This implies that Danish geography, biology and physics/chemistry teachers´ competences might complements each other, and the subject geography might also offer a social science perspective on some of the science issue at the new common science exam.

1 Introduction
In the lower secondary school in Denmark, geography consist of both physical geography and human geography, and is part of the science domain together with biology and physics/chemistry. Compared to their science colleagues, Danish geography teachers´ professional teacher profiles are more influenced by matters from the humanities, and they find content especially from the physics/chemistry subject difficult (Nielsen, 2011). Though, only little is known about Danish geography teachers´ pedagogical knowledge (PK) and subject matter knowledge (SMK) (Clausen, 2016), which is topic specific (e.g. Shulman, 1986; Veal & MaKinster, 1999). This knowledge might be influenced by the teachers´ beliefs and orientations, and thus affecting their PCK (Ellebæk and Nielsen, 2016; Gess-Newsome, 2015).
By the summer of 2017, all Danish students leaving the lower secondary school are going to complete a common practical and oral science exam. The teachers from the three science subjects have to coordinate and implement interdisciplinary teaching and complete the following examination of the students. This is a new and challenging task for the involved science teachers. So in many ways, this require knew knowledge about the teachers PK, SMK, and beliefs and orientations.

2 Danish geography teachers pedagogical content knowledge (PCK)
At the beginning of the twentieth century, Danish geography teachers emphasised teaching regional geography and the memorization of facts (Lørring, 1995). While teaching geography today is increasingly characterized by teaching socio-scientific issues (SSI) like climate change, which includes relevant parts of the systematic geography, such as the carbon cycle and demography (Clausen, 2016). SSI are present societal issues with a scientific content frequently presented in the news (Ratcliffe & Grace, 2003). Working with SSI, students are not only expected to acquire knowledge about the problem, but also have to consider the value-based dilemmas. Having this double perspective in mind, it demands a broad and deep teacher professionalism to support this kind of student work within geography lessons (Clausen, 2016; Lewis & Leach 2006; Zeidler, 2003).
Teacher professionalism, which Shulman (1986) named pedagogical content knowledge (PCK), is closely connected to the teachers´ practice in the classroom (Gess-Newsome, 2015). PCK is dependent on the teacher professional knowledge base and the teachers´ subject-specific professional knowledge, which again is affected by the teachers´ personal beliefs, orientations, prior knowledge, and context (Ellebæk

& Nielsen, 2016; Gess-Newsome, 2015). Thus, the aim of this paper is to investigating geography teachers´ strengths and weakness according to specific SMK and PK items as well as their beliefs and orientations, which might reveal some tendencies about their ability support their students learning.

3 Research methods

A survey was sent to all the 192 geography teachers at 72 schools in the central part of Jutland in the spring of 2015. 45 geography teachers reported back (=23%). This is only equal of 1.6% of the total amount of geography teachers in Denmark, why the results are only indicative. The relatively low rate of response might be explained by the fact that an extensive school reform was implemented on 1 August 2014, and therefore many Danish school teachers were stressed. The geography teachers rated their SMK, according to 10 items (figure 1), and 9 items according to their PK (figure 2). They rated their considerations on a five point Likert scale (Krosnick & Presser, 2010), where 1 = weak SMK/PK, and 5 = strong SMK/PK. The standard deviation was calculated for each item.
Semi-structured interviews (Brinkman & Tangaard, 2015) was conducted among 8 geography teachers at four schools, also in the central part of Jutland. The interviews were fully transcribed and subsequently analysed in an iterative process.

4 Results

Survey results:
According to the results in figure 1 (SMK), on average the geography teachers feel academically strongest to teach the topics water cycle and rich and poor people, whereas least in economic geography and Nature of Science (NoS). The standard deviation (SD) is relatively constant around 1 and represents approximately ¼ of the average response value. However, concerning teaching globalization, SD is rather low (0.46).

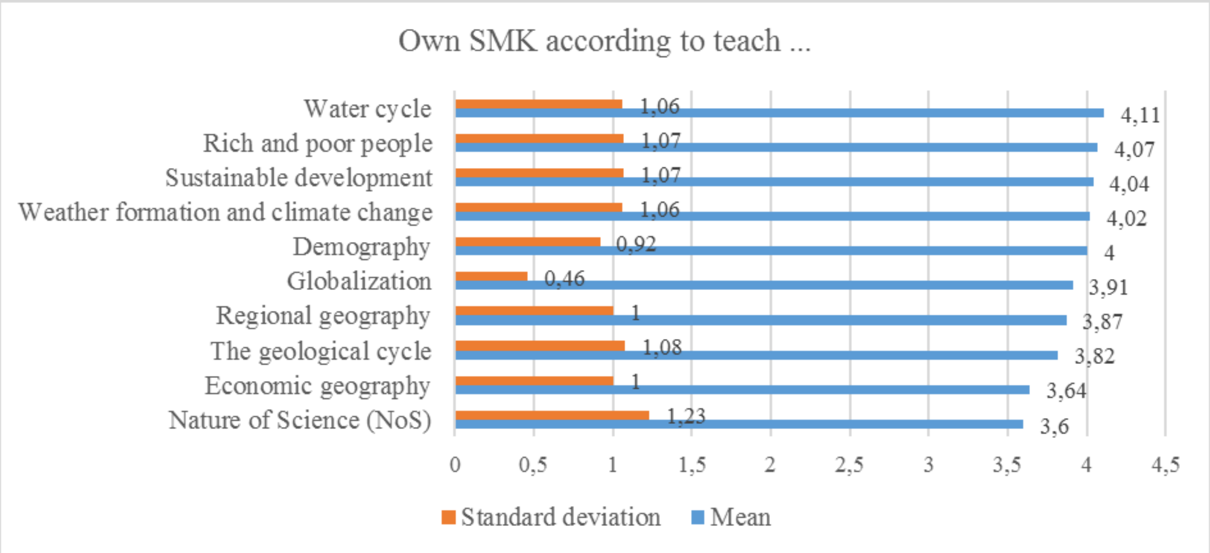

Figure 1: The geography teacher´s considerations about own SMK according to teach the topics.

According to the results in figure 2, the geography teachers considered they had strongest PK when supporting students understanding of academic texts and problem-based work, whereas they considered having less strong PK when supporting students understanding of models and animations as well as practical work / field work. The average levels of geography teachers' answers differ more compared to the responses in the previous category (SMK). The SD varies somewhat more compared to the previous category, with a considerable peak concerning the item maps.

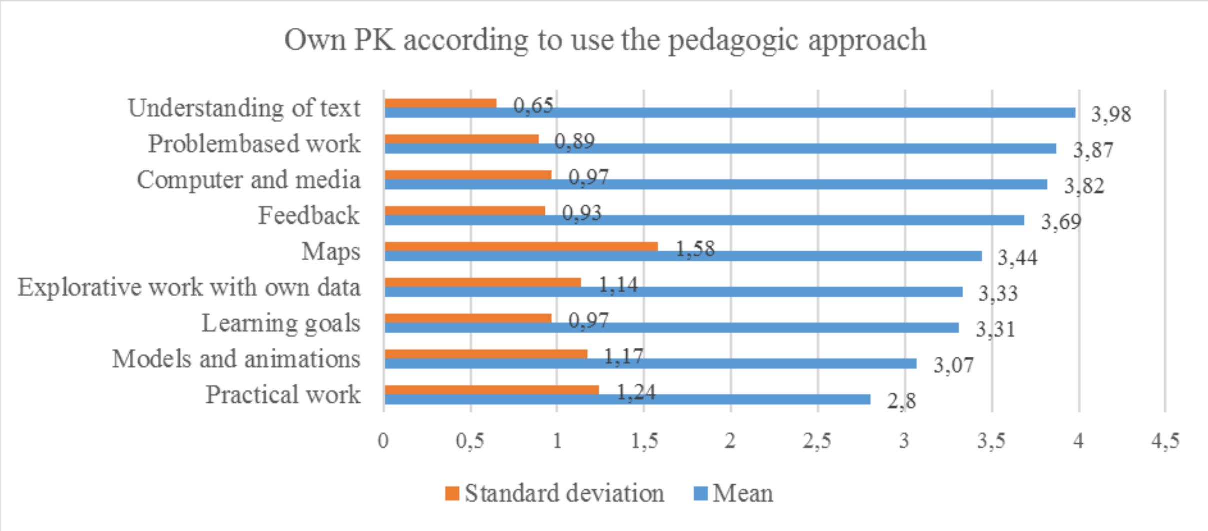

Figure 2: The geography teacher´s considerations about own PK according to use the pedagogic approach.

Interview results:
The geography teachers frequently compared geography with the other science subjects, but with very large span. A geography teacher who taught other science subjects said: "*I do not think you can teach climate change in geography without also having some strands to biology and physics/chemistry*". Though, another geography teacher distanced geography from the other sciences subjects by saying: "*In some ways, geography and social sciences are more into the humanities...*". One geography teacher also thought that practical work was easier to practice in biology than geography, saying: "... *It is easier to do things in biology, than to go out and dig some soil up in geography [..] biology is the everything* ... ".

4 Discussion and conclusion

The four topic the geography teachers considered having strongest SMK - the water cycle, sustainable development, rich and poor people as well as weather and climate change - represents the interaction between man and environment, and are topics which is highlighted as the subject's core (Castree et. al, 2005) and are part of SSI (Ratcliffe & Grace, 2003). The results also indicate that the teachers consider themselves having strong PK concerning supporting students work with texts and problem based work. Though the geography teachers don not feel competent to implement practical work and work with models, which is in alignment with previous research (Clausen, 2016; Jensen et al., 2000; Nielsen et al., 2006), and is also supported by one of the teachers' statements. These parts of the teachers PK is directly linked to the development of students' investigation and modeling skills, which is an important part of the common science exam. On the other hand, the geography teachers can in particular support problem-based work on SSI, such as climate change or water cycle, and thereby qualify the students´ perspective competencies, which is also an important part of the exam. The biology and physics/chemistry teachers typical have strong competencies related to the development of students´ investigation and modeling skills (Nielsen et al., 2006). Some of the teachers can easily make strands to the other science subjects, whereas others make strands to social sciences and humanities. Thus, the various science teachers might complement each other PK and SMK, when qualifying the students to the new common science exam.

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31. TOWARDS BILDUNG-ORIENTED SCIENCE EDUCATION – FRAMING SCIENCE TEACHING WITH MORAL-PHILOSOPHICAL-EXISTENTIAL-POLITICAL PERSPECTIVES

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Abstract
In this paper I discuss and problematize the notion of *Bildung* in relation to science education and scientific literacy. I both discuss it in relation to different philosophies of education and in relation to practical implications for teaching and learning in and about science-technology-society-environment (STSE) and nature-of-science (NOS). Furthermore, I connect the discussion to Roberts' (2007) two visions of scientific literacy and develop the ideas behind a third vision, *Vision III* (Sjöström & Eilks, 2017), emphasizing moral-philosophical-existential-political perspectives in education. For each of the three visions I suggest (for vision I and II based on previous studies) two subversions connected to different curriculum emphases. For Vision III this mainly means curriculum emphases not suggested by Roberts. One exception is the curriculum emphasis "self as explainer", which can be interpreted as being about existentialism. I claim that science education based on reflexive *Bildung* can be seen as an alternative to science education based on Western modernism (Sjöström, in press). It integrates cognitive and affective domains and includes politicisation to address complex socio-scientific and environmental issues, but also moral-philosophical-existential perspectives, including NOS. I discuss and describe implications of this *Bildung*-philosophy on science teacher educations, on-going teacher development programs/initiatives, and curriculum development.

1 Introduction
My paper "Towards *Bildung*-oriented chemistry education" was published online in 2011 (Sjöström, 2013). Since then I have – together with co-authors – developed and contextualized the thoughts regarding chemistry education (e.g. Sjöström & Talanquer, 2014; Sjöström, Rauch & Eilks, 2015) and also broadening the perspective to deal with science education more in general (Sjöström, Eilks & Zuin, 2016; Sjöström & Eilks, 2017). We identified different versions of *Bildung* and connected them to Roberts' (2007) two visions of scientific literacy. For critical-reflexive *Bildung* we needed to introduce a third vision of scientific literacy (Sjöström & Eilks, 2017). I regard reflexive *Bildung* as a posthumanist version of *Bildung*, in contrast to most other versions which are highly influenced by Western modernism. Science education based on reflexive *Bildung* integrates cognitive and affective domains and includes politicisation to address complex socio-scientific and environmental issues, but also moral-philosophical-existential perspectives. Relations and responsibility are emphasized (Sjöström, in press).

In this paper I further discuss the theoretical underpinnings of reflexive *Bildung* and its implications for philosophy of science education, scientific literacy, curriculum development and praxis of science education.

2 The notion of *Bildung*
Before more in-depth describing the posthumanist version of *Bildung*, I will give a short introduction to the notion of *Bildung* more generally. It is definitely not a homogenous concept, but one can say that it has both objective and subjective aspects and both educational and political dimensions. Because there is no precise English translation of *Bildung*, the German term is used in the international educational literature (see e.g. Westbury, Hopmann, & Riquarts, 2000).

Bildung consists of two elements: "autonomous self-formation and reflective and responsible action in (and interaction with) society" (Fellenz, 2016, p. 273). It is about "the individual embedded in a world" (Løvlie & Standish, 2002, p. 319) and accordingly *Bildung* can be seen as an educational ideal for citizens. The concept was in its modern form coined in Germany in the late eighteenth century, with roots in both the Enlightenment and Romanticism (Reichenbach, 2014). Today at least five versions of *Bildung* are well-established and all of them have transformed over time from a North European to a global focus (Gustavsson, 2014; Sjöström & Eilks, 2017). One of the most complex versions is critical-hermeneutic *Bildung* and I regard reflexive *Bildung* as a further developed variant of this version.

During the last fifteen years the concept has been problematized by postmodern theorists. Some scholars have claimed that the concept should be abandon, whereas others claim that *Bildung* still works as a critical concept in a postmodern world. Gur–ze'ev (2002, p. 405) writes: "As counter-education, today's *Bildung* can contribute greatly to the reconstruction of […] subjectification". Instead of truth, *Bildung* should be about cultural respect and socio-political justice (Peukert, 2002). It can show us moral-philosophical-existential-political alternatives (Gur–ze'ev, 2002).

3 Connecting to Roberts' visions and curriculum emphases

During the last sixty years policy makers and science educators have argued for scientific literacy. Roberts (2007) distinguished between two main orientations: *Vision I*, which focuses mainly on learning about scientific content and scientific processes for later application, and *Vision II*, which focuses on understanding the usefulness of scientific knowledge in life and society by starting science learning from meaningful contexts. Other authors have described different subversions of Vision I and II (Lundqvist, Säljö & Östman, 2013; K. Ottander, 2015; Sund, 2016; Lidar, Karlberg, Almqvist, Lundqvist, & Östman, accepted). Roberts (2011, p. 14) connected four (of his seven empirically based) curriculum emphases (solid foundation; structure of science; correct explanations; scientific skill development) to Vision I and the other three (self as explainer; everyday coping; science, technology, and decisions) to Vision II.

As mentioned above, for reflexive *Bildung* I have suggested a third vision of scientific literacy and science education (Sjöström & Eilks, 2017), which I view as driven by late/postmodernism. The philosophy of this orientation can be characterized with e.g. the terms post-positivism, relationalism, embodied science, subjectification, eco-reflexivity, and reconstructionism (Sjöström, in press). It is interesting to note that there are no curriculum emphases among Roberts' that clearly emphasize socio-political actions, philosophical values and/or existential perspectives, which are in focus in science education framed by Vision III. Here I suggest a differentiation between two subversions of *Vision III*:

Vision IIIA: socio-political actions (see further: e.g. Sjöström & Eilks, 2017)

Vision IIIB: moral-philosophical-existential perspectives, including nature-of-science (NOS) aspects

However, I think the curriculum emphasis "self as explainer" can be interpreted as being about existentialism, but most often I suppose it is not. In the literature there are some papers arguing for the importance of "holistic experience", emotional sensitivity toward nature, philosophical values, and the importance of wonder (e.g. Hadzigeorgiou & Schulz, 2014; Dahlin, Østergaard & Hugo, 2009). These ideas are in line with the moral-philosophical-existential perspectives emphasized in Vision IIIB and are also related to the ideas of many Eastern philosophies (Sjöström, in press).

Bildung-oriented science education covers both Vision IIIA and IIIB (and to a large extent also Vision II and I) and can function as a bridge between activism-oriented science and technology education (Bencze & Alsop, 2014) on the one hand and traditional ideas of *Bildung* on the other hand.

4 Implications

During the presentation reflexive *Bildung* and Vision III of scientific literacy will be discussed in relation to science education research and praxis and to the research field Environmental and Sustainability Education (ESE). This includes both the philosophical ground and practical implications for teaching and learning, science teacher educations, on-going teacher development programs/initiatives, and curriculum development. Furthermore, the results of ongoing empirical studies related to the three visions will be presented.

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32. EVALUERING AF NY TVÆRFAGLIGHED I NATURFAGENE.

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Abstract
In lower secondary school in Denmark the science subjects biology, physic/chemistry and geography are framed by competence-based skills and knowledge aims. The subjects are being tested with two different tests at the end of year 9. One of the tests is an on-line written test in one of the subjects drawn by lot. The other is new practical oral test in all three subjects at the same time. This present study focus on this new practical oral test, that is compulsory from summer exam 2017, but was tried voluntarily in pilot schools in summer exam 2016.
We have made survey among science teachers in lower secondary school in Denmark, we received 94 complete replies. We have made observations and interviews with 10 teachers how participated in the pilot run of the test. The survey reveals that science teachers generally see many options in the integrated test, but that they also find it a challenge. The observations and interviews add nuances to the perspectives raised in the survey. Especially the need for proper instruction of the students is a common concern for the interviewed teachers. They do however also present some ideas and proposals for guidelines that can help the students.

1 Indledning
I Danmark er der sammen med kompetencebaserede færdigheds- og vidensmål indført fællesfaglige fokusområder for biologi, fysik/kemi og geografi i folkeskolens 7. – 9. klasse. De tre fag skal samarbejde om at gennemføre mindst 6 fællesfaglige undervisningsforløb i 7. – 9. klasse. Disse fællesfaglige forløb leder frem mod en ny fælles mundtlig og praktisk prøve i naturfagene i folkeskolen fra skoleåret 2016/2017. Prøveformen er gennemført på en række skoler i skoleåret 2015/2016. Denne afprøvning er ikke blevet fulgt op af en systematisk evaluering fra officielt hold.

Nærværende projekt forsøger derfor at afdække naturfaglige læreres forståelse af og holdning til den nye fællesfaglige agenda, samt udpege udfordringer og muligheder for dens videre implementering. Projektet er pragmatisk af natur og tilsigter primært at levere brugbar viden til lærere i folkeskolen.

2 Teoretisk ramme
Fællesfaglig undervisning inden for naturfag er kendt fra andre lande end Danmark, fx i form af Science-fag i mange engelsksprogede lande, Naturkunde i tysktalende lande og Naturfag i Norge. Det særegne i den danske model er, at undervisningen skal veksle mellem fællesfaglig og monofaglig undervisning, og at eleverne skal til en obligatorisk fællesfaglig praktisk mundtlig prøve. Eleverne forbereder sig til prøven gennem et projektarbejde, som strækker over sig 1-1½ måned i foråret i 9.kl. Denne specielle prøveform vanskeliggør en direkte international sammenligning. Vores undersøgelser af undervisning og tilhørende prøveform er derfor paradigmatisk og metodologisk pragmatisk af natur (fx Johnson & Onwuegbuzie, 2004).
Teoretisk er det forankret i sociokulturel teori for læring og for evaluering (fx Gipps, 1999). Socio-kulturel læringsteori er relevant for at forstå og evaluere læring i en kompetenceorienteret sammenhæng, med kraftfuld mediering i form af kollaboration, modeller og andre artefakter, samt praktisk-eksperimentel deltagelse (Tobin, K., 2012; Kincheloe, J.L. and Tobin, K., 2015).

Evalueringsmæssigt læner projektet sig desuden op ad T. Guskeys evalueringsmodel (2000), hvor vi har fokus på de deltagende læreres reaktioner, deres oplevelse af organisatorisk støtte og deres udvikling af ny viden og nye færdigheder.

Litteraturstudier har godtgjort, at der er meget få forskningsmæssige reviews om fælles naturfagsundervisning og at mange begreber bruges til at beskrive samarbejdet. Czerniak (2007) fremhæver i sit review, at der ikke er konsensus omkring, hvad der skal forstås ved integreret naturfagsundervisning. Fx anvendes internationalt både termerne interdisciplinaritet og transdisciplinaritet, med en delvis uklar distinktion. I et review over *Interdisciplinary science teaching* fremhæver Czerniak og Johnson (2014) tilsvarende, at det er vanskeligt at afgrænse indhold og arbejdsmåder. Denne mangel på afklaring gør også, at det er vanskeligt entydigt at hente vejledning, rådgivning og lignende ud af forskningslitteraturen. Der findes et enkelt metastudium (Hurley, 2001), som viser, at organiseringen af det faglige samspil (konkret mellem naturfag og matematik) har stor betydning for elevernes udbytte i hvert af fagene. Den manglende konsensus og store mangfoldighed i typer af integration af naturfagene (til tider også med matematik) gør, at en nærmere undersøgelse af den aktuelle danske model kan bidrage til feltet interdisciplinær eller transdisciplinær undervisning og læring i naturfag.

3 Forskningsmetode

Det nye i den danske kontekst er fællesfagligheden, hvorfor vi har fokuseret på at indsamle lærernes vurdering af denne nye tværfaglighed i naturfagene. Med afsæt i den eksisterende forskningslitteratur om tværfagligt samspil (Czerniak, 2007) inden for naturfag designedes et spørgeskema mhp. at indfange læreres forståelse af tværfagligt samspil, deres erfaringer, selvtillid (self-efficacy) og praksis mht. fagligt samspil, samt deres holdninger til denne type undervisning. Åbne respons-felter gav lærerne mulighed for at give konkrete eksempler fra praksis og beskrive centrale udfordringer. Et diverst convenience-sample (N=94) af lærere fra alle naturfag i overbygningen besvarede spørgeskemaet.

Pilotafprøvningen af den nye fællesfaglige prøve blev fulgt via et antal observationer (4) og semistrukturerede interviews med et antal (10) naturfagslærere, for at få adgang til deres praktiske erfaringer på feltet og afdække de mest udfordrende aspekter af prøveformen. Disse lærere havde frivilligt valgt at starte et år før prøven bliver obligatorisk, hvorfor de kan betegnes som særligt motiverede for fællesfaglige tiltag inden for naturfag.

4 Resultater

Præsentation på NFSUN vil fremlægge centrale resultater fra såvel de kvantitative som de kvalitative undersøgelser.

Spørgeskemaundersøgelsen viser bla. interessante spændinger mellem lærernes *forståelse* af, at den intenderede tværfaglighed bør være problemorienteret, og så den emneorienterede *praksis*, som mange lærere beskriver.

> *"Vi har arbejdet med fælles overemner i de 3 naturfag, hvor hvert naturfag har lavet undervisning i fagstof som er relevant for fagene og derefter har eleverne lavet et skriftligt produkt til aflevering og vurdering."*

Nogle lærere arbejder dog mere eksemplarisk fællesfagligt:

> *"Der arbejdes i en periode på ca. 3 uger med et fællesfagligt emne i alle naturfagstimer (typisk 6-7 pr. uge). Optakt kan fx være et besøg på en virksomhed, et*

fagligt oplæg om problemstillingen, en film etc. Derefter laves mindmap, der resulterer i forsk. problemstillinger, som eleverne opstiller arbejdsspørgsmål til og arbejder med i de flg. timer. Som afslutning skal alle grupper fremlægge deres resultater. Vurderingen sker med fokus på de naturfaglige kompetencer."

Fra interview og observationer har vi eksempler på praksis, hvor eleverne klart bliver hjulpet gennem det forberedende projektarbejde og selve prøven gennem en tydelig instruktion og stilladsering om forventninger i hver fase af forberedelserne og selve prøven. I sådanne forløb udviser eleverne stor kreativitet med hensyn til at visualisere og belyse deres problemstilling gennem naturfaglige modeller, undersøgelser og forsøg. Vi har også observationer og interviewudtalelser fra prøvesituationer, hvor udfordringerne ved en fællesfaglig vurdering af elevers kompetencer bliver tydelige.

"Synes det er svært, men vi kører et forsøg med eleverne, hvor de laver problemstilling og fremlæggelse."

„Det er ikke anderledes end i alle mulige andre sammenhænge, du har nogle grupper som arbejder godt og nogen som arbejder dårligt. Nogen har svært ved at forstå når det ikke er sat op i snorlige spørgsmål og nogen som er gode til det og ser muligheden for at være kreative."

Grundet det unikke danske samspilsformat lader resultaterne sig kun vanskeligt validere internationalt. Undersøgelsernes implikationer for praksis vil imidlertid blive uddybet ved præsentationen.

4 Diskussion og konklusion.

Internationalt findes der nogle få undersøgelser, som afdækker læreres barrierer og udfordringer ved interdisciplinært arbejde; mellem naturfagene eller mellem naturfag og matematik. Tematisk og diskursivt kan vi dog relatere til internationale forskningsagendaer om fx "socio-scientific issues" (SSI)-undervisning og om backwash-effects af tests og nye prøveformer.
At arbejde med "socio-scientific issues" i naturfag giver muligheder for at elever kan tage afsæt i deres egen hverdag og belyse dem gennem naturfaglige undersøgelser og begreber. Gennem dette arbejde kan elever træne deres naturfaglige argumentation og vurdere etiske aspekter af naturfags betydning for den aktuelle problemstilling (Zeidler, 2014). En tilgang som stemmer godt overens med flere af de fælles naturfaglige kompetencer, som biologi, fysik/kemi og geografi bygger på i Danmark fx undersøgelseskompetence og perspektiveringskompetence (EMU.dk; 2017).

Både i interview og i de åbne kommentarbokse i spørgeskemaet giver lærerne udtryk for, den udfordring de aktuelt står overfor med at ændre deres undervisning i biologi, fysik/kemi og geografi, så den støtter eleverne i deres forberedelse af den fællesfaglige prøve. Det er især arbejdet med at få de tre fag til ligeværdigt at præsentere sig med metoder og tilgange, som belyser den aktuelle problemstilling. Endvidere er balancen mellem forventningen om elevernes selvstændighed i det prøveforberedende projektarbejde og nogle elevers udtalte behov for stilladsering en markant forandring for lærerne.

I den sammenhæng tilbyder den aktuelle danske model en god mulighed for forskningsmæssigt at undersøge, hvorledes den nye prøveform tilskynder integrationen af naturfagene. Dette aspekt vil have international betydning for arbejdet med interdisciplinaritet inden for naturfagsundervisning.

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33. DESIGNING AN ICE CREAM MAKING DEVICE: AN ATTEMPT TO COMBINE SCIENCE LEARNING WITH ENGINEERING

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Abstract
In the current study, lower secondary school students' problem-solving was explored while using a design-based science learning (DBSL) approach. A learning module in which students were expected to design an ice cream making device was developed. The goal of the study was to introduce the DBSL module and to explore how student design products can be characterised and eventually, assessed. Data were gathered by students' written reports and video recorded classroom observations. As a result of the study, a set of assessment criteria was developed which covered the functional, structural, safety and feasibility aspects of the device. According to the criteria, it was found that amongst the initial individual design projects (N=23), only eight could be classified as realistic, nine as realistic with reservations while seven were classified as unrealistic. The initial difficulties, though, were overcome by peer support, teacher guidance, and some trial and error experiences resulting in five mostly realistic group designs.

1 Introduction
The development of students' design skills has been highlighted during the recent years (e.g. NGSS, 2012). It is hoped that design tasks act as triggers for learning science by making students feel the need to expand their knowledge to be able to solve a given problem (Hmelo, Holton, & Kolodner, 2000). Design problems are considered to be one of the most ill-structured and complex, as they are open-ended and more in line with real-world problems (Jonassen, 2011; Hathcock, Dickerson, Eckhoff, & Katsioloudis, 2014).

Design-based science learning (DBSL) is a teaching approach that tries to integrate science learning and the processes of engineering design. By DBSL, it is attempted to engage students in scientific reasoning through solving authentic design problems in situations that are quite similar to engineers' everyday work (Apedoe & Schunn, 2013). Starting from an authentic problem, students themselves design artefacts and solutions to solve a given design task.

Jonassen (2011) claims that student assessment is currently the weakest link in teaching students to solve complex problems. Teachers and educators far too often rely on a single type, such as recall-oriented assessment, though, in principle, recognising the need for developing higher-order problem-solving skills by students. Therefore, student assessment methods (both formative and summative) need to be more aligned with contemporary learning goals and implemented learning methods (such as DBSL).

Based on the earlier, two goals were posed for the current study:

- to develop a DBSL module which tries to integrate the knowledge from chemistry, physics and engineering;
- to explore how student design products can be characterised and eventually, assessed.

3 The study
This study was conducted in one 8th-grade science class (24 students) at a public city school in Estonia. Students' written reports and video recordings were used as a data source while implementing the DBSL module "Designing an ice cream making device" in the classroom. The module was taught within five ordinary science lessons (à 45 min.) by the students' science teacher. Lessons were recorded by two cameras, one placed in the front, and the other in the back of the classroom.

Design and implementation of the module

A DBSL module was developed by the research team within which the students were expected to design an ice cream making device from simple and easily available materials.

The learning module consists of four stages (Figure 1). It starts from a **scenario** (stage I) which gives a short overview of the history of ice-cream making technology. After the introduction, students in groups are asked to discuss the scenario and put forward as many ideas and questions as they can. Finally, students are asked to design an ice cream making device and make an "old-fashioned" ice cream.

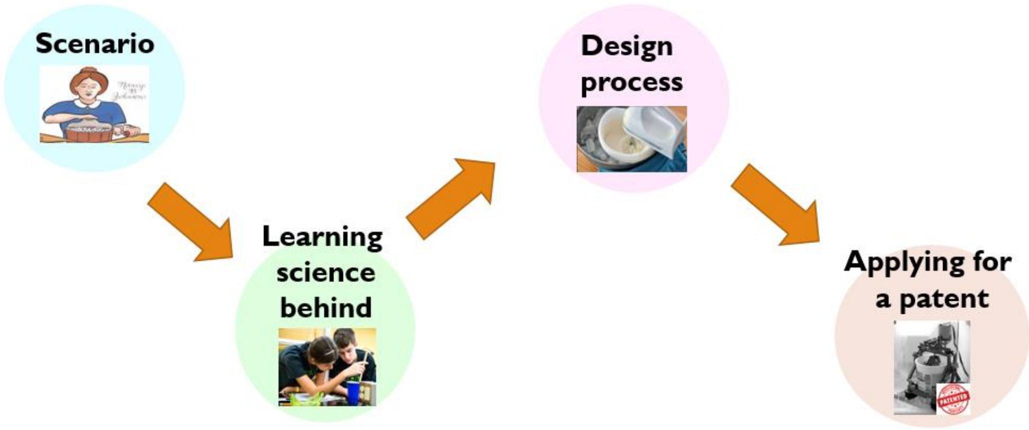

Figure 1. Learning sequence of the module

The discussion is followed by an **inquiry** session (stage II) which is expected to provide students with relevant science knowledge needed for their subsequent design. Through inquiry learning, students pose hypothesis based on a given problem and carry out experiments on dissolution heat and thermal conductivity. In addition to the knowledge gained through experimenting, students are provided with additional written information about the available substances and materials such as their chemical properties and uses.

In stage III, students **design and build** their device for making ice cream. First, students have to make a decision on the choice of substances and materials needed for their design and draw initial drafts of their device. This particular task is done individually, but is later continued as a group work. After that, students in groups make a prototype and test it while making ice cream from cream and flavourings.

In stage IV, students have to **apply for a patent** and defend it in front of their classmates.

Data analysis

In the current paper, data analysis is focused only on stages III and IV of the module within which students had to develop and execute their design ideas and apply for a patent.

Students' reports were analysed using a set of criteria as given in Table 1. Criteria development took place together with data analysis and it was conducted in three rounds. During the first round, it was tried to operationalise the theoretical knowledge about design (Cross, 2000; etc.) into more specific descriptors suitable for the current study, and where the review of students' design drafts gave a lot of insights.

Moreover, it was the mutual interaction between theoretical knowledge and the empirical data that helped to derive the criteria and develop the descriptors. The first version of criteria was randomly tested on students' design drafts, and resulted in a need for an additional criterion that would encompass the design as a whole (not only its single elements) keeping in mind the ultimate purpose of the device – it should be able to produce edible ice cream while the design process should be in compliance with a given timeframe and available equipment. Therefore, in the second round, the feasibility criterion was added and again, the student drafts were roughly analysed against this criterion after which a descriptor was improved to be more concrete. In the third round, students' drafts were analysed independently by the first two authors according to the criteria in Table 1. In the case of disagreement, the two researchers discussed to reach consensus.

4 Results

The results of the analysis of the individual and group design drafts (as given in their patent applications) are shown in Table 1. An example of an individual design project representing an “unrealistic” design can be seen in figure 2 while figure 3 represents a “realistic” group design.

***Table 1:** Assessment criteria for student design solutions*

	Assessment criterion	**Individual design** N=23	**Group design** N=5
Choice of substances and materials	**Cooling system** The mixture of the substance able to absorb heat while dissolved in water and ice is used for cooling. (Yes/No)	17	5
	Container system A good thermal conductor such as aluminium or steel is chosen for the vessel separating cream and flavourings from a cooling mixture. (Yes/No)	12	4
	A bad thermal conductor such as plastic or glass is chosen for the outer vessel helping to keep substances inside the vessel cool. (Yes/No)	10	3
Configuration of sub-systems	Cooling mixture is separated from the edible components by a septum. (Yes/No)	15	5
	Cream can be whipped up/foamed at the same time while cooling it down. (Yes/No)	8	5
	The distance between two containers is optimal (Yes/No)	14	5
Safety	Device seems to be safe when used as intended. (Yes/No)	17	5
Feasibility	Design project seems applicable for making edible ice-cream within the given time frame and equipment.		
	Realistic	8	4
	Realistic with reservations	7	1
	Unrealistic	9	0

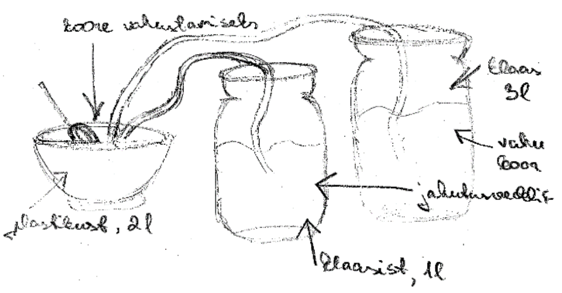

Figure 2. Example of an unrealistic individual design

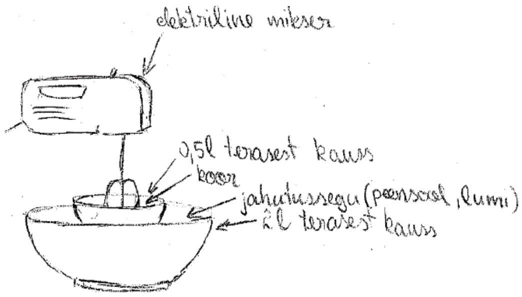

Figure 3. Example of a realistic group design

4 Conclusion

As a result of the study, the DBSL module was developed and implemented in 8th grade science classroom. A set of criteria was established for characterising students’ design products encompassing their functional, structural, safety and feasibility aspects and the choice of materials. Also, it was possible to analyse the students´ design products according to the developed set of criteria. These criteria cannot be seen as mutually exclusive. Rather, they are geared to supplement each other while trying to capture the most crucial aspects of the designed artefact and enabling to assess whether the device is able to fulfil its expected function. It should also be admitted that the list of criteria is not universal nor easily transferable to any other student design product but, it may still provide curriculum developers and teachers with a working example and further insights how student designed artefacts can be assessed. Rather than being an ultimate "judgement list" for summative assessment purposes it may help teachers to guide students during their design process or can be a tool for both students and a teachers, helping them to analyse together the already developed prototypes.

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35. LANGUAGE INTERFERENCE IN UNDERSTANDING OF NEWTON'S 3RD LAW: CASE OF NORWEGIAN PRIMARY SCHOOL PRE-SERVICE TEACHERS

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Abstract
Newton's laws of motion are part of the basics in classical physics curriculums in many countries. We have noticed a tendency among physics students in Norway to mix up third law (the notion of action-reaction) with first law (balanced forces on one body). Previous studies found in literature mostly attributed this difficulty to underlying conceptual misunderstanding or lack of ontological foundations of the concept of forces. None of the studies addressed the possibility of language interferences. In Norway we use the words "kraft og motkraft" which can be directly translated into "force and counterforce". Such wording could cause confusion, as "counterforce", can easily and intuitively be misunderstood as merely a force in the opposite direction, a similarity with Newton's first law. To investigate, we conducted exploratory research on the primary school science teacher trainees' understanding of "kraft og motkraft" using multiple-choice tasks, interviews and analyses of exam papers. The results indicate that the terminology causes problems for students trying to understand Newton's 3rd law. Their understanding of "motkraft" does not only cause the students to mix up Newton's third law with the first, but with the second as well.

1 Introduction
Newton's laws of motion are part of the basics in classical physics curriculums in many countries. In Norway they are introduced at middle school (age 13-16) through the notion of acceleration and forces, and then the connection between them (Newton's 2nd law). The more advanced mathematical formalities including vector calculation are introduced at a higher level, i.e. upper secondary in the "specialized study program" Fysikk 1 (age 17-18). There, all three laws are part of the curriculum (Utdanningsdirektoratet, 2013). Our study is within the context of teaching Newton's laws to pre-service teachers (PST), as part of their education.

2 Theoretical framework
Misconceptions about Newton's third law have been extensively studied. The most frequent stem from everyday experiences, which are often counterintuitive and asymmetrical (Hestenes, Wells, & Swackhamer, 1992). E.g. 'The more forceful wins', wherein 'more forceful' means 'bigger', greater mass' or 'more active' (Hestenes et al., 1992). While first and second law are closely connected (e.g. Hart, 2002), third law, however, is different from the first two and should be treated separately. The third law calls for understanding that, a force always involves an interaction between *two* bodies, which manifests itself as *two* forces of equal magnitudes but opposite direction, exerted on *each of the two interacting bodies*. Hestenes argues that the failure to understand the third law underpins difficulties in understanding the first and the second, hence the importance of understanding the 3rd law (Hestenes et al., 1992). Further, by understanding forces as resulting from interaction between two bodies, it lays the argument that the third law is essential in giving ontological foundation to *the concept of forces* (e.g. Brown, 1989).

On the other hand, the incomprehension of the *concept of forces* could cause difficulties with understanding Newton's laws (e.g. Reiner, Slotta, & Resnick, 2000). Reiner et al. (2000) reported naïve conceptions often found in novices, wherein forces were closely related to the impetus "theory", hence a substance-based ontology, instead of the interaction "theory" (Brown, 1989) which is a process-based ontology.

A huge body of literature exists on the role of language in science, including the influence of everyday language. For instance, the words *force*, *energy* and *current* have specific meanings in physics and yet can mean something different in everyday life (e.g. Duit, Schecker, Höttecke, & Niedderer, 2014) and can cause difficulties when learning those concepts unless the teacher is aware. Oyoo (2012) investigated physics teachers' use of instructional language and concluded on lack of awareness of the difficulty, nature and functional value of different categories of words (e.g. technical and non-technical). No study has been found however, which focused on the consequences of the way we name the force-pair in Newton's 3rd law in different languages, except perhaps a hint to the problems of calling them action-reaction in English (Eshach, 2010). Eshach (2010) investigated students' and pre-service teachers' understanding of Newton's 3rd law using CIP and revealed a new type of misconceptions wherein the word "reaction" was used in its colloquial sense, i.e. as response to a stimuli.

Prior to this study, we had noticed a tendency among physics students in Norway to mix up the third law (the notion of action-reaction) with the first law (balanced forces on a body). In Norwegian, we call action-reaction "kraft og motkraft" which directly translates to "force and counterforce". We wondered whether the Norwegian names of the force-pair creates confusion, since the terminology "counterforce" can intuitively be misunderstood as merely a force in the opposite direction, a similarity with Newton's first law. Viennot (1979) studied students' spontaneous reasoning and reported confusion between "reaction" in Newton's 3rd law with the "counterforce" on a body. We are not arguing against possible lack of conceptual understanding (Reiner et al., 2000) or spontaneous reasoning (Viennot, 1979) among Norwegian students; we argue that Norwegian students face another potential source of difficulty which teachers should be aware of, i.e. the language interferences due to the way the force-pair is named.

We decided then to investigate whether Norwegian students experience confusion due to this language problem, giving rise to our research question: *How do students understand the words "kraft og motkraft"?*

3 Research methods

We conducted exploratory research using a mixed-method approach to ensure in-depth analysis from multiple data sources (Cohen, Manion & Morrison, 2011). Our participants were first year primary school PST. We started by giving 31 PST multiple-choice (MC) tasks inspired by Concept Force Inventory (FCI) (Hestenes et al., 1992). Based on their answers, we randomly chose two PST for semi-structured interviews to get an in-depth insight on their understanding of the term "motkraft". In addition, we collected 36 exam papers and analyzed the answers of one particular question.

4 Results

MC task

An apple on a table. The PST were asked to identify the force, if any, from the table.
While 59.4% ticked the correct alternative D (a normal force from the table, equal to the gravitational force in magnitude and opposite in direction), 40.6% ticked alternative B (a "Newton's 3rd law force", acting as a reaction force to the gravitational force). 12.5% ticked both alternatives.

Interview

The following are quotes from an interview with one of the students, after the MC tasks.
(I:Interviewer; S:Interviewee)

I: You have a force of gravity pointing downwards, and then there is a force from the table on the apple. And you answer this is the "motkraft". But now my question, concerning the very word "motkraft". If you were to describe/explain "motkraft" with your own words. How would you do that?

S: I'm thinking it must render zero.

I: Hm…m

S: So, when you have the one force pulling the apple downwards, I know there must be something that makes it become zero, that (makes it) remain at rest

…….

The interviewer presents a new situation: A person pushing a car.

I: How would you draw the reaction force (motkraft) to this one [Pointing at the force from the person, acting on the car].

S: There is first of all there is acting a reaction force (motkraft) to this force. It depends whether the car is at rest or not. Whether it is moving when he is pushing. But the reaction force (motkraft) will be acting in the opposite direction anyway.

Exam papers

What is the reaction force (motkraft) to the gravitational force acting on a car at rest, specify which object the force is acting on, its magnitude and direction.

38.9% identified correctly the reaction force as the gravitational force from the car acting on the earth, while another 38.9% specified the normal force from the ground as the reaction force.

4 Discussion and conclusion

The MC task results show that nearly half of the PST thought of the normal force as the pair of the gravitational force in Newton's 3rd law, indicating possible mix-up. The in-depth insights from the interviews support our initial assumption of language interference, when the interviewee immediately associated "motkraft" to a force that canceled the gravity out ("it must render zero"). Next, it became clear that the interviewee's understanding of "motkraft" was simply a force acting in the opposite direction, regardless the magnitude.

The problems seem to be caused by the strong and here unfortunate colloquial sense of the word "motkraft" as a force acting in opposition to another force, hence an effect similar to the findings of Eshach (2010). The interview results suggest that the language interference did not only cause the mix-up Newton's third law with the first, but also with the second.

The exam paper analysis indicates that for ~39% of the students this confusion persisted even after the teaching. This resonates with previous findings that misconceptions generally are resistance to teaching (Duit et al., 2014). In conclusion, the exploratory study seems to indicate that the used terminology causes problems for Norwegian students in building understanding of the Newton's 3rd law. Further research is planned to confirm this result at a larger scale.

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36. UNPACKING STUDENTS' EPISTEMIC COGNITION IN A PROBLEM SOLVING ENVIRONMENT

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Abstract
It is a widely held view that students' epistemic beliefs influence the way they learn and think in any given context. However, in the science learning context, the relation between the sophistication of epistemic beliefs and success in scientific practice is sometimes ambiguous. Taking this inconsistency as a point of departure, we examined the relationships between students' scientific epistemic beliefs (SEB), their epistemic practices, and hence their epistemic cognition in a computer simulation in classical mechanics. The 19 tenth grade students' manipulations of the simulation, spoken comments, behavior, and embodied communication were screen and video-recorded and subsequently described and coded by an inductive approach. The screen and video recordings were triangulated with a stimulated recall interview to access a broader understanding of the dynamic processes of epistemic cognition. Our findings focusing on three different students reveal a dynamic pattern of interactions between SEB and knowledge, i.e., epistemic cognition, showing how epistemic cognition can be understood in a specific problem solving context due to the actions the student express.

1. Introduction
Students' epistemic beliefs (i.e., their assumptions about the nature of knowledge and knowing) have received considerable attention in recent decades. Nevertheless, this field may be perceived as both vast and muddled due to methodological and conceptual issues (Kitchener, 2011). To move the research field forward, we claim there is a need to focus on how students' scientific epistemic beliefs (SEB) are brought to bear in different learning contexts (i.e., students' epistemic practices). Therefore, the current study strives to unpack the processes that are in play and can be understood by students' actions in relation to a specific problem solving situation in science. We use the term epistemic cognition since we argue that there is a distinction between epistemic beliefs and epistemic cognition. Epistemic beliefs are generally stable over time and contribute to the scope of epistemic practices, and though epistemic cognition draws upon epistemic beliefs, it is more context sensitive and relates to context-specific knowledge and skills (Sinatra, 2016). Revealing students' thinking and behavior while they engage in specific contexts may provide important insights and advance the understanding of their dynamic process of epistemic cognition.

The aim of the study was to deepen our understanding of students' epistemic cognition in a problem-solving situation by capturing students' epistemic practices and their sense making in the moment. The following research questions guided the present study:

- What actions characterize students with different SEB, i.e. their epistemic practices, in a computer-based problem-solving situation?
- Howcan the process of epistemic cognition be understood from students' epistemic practices in this specific context?

2. Theoretical framework
To understand students' epistemic cognition during a specific problem-solving situation a framework is needed that can be applied to epistemic practices in the situation. Initially, students will frame and understand the problem-solving situation differently depending on how their SEB, conceptual knowledge, and problem-solving skills (epistemic resources) interact with their perceptions of the problem-solving situation (Bodin, 2012). Studies indicate that there are relationships between students'

SEB and their views of science learning (Bodin, 2012) and achievement in science (Bråten, Ferguson, Anmarkrud, Strømsø, & Brandmo, 2014). Moreover, how students' interact with the situation will in turn affect their ability to make decisions regarding their scientific strategies and reasoning in a particular moment, i.e., their epistemic practice (Sinatra, 2016). Epistemic practice is therefore how a person within a given context is approaching, justifying and evaluating knowledge. According to Russ (2014) actions, rationales and decisions serve as clues about how a person determines the use of knowledge in learning. This view is supported by Muis and Gierus (2014), who recommend a greater focus on behavioral indicators of epistemic cognition in different situations where the epistemic thinking and understanding are involved. It is currently possible to determine a shift away from mainly characterizing epistemic beliefs towards a more situated perspective on epistemic cognition in order to capture the richness of these processes (Sandoval, 2014).

3. Research Methods

This study draws on findings from a previous study on students' SEB in computer-simulated problem solving. Three out of 19 students were purposefully chosen based on their SEB and outcomes, to understand in more depth their epistemic practices and hence their epistemic cognition in a computer-simulated problem-solving situation. Data collection was undertaken by video and screen recordings from the computer simulation and audio recordings from a recall interview. Narratives for each of the three students were constructed based on their SEB, behavioral responses to the simulation and answers in the interview.

A problem-solving situation that included problems that could be solved in different ways, was the computer simulation software, Algodoo (Gregorcic and Bodin, 2017). The task was to bring a plain seesaw into balance in at least four different ways. The starting scene included a number of different objects with varying sizes and shapes. The students could easily adjust properties of objects, such as mass, shape, material, coefficient of friction. Their solutions were saved on the computer when equilibrium was reached.

Observations of the screen and video recordings focused on the students' behavior and actions as these occurred and were triangulated with stimulated recall interviews. Students were asked to justify their solutions and describe their experiences from the simulation. Data were transcribed and coded according to solution complexity, frequency of exploring properties and instruction reading, problem solving strategies, time devoted to each solution, proportion of unique solutions, and numbers of solutions. Combining all these data enabled us to determine what the narratives should include, which was problem solving strategies and understanding of the exercise, ability to judge own performance, and conceptual understanding. The students' behavioral response revealed different conceptual knowledge, which was evident in how they used concepts in explanations and also how they explored them in practice.

4. Results

Patterns of behavior for each student could be related to SEB as summarized in table 1. The observed actions constitute students' epistemic practices.

***Table 1:** Findings from the narratives: Students' epistemic practices*

Student/ Outcome	SEB	Actions		
		Problem-solving strategies	**Judgement of own performance**	**Conceptual understanding (from transcript and observation)**
Nelly 12 solutions, 1 type. Median complexity level 1.	Naïve. Quick learning. Certainty.	Consistent. Non-logical. Trial and error.	Confident. Motivated. Proud of attempts.	Limited knowledge of concepts, including equilibrium.
Julian 6 solutions, 3 types. Median complexity level 2.	Mixed naïve and sophisticated. Authority dependence. Effort leads to understanding.	Consistent. Follows instructions, logical. Uses pre-determined rules. Does not like complication.	Confident. Proud and satisfied with attempts, even though simplistic until challenged.	Good knowledge of concepts but does not transfer to problem-solving at first. Reflects productively.
Alex 7 solutions, 5 types. Median complexity level 7.	Sophisticated. Questions authority. Values creativity. Effort important.	Follows instructions. Decides on own rules to achieve different solutions.	Confident. Not difficult as long as draws on previous experience.	Actions indicate good understanding of concepts and task. Effectively interprets, applies and integrates principles.

5. Discussion and Conclusion

In this study we have examined how SEB and conceptual knowledge work together in a specific computer-based problem solving context in order to describe the process of students' epistemic cognition. Whilst observing three students with different SEB as they solve a problem using Algodoo, actions, in terms of strategies and expressions of conceptual understanding and judging of own performance, provide an indication of their conceptual knowledge and skills in the domain. For a student (Nelly) with naïve SEB and limited conceptual understanding of mechanical equilibrium, problem-solving is consistently trial and error leading to low-level solutions. For a student with good conceptual knowledge but mixed naïve and sophisticated SEB (Julian), higher level solutions are obtained only when encouragement to reflect on practice occurs, thus challenging his naïve SEB. A student with more sophisticated SEB and good conceptual knowledge (Alex) demonstrates more innovative approaches – his SEB allow him to devise his own set of rules to determine strategies that result in high level solutions. Thus epistemic cognition, the process through which SEB, knowledge and skills work together in epistemic practice, determines problem-solving, which has implications for students' applying their knowledge in different contexts.

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37. FRA VISJON TIL KLASSEROM: HVA SLAGS STØTTE TRENGER LÆRERE FOR Å FREMME DYBDELÆRING I NATURFAG?

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Abstract

Deep learning is a new vision in Norwegian policy documents. Deep learning involves skills and competencies related to critical thinking, problem solving, communication, collaboration and self-regulation. However, many teachers lack necessary competencies to promote deep learning, including pedagogical strategies, understanding of science content and processes of science. In this paper, we focus on what teachers emphasize as their needs to develop such competencies. We report from a professional development (PD) course, *Science Keys*, where teachers were given time and space to discuss and reflect on experiences related to the course, including implementation of teaching material designed to promote deep learning. Over a three year period 56 courses were conducted all over Norway, reaching 1192 teachers. Results indicate that the material and the course combined provided structure and support that teachers found essential when teaching for deep learning. They especially valued discussions and exchanges of experiences with colleagues on implementation of course content. Our present results are based on teachers' observations and statements related to reflection sessions and course evaluation.

1. Bakgrunn og teori

Policydokumenter argumenterer for økt fokus på dybdelæring for å forberede barn og unge på kompleksiteten i moderne samfunn (Kunnskapsdepartementet, 2015, 2016; Ludvigsen et al., 2015; National Research Council, 2012). Dybdelæring handler om ferdigheter og kompetanser relatert til kritisk tenkning, problemløsning og selvregulering. Dybdelæring defineres ofte som en prosess der den lærende blir i stand til å overføre og anvende kunnskap i nye situasjoner (National Research Council, 2012). Dybdelæring inkluderer innholdskunnskap og prosedyrekunnskap; hva, hvordan og når man skal anvende kunnskapen til å finne svar på spørsmål og løse problemer.

Dybdelæring er viktig, men det er et gap mellom visjoner og klasseromspraksis. Naturfaglæreplanen er omfattende til tross for få timer, både i norsk og internasjonal sammenheng (Bergem, Kaarstein, & Nilsen, 2016). Undervisningen er ofte tradisjonell og dominert av lærebøker (Hodgson, Rønning, & Tomlinson, 2012) som dekker mange tema presentert som fakta (Nelson, 2006). Mange naturfaglærere på barnetrinnet mangler naturfagutdanning (Lagerstrøm & Moafi, 2014) og Norge ligger langt under OECD-gjennomsnittet på etterutdanning (Kaarstein, Nilsen, & Blömeke, 2016). Dersom lærere selv har erfaring og opplæring fra andre tradisjoner, eller mangler relevant naturfaglig kompetanse (Stadler & Jorde, 2012) blir det utfordrende å fremme dybdelæring.

Hvordan kan utfordringene møtes for at visjonen om dybdelæring skal realiseres i klasserommet? Vi utviklet etterutdanningskurset *Nøkler til naturfag* for å hjelpe lærere å fremme dybdelæring. Det finnes mange forslag til vellykket etterutdanning for lærere, hovedsakelig fra forskernes synspunkter (f.eks. Capps, Crawford, & Constas, 2012; Stadler & Jorde, 2012). Vi lytter til lærernes stemmer. Målet er å bidra med evidens fra lærerne om hva som fungerer og hvilke støttebehov de har når de underviser for dybdelæring. Forskningsspørsmålene er:

- *Hva mener lærere fungerte bra og hva var utfordrende med Nøkler til naturfag, inkludert implementering av undervisningsmateriale?*
- *Hva mener lærere elevene lærte fra undervisning med dybdelæringsfokus?*

Kursdesign *Nøkler til naturfag*

Nøkler til naturfag ble designet i henhold til prinsipper om vellykket etterutdanning (Capps et al., 2012; Stadler & Jorde, 2012): Kurset bør adressere naturvitenskapelig innhold i form av fakta, begreper, naturvitenskapelige prosesser, utforskende arbeidsmåter og relevante undervisningsstrategier. Andre prinsipper er at lærerne skal jobbe utforskende, reflektere over erfaringer fra kurset, få tilgang til undervisningsmateriale som integrere utforskende arbeid og literacy og diskutere hvordan kursinnhold kan implementeres i eget klasserom.

Nøkler til naturfag besto av tre kursdager over ett semester, se figur 1, inkludert omfattende arbeid mellom kursdagene.

Figur 1: *Nøkler til naturfag med tre kursdager over et semester.*

Hver kursdag fokuserte på teori, utforskende arbeid og literacy. Målet var å modellere undervisningsstrategier, gi faglig påfyll i kjemi og nødvendig teoretiske bakgrunn for å integrere utforskende arbeid og literacy med egne elever. Lærerne skulle også erfare utforskende aktiviteter som elever, som forberedelse på gjennomføring i egen klasse. Kursdeltagerne vekslet mellom rollen som lærer, elev og student.

Lærerne implementerte undervisningsopplegget *Kjemiske endringer,* som er designet for å fremme dybdelæring og integrerer utforskende arbeidsmåter og literacy (Barber, 2009). *Kjemiske endringer* engasjerer elevene i utforskende arbeid, kritisk og logisk tenkning (Barber, 2009), i tråd med litteraturen om dybdelæring (National Research Council, 2012; Sawyer, 2006).

2. Metode

Nøkler til naturfag var et samarbeid mellom lærerutdanningsinstitusjoner i fem regioner. Gjennom tre år ble 56 kurs gjennomført over store deler av Norge, med til sammen 1192 lærere fra 5.-7.trinn. Mellom kursdagene implementerte lærerne 10 økter av *Kjemiske reaksjoner* i egen klasse og skrev refleksjonsnotater. Datamaterialet vårt består av refleksjonsnotater, kursevalueringer og observasjonsnotater fra erfaringsdelingene.

Datamaterialet ble transkribert og analysert kvalitativt. Vi benyttet Nvivo 11 til å kode og hente ut sitater. Vi benyttet åpen koding (Strauss & Corbin, 1990), der kodene i hovedsak ble generert induktivt, basert på respondentenes faktiske uttalelser. Kodingen ble guidet av forskningsspørsmålene og teoretiske perspektiver på dybdelæring og etterutdanning.

3. Analyser og funn

Vi identifiserte flere koder som beskriver praksiser koblet til dybdelæring, se tabell 1.

Tabell 1: Oversikt over resultater, organisert i henhold til forskningsspørsmålene.

1a. Hva fungerte bra?		**1b. Hva var utfordrende?**	**2. Hva lærte elevene?**
Struktur og støtte			
Undervisningsmaterialet	**Kurset**		
Trinnvis lærerveiledning med progresjon for naturfaglig innhold, begreper, utforskende arbeidsmåter og literacy Støtter lavtpresterende elever og minoritetsspråklige elever, utfordrer høytpresterende elever Elever opplever mestring og motivasjon når de jobber med samme tema over tid Undervisningsstrategier og klasseledelse, også overførbare til andre fag	Øve med veiledning fra naturfagdidaktikere og kjemikere Implementere undervisnings-materiale mellom kursdagene Utveksle og diskutere erfaringer og ideer med andre lærere	Tidkrevende Omfattende og detaljert lærerveiledning Tar tid å få eierskap til undervisnings-materialet.	Naturfaglige begreper Naturfaglig innhold Lesestrategier Å skrive instruksjoner Å formulere spørsmål Å lage hypoteser Å planlegge og gjennomføre eksperimenter Å delta i naturfaglige samtaler

Det første forskningsspørsmålet fokuserer på lærernes refleksjoner om hva som fungerte bra og hva som var utfordrende. Om det som fungerte bra, understreket lærerne faktorer assosiert med struktur og støtte, både angående undervisningsmaterialet og etterutdanningskurset. Tabell 1 oppsummerer kodene i en hovedkategori kalt "struktur og støtte". Her er eksempler på lærerutsagn som dannet grunnlag for koder knyttet til dette forskningsspørsmålet:
"Alle elevene, både høyt- og lavtpresterende deltar i diskusjonene ".
"Det var nyttig å diskutere både undervisningsopplegget og implementeringen med andre lærere på kurset".
"Jeg har blitt mer selvsikker som lærer når jeg gjør eksperimenter. Jeg synes ikke lenger det er skummelt med spørsmål fra elevene".

Angående utfordringer knyttet til dybdelæring, var lærerne enige om at det største problemet var å finne nok tid i en overfylt læreplan. Flere synes også det var vanskelig å få eierskap til materialet.

Vi spurte lærerne om elevenes læring, og de kom med en rekke eksempler på hva elevene hadde lært. *"I økt 6, skrev alle elevene, også de lavtpresterende, veldig gode instruksjonstekster".*

"*Bevis for læring….., vel, det må være måten de snakket på når de lagde nye hypoteser og gjennomførte eksperimenter som fikk meg til å innse hvor mye de hadde lært".*

4. Diskusjon

Resultatene indikerer at både undervisningsmaterialet og kurset bidro til å gi struktur og støtte når lærerne skulle undervise for dybdelæring. På kursdagene prøvde de ut undervisningsmateriale og fikk veiledning og støtte knyttet til praktisk arbeid, pedagogiske strategier og faglig innhold. Disse elementene anbefales for effektiv etterutdanning (Capps et al., 2012) og støtter forskning som viser at undervisningsmaterialet er viktig, men ikke nok for alle lærere (Fogleman, McNeill, & Krajcik, 2011). Lærerne verdsatte også diskusjoner og erfaringsutvekslinger med kolleger.

Den største utfordringen var at dybdelæring er tidkrevende.

Et flertall rapporterte omfattende bruk av naturfaglige begreper som evidens for elevenes læring. Elevene tilegnet seg begreper som gjorde dem i stand til å delta i faglige diskusjoner og reflektere over naturfaglig innhold og prosesser, hvilket i følge Sawyer (2006) er sentrale trekk ved dybdelæring.

Vi konkluderer at mange er i ferd med å endre undervisningspraksis som en følge av kurset. Resultatene er basert på læreres observasjoner og utsagn. For å utvide vår forståelse av hva som skjer i klasserommet, er vi i gang med en videostudie hvor vi observerer implementeringsprosessen direkte.

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38. FINNISH MENTOR PHYSICS TEACHERS' IDEAS OF A GOOD PHYSICS TEACHER

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Abstract
In the Finnish subject teacher training, the majority of teaching practice happens at university teacher training schools guided by mentor teachers. In this study, Finnish mentor physics teachers' conceptions of a good physics teacher were examined by interviewing three teachers with long teaching careers. All the teachers thought that subject matter knowledge and skills of practical work are necessary for a physics good teacher. The mentor teachers especially stressed the importance of subject matter knowledge as the basis for the ability to make connections between school physics and students' everyday lives in an interesting manner. The mentor teachers also emphasised the importance of physics teacher's abilities to implement student-centred teaching approaches. The ideas of mentor physics teachers resemble the idea of a modern, learner-centred teacher that understands the importance of student interest, engagement, and motivation in the learning. The ideas of mentor physics teachers seem to offer a fruitful basis for the guidance of student teachers.

1 Introduction
Finnish teachers are highly educated. All the teachers from primary to secondary schools have a master degree. Subject teachers have wide studies in their major subject supplemented with minor subject studies at least in one subject. One important part of Finnish teacher training is a teaching practice. In subject teacher training, approximately 80 of teaching practise happens in teacher training school guided by mentor subject teachers who have mastered similar teacher training. The function of these teacher training schools is similar to medical hospitals: they are both an important component of professional training.

Teaching practise is one of the most important phases of teacher training. The mentor teachers' role is to guide and support student teachers, model and discuss good teaching, and help student teachers to combine theory and practise. Therefore, have the most powerful position to support student teachers in the process of becoming a teacher.

In this study, Finnish mentor physics teachers' ideas of a good physics teacher were examined. The mentor teachers have ideas and beliefs that have an effect on both their own teaching and on how they usher student teachers. Therefore, it is interesting to find out what kind of ideas and beliefs the mentor teachers possess on good teachers. We assume that a mentor teacher's ideas of a good teacher are some kind of ideal of a teacher towards s/he guides student teachers either implicitly or explicitly.

2 Theoretical framework
Teachers' knowledge has been examined to understand what kind of knowledge base makes a good teacher. It has been argued that the quality of a teacher's knowledge has a strong influence on how the teacher is able to link and use his/her knowledge both during the preparation of lessons and in teaching (Schoenfeld, 1992). Shulman (1986) introduced term Subject matter knowledge to describe the extent and organization of a teacher's subject matter knowledge. A teacher who teaches physics has to have an understanding of the structures of physics (e.g., phenomena, entities, concepts, laws) and the ways in which these structures are related to each other (Hewitt 2002). This is called conceptual understanding and it is necessary for a teacher to support students in learning physics.

Besides Subject matter knowledge, a teacher should also have general Pedagogical knowledge for effective teaching that includes knowledge of the general variables of instruction, like classroom management, pacing, and questioning strategies (Boz & Boz, 2008).

When a teacher's Subject matter knowledge and Pedagogical knowledge combine, Pedagogical content knowledge (PCK) develops. For instance, understanding how certain topics, problems, or issues are organized, represented, and tailored to the various interest and abilities of learners are types of PCK (Shulman, 1987, p. 8). Acknowledging students' preconceptions and models form one part of present-day physics teaching (McDermott, 2001). In order to support students' learning processes, a teacher has to have knowledge of the same range of common conceptions and reasoning models as the students have.

One special way to transform subject knowledge for teaching and construct students' conceptual understanding in natural sciences is practical work that plays an important role in physics learning in Finnish schools (Reinikainen, 2004). By using practical work, a teacher can arouse students' interest, allow their active engagement, and support them in constructing meaningful knowledge of physics. Finnish physics teacher education programs do have special courses aimed at preparing future physics teachers to use practical work efficiently in their work.

3 Research methods

Interviews of three mentor teachers from three Finnish teaching training schools form the data of the study. Their teaching experience was over 25 on average and they had mentoring experience of over 20 years on average. The teachers taught all grade levels at teacher training school that include both lower and upper secondary grades (students aged 13-18). Two of the teachers were male and one female.

The teachers were interviewed individually at their schools. The interview was designed to find out teachers' conceptions of teacher knowledge of a good physics teacher and of a certain physics teacher education framework (Authors, 2010). The interview section used in this particular study took approximately 15 minutes and it was audiotaped. For the analysis, the audiotaped interviews were transcribed and it was sought phrases that describe the know-how of a good physics teacher or good physics teaching (Mayring, 2014). The main author preformed the categorisation and the authors discussed unclear or conflicting conclusions until a consensus was reached.

4 Results

The interviewed mentor teachers shared some similar ideas about a good physics teacher but they also expressed personal views of what it is needed to be a good physics teacher. They all thought that subject matter knowledge is necessary for a physics good teacher. The mentor teachers stressed the importance of subject matter knowledge in teacher's profession as the basis for an ability to make connections between school physics and students' everyday lives in an interesting manner. In addition, all the teachers emphasised the skills of practical work needed in teaching physics that is a corner stone of physics teaching at school and one way to activate student learning.

The teachers also discussed the differences of being a lower secondary or upper secondary physics teacher. One of the teachers mentioned that upper school teachers must have better subject matter knowledge than the lower secondary teachers. Other teacher thought that upper secondary teaching is more challenging because a teacher has to do more work to make sure students understand the taught topics. The third teacher saw that the ability to teach mathematics needed in physics is essential for an upper secondary school physics teacher because students need to have certain mathematical skills to understand physics.

Other aspects of a good physics teacher that the mentor teachers mentioned were being as a role model of an adult, having good negotiation skills, and possessing general skills related to keeping classes in check.

5 Discussion and conclusion

The results show that the interviewed Finnish mentor teachers share similar basic ideas about good physics teachers but they also have individual differences. From the viewpoint of teacher training, it is richness that the teachers also emphasise different, personal ideas in addition to the similar ones. When a student teacher cooperates with several mentor teachers, as it is typical for the Finnish student teaching practice, s/he forms a versatile view on what is needed to become a good physics teacher.

The mentor teachers stressed the importance of subject matter knowledge in teacher's profession as the basis for the ability to make connections between school physics and students' everyday lives in an interesting way. This kind of knowledge can be identified as a process of transforming subject matter knowledge for teaching (Shulman, 1987).
Deng (2007) calls this kind of subject matter knowledge as a classroom meaning of subject matter knowledge. We claim that the wide physics studies and good knowledge on teaching materials, curricula, and students are needed to enable effective transformation processes of knowledge in physics teaching.

The mentor teachers did not consider good physics teachers only as physics experts but also emphasised the importance of physics teacher's abilities to use student-centred teaching approaches.

These ideas of mentor teachers resemble the idea of a modern, learner-centred teacher that understands the importance of student interest, engagement, and motivation in the learning (Singh, Granville, & Dika, 2002). It seems that the interviewed Finnish mentor teachers are excellent mentors and role models for future physics teachers.

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39. SNAPPING STORIES IN SCIENCE - LOKALE HVERDAGSKULTURER OG SOSIALE MEDIER SOM INNGANG TIL NATURFAG OG BÆREKRAFTIG UTVIKLING

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Abstract
This study is part of the LOCUMS-project that intends to investigate whether students' cultural backgrounds can situate and contextualize their learning in Science and Mathematics, thus enhancing achievement, motivation and engagement. Students were requested to use Snapchat and MyStory, as a cultural artefact, in order to investigate their own consumer habits and link them to sustainable development. In this way knowledge in science and sustainable development was situated in the students own experiences, and they were encouraged to be experts in their own learning process. Students expressed that it was fun and creative to use their cell phones in this way in science, but also mentioned that it could be distracting. They indicated that it was demanding to link their everyday life to knowledge in science. The teachers conveyed that the learning activity was engaging but challenging.

1 Introduksjon
I denne studien undersøker vi hvordan praktiske aktiviteter basert på elevenes livserfaringer og kulturelle bakgrunn kan brukes som utgangspunkt for å utvikle engasjement og forståelse for bærekraftig utvikling i naturfag. Ved å la elevene jobbe utforskende med velkjent hverdagsteknologi (mobiltelefon og MyStory på Snapchat) som er knyttet til moderne ungdomskultur, får elevene en nærere tilhørighet og eierskap til den kunnskapen de skal tilegne seg. Målet er at de skal oppleve en forbindelse mellom sitt eget liv, framtida og det som gjøres i naturfagundervisningen på skolen. Ved å bygge på unge menneskers kulturelle tilhørighet håper vi at elever opplever bedre engasjement og læring i naturfag.

Studien er knyttet til NFR-prosjektet LOCUMS[2] (Local Cultures for Understanding Mathematics and Science). LOCUMS ønsker å videreutvikle konseptet med kulturtilpasset undervisning ved å knytte aktiviteter i naturfag til elevenes nærmiljø. Dette er relevant for elever med ulik kulturell bakgrunn, det være seg urbefolkning eller ulike kulturer som har kommet til etterhvert. Alle elevaktivitetene starter med en lokal gjenstand eller aktivitet, og gjennom dette blir elevene utfordret til også å arbeide med skolefaglige begreper og forklaringsmodeller. Et elevprosjekt kan typisk vare i en uke og være tilknyttet natur og naturressurser, og gjerne lokale levemåter. Forskningen er lokalisert i Finnmark, Trøndelag og i det sentrale østlandsområdet.

Denne studien består av fire delstudier (masteroppgaver) med felles utgangspunkt og overbyggende problemstilling. Et felles undervisningsopplegg koblet til LOCUMS' prinsipper, er utviklet og prøvd ut på to skoler i ulike deler av landet. Felles problemstilling er
å samle inn data fra disse to casene og studere hvordan involvering av lokalkunnskap og elevenes hverdagskultur kan engasjere og legge til rette for forståelse av naturfag og bærekraftig utvikling. Dette gjøres gjennom fire delspørsmål: i) Hvordan opplevde elevene at det å bruke mobiltelefoner og Snapchat i undervisninga responderte med deres hverdagskultur? ii) Hvordan kan bruken av elevers hverdagskultur i undervisning for bærekraftig utvikling bidra til å økt handlingskompetanse blant elever i naturfag? iii) Hvordan bidrar bruk av MyStory på Snapchat til å utfordre elevenes engasjement og læring i naturfag? iv) Hvordan opplever læreren bruken av elevenes digitale hverdagskultur (som Snapchat) som et læringsverktøy i naturfag?

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[2] https://www.ntnu.edu/locums

2 Teoretisk rammeverk

Gay (2000) definerer kulturtilpasset undervisning (culturally responsive teaching) som å bruke kulturell kunnskap, tidligere opplevelser og ferdigheter fra et mangfold av elever for å gjøre læring mer tilpasset og effektiv. På denne måten gjør undervisningen bruk av og profitterer på elevenes styrker. Kulturelt tilpasset undervisning er basert på formodningen av at når akademiske kunnskaper og ferdigheter situeres i levde erfaringer og brukes som referanseramme for elever, er de mer personlig meningsfulle, interessante og forstås lettere og dypere (Gay, 2000).

Gjennom den teknologiske utviklinga er både voksne og unge del av en voksende digital kultur. De unge blir ofte omtalt som digitale innfødte, mens de eldre blir omtalt som innvandrere i den digitale kulturen (Erstad 2013). Til tross for det bilde media har skapt av de unge, og tilgangen på internett og teknologi, er det faktisk ikke slik at alle unge er kompetente eller interesserte i digitale medier og ny teknologi. Studier viser at mange av dem ikke er gjennomtenkte eller reflekterte brukere (Erstad 2013). Sosiale medier kan fungere som en forbindelse mellom kjent kunnskap og ny kunnskap. Dette kan være viktig for hvordan elever opplever seg selv som lærende i undervisningen (Vasbø, Silseth, & Erstad, 2014). Selv om statistikken viser oss at digitale medier og teknologi er en stor del av norsk ungdoms hverdag, må skolen aktivt tilpasse seg denne endringen i samfunnet for at elever skal kunne utnytte den nye teknologien i læringsarbeidet.

Naturvitenskap har også blitt omtalt som en egen kultur med et verdenssyn som sammenfaller med den vestlige verdens kultur (Cobern, 1996). Noen elever kan oppleve en avstand mellom sin egen kulturelle identitet og skolens, spesielt i naturfag. Da kan det oppstå hindringer for elevers engasjement hvis dette ikke tas hensyn til i undervisningen (Aikenhead, 1996; 2001).

3 Metoder

For å skape en kobling mellom elevenes egne erfaringer og skolekunnskapen brukte vi et sosialt medium elevene er kjent med; Snapchat. Mer presist tok vi utgangspunkt i en funksjon i dette sosiale mediet; MyStory. MyStory er en funksjon som lar brukerne legge ut klipp, som blir satt sammen til en sammenhengende multimedia-representasjon. Dette åpnet opp for muligheten til at elevene kunne kartlegge egen hverdag, og ble koblet opp mot kompetansemålet; *kartlegge egne forbruksvalg og argumentere faglig og etisk for egne forbruksvalg som kan bidra til bærekraftig forbruksmønster* (Udir, 2013). Opplegget ble utarbeidet i samarbeid med lærere. Elevene skulle utforske og dokumentere egne forbruksvalg. Dette skulle resultere i to elevprodukter; en film og en tekst som inneholdt forhåndsbestemte begreper knyttet til temaet. Elevene arbeidet i grupper og brukte mobiltelefonene sine til å lage filmen med applikasjonen Snapchat, der sluttproduktet lagres som en MyStory[3] (se figur 1). Elevene brukte fem timer på opplegget inkludert presentasjon og diskusjon i plenum. Dette ble gjennomført i to førsteklasser på videregående skole; en i Finnmark og en på Østlandet. Begge klassene var flerkulturelle. Finnmarksklassen hadde elever med samisk bakgrunn. Etter gjennomføringen av undervisningsopplegget ble utvalgte grupper av elever intervjuet i gruppe. Begge lærerne ble også intervjuet.

Datamaterialet består av fokusgruppe intervjuer, lærerintervjuer, videoopptak av undervisningsøkter, og elevprodukter (MyStory-filmer med tilhørende tekst hvor elevene beskriver budskapet i filmen og argumenterer faglig for eget forbruk). Elevenes MyStories ble brukt som utgangspunkt for intervjuene. Hver delstudie har analysert egnede deler av datamaterialet, fortrinnsvis intervjuene, for å besvare de ulike forskningsspørsmålene. Det er brukt tematisk analyse (Braun & Clarke, 2006).

4 Resulter

Elevproduktene (film og tekst) vitner om bruk av kreativitet og engasjement for oppgaven både i forhold til fag og digitale ferdigheter. Filmene inneholdt ulike aspekter av elevenes hverdag knyttet til forbruk

[3] MyStory består av 10sekunders filmsnutter som blir satt sammen til en film på 2-3 minutter. De er vanligvis tilgjengelig på Snap i 24 timer.

felles for elever på videregående skole, som bruk av strøm til elektroniske «dippedutter», kildesortering på skolen, kosthold og mote. Enkelte grupper laget filmer som også viste forbruksvaner knyttet mer til sitt lokale miljø, som transportmidler (hhv. snøscooter i nord og t-bane i sør), trafikk og matvaner. Filmene brukte en del artistiske virkemidler som musikk, tekst og emojier for å understreke poeng, men de faglige poengene var mest knyttet til tekstene elevene la fram i tillegg til filmene. Plenumsdiskusjonen ble veldig forskjellig i de ulike klassene, siden lærerne oppsummerte læringsaktiviteten på ulik måte.

Elevene var stort sett godt kjent med Snapchat og MyStory som sosialt medium, men ikke i skolesammenheng. De fleste av elevene brukte Snapchat i mye større grad enn antatt. MyStory var en funksjon alle kjente til men den var mindre brukt enn chatte-funksjonen. Elevene løste teknologiske utfordringer ved enten å prøve å feile eller ved å spørre andre elever. De ville ikke ha hjelp av lærer, for her var de selv eksperter. Elevene uttrykte både positive og negative sider ved å bruke mobiltelefonen i undervisningen. Det var gøy, kreativt og spennende, men det kunne også virke distraherende med mobilbruk i timene.

Selv om oppgaven handlet om elevers egne forbruksvaner, brukte de lite tid på oppgaven utenom skoletiden og flere grupper brukte bare skolen som filmingsarena. Elevene syntes det var utfordrende å koble deres eget hverdagsforbruk med det faglige. Noen uttrykte allikevel at de fikk noen overraskelser av sitt eget forbruk, og erklærte at de ønsket å leve mer bærekraftige. Lærerne uttalte at arbeidsformen var utfordrende siden de mistet en del kontroll, men at temaet passet som en utforskning utført av elevene ved bruk av sosiale medier. De ville gjerne bruke arbeidsformen mer.

5 Diskusjon og konklusjon

MyStorys natur, med små filmsnutter (10 sek), viste seg å være velegnet til å utforske en så sammensatt og kompleks problemstilling som unges forbruksvaner. Bruk av mobil og MyStory som kulturelle artefakter knyttet til ungdomskulturen, inviterte også til bruk av lokal kulturell kontekst for å undersøke temaet og koble det til ungdommenes egne levde liv. Kunnskapstilegnelsen ble kulturelt tilpasset (Gay, 2000), den engasjerte elevene på en personlig måte og de ble eksperter i deler av læringsaktiviteten (Vasbø, Silseth, & Erstad, 2014). Den akademiske kunnskapen ble situert i ungdommenes egne erfaringer, men de faglige koblingene ble allikevel i stor grad styrket under veiledning av læreren.

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40. CHANGES IN PRESERVICE TEACHERS' KNOWLEDGES. A CASE STUDY FROM THE NEW TEACHER EDUCATION PROGRAM AT UiT – THE ARCTIC UNIVERSITY OF NORWAY

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Abstract
From 2017 the primary and lower secondary teacher education will be a master education in Norway. UiT - The Arctic University of Norway started a master education already in 2010. The main differences between the former and new program are: increased credits in both pedagogy and the master subject, more emphasize on pedagogical content knowledge (PCK) and early focus on the master subject. In this case study, teacher mentors evaluate students' knowledges in their school practice. All mentors with experience from both programs stated that the master students had increased knowledge in both science matter knowledge and PCK. These changes in preservice teacher knowledges can possibly be explained by changes in the master program. Our results show that early emphasize on and more credits in the master subject and increased focus on PCK in science courses, seem to be important features in the development of the preservice teachers professional knowledge.

1 Introduction
OECD (2005) concludes that the teacher is highly important for pupils achievement in school. Especially the teachers' subject matter knowledge has shown to be vital (Gustafsson, 2003; McKenzie et al., 2005; Monk, 1994). There are also some studies that show a positive correlation between teachers' pedagogical content knowledge and pupils' achievement gain (Baumert et al., 2010). In a review by Wilson, Floden, & Ferrini-Mundy (2001) there are some results which suggest that the teachers general pedagogy knowledges influences the pupils learning outcome.

From 2017 the Norwegian teacher education in primary and lower secondary school will be a five-year master education. UiT - The Arctic University of Norway (UiT) started a master education already in 2010. This was a national pilot. In this new master education, it was highlighted four point where the new education differed from the former one (Norwegian: allmennlærerutdanningen (ALU-education)) (UiT, 2009):

- A teacher education which provides better totality and coherence between subject, subject didactics and school practice
- An extended and more R&D oriented school practice
- An teacher education divided into different school-levels (grade 1-7 and 5-10) that ensure better subject knowledge
- Increased emphasis on R&D knowledge to stimulate teachers to develop the Norwegian schools in a scientific tradition

In the 4-year ALU-education the students could at a maximum get 60 ects in science and 30 ects in general pedagogy. In the new master program for grade 5-10 the students get 120 ects in their master subject and 70 ects in general pedagogy. Thus, these two subjects have increased considerably in the new program. In addition, the emphasize on PCK in the science courses has increased considerably.

In the project “New master education in science – improved teacher competences?“ we have followed the first preservice teachers in science during their master education. In this study, teacher mentors evaluate master students’ knowledges and progress in school practice. Data from the students have also been included to answer our research question: How can a teacher education be designed in order to get science teachers with high professional knowledges?

2 Theoretical framework

PCK-models are considered to be useful tools to understand the teachers’ professional practices. Kind (2009) points out that Magnusson, Krajcik, & Borko’s (1999) PCK-model is useful as a theoretical background for training novice science teachers becoming effective teachers. In this study we use the Magnussen et. al.’s (1999) model to evaluate the knowledges of preservice science teachers. The model has four general areas of teacher knowledges: Subject matter knowledge, pedagogical content knowledge and general pedagogical knowledge and knowledge of context (Figure 1). The PCK area is then divided into five components: Orientations to teaching science, knowledge of science curricula, knowledge of assessment of scientific literacy, knowledge of instructional strategies and knowledge of students’ understanding of science (Figure 2).

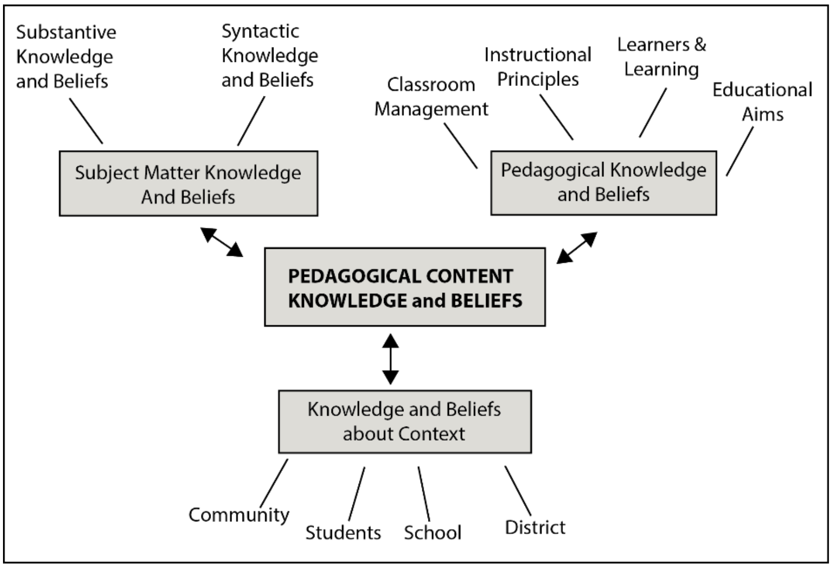


Figure 1

A model of the relationship of the domain of teacher knowledge. The figure is copied from Magnusson et. al. (1999).

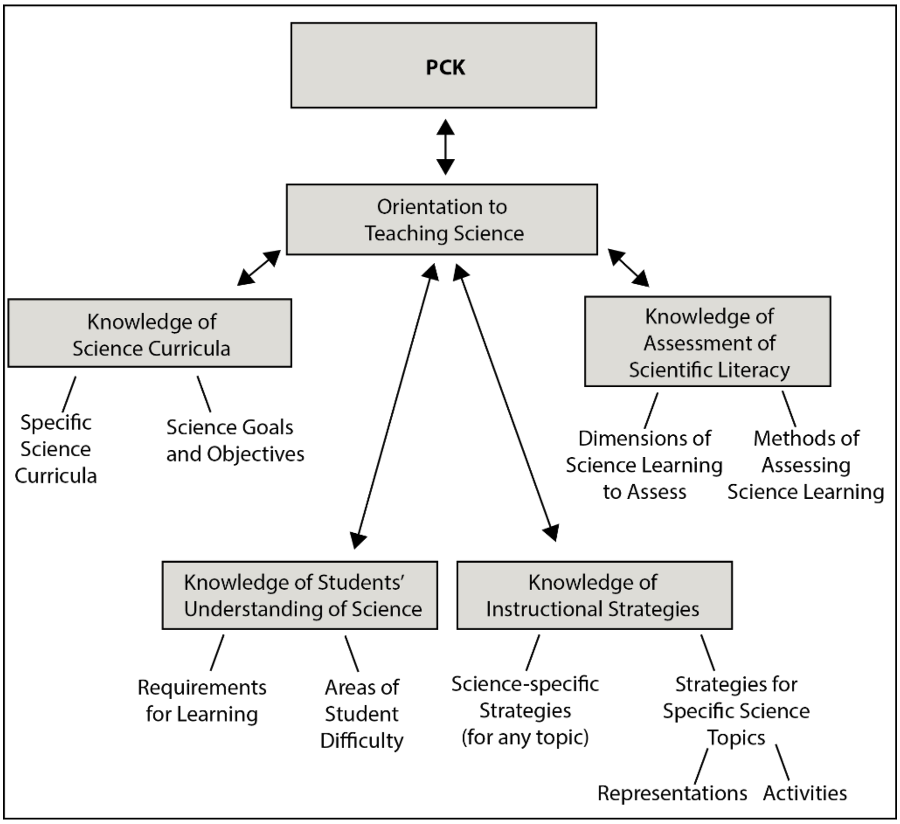


Figure 2

The components of PCK for science teaching. The figure is copied from Magnusson et. al. (1999).

3 Research methods

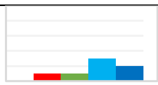
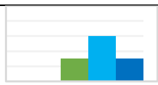
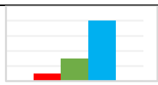
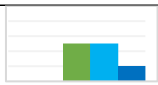
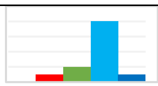
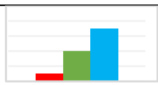
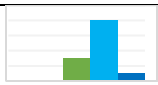
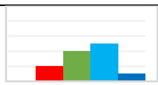
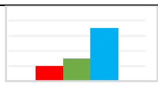
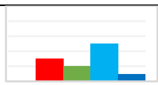
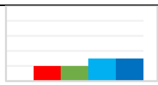
In this study, mentors answered a questionnaire and were interviewed about their students' knowledges in general pedagogy, SMK and PCK during their school practice. Altogether, there were done nine interviews over two years, which comprised twelve school practice periods and nine master students. The students were in their three first years of their study. All of the teachers were experienced teachers and six of them had mentored students in both programs. Magnusson et. al.'s (1999) PCK-model was used as a basis for development of the questionnaire and interview guide. The interviews, which were semi-structured, were taped and transcribed. The questionnaires were analyzed by descriptive statistics and the interviews were analyzed using a theme based analytical approach (Thagaard, 2013).

4 Results

Our results are based on the mentors' evaluation of the students in their school practice. The mentors describes that the students had a relative high SMK in science, especially in topics they have worked with in the science courses. The mentors experienced discussions with the master students at a higher academic level compared to the ALU-students. Here is a quotation that illustrates this: "*The general academic level in science and math has increased. That is one of the things that have pleased me most in the new education.*" All mentors with experience from both programs find that the master students have increased knowledge in SMK compared to the ALU-students.

The mentors evaluated the master students PCK both in the interview and in a questionnaire. In Table 1 the result from the questionnaire are shown. On average, they find that the master students PCK was good. They reported an improvement in use of different teaching methods and use of active learning methods. Most mentors pointed out that the students had knowledge about open-ended inquiry based experiments and they were not so dependent of the textbook. One teacher said: "*They want to distance themselves from traditional science teaching and want to do more experiments. They are more focused on open-ended inquiry based experiments. They don't want to just follow the textbook and do cookbook experiments. I can see that they have got impulses which they bring into school practice*". All the mentors with experience from both educations pointed out that that the master students had higher knowledges in PCK compared to the ALU-students.

Table 1: *Overview of the mentors evaluation of the students' pedagogical content knowledge. The diagram shows the distribution of answer. The horizontal lines in the diagram correspond to two answers.*

	Question How do you evaluate the student when it comes to…	**Fordeling** 
1	integrating inquiry based methods (forskerspiremetodikk) in the lessons?[1]	
2	using active learning methods (experiments, practical activities, etc)?	
3	repertoire of teaching methods?	
4	communicating science content?	
5	presenting learning goals at the start of lessons?	
6	summarizing the lesson according to the learning goals?	
7	informing the pupils about their school work in a clear and concise manner?	
8	adapting the teaching to the pupils different abilities and needs?	
9	giving the pupils challenges in science?	
10	relating science to the society and to the everyday life of pupils?[1]	
11	do formative assessment (homework, talks, presentations, etc)?[1]	

[1] One or more mentors answered «*don't now*»

In general pedagogy, the master students were evaluated as natural and reflective classroom leaders. The mentors gave the master students particularly good evaluation when it came to making good relations with the pupils. One quote describing this was: "*He took care of the weaker students and gave them attention. It has been good relations*". The master students were also confident and showed responsibility for the students. In the area of classroom management, the mentors with experience from both programs don't experience any differences between the master- and ALU-students.

5 Discussion and conclusion

All mentors in the study with experience from both teacher education programs, find that the master students have increased knowledge in both SMK and PCK. These changes in preservice teacher knowledges can possibly be explained by changes in the education program. In the new master program the extent of the master subject is increased considerably and there has been an increased emphasizes on PCK in the science courses. In the master program, the students get 40 ects in their master subject (science) already in their first year. This is a distinct different from the ALU-education where the students only could choose this subject in their third or fourth year. The change make it possible for the master students to practice science teaching during the entire education and to make the school practice more relevant for the students. This could be a contribution to link theory and practice together, which is considered as a key element in the professional development of teachers.

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41. BUILDING SCIENCE TEACHER IDENTITY FOR GRADES 8-13 AT THE UNIVERSITY OF OSLO

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Abstract

An integrated science teacher education program at the University of Oslo for grades 8-13 is the object of this paper. The actors in the program include teacher education students, academic staff at two faculties (Faculty of Mathematics and Natural Science (MN) and Faculty of Education), and practicing teachers in schools. In a period of five years, students are introduced to subject, subject didactics, pedagogy and practice. We argue that it should not just be up to students to integrate these different knowledge domains. Rather, by using data from student questionnaires and interviews, we are learning more about how to communicate across knowledge domains so that the science student teacher identity is in focus. The model for integrated teacher education needs to be in constant change with revisions that meets the needs of our students and contributes to building their identity as professional science teachers.

1 Introduction

There are several models for science teacher education in Norway qualifying for teaching at grades 8-13. Most students complete a disciplinary master degree (5 years) before building on a one year pedagogical education (PPU). The University of Oslo (UiO) started a pilot integrated teacher education program in 2003 and in 2013 Norway introduced a national model for integrated teacher education in which students combine their academic and professional studies into a 5 year lector/master degree: (https://www.regjeringen.no/globalassets/upload/kd/vedlegg/rammeplanen/lektorutdanning.pdf). The model specifies that students be introduced to academic subjects, pedagogy and subject didactics in addition to school practice during 4 of the 5 years. Students should experience an education that is close to the practice field (schools), and which is research based. The University of Oslo initiated the integrated Lector program in the fall of 2014. ILS (Department of Teacher Education and School Research) is responsibility for the program, working jointly with four academic faculties (Faculties of Math and Science, Humanities, Social Science and Theology). In this paper we describe the cooperation between ILS and the Faculty of Math and Science (MN). We look at how the actors in the program are cooperating so that students see coherence in the integrated model where several knowledge domains are a part of their education.

2 Theoretical framework

In the new integrated program for teacher education 8-13, students are asked to develop their science teacher identity in multiple knowledge domains. Integrating subject matter courses into pedagogy, subject didactics and school practice is a complex process for students where even research methods vary. Understanding how students assimilate these multiple domains into their “teacher professional identity” is essential if we are to provide a quality driven integrated teacher education program (Beauchamp, 2009; Ellis, 2015; Ringdal, 2015; Lund, 2016; Luehmann, 2007) rather than one that is fragmented.

At UiO, the integrated science teacher education program integrates subject knowledge (Physics, Chemistry, Biology, Geology and Mathematics) together with knowledge about pedagogy, knowledge about subject didactics and knowledge about schools (practice). Identity development is constantly being formed during these five years, with emphasis and experience changing from semester to semester. Students seem to juggle their different identities throughout this process and in many cases, may even loose site of their desire to become a science teacher, thus resulting in “drop-out” if they move to pure academic studies. Acknowledging that communities of practice in pure science are different from communities of practice in schools (and in teacher education) requires that students be given opportunities to work with these multiple identities (Avraamidou, 2016) . When is the student a Biologist? When is the student a teacher? When does the student become a Biology teacher?

3 Research methods

Since implementing the new 5 year teacher education program at the University of Oslo in 2014, we have been following students through their studies in efforts to understand development towards becoming professional science teachers. Through interviews and questionnaires related to the university quality evaluation system, we have identified challenges for students related to the courses they take at MN as well as those taken at ILS (for example:formative evaluation of the Lector program 2014/2015; lektorprogrammets programutvalg report; statistical reports, etc).

4 Results

The following are representative examples of results:

Results from student register data indicated that not all students starting in the science lector program were completing the program. Early on, when students were taking their subject courses, they redefined their course of study into pure academic science areas. We started calling this “drop-out” from the lector program.

Math and science students indicated in interviews that they struggled with the different knowledge domains. Whereas science courses are of a hierarchical nature leading to increasing abstraction, courses in didactics and pedagogy are more related to a social science approach to knowledge. When taking science courses, students were thinking more like “scientists”. When moving into pedagogy and didactics, students were thinking more like “science teachers” or even feeling alienated from the coursework.

Results from student questionnaires indicated that science lector students wanted earlier contact with the practice arena (schools), and considered this an important and necessary component of their professional development as a science teacher. The same students also voiced the need to have a subject identity early on in the program.

Math and science students indicated in interviews that they were not given the opportunity during the lector program to learn the appropriate data competencies (and programs) used in the schools. For math teachers this would include CAS-tools, GeoGebra, etc.; for science teachers, data logging, use of apps, etc.

Students meant that they needed more time during their studies to reflect on how the components of the teacher education are integrated into their professional identity (subject, pedagogy, didactics, and practice).

5 Implemented changes

The integrated teacher education program is constantly under evaluation and change as we redefine the actors who are teacher educators (including subject faculty, ILS faculty and teachers in schools). Perhaps the greatest change at UiO has been both MN and ILS acknowledging that they need close cooperation in order to educate tomorrow’s science teachers, leading to the creation of a full time position at MN to coordinate the lector program. In listening to the student voice, we (the actors) acknowledge the need to be sensitive to how the different knowledge domains are presented and integrated into student thinking and identity trajectories.

To address student drop-out from the science lector program, the Faculty of Math and Science has implemented a number of projects to strengthen the professional identity of science and math teachers through improving their learning environments as well as working with ideas of student active learning.

- Creation of a learning environment specifically designated for lector students at the library for math and science.
- Introductory two day seminar for lector students by MN in which students form a science/math lector network and meet faculty from Mat/Nat and ILS.
- Creation of group seminars specifically for lector students taking science courses (FYS1000, MAT1100, KJM1100, MBV1010 and BIO1000), including pilot projects for learning about more student active methods. Seminars are run by senior lector students.
- Involving lector students in the ReleQuant project (Learning and conceptual development in relativity and quantum physics) serving as research assistants participating in classroom observations, video transcribing and workshops.

To address similar issues from the perspective of ILS and teacher education, the following projects have been initiated:

- PROMO is a mentor program initiated to bridge the gap between “campus” and “school” learning environments. Teachers from schools lead seminar groups for lector students throughout the five year study where connections are made between academic subjects and schools subjects and where students meet and discuss their professional identity with practicing teachers. PROMO is established from the first semester.
- In an earlier model, ILS had a 15 point course introduction to lector students in the first semester of their study. This has now been moved to the third semester as a result of students expressing the need to have a solid subject anchoring in the first years.
- ILS has initiated digital learning modules (SPOC) for students.
- The University partnership program involving 20 schools has allowed us to work more closely with the link between research and schools so that math and science students may be actively involved in school based research practices.

6 Discussion and Conclusion

Creating the best possible integrated lector program for science students is the aim of UiO. Who are the teacher educators? We all are: academic faculty, ILS faculty and practicing teachers. Together we strive to create a coherent program meeting the needs of tomorrow’s science teachers. Listening to the voice of lector students has helped us shape the program to meet their challenges in in building their identity as professional science teachers. It has been important for the Faculty of Mathematics and Natural Sciences to recognize the importance of educating science teachers, thereby implementing projects to support students in their professional development. It has been important for ILS to understand the differences students experience between academic and professional subjects. Forming a professional identity in which studies in science lead to becoming a science teacher is a complex process and one which needs our full attention.

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43. GRUBLETEGNINGER SOM VERKTØY FOR Å SKAPE ØKT NATURFAGLIG FORSTÅELSE FOR ELEVER OG LÆRERSTUDENTER

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Abstract

The purpose of this research is to investigate Concept Cartoons as a method in natural science in teacher education and to find out more about how Concept Cartoons influence and support the learning of the subject. In recent years, it has become clearer that systematically facilitating discussions of the topic increases students' understanding and learning. In this study we examined how 45 teacher training students experience the use of Concept Cartoons in natural science in developing their own didactic skills. Research methods are qualitative, involving interviews, students' written work and a survey to pupils taught by the students. Results show that students' reflections increased and argumentation became richer after their own testing of Concept Cartoons in classroom. In particular, it became clear that terminology in their study of literature was subjected to analysis and used in self-reflection and reasoning.

Innledning

Faget naturfag har lang tradisjon for læring bl.a. gjennom praktisk erfaring i laboratorium og feltarbeid. De senere årene har det blitt tydeligere at ved systematisk tilrettelegging for faglige samtaler øker også elevenes læring og forståelse (Mercer & Dawes, 2008). Grubletegninger har vokst frem som et verktøy for å legge til rette for samtale og argumentasjon i grunnskolen. Imidlertid er det lite forskning som belyser hvordan grubletegninger kan bidra til å utvikle studenters kompetanse som naturfaglærere. Hensikten med studien er derfor å finne ut hvordan bruk av grubletegninger har innvirkning på læringsprosessene i naturfag på lærerutdanningen. Studentenes forståelse av grubletegninger og deres tilrettelegging for elevenes læring ga en mulighet til å dokumentere og diskutere hvordan studenter ser på grubletegninger som metode. I studien undersøker vi *hvordan lærerstudenter opplever bruken av grubletegninger i naturfag i utvikling av egen didaktisk kompetanse.*

Teoretisk grunnlag

Grubletegninger er enkle strektegninger som tar opp naturfaglige spørsmål fra dagliglivet (Naylor & Keogh, 2000). Gjennom tegningene synliggjøres ulike situasjoner og problematiseres ulike måter å se situasjonen på. I tillegg til å illustrere en faglig problemstilling, viser tegningene ulike løsningsforslag som kan virke meningsfulle for elevene. Ikke alle forslagene er faglig korrekte og grubletegninger fører dermed til at elevene må selv tenke og stimuleres til å utvikle ideene og forståelsen videre. Tegningene er ment å skape diskusjoner og stimulere til naturfaglig tenkning. Grubletegninger er derfor en tilnærming til undervisning og læring som vektlegger bruk av språket i læring naturfag (Keogh, 1999; Mork & Erlien, 2010). Utforskende samtaler som redskap i læringsarbeidet (Mercer & Dawes, 2008; Mortimer & Scott, 2003; Munkeby, 2016) vektlegges ved bruk av grubletegninger i undervisningen. Tegninger representerer et annet språklig uttrykk enn skriftlig og muntlig kommunikasjon. Å supplere tradisjonelle kommunikasjonsformer med tegninger kan øke studentenes og elevenes forståelse av både fagbegrep og faglige sammenhenger (Madsen 2013).

Metode

Denne studien er gjennomført som en kvalitativ undersøkelse hvor data er hentet fra intervjuer, studenters skriftlige arbeider i studiet og en spørreundersøkelse til elever.

Datainnsamling: Empiriske data er samlet i faget naturfag, grunnskolelærerutdanning (GLU 5-10). Data er innsamlet over 2 år fra to kull i alt 45 studenter.

Grubletegninger ble brukt i undervisningsopplegg på lærerutdanningen. Deretter skrev studentene et refleksjonsnotat over deres egen opplevelse av denne læringsprosessen (notat 1). Studentene planla et undervisningsopplegg for elever i grunnskolen med bruk av grubletegninger og skrev et refleksjonsnotat (notat 2) med fokus på tegningene og deres nytteverdi i læringsprosessen både for elevene og seg selv. Studentene skrev også en praksisoppgave hvor de i sammenhengende tekst beskrev, begrunnet og reflekterte over bruken av grubletegninger i læringsprosesser.

Elevene i studentenes praksisklasser har vært gjennom undervisningsopplegg med bruk av grubletegninger og alle har avsluttet med en enkel spørreundersøkelse som setter fokus på elevenes opplevelse av engasjement, motivasjon og læring. Studentene analyserte svarene og dannet seg på bakgrunn av disse en forståelse som ble gjengitt i deres refleksjonsnotat.

Fem tilfeldig utvalgte studenter ble intervjuet om deres opplevelser av bruk av grubletegninger i naturfag i ungdomsskolen. Intervjuene er transkriberte før analyse.

Analyse: Notatene og praksisrapportene analyseres med elementer fra konstant komparativ metode hvor data kodes og kategoriseres (Postholm, 2010). Denne typen forskning genererer store mengder rådata som reduseres gjennom tolkning av innhold i kategoriene. Teori har ført til de to forhåndskategoriene a) grubletegninger som utgangspunkt for *faglige samtaler* og b) grubletegninger som utgangspunkt for *elevengasjement*. Under analysearbeidet kom også den empiridrevne kategorien c) grubletegninger som utgangspunkt for *variert undervisning* frem. Alle disse tre kategoriene har fokus på studentenes læring om didaktikken i naturfag

Resultater

Både studentene og elevene var overveiende positive til bruken av grubletegninger i undervisningen. Ord som gjentas i studentenes notat 2, er knyttet til positive erfaringer med å lykkes med å få ungdomsskoleelevene til å diskutere og reflektere, og at deres elever uttrykte økt nysgjerrighet etter å finne svar. På den andre siden uttrykker studentene seg negativt om at man ved bruk av grubletegninger risikerer at elevene misoppfatter og misforstår. Det hadde også i noen tilfeller oppstått frustrasjon og usikkerhet og noen elever ble passivisert og utålmodige i deres søken etter 'fasitsvar'.

Resultatene viser at engasjementet var stort både hos studenter og elever. Med utgangspunkt i kategoriene a) *grubletegninger som utgangspunkt for faglige samtaler* og b) *grubletegninger som utgangspunkt for engasjement*, fremgår det av analyser at også for studenter kan grubletegninger være et nyttig engasjerende utgangspunkt for faglige og eksplorerende samtaler. Samtalene letter overgangen fra hverdagslige samtaler til bruk av vitenskapelige begrep. Studentene opplevde i egen undervisning at elevene knyttet spørsmålet i tegningen til egne erfaringer og dagligdagse ting og at dette ga mening og engasjerte. De fleste av studentene hadde opplevd stort engasjement i klassene og hadde observert at også de elever som ellers snakket lite, samtalte og argumenterte rundt en tegning. De erfarte at samtalene tok utgangspunkt i elevenes egen tidligere forståelse og kunnskap. Respons på sin argumentasjon fra medelever var nok opplevd som mindre farlig når en sammenfallende påstand allerede stod på trykk. Engasjementet artet seg også i form av en iver blant elever for å finne argumenter, formulere og reformulere sin forståelse. Studentene så også at elevene ønsket å finne svar. Dette skapte behov for læring og det ble både viktig og en mulighet til å gi korrekte og utdypende faglig forklaringer. Studentene pekte videre på at elevene utviklet faglig relevante begrep i naturfagundervisningen bl.a. gjennom samtaler og diskusjoner hvor elevene utforsket og delte forståelse. Det må ytterligere noe analysearbeid til for å klargjøre om engasjementet er et kortsiktig resultat av å ta i bruk noe nytt, eller om metoden i seg selv påvirker deltakelse og engasjement.

Innenfor kategori c) *grubletegninger som utgangpunkt for variert undervisning*, omtalte studentene grubletegninger som et nyttig verktøy for å skape variasjon og læring i deres egen undervisning. Flere studenter trakk flere frem det visuelle og det semikonkrete som læreren kan knytte til både konkrete aktiviteter og til relevant faglig teori. Metoden fremsto dermed med mange muligheter for praktiske og teoretiske variasjoner hvor elever kan reflektere systematisk på et høyt faglig nivå. Det så ut til at denne metoden gjorde det lettere for studentene å legge til rette for variert undervisning også innen naturfagstema som ikke kan knyttes til laboratorie- og feltarbeid. Det kom også tydelig frem at de ser på metoden som egnet både som en introduksjon for å sjekke elevenes forkunnskaper og som avslutning for å vurdere elevenes læring. Det var stor enighet i at metoden bør brukes gruppevis.

Diskusjon og konklusjon

I henhold til Mercer &Dawes (2008) øker elever som går inn i læringsprosessene i samarbeid med klassekamerater forståelsen fordi gjensidig, verbal respons og tilbakemeldinger er kjennetegn ved samarbeid. Studenters erfaring og tilbakemeldinger støttet opp om nettopp dette.

Man kan tenke seg at grubletegningene kan begrense de faglige diskusjonene, da grubletegninger presenterer bestemte, fast formulerte løsningsforslag. Man kunne da tro at nytteverdien av grubletegninger ikke er den samme for elever på et grunnleggende nivå som på for lærerstudenter på et videregående nivå. Studien viste likevel at studentenes refleksjoner ble flere og argumentasjonene ble rikere etter egenutprøving av grubletegninger i klasserommet. Særlig ble det tydelig at fagbegrepene i studielitteraturen ble gjort til gjenstand for analyse og benyttet i egen refleksjon og argumentasjon. Studentenes forståelse av dialogen betydning for elevengasjement økte og studentens refleksjoner rundt undervisning og viktighet av bevissthet og variasjon i egen tilrettelegging for læring så ut til å være styrket.

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44. ACHIEVEMENT GOAL FACTOR STRUCTURE AMONG CHEMISTRY STUDENTS IN GRADE 5 – 11: A COMPARISON BETWEEN SWEDEN AND GERMANY

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Abstract

In this study, the factor structure of German and Swedish students' achievement goals in chemistry were investigated. The national culture of Germany and Sweden are very different in the masculinity versus femininity dimension, expressing the level of competitiveness and the way performance is evaluated in the society. Therefore, the structure of students' achievement goals, in part based on their evaluation of performance, may very well differ between the countries. The results showed that a three-factor CFA model, separating mastery-approach, performance-approach, and performance-avoidance goals, fitted the German data best. In Sweden, the three-factor model and a two-factor model combining the two performance goals fitted the data equally well. However, the correlation between the performance approach and avoidance goals in the Swedish three-factor model was not significantly different from 1 and the separation thus lacked practical significance. Further, the same pattern was repeated for grade 5 – 11 individually within each country. Measurement invariance between grades within the countries support an invariant factor structure, and thus age-independent factor structures. We argue that differences in factor structures between the two countries are related to the differences in national culture.

Introduction

Achievement goal theory is one of the most prominent theories of motivation in educational achievement situations (Wirthwein, Sparfeldt, Pinquart, Wegerer, & Steinmayr, 2013).

Existing research on achievement goals (AG) mostly assumes that constructs are freely transferable between cultures. However, referring to the increased recognition of the influence of contextual factors on motivation, King and McInerney (2016) questioned this assumption and argued that modern motivation research needs to acknowledge both universal and culturally specific features of motivation constructs. Hence, when applying achievement goal instruments in "new" contexts, thorough analysis of goal construct dimensionality is important. Furthermore, when comparing results across different cultural contexts, investigations of measurement invariance of goal constructs across cultural groups are warranted (King & McInerney, 2016).

The aim of the present study was to investigate the factor structure of achievement goals in chemistry among students in Sweden and Germany, two countries very different in the masculinity-femininity dimension of national culture (Hofstede, Hofstede, & Minkov, 2010). Furthermore, we wanted to investigate if the factor structures depend on age. Our research questions were:

- Which achievement goal structures are most appropriate for describing chemistry achievement goals in Sweden and Germany, respectively?
- How consistent are the respective factor structures over grades 5-11?

Theoretical framework

Achievement goals

Most theorists agree on a separation of two main categories of AG: mastery goals and performance goals. Students pursuing performance goals are characterized by a normative evaluation of competence, leading to an effort to demonstrate and validate competence in relation to others. Students adopting mastery goals are instead characterized by an absolute, intrapersonal evaluation of competence with aims such as development of knowledge or mastering tasks (Ames, 1992).

This dichotomy was further refined to include an approach and avoidance distinction for performance goals. The difference between an approach goal and an avoidance goal lies in the valence of the goals: seeing the chance of success and approaching it, or seeing the risk of failure and avoiding it (Elliot & Harackiewicz, 1996). The introduction of this second dimension led to a trichotomous model with mastery-approach (MAp), performance-approach (PAp), and performance-avoidance (PAv) goals. As this trichotomous model "have produced the most solid empirical base" (Lau & Nie, 2008, p. 15), it was adopted for this study.

Culture

Culture can be defined as shared "patterns of thinking, feeling, and acting" that distinguishes groups of individuals from other groups (Hofstede et al., 2010, p. 5), and it has a key role in understanding students' motivation and learning (King & McInerney, 2016). Hofstede's Index of National Cultures (INC; Hofstede et al., 2010) comprises six dimensions which have not been used for AG studies before:

1. Power distance (equality between individuals),
2. Individualism versus collectivism (strength of ties between individuals),
3. Masculinity versus femininity (importance of external validation, explained below),
4. Uncertainty avoidance (tolerance of ambiguity),
5. Long term orientation (focus on past and present or future),
6. Indulgence (acceptance of pleasure-seeking).

Of these dimensions, the masculinity versus femininity dimension is highly relevant to AG studies. Societies with high masculinity score are characterized by competition and success defined in comparison with others, the best students are considered role models, and competition between students is promoted. In this context, failure often has negative social and psychological implications. In contrast, in feminine societies people tend to strive for self-fulfillment rather than competitive performance, average students are the norm, even weak students are praised, and the consequences of failure are less dramatic. Sweden is the most feminine country listed by Hofstede et al. (2010) while Germany is much more masculine (Figure 1) with rank 11 out of 76 countries.

Methods

Data collection

In total, 2019 Swedish and 2762 German students (40% female in both countries) in grade 5 -11 participated in the study.

Students completed questionnaires influenced by Elliot and Murayama's Revised Achievement Goal Questionnaire (AGQ-R; 2008). Due to the solid empirical support for the trichotomous model, we adopted the MAp, PAp, and PAv subscales for the present study.

Analysis

We performed confirmatory factor analysis (CFA), investigating the most appropriate factor structure for each country and for the respective grades within the countries. All CFA models were designed so that: a) each item loaded freely on one latent factor, but had zero loadings on all other factors; b) latent factor variances were 1.0; and c) latent factors were allowed to correlate.

We compared four CFA models:

Three factor model:
A: MAp – PAp – PAv

Two factor models:
B: MAp – PAp/PAv
C: MAp/PAp – PAv
D: MAp/PAv – PAp

After finding the best fitting model for each group, we performed multigroup CFAs to test measurement invariance (MI) between grades in the respective countries. Following Wang (2012), at least three, consecutively more restrictive, levels of MI must be established to make meaningful comparisons of factor scores for different groups:

1. Configural invariance – all groups are restricted to have the same number of latent factors and same factor loading patterns (i.e. items load on the same factors in all groups).
2. Metric invariance – equal factor loadings across groups.
3. Scalar invariance – equal factor loadings and item intercepts across groups.

Results

In Germany, the three-factor model A fitted the data best and showed acceptable fit on all goodness-of-fit-indexes after opening a correlation between two items. In Sweden, both model A and B showed acceptable fit for all goodness-of-fit-indexes. For both countries, data from each individual grade fitted the same CFA model as the country overall, although post-hoc modifications were sometimes necessary to attain models with acceptable fit.

Configural, metric, and partial scalar MI between countries was found for the three factor model. However, in Sweden the correlation between PAp and PAv in model A was very high (r=.98) and not significantly different from 1, $\chi^2(1, n = 1427) = 3.14$, $p = .08$. These high correlations between PAp and PAv were repeated in all grades, indicating that the separation of performance goals in Sweden lacks practical significance. In comparison, for Germany, correlations were significantly different from 1 overall, $\chi^2(1, n = 2694) = 204.72$, $p < .0001$, and for the individual grades. Hence, we conclude that model B is most appropriate to describe the Swedish students' AG, while model A is most appropriate for the German sample.

The best model for each country, was used in MI testing between the grades within the respective countries. In Sweden, goodness-of-fit-indexes and deterioration of fit between levels indicated configural, metric, and scalar invariance across grades in Sweden. In Germany, goodness-of-fit-indexes and deterioration of fit between levels supported metric invariance. After relaxing invariance constraints of two intercepts, partial scalar invariance was also demonstrated across the grades.

Discussion

Differences in AG structures were found between Sweden and Germany. The main difference was the PAp-PAv correlations, rendering the 3-factor model unsuitable in Sweden, which might be explained by differences in the masculinity dimension between the countries. The allegedly less severe consequences of failure in Sweden could cause the normative dimension to gain precedence over the valence dimension, hence making the two performance goals, sharing the normative dimension, inseparable.

The AG structures in the respective countries were consistent over all grades, indicating that the structures are not age-dependent and supporting the reliability of the national level models.

We do not argue for a revision of the achievement goal model, or to revert to earlier models. However, the relation between the goal constructs can apparently vary for different samples in different contexts. Therefore, the results of this study highlight the need to avoid a pure universal view of the goal constructs and instead acknowledge the role of the specific context of each study. Each time researchers use an instrument in a new context, they should investigate the dimensionality and adjust the model accordingly.

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45. USKARP FORSTÅELSE: ANALYSE AV ELEVSVAR KNYTTET TIL PARTIKLERS BØLGEEGENSKAPER OG USKARPHETS-RELASJONENE

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Abstract
The Norwegian upper secondary physics curriculum requires students to be familiar with the wave properties of particles and the Heisenberg uncertainty relations and to discuss epistemological consequences of these. During testing of an online learning resource on quantum physics in 9 classes (184 students) in spring 2016, students' written responses were registered through the learning platform *viten.no*. The present paper reports on results of a thematic analysis of responses to three questions about the wave properties of particles, the uncertainty principle, and the significance of these for how much we can know about nature. Most students could give adequate definitions in response to the two first questions, relating particles' wave properties to experimental results and interference phenomena and the uncertainty principle to momentum and position not being precisely known at the same time. Previously documented misconceptions like the uncertainty principle being connected to technical difficulties while measuring were not explicitly observed in the written responses. For the last question, the quality of responses varied within and between answers. Some showed mature epistemological reflections, whereas others appeared to not distinguish between quantum mechanical uncertainty and the incomplete and temporary nature of the scientific description of natural phenomena more generally.

1 Introduksjon

Kvantefysikk kan for mange være vanskelig å forstå, særlig fordi vår forståelse av naturen på kvantenivå bryter med vår intuitive forståelse av fysiske fenomener og med kunnskaper fra klassisk fysikk. Elever bruker ofte klassiske beskrivelser og mekanismer for å forklare fenomener på kvantenivå (Olsen, 2002), som kan lede til misoppfatninger. Samtidig forteller lærere at de ikke er like komfortable med å undervise kvantefysikk som andre emner, og elevspørsmål kan til tider være vanskelig å svare på (Bungum, Henriksen, Angell, Tellefsen, & Bøe, 2015). Med læreplanreformen K06 (Kunnskapsløftet) i Norge fikk læreplanen i fysikk et mer tydelig fokus på kvalitativ forståelse av kvantefysiske fenomener, bl. a. skal elevene i Fysikk 2 kunne gjøre rede for hvordan partiklers bølgenatur representerer et brudd med klassisk fysikk, gjøre rede for Heisenbergs uskarphetsrelasjoner, og gjøre rede for erkjennelsesmessige konsekvenser. For å hjelpe lærere med å undervise og nå disse læreplanmålene utvikler prosjektet ReleKvant (www.mn.uio.no/fysikk/forskning/prosjekter/relekvant/) læringsressurser om moderne fysikk. I denne presentasjonen vil det bli fokusert på ressursen «Kvantefysikk», spesifikt den delen som tar for seg «partikler som bølger» (se www.viten.no/kvantefysikk/ for siste version) og spørsmålene:

1. Hva menes med at partikler har bølgeegenskaper?
1. Hva sier Heisenbergs uskarphetsrelasjoner?
2. Hvilken betydning har partiklers bølgeegenskaper og uskarphetsrelasjonene for hvor mye vi kan få vite om naturen?

Forskningsspørsmålene for dette studiet er:
FS1: *Hvordan beskriver elever partiklers bølgeegenskaper og uskarphetsrelasjonene etter å ha brukt læringsressursen Kvantefysikk?*

FS2: *Hvilke implikasjoner skriver elever at disse fenomenene har for hva vi kan vite om naturen etter å ha brukt læringsressursen Kvantefysikk?*

2 Teoretisk bakgrunn

Læringsressursene i ReleKvant bygger på et sosiokulturelt syn på læring (e.g. Vygotsky, 1978), der det antas at elever bygger opp forståelse av fysikkens begreper gjennom å «snakke og skrive» fysikk og bruke språket i faglige diskusjoner (Henriksen et al., 2014). Spesielt læreplanens kvalitative elementer som fokuserer på forståelse vil dra nytte av denne formen for læring, særlig siden det er knyttet en rekke utfordringer til en kognitiv overgang fra klassisk fysikk til kvanteverden/kvantefysikken. Eksempler på misoppfattelser inkluderer forestillingen om partiklers bølgeegenskaper, der noen elever beskriver partikler som beveger seg i et bølgemønster (Olsen, 2002), eller uskarphetsrelasjonene, som ofte blir forbundet med måletekniske utfordringer snarere enn en iboende egenskap ved naturen, (Ayene, Kriek, & Damtie, 2011).

3 Metode

ReleKvant-prosjektet baserer seg på Educational Design Research hvor man har flere sykluser med utvikling og tilpasning (for mer informasjon: Henriksen et al., 2014). Læringsressursene benytter seg av film, animasjon, tekst, simuleringer og oppgaver, både muntlige og skriftlige. Svarene fra elevene ble registrert gjennom læringsplattformen *viten.no*. Datamaterialet ble hentet gjennom utprøving av ressursen Kvantefysikk våren 2016, hvor 9 fysikklasser fra 7 skoler deltok. Totalt 184 elever brukte modulen hvor 104 svar ble registrerte på spørsmål 1, 103 på spørsmål 2 og 85 på spørsmål 3. Svarene er analysert med tematisk analyse (Braun & Clarke, 2006), med primært induktiv tilnærming og gjennom flere runder med diskusjon mellom forfatterne.

4 Resultater

På spørsmålet "Hva menes med at partikler har bølgeegenskaper?" knyttet de fleste elevene partiklers bølgeegenskaper til interferens, og en over halvparten forklarte det med eksperimentelle funn, spesielt dobbeltspalteeksperimentet.

Den oppfører seg som bølger ved at det f.eks. blir interferens når det sendes gjennom spalter

Uskarphetsrelasjonene ble av nesten alle elevene beskrevet som par av variabler (oftest bevegelsesmengde og posisjon) som ikke kunne bestemmes skarpt samtidig. En del uttrykte at partikler ikke kan *ha* veldefinert posisjon og bevegelsesmengde samtidig, mens mange uttrykte at det er umulig å *måle* begge disse størrelsene nøyaktig på én gang. Ingen knyttet dette eksplisitt til måletekniske problemer.

At man ikke kan måle nøyaktig bevegelsesmengde og posisjon samtidig.

Det siste spørsmålet dreide seg om betydningen av partiklers bølgeegenskaper og uskarphetsrelasjonene for hvor mye vi kan få vite om naturen. Her gjenga en del av respondentene generaliserte varianter av hva de hadde svart på spørsmålene over, men en vesentlig andel av elevene kunne reflektere over implikasjoner av uskarphetsrelasjonene og partiklers bølgeegenskaper. Det var stor variasjon på kvaliteten til svarene, både internt i enkeltsvar og mellom svar, og noen gikk dypere inn på epistemologiske refleksjoner som på sitt beste viste betydelig innsikt.

Det begrenser det vi kan vite om naturen, vi må f.eks regne med sannsynlighet istedenfor nøyaktige verdier. Vi mangler også kanskje en definisjon på hva partikler og lys egentlig er, siden partikkel og bølgemodellene kræsjer med hverandre når vi snakker om dette.

Imidlertid tyder en del av svarene her på at kvantefysisk uskarphet forveksles med eller generaliseres til den mer generelle vitenskapsfilosofiske innsikten at vår kunnskap om og modeller av naturen ikke er endelige og komplette, eller utfordringer knyttet til selve målingen.

På grunn av dette kan vi ikke si noe om naturen presist, vi har altså ikke nok kunnskaper og heller ikke nok forståelse til å få vite alt om naturen.

5 Diskusjon og konklusjon

Læringsressursen Kvantefysikk ser ut til å hjelpe elevene til å få en oversikt over hva både partiklers bølgeegenskaper og uskarphetsrelasjonene går ut på, og veldig få elever uttrykker direkte misoppfatninger. Spesielt partiklers bølgeegenskaper ble beskrevet på en god måte av de fleste elever, mens uskarphetsrelasjonene av en del elever ble gjengitt med formuleringer som gjorde det uklart om de så på uskarphet som et måleteknisk problem, siden flere pekte på at man ikke kunne *måle* nøyaktig..

Når det gjelder elevers evne til å vurdere de erkjennelsesmessige konsekvensene av de kvantefysiske fenomenene, viser svarene at noen elever er på vei mot en forståelse, mens andres er mer overfladisk. Spesielt ser de ut til at elever har problemer med å se hvordan uskarphetsrelasjonen er knyttet til hva vi kan vite om naturen, hvor noen også gir utrykk for en resignasjon når det gjelder hva vi kan oppnå av innsikt om naturen. Svarene indikerer at ikke alle elever skiller mellom hva vitenskapen hittil ikke har en endelig beskrivelse av, og hva vi vet at det ikke er mulig å bestemme nøyaktig. Dette, sammen med bruken av ordet *måle* i flere elevsvar, gir grunnlag til å stille spørsmål ved forståelsen elevene har for uskarphetsrelasjonene. Når det gjelder implikasjoner av partiklers bølgeegenskaper var ingen elever som eksplisitt prøvde å beskrive partikler med mekanismer fra klassisk fysikk. Noen elever pekte på hvordan vi har en ufullstendig forståelse av partikler på kvantenivå, og andre på hvordan det var det bryter med klassisk fysikk.

Kvantefysikken generelt inneholder flere utfordrende elementer, og det er urealistisk at fysikkelevene skal ha en dyp forståelse for sentrale elementer etter en kortvarig innføring på. Men fra svarene til elevene ser det ut som flere har fått en god start på forståelsen av fenomenene, og i noen tilfeller også en god forståelse av implikasjonene. Det er helt klart begrensinger knyttet til at man kun har elevenes skriftlige svar som datapunkter for å analysere denne forståelsen, og i videre oppfølging vil det være gunstig med opptak av elevdiskusjon eller intervju av enkeltelever for å bedre dokumentere ellers forståelse av sentrale kvantefysiske begreper og av erkjennelsesmessige spørsmål.

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46. SJØUHYRET - ET TVERRFAGLIG UNDERVISNINGSOPPLEGG OM MARIN FORSØPLING INNENFOR UTDANNING FOR BÆREKRAFTIG UTVIKLING

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Abstract

In this paper we present the developement and evaluation of a multi-disiplinary educational project on marine litter in the tidal zone with natural science as the main subject. We wish to investigate how the project aims to meet the criteria in education for sustainable development and how the participants' experiences can contribute to change their attitudes towards littering, develop critical thinking skills and competence to act sustainable in relation to marine litter. The project has been carried out in kindergartens, primary and secondary schools and in high schools. We use observations, questionnaires and interviews to answer our objectives. The project meet major key requirements for educational programs focusing on sustainable development. It can be adapted to a broad audience that embraces both preschool children and pupils in high school. Preliminary results from observations, surveys and interviews show that our marine litter project was well suited to achieve the educational and didactic objectives of teaching. Participants got the opportunity to develop attitudes, critical thinking skills and action competence for sustainable development and expertise to handle a serious worldwide environmental problem in their own local communities.

1 Teoretisk bakgrunn

Marin forsøpling er et voksende miljøproblem og anses som en av de største globale miljøutfordringene (Miljødirektoratet, 2014). Det Norske Miljødirektoratet anslår at plastavfall utgjør ca. 75 % av det marine avfallet. Plast brytes ikke ned, men vil påvirkes av naturkrefter og dele seg i mindre biter – mikroplast. Plastavfallet kan gi delvis dødelige fysiske skader til dyr. Mikroplast som inneholder toksiner introduseres i næringskjeden og gir problemer både for dyr og mennesker, så marin forsøpling kan i høyeste grad sees på som et sjøuhyre. Utdanningsloven og læreplanene forplikter oss til å utdanne miljøbevisste mennesker (Kunnskapsdepartementet 2012). I Norges Offentlige Utredninger om Fremtidens Skole (NOU, 2015: 8) trekkes undervisning om bærekraftig utvikling frem som et sentralt flerfaglig tema som bør løftes i naturfagundervisning. Skoleklasser deltar ofte i opprydningsaksjoner men det er få målrettede undervisningsopplegg der strandrydding blir brukt systematisk i undervisning for bærekraftig utvikling (UBU) (http://holdnorgerent.no/wp-content/uploads/2014/06/Hoveddokument-Marin-Fors%C3%B8pling.pdf).

Vi ønsket å utvikle et undervisningsopplegg om marin forsøpling med naturfag som regifag. Prosjektet skulle oppfylle kravene som kjennetegner UBU: formidling av faglig oppdatert kunnskap om marin forsøpling som lokal og global miljø- og samfunnsutfordring, tverrfaglig orientering, tilrettelegging for erfaringer i nærområde og verden utenfor klasserommet (Sinnes, 2015). Fokuset er på erfarings- og fenomenbasert læring og kreative arbeidsmetoder i en holistisk og stedsbasert undervisning som skal gi deltakerne mulighet til å samarbeide og utvikle kritisk sans og den handlingskompetansen som trenges for å leve bærekraftige liv for en mer bærekraftig verden.

Følgende problemstillinger belyses:

1. Hvordan oppfyller undervisningsoppleggets innhold kriterier innenfor UBU (etter Sinnes 2015)?
2. Hvordan bidrar deltakernes opplevelser og erfaringer i prosjektet til holdningsendring, kritisk tenkning og utvikling av handlingskompetanse i forhold til marin forsøpling?

2 Prosjektdesign og gjennomføring

Nord universitet, campus Nesna (NUCN) er lokalisert på Nordlandskysten som utgjør nesten 40% av Norges kystlinje. Befolkningen er i sine lokalsamfunn i stor grad eksponert for marint søppel fra hele verden.
Prosjektets hovedmål er å:

- øke kunnskapen om marin forsøpling og elevers og samfunnets engasjement for å rydde lokale strender
- gi deltakende elever eierskap til problemet, samt motivasjon og ferdigheter for å kunne forbedre situasjonen
- sikre at oppsamlet avfall blir håndtert på en bærekraftig måte for å redusere mengden av plast og mikroplast i havet
- bruke «community og environmental art» for å gjøre samfunnet oppmerksom på problematikken gjennom offentlige utstillinger av deltakernes «Sjøuhyre»
- implementere stedsbasert læring med fokus på bærekraftig utvikling samt kreative og varierte arbeidsmåter i naturfag i deltakende skoler.

Prosjektoppgavene var fordelt på 3 undervisningsøkter: en teoretisk innføring med klasseromsaktiviteter, en stedsbasert uteskoleaktivitet og etterarbeid.

Teoretisk innføring og klasseromsaktiviteter:

1. Det ble gitt innledende teori om marint søppel og om problemene dette skaper. Blant annet satte vi fokus på utfordringer med mikroplast i næringskjeden, for fiskenæringen og for turismen. Innholdet og aktivitetene i den interaktive undervisningsøkten var tilpasset de forskjellige målgruppene.
2. Gruppearbeider:
   a) Sortering av søppel i henhold til anbefalinger i regionen for å øve på å identifisere, skille og tilordne ulike materialer og diskutere på hvilken måte de kan skade oss mennesker og naturen. Fokus på diskusjoner om materialbruk.
   b) Skolesekken/klesplagg - materialbruk før og nå. Målet var å motivere elevene til kritisk tenkning om egen bruk av plast.
3. Estetisk arbeid med sjøuhyret og igangsetting av en kreativ og skapende prosess: Elever tegnet tanker og følelser om marint søppel i form av sjøuhyrer som ble utstilt i klasserommet. Tegningene var utgangspunkt i prosessen som ledet frem til et felles utrykk på det fysiske sjømonsteret som ble skapt av hele klassen på strandryddedagen. Flere av tegningene ble senere tatt med i utstillinger.
4. Utforskende arbeid:
   a) Barnehage og barnetrinnet: sanselig utforsking av og samtaler om medbrakte organismer fra fjæra
   b) Fra mellomtrinnet: utforskning av mikroplast i kosmetiske produkter under mikroskopet og diskusjon

Uteskoleaktivitet – strandrydding og bygging av sjøuhyrer:
På strandryddedagen ved skolens eller barnehagens lokale strand, fikk barna i oppgave å plukke søppel fra stranda og bygge et felles sjøuhyre. Elevene samarbeidet, fordelte oppgaver og ble enige om hvordan sjøuhyret skulle se ut. Sjøuhyret ble fotodokumentert for senere utstilling. Søpla ble deretter sortert i ulike fraksjoner og registrert i nettportalen «Hold Norge Rent» (http://holdnorgerent.no/aksjon/1844/). Lokale renovasjonsfirma hentet søpla og sikret en bærekraftig håndtering av avfallet.

Etterarbeid og utstilling:
Elevene utforsket en av gjenstandene de fant i fjæra på klasserommet og skrev en tekst om den. Teksten og gjenstanden ble forberedt til utstilling. Klassene ble oppfordret til å skrive om prosjektet i avisen.

Skoler og barnehager bidro med pastellkritt-tegninger av sjøuhyrer, fotodokumentasjon av byggeprosessen og sjøuhyre, samt utvalgte gjenstander i utstillinger som ble vist på bl.a. Helgeland Museum, Mo i Rana, NUCN og ved the Gallery of Fine Arts of the University of Alaska, Anchorage.

3 Material og metode

Undervisningsopplegget ble utviklet og gjennomført i 4 barnehager, 6 grunnskoler og ved 2 videregående skoler våren 2015 og 2016. Oppleggets innhold er evaluert i forhold til UBU-kriteriene skissert i Sinnes (2015).
Datamaterialet fra de ulike casi består av egne observasjoner, spørreundersøkelser (2 klasser fra ungdomsskole og 2 klasser fra vgs), og intervju av 5 elever fra 2 ungdomsskoleklasser, og 5 elever fra 2 vgs. klasser. Data analyseres fenomenologisk (Smith, Flowers & Larkin, 2009) med tanke på hvordan opplevelser og erfaringer fra prosjektet har bidratt til holdningsendring, kritisk tenkning og utvikling av handlingskompetanse i forhold til marin forsøpling hos deltakerne.

4 Resultater og konklusjon

Det marine søppelprosjektet for undervisningsinstitusjoner på forskjellige nivå oppfyller viktige og sentrale krav som stilles til undervisningsopplegg med fokus på UBU. Prosjektet tar utgangspunkt i en miljøutfordring som har både lokal og global betydning. Deltakerne får mulighet til å tilegne seg og kommunisere oppdatert faglig kunnskap om marin forsøpling og dens økologiske og samfunnsmessige aspekter. Gjennom tverrfaglighet kan undervisningsopplegget gi en bred forståelse av problemstillingene knyttet til marin forsøpling og undervisningsopplegget kan ivareta kompetansemål både fra den generelle og fra den fagspesifikke delen i mange fag. Spesielt samarbeidet mellom naturfag og kunst og håndverk legger til rette for at elever kan utvikle mangfoldige relasjoner mot verden (Boeckel, 2013; Østergaard, 2013). Prosjektet gir elevene førstehåndserfaringer med marin forsøpling på deres egen lokale strand og gir anledning til samarbeid med en rekke lokale aktører. Elevene får mulighet til å øve seg i kreative og skapende prosesser, kritisk tenkning og samarbeid for et felles mål. Prosjektoppgaver som avfallsregistrering, strandrydding og utstilling er til en viss grad egnet til å styrke deltakernes handlingskompetanse for BU. Vi ser imidlertid at prosjektdesignet har forbedringspotensial. Når det gjelder å fremme elevenes tro på fremtiden og å leve gode liv uten overforbruk skulle vi lagt mer vekt på positive opplevelser og løsningsorientering. Vi bør også inkludere undervisning SOM BU i større grad.
Foreløpige resultater fra observasjoner, spørreundersøkelser og intervju viser at vårt marine søppelprosjekt var godt egnet til å nå de pedagogiske og didaktiske målene i undervisningen. Deltakerne fikk mulighet til å utvikle holdninger, kritisk tenkning og handlingskompetanse for bærekraftig utvikling, kompetanse til å håndtere et alvorlig verdensomspennende miljøproblem i sitt eget lokal samfunn. Dette kommer tydelig frem i mange elevers svar på åpne spørsmål i spørreskjemaet, f. eksempel utrykker en elev det slik:

«Jeg er blitt mer bevisst på hva jeg kaster og bryr meg mere om søppel generelt. … Jeg tenker mer over hva jeg kjøper noen ganger. Er blitt veldig interessert og føler at jeg har ansvar!».
Og mange ser også muligheter for å påvirke sine omgivelser direkte på en positiv måte; en elev sier:
«Ja det har forandret meg … (jeg) har skjønt hvor mye (søppel) det faktisk var, og at det (strandrydding) er viktig på grunn av samfunnet, miljøet og fremtiden. Nå kaster jeg plast jeg ser i bakken og ting som ligger ute.»

Prosjektet kan tilpasses en bred målgruppe som favner både førskolebarn og elever på vgs. Utover dette gis samarbeidspartnere og besøkende av utstillingen, både lokalt og internasjonalt, innsikt i miljøproblematikken og UBU. Et flerfaglig prosjektdesign, der naturfag har en sentral plass, men med mulighet for en kreativ tilnærming er godt egnet til å engasjere både elever og lokalsamfunn, og gi deltakerne ansvar og eierskap til prosjektet og det lokale miljøet. Det viste seg å være enkelt å involvere offentlige og private partnere, samt lokalsamfunnet i samarbeidet med barnehager og skoler i dette prosjektet.

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48. DEVELOPING AWARENESS OF ILLUSTRATIVE EXAMPLES IN SCIENCE TEACHING PRACTICES: THE CASE OF THE GIRAFFE-PROBLEM

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Abstract
Teachers use examples for many different reasons, for example in order to concretise abstract principles and to connect the teaching of a curricular topic to students' experiences from outside the classroom. However, in science teacher education examples in relation to teaching and learning need to be problematized and evaluated in the courses. Particular examples, refined and reused over decades, may be perceived as being useful for the teaching and learning, but might in fact lead to over-simplification and nurturing stereotypic notions of the subject matter in focus. One recurring example is that of the evolution of the long neck of giraffes, known from Lamarck and the history of science. The aim of this paper is to problematize the use of 'illustrative examples' in science education by looking more deeply into the 'giraffe-problem' and how this is manifested in the context of teaching biological evolution in grade 9. Based on social semiotic theory the analysis shows the details of how a teacher *designs* the example of the giraffe, and how the manifested example for two student groups provides different *affordances* in relation to meaning making and the evolutionary mechanisms involved.

1 Introduction
Teachers use examples in order to make abstract principles more concrete, visualize complex processes, to suggest applications to which students might relate and more: thus supporting students meaning-making processes. Our concern is that examples used in science teaching practices are not sufficiently problematized within teacher education. The prospective teacher needs to be able to evaluate the role of examples in relation to the teaching and learning. Even if examples work as resources for students meaning-making subject-matter considerations is not the main factor when science teachers plan and implement their instruction (Duschl & Wright, 1989). If uncritically refined and reused over decades, examples assumingly 'traditional' and seemingly 'pedagogical', may lead to over-simplification and nurturing stereotypic notions of subject matter (Marianne Achiam (formerly Mortensen), 2015). The nature of scientific knowledge is not unproblematic and prospective teachers may need to be challenged on this (Berry & Loughran, 2012). At the same time, examples from the history of science can be used to demonstrate the range of scientific knowledge claims and evoke critical assessments (Irwin, 2000).

In this presentation we explore some of the difficulties associated with teaching and learning the principles of biological evolution through the lens of an example: the giraffe-problem. Teaching lessons on evolution contain vast amount of information ranging from animal behaviour to molecular mechanisms of genetic variance. This might be one of the reasons why students understanding of principles and applications of evolution are superficial and limited (Jensen & Finley, 1997). The use of illustrative examples like the giraffe's long neck to compare and contrast Lamarck's view of evolution with Darwin's theory is commonly used in textbooks and classroom practices and supposedly seen as an efficacious example that is stuck in the student's mind (Rocha et al., 2007; Tyson & Woodward, 1989). The problem is if the example leads to an over-simplification and counteracts holistic and contemporary understanding of evolutionary biology. In this paper, we explore how the giraffe-problem is manifested in a classroom situation. The aim is here to provide an empirical analysis based on the teaching of an experienced teacher, and discuss possible implications for teacher education from such analysis. By problematizing 'illustrative examples' as used in science education, we want to contribute to a critical discussion in teacher education and to its empirical base.

2 Theoretical framework

The notion of an *example* and its use in a practical teaching situation, is an expression of the school science culture (Martin & Rose, 2008). The teacher designs the lesson also in respect to what examples to use, their function, prominence and what the students are expected to do with the examples (Selander & Kress, 2010). The affordance of the example is largely decided by its textual representation and the context it is presented in. An example is often elaborated on over several modes such as images, written alphabetical text and spoken words. Each of these modes contributes to the total epistemic affordance of the example (Bezemer & Kress, 2008). Moreover, the example can be connected to a context – in our case this context is twofold; the context of evolutionary science and the pedagogical/didactical context of teaching and learning in the classroom. When the example is read into each of these contexts the interpretation will differ (Kress, 2010) and tensions may appear.

3 Research methods

The video data is re-used from a previous project and captures the teaching of a curricular unit about evolution in a Swedish 9'th grade (15 years old). The teacher was responsible for the teaching and the researchers did not intervene with the planning of the eleven lessons. The teacher was well known to the group of students and had about ten years of teaching experience. Four simultaneous cameras were used for the recordings. Two of the cameras provided close-ups on two different student groups, one camera followed the teacher and one camera provided an overview of the classroom.

During the first lesson the teacher introduced the 'giraffe-problem' to the students and they were supposed to give a written explanation to the development of the giraffe's long neck. The presentation of the task made by the teacher and the work in two student groups were selected for a more detailed analysis. Verbatim transcripts were used to capture how the 'giraffe-problem' was interactionally constructed between students and the teacher in each episode. This became one way to establish how certain resources (spoken and written language, gestures, moves, symbols and interpersonal relations among participants) as part of school science practice were made available to participants. By returning and repeatedly looking at the video the transcripts were iteratively revised and became key data (Derry et al., 2010, p. 20).

4 Results

The analysis shows the multiple modes involved when the teacher designs the problem and when the students work with the assignment. Examples are the textual resources used in the instruction (Fig 1), and students' reasoning together using gestures and jokes (Fig 2). During the collaborative conversation students coordinate their attention in four different dimensions: interpersonal, activity, content and text and genre dimensions. The content dimension is emphasised when students articulate what they already know. Hence, the results show how the 'giraff-problem' provides opportunities to talk about the giraffe as a species and the ecological context, like food, predators, and ethology, and less about evolutionary mechanisms. In certain instances students' display ambiguity towards the giraffe-example: "*are not the giraffes like endangered*". In this quote the word 'endangered' resonates with nature preservation rather then survival of species. Moreover, the textual representation of the giraffe-problem addresses two different levels: 'how come that giraffes have developed such long necks?' alternatively: 'how come that we believe that giraffes of today stem from giraffes with much shorter necks?'. In both cases the 'giraffe-problem' evokes ambiguities both in relation to evolutionary biology and in relation to the pedagogical/didactical context of teaching and learning in the classroom.

5 Discussion and conclusion

To sum up, the study shows the affordance of the 'giraffe-problem' in that it engages the students to discuss and write up the explanation, which they hand in to the teacher by the end of the lesson. The 'giraffe-problem' points to the complex relation between the curricular content biological evolution and mechanisms involved in the evolution of physical traits. In the investigated classroom the 'giraffe-problem' was implemented before teaching and might have served the functions aimed for in this particular classroom. However, the details shown provide a resource for how to evaluate the role of examples in relation to the teaching and learning and developing critical discussions together with prospective teachers. The study problematizes the use of 'illustrative examples' and the affordance of such examples in science teaching and learning by looking into authentic teaching practices. Further research may uncover the details of other 'illustrative examples' and how they are manifested in classroom practices. Implications are how to support teacher students' work of selecting and motivating examples and develop useful strategies for their future teaching practices.

Acknowledgement

Part of this paper is based on an unpublished manuscript, included in a licentiate thesis defended in 2012 by the first author.

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49. THE CONCEPT OF SCIENTIFIC LITERACY AND HOW TO REALIZE CONTEMPORARY SCIENCE EDUCATION PRACTICE DISCUSSED FROM AN INTERNATIONAL PERSPECTIVE

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Abstract

In the context of the PROFILES project funded by the European Commission, the "International PROFILES Delphi Study on Science Education" was conducted in 21 countries in Europe and beyond, collecting data from more than 2.700 people involved in science education or science. The data, representing experts' opinion about the contours of a contemporary science education, were gathered and analysed by each partner's institution to come to specific insights into the specific national science education practice.

In this study, the data of 19 different National Curricular Delphi Studies is compiled and compared in terms of a meta-analysis. In our presentation, we are going to present aspects of science education perceived as particularly relevant by the collective of experts involved in this international survey. In addition, focussing on the experts statements we are able to point out which aspects are realised to a higher or lower extent in science education practice in Europe. Finally, the comparison of the importance and extent of each relevant aspect of science education practice allows the identification of areas which require further improvement in European science education systems.

1 Introduction

Although science education in Europe is generally considered important for a society, the current science education practice is criticized by the community as unsatisfactory (EC, 2007). Therefore, the question arises how science education could be changed to better fulfil its important role in helping young people find their place as citizens of tomorrow's society and secure the future of research and innovation.

2 Theoretical framework

Finding evidence-based answers to this important and complex question was one of the major issues of research addressed in the PROFILES project (PROFILES, 2010; Bolte et al., 2012). The project, funded by the European Commission, involved colleagues from 22 institutions in 21 different countries in Europe and beyond (see Fig. 1). This way, the project brought together a large number of stakeholders involved in science education and science. In order to collect and analyse these stakeholders' opinions in a systematic way, the Delphi method was chosen (Linstone & Turoff, 1975).

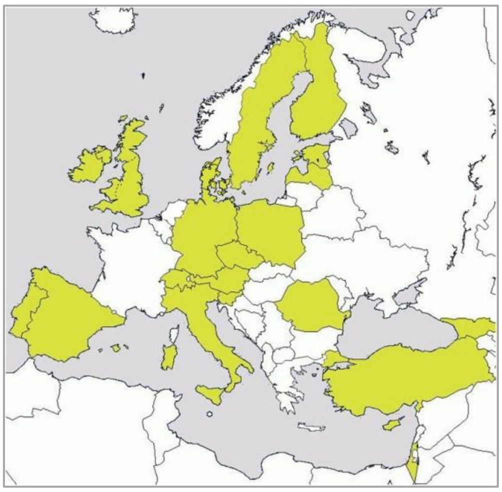

Figure 1. *Overview of the countries involved in the PROFILES Project*

This method has previously proven suitable for investigating aspects that are relevant for scence education of the present and the future (Osborne et al., 2003; Häußler et al., 1980; Bolte, 2008; see Fig.

2). While the mentioned studies were conducted for Germany and the US only, the PROFILES project offered the opportunity for Delphi studies on an international scale – conducted in the different PROFILES countries. The PROFILES Curricular Delphi Studies realized by each institution give insights into stakeholders' opinion focussing on their national science education system (Schulte & Bolte, 2012; Kapanadze et al., 2015; Keinoonen et al., 2015; Schulte et al. 2015).

However, a meta-analysis of the data collected in the different PROFILES countries seems of additional interest and value, as it can hint at a common perspective on the current status and possible deficiencies of science education practice in Europe and beyond.

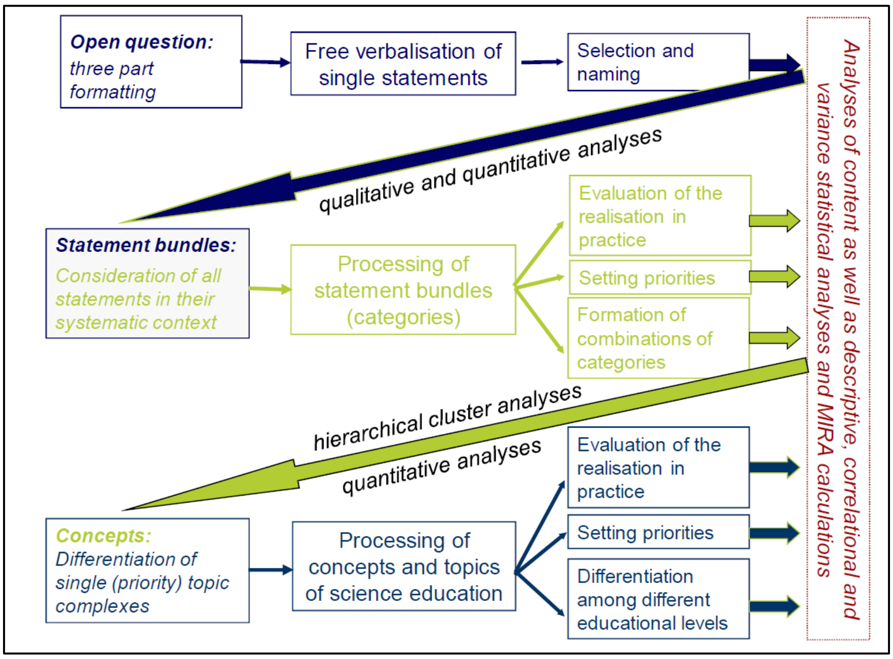

Figure 2. *Method of data collection and analysis in the Curricular Delphi Study (Bolte, 2008)*

In particular, the following questions are addressed in the meta-analysis of the International PROFILES Curricular Delphi Study:

1. How important are the empirically identified aspects of science education in the opinion of stakeholders from different countries?
2. To what extent are these aspects realized in practice in the opinion of stakeholders regarding their respective countries?
3. What differences between importance and extent of realization can be found for these aspects?

3 Research methods

In order to answer these questions, the data reported by each institution regarding their findings in the first round of their Delphi Study was compared by establishing a common classification system (see Fig. 3), which finally includes 88 categories that closely correspond to the aspects mentioned as relevant for science education by European stakeholders from the different institutions in round no. 1 (Schulte & Bolte, 2012). Based on the data collected in round no. 2, the mean values of the experts' priority and practice assessments regarding the categories are calculated in order to identify a common European perspective on science education (see Fig. 3 to 5).

4 Results

The sample for the meta-analysis consisted of 20 partners' Delphi studies with a total of 2.706 participants for the first round and 18 partners with a total of 1.867 participants for the second round. A total of 839 participants from different countries dropped out between the first and the second round of the PROFILES Delphi studies, which is a reasonable and acceptable drop-out rate.
Our analyses show that all stakeholders on average assessed all categories except for the category "learning in mixed-age classes" as at least fairly important, with priority values of over 3.5, which is the theoretical mean of the used 6-point rating scale. This suggests that the established categories

correspond to the stakeholders' general opinion on important aspects of science education. Categories with the highest as well as lowest priority assessments are listed in Figure 3.

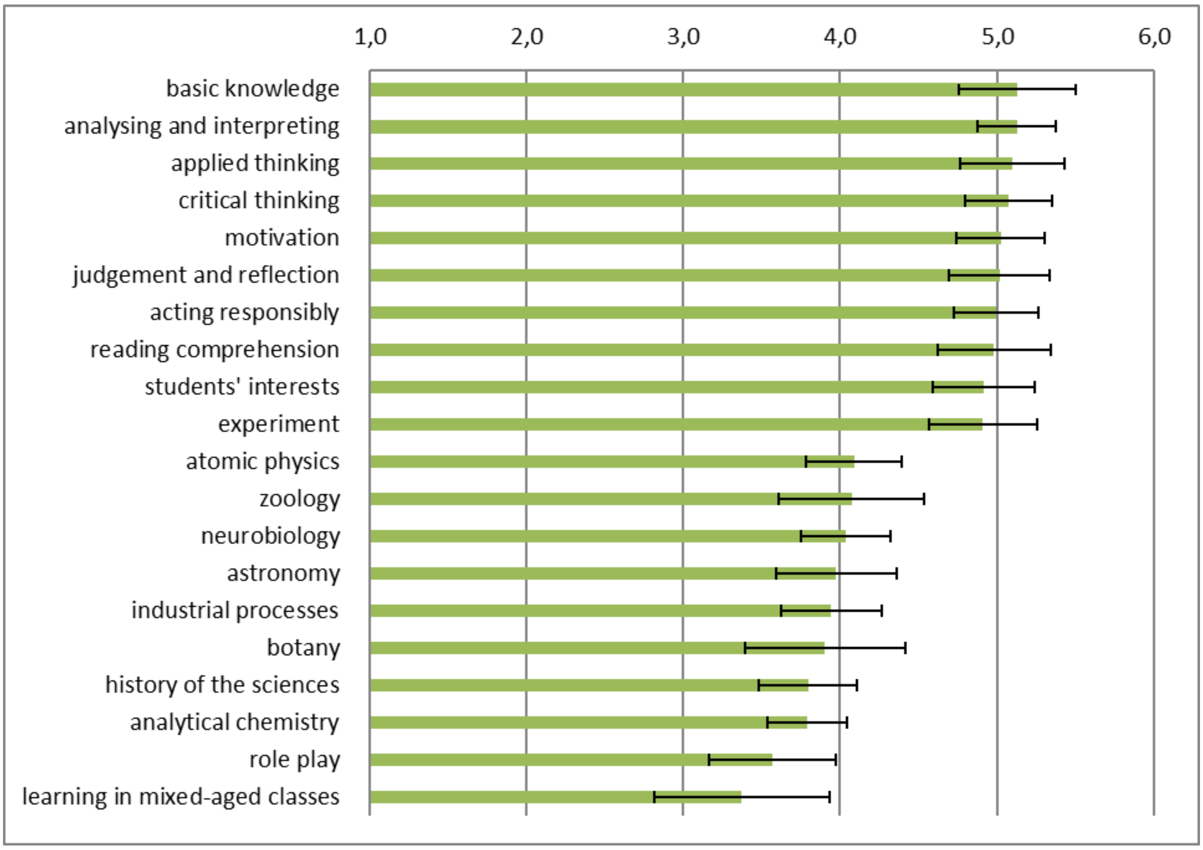

Figure 3. Categories with the highest and lowest priorities assessments (Top 10 / Low 10)

In contrast, only about a third of the categories were considered at least fairly realized in science education with mean values over 3.5; no category reached a value over 5. According to the stakeholders involved in this study, current science education in Europe consists mainly of curriculum orientation, scientific disciplines and sub-disciplines as well as scientific concepts (Fig. 4) and none of the most important categories can be found amongst the categories that are most present in science education.

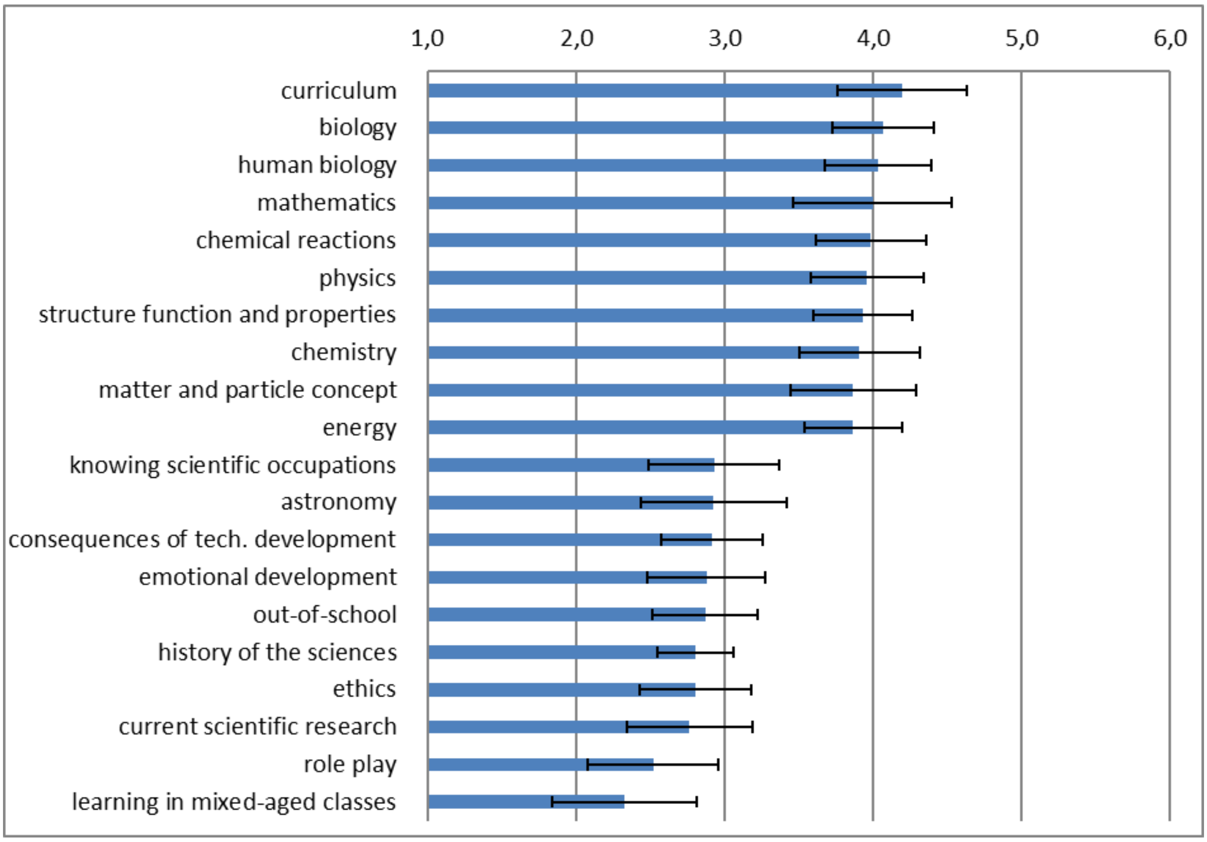

Figure 4. Categories with the highest and lowest practice assessments (Top 10 / Low 10)

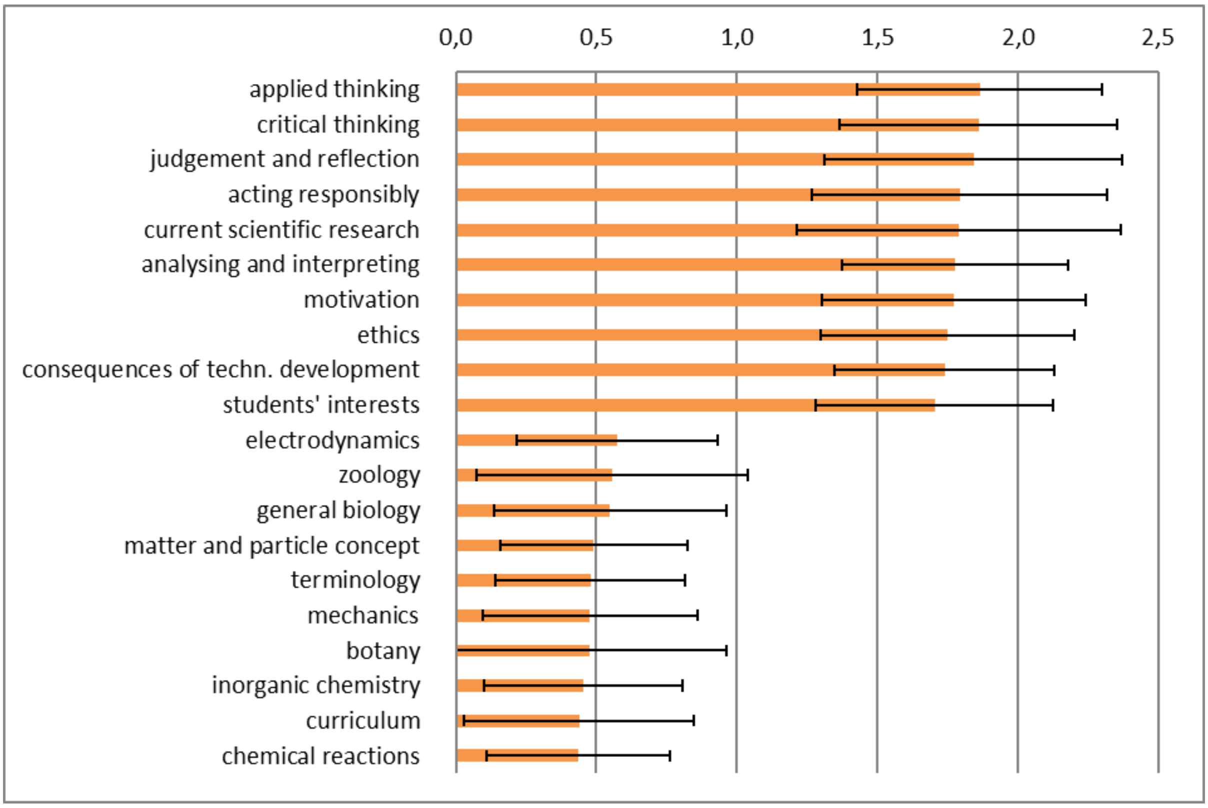

Figure 5. Categories with the greatest and smallest absolute priority-practice differences (Top 10 / Low 10)

From the stakeholders' priority and practice assessments, the difference was calculated. For all categories, these differences were greater than zero, indicating that the respective aspects are more important than present in practice and therefore underrepresented in regular science lessons. The greatest priority-practice differences, which indicate a substantial lack of these aspects in current science education, were found for general skills and competencies (Fig. 5). In contrast, scientific sub-disciplines and concepts show a closer match between priority and practice, indicating that these aspects are almost sufficiently present in science education (Fig. 5).
In conclusion, stakeholders consider general skills, in particular competences related to scientific thinking and reasoning, as well as student motivation as the most important issues but at the same time the most underrepresented in European science education.

5 Discussion and Conclusion

A certain consensus between stakeholders from the participating countries about the aspects that are relevant for science education could be identified. According to the *priority* assessments, the most important aspects and issues of science education from a European perspective are competencies related to higher order thinking. What is more, the high priority value of basic scientific knowledge implies that these competencies should be based on and considered in interaction with basic scientific knowledge. In contrast to that, aspects that have a rather high *practice* assessment in European science education are specific scientific contents and concepts of specific sub-disciplines as emphasised by the national curricula. This misrepresentation is further illustrated when considering the *priority-practice differences*. All aspects that were identified and assessed by stakeholders are underrepresented in science education in Europe, most prominently competencies related to higher order scientific thinking.
As pointed out in the beginning, the main goals as well as the main concerns regarding science education in European countries are comparable. Therefore, we assume that the presented results on science education gathered from almost 2.000 stakeholders involved in science and science education are relevant. In particular, the results of the presented meta-analysis provide starting points for comparisons, reflection and improvement of science education.
At the conference, we would like to present a more detailed overview of the aspects which are considered most important, most present and most underrepresented in current science education in different European countries.

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50. PRE-SERVICE TEACHER UNDERSTANDING OF BUOYANCY: CASE OF PRIMARY SCHOOL SCIENCE TEACHER

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Abstract

Students in school and kindergarten often encounter activities involving floating and sinking. Floating/sinking involves complex concepts which are known to be difficult to understand.
This study aims at getting an insight on pre-service science teachers' (PST') meaning making of the underlying concepts of "floating/sinking". In this study we designed lessons in the topic of floating/sinking for our PST based on the principles of guided inquiry within the constructivist view and with the model of educational reconstruction (MER) in mind. The overarching guiding question is *"How do PST make sense of the underlying concepts in floating/sinking?"* This proposal is focused on how PST understand the concepts of *buoyancy* and *gravity* in floating/sinking. Our preliminary analysis shows that PST gained a good understanding of buoyancy as an upward directed force. Most PST identified it as equal to gravity when the object floats at rest at the surface and less than gravity when the object sinks. We also identified that the PST had an improvement of their language throughout the course. A large number of PST failed on the other hand to understand that the magnitude of the buoyancy force depends on the *volume* of *part of the object immersed in the liquid*.

1 Introduction

Activities involving floating and sinking are often encountered by children both at school/kindergarten and outside of school, e.g. while playing. While observation in itself is relatively easy to undertake, the explanations behind floating/sinking involve understanding of complex concepts of *buoyancy force* and *mass density* (e.g. Hardy, Jonen, Möller, & Stern, 2006). The concept of buoyancy itself is based on the Archimedes' principle which is known to be difficult to understand, even for secondary level students (e.g. Wedøe, 2005).

Science teachers' subject matter knowledge (SMK) has been subject for research over many years. A review by Abell (2007) includes studies on science teachers' misconceptions and alternative conceptions, and mentioned the teachers' generally poor knowledge of concepts in physics. The main finding was that teachers' misunderstanding mirror students' misunderstanding in a many concepts, including "floating/sinking" (e.g. Ginns & Watters, 1995 in Abell (2007)). Further, Abell (2007) pointed out lack of research on how science teachers understand the relation among concepts. This study aims at getting an insight on pre-service science teachers' (PST') meaning making of the underlying concepts of "floating/sinking".

2 Theoretical framework

A substantial body of empirical research has been done on students' conceptions in physics (Duit, Niedderer, & Schecker, 2007). The most common misconceptions related to floating/sinking (e.g.Smith, Maclin, Grosslight, & Davis, 1997) are "one-variable-only" based-explanations, for instance: the mass only ("light things float") or the volume only ("large things sink").

The dominating perspective this kind of research have been constructivist views of conceptual change (Duit et al., 2007). Students are not considered passive recipients of knowledge but are expected to engage actively in constructing knowledge. The model of educational reconstruction (MER) (Duit, Gropengiesser, Kattmann, Komorek, & Parchman, 2012) involves discovering of misconceptions, then carefully restructuring the initial conceptions to build understanding based on scientific concepts. Within this view, it is crucial to create learning environment supportive for constructivist learning. Hardy et al. (2006) showed that providing appropriate instructional supports, such as give students opportunities to communicate, is effective in increasing students' understanding of floating and sinking, when the teaching was done in constructivist environment.

In this study we designed lessons in the topic of floating/sinking for our PST based on the principles of guided inquiry within the constructivist view and with MER in mind. The overarching guiding question is *"How do PST make sense of the underlying concepts in floating/sinking?"* This proposal is focused on how PST understand the buoyancy and gravity in floating/sinking.

3 Research methodology and analysis

We used designed-based research (Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003) as overall research design. The data collection followed case study approach with mixed-method (Cohen, Manion, & Morrison, 2011). The case unit consisted of a series of lessons on floating/sinking given to PST (N=46) from primary teacher education: (A) A half-day guided inquiry session introducing forces on objects in water, (B) "work with problems"-session and (C) a repetition lecture.

To ensure in-depth analysis, multiple data sources were collected: 1. Pre- and post-tests 2. Audio recordings during (A), 3. Interviews with randomly selected PST. The analysis of the interviews and the audio-recorded group work was done using qualitative content analysis method (Mayring, 2000). This paper reports on preliminary analysis of posttest, audio recording and interviews of the first cycle in the designed-based research. The result will feed in to the intervention design of the next cycle.

4 Results

During (A) the PST explored the concept of buoyancy using a metal sphere on a spring scale. They were encouraged to use their hands to push the sphere upwards and discover that by applying a force upwards the scale displayed a lower force; simultaneously they could feel that the mass of the sphere did not change. Afterwards they explored what happened when they lowered the sphere, still hanging on the scale, into water.

The PST soon discovered that the scale showed 12 g less when they lowered the sphere into water. Throughout the PST's discussion their language was rather inaccurate. An example is that they often talked about the weight getting less in water (Fig. 1). Besides, the experiment inspired them to talk about their own experiences (Figure 1).

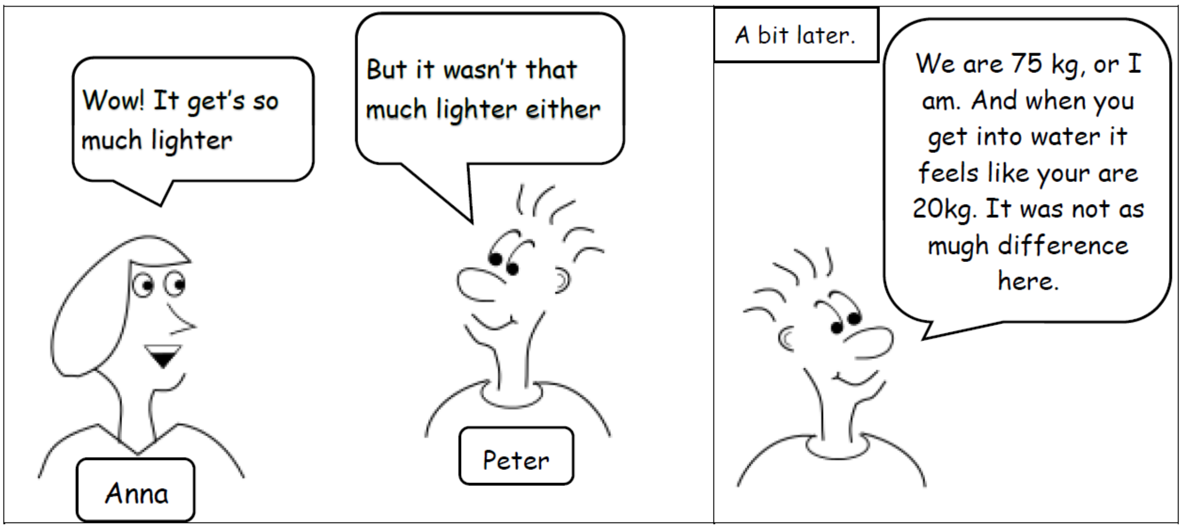


Figure 1. Example of PST discussion

Fig. 2 shows excerpt of further discussion. They talked about the forces in water. Sam called the force buoyancy. Peter and Anna managed to draw analogy between the force from the water and the force from the hand.

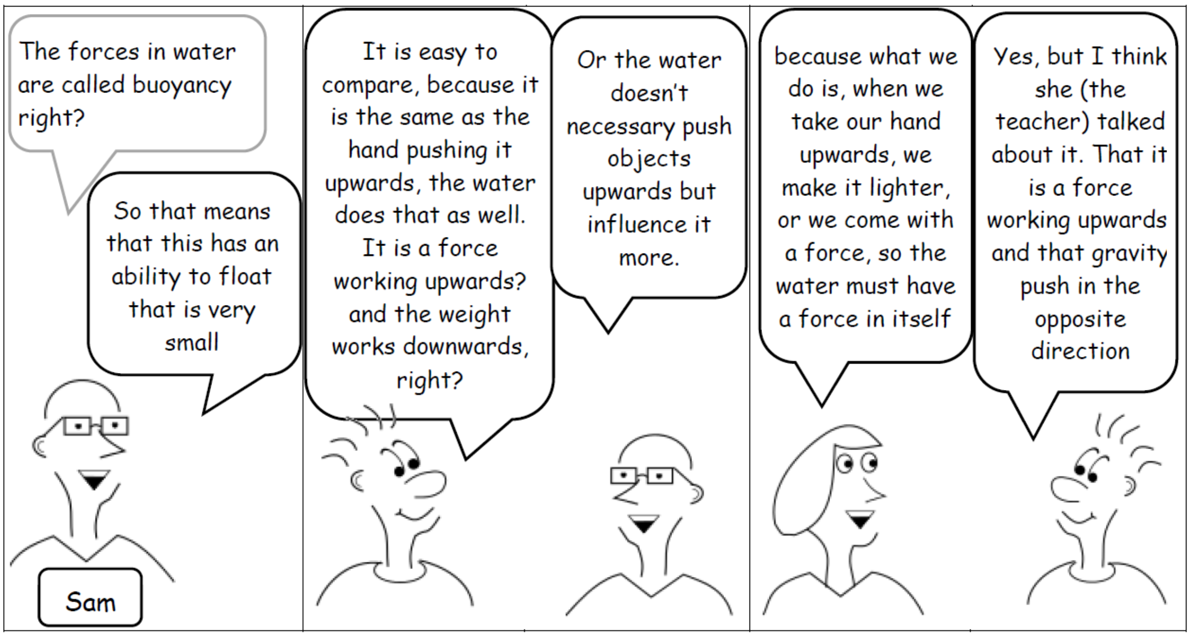


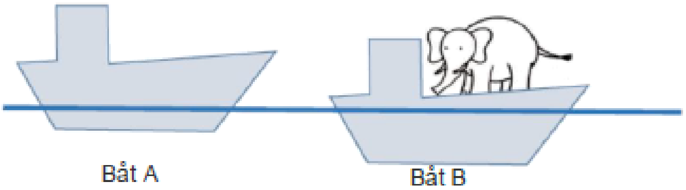
Figure 2. PST reaching the conclusion of the experiment

During the interviews we asked the PST to look at two questions from the post-test (Fig. 3). All of them answered that for an object that floats, buoyancy had to be equal to the force of gravity. For an object that sinks they all stated that buoyancy had to be smaller than gravity. Although they were capable of stating that the buoyancy on the heavier boat was larger than on the lighter one, only one of the PST managed to explain that the magnitude of the buoyancy force depends on the *volume* of water displaced by the boat.

The results of the posttest for all PST are shown in Fig. 4. On question 11 a majority of the PST gave the correct alternatives, whereas on question 12 about half the PST answered correctly.

Spørsmål 11

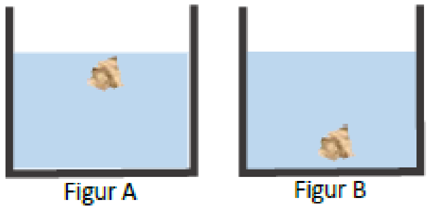
Se figur av de to båtene under. Båtene er identiske, den ene uten last (Båt A) og den andre med last (Båt B). Begge flyter i ro på vannoverflaten. Hvilke av følgende utsagn er korrekte: (du kan krysse av mer enn ett svaralternativ)



- ☐ Oppdriftskraften fra vannet på båt A er større enn på båt B fordi båt A er lengre oppe i vannet.
- ☐ Tyngdekraften på båt B inklusive lasten er større enn på båt A
- ☐ Tyngdekraften på båt B inklusive lasten er mindre enn på båt A
- ☐ Oppdriftskraften fra vannet på båt A er mindre enn på båt B fordi båt A er lettere enn båt B.
- ☐ Oppdriftskraften fra vannet på båtene må balansere tyngdekraften for at båtene skal være i ro
- ☐ Ingen av disse er korrekt

Spørsmål 12

En stein holder på å synke/ er på vei mot bunnen av vannet. I figuren nedenfor ser du steinen i to ulike posisjoner etter at den er fullstendig under vannoverflaten. Hva kan du si om oppdriftskraften?



- ☐ Oppdriftskraften på steinen i figur A er mindre enn i figur B
- ☐ Oppdriftskraften på steinen i figur A er større enn i figur B
- ☐ Oppdriftskraften på steinen i figur A og i figur B er like stor
- ☐ Vi kan ikke sammenlikne oppdriftskraften på steinen i de to figurene da vi ikke vet massen til steinen

Figure 3. Pre-test and post-test questions relevant for this proposal

Figure 4. Answers from posttest from 42 PST in total. Blue bars marks correct answers and orange wrong answers. A) Question 11 Numbers of PST answering the different alternatives. B) Question 12. Number of PST answering correct and wrong

4 Discussion and conclusion

During session (A) it is apparent that they gain a larger understanding. The PST tried to make sense of the observation by connecting to personal experience from everyday life (swimming, cf. Fig.1). The comparison of the hand and the water shows that they understand that there is a force acting on the object from the water. “Mental model are often constructed through analogy” (Collins & Gentner, 1987 in (Lancor, 2014, p. 3)). The act of using own hands to push the weight upwards served as analogy to build a mental model of buoyancy and supported PST’s meaning making of this concept.

Analysis of the language used by PST witness development from being rather inaccurate towards using more precise scientific terminologies, which suggests better understanding of the concept (Wellington & Osborne, 2001). The interviews showed that the PST gained a good understanding of some concepts regarding buoyancy but lack understanding of other. The understanding of buoyancy as an upward directed force seems to be acquired by all of the interviewed PST. Most of these PST also understand that buoyancy and gravity have to be equal when an object floats, and that gravity has to be larger than buoyancy when the object sinks. Most PST have not on the other hand gained understanding of the connection between the volume of water that is displaced by the object and the size of the force of buoyancy, documenting still poor understanding of the Archimedes' principle. This is also reflected on the post-test where half the PST have answered incorrectly on question 12.

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51. LÄRARES SYFTEN MED KONTEXTBASERADE UNDERSÖKANDE AKTIVITETER UTVECKLADE UNDER EN LÄRARFORTBILDNING

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Abstract
The purpose of this study was to investigate what learning outcome lower secondary teachers planned to involve their students in when developing an inquiry-based teaching sequence embedded in a socio-scientific context. The study was based on 15 teachers, distributed in four groups with one teacher designed activity per group. The analysis is based on audio recorded group reflections, group interviews and the teachers' written plans. The result shows that the teachers emphasized different kinds of learning outcomes. Learning to do inquiry was made explicit by all groups; nature of science was only emphasized by one of the group. The result also shows that for two of the groups, the context in itself was made a learning outcome. The study shows that reflections about the purpose of an activity, choice of context and choice of inquiry activity can be crucial for what knowledge is made potential for students during an inquiry activity; especially related to what knowledge about the scientific process is made possible.

1 Introduktion
I den svenska läroplanen har det blivit en stark betoning på undersökande arbete med syfte att utveckla ett kritiskt tänkande hos elever (Skolverket, 2011). Men i svensk skola har laborativt och undersökande arbete traditionellt varit förknippat med begreppsligt ämnesinnehåll samt affektiva aspekter (Högström, Ottander, & Benckert, 2006). Därmed är lärandemål kring de naturvetenskapliga arbetssätten och naturvetenskapens karaktär inte inarbetat i undervisningstraditionen. Öppna undersökande aktiviteter är sällsynta och sammanblandas ofta med en pedagogisk undervisningsmetod (Gyllenpalm, Wickman, & Holmgren, 2010; Lunde, Rundgren, & Chang Rundgren, 2015). Detta tog vi fasta på i en fortbildning för praktiserande högstadielärare. I fortbildningen fokuserade vi på att betona olika syften med undersökande aktiviteter med särskild betoning på lärandemål förknippade med den naturvetenskapliga processen och dess karaktär. Lärarna fick under fortbildningen planera och utforma en undervisningsmodul som innehöll en undersökande laborativ aktivitet inbäddad i en samhällskontext. Syftet med denna studie är att analysera vilka lärandemål som lärarna önskade aktualisera genom sina moduler.

2 Teoretiskt ramverk
Långsiktiga dekontextualiserade lärandemål är i de flesta fall ogripbara för eleverna. Detta är ett problem i och med att läraren inte kan styra elevernas handlingar i relation till dessa överordnade syften. Istället måste läraren involvera eleverna i närliggande syften som de förstår hur de på ett meningsfullt sätt kan handla i enlighet med (Johansson & Wickman, 2011). Övergripande och närliggande syften kan fungera som organiserande för lärarens handlingar. Det innebär att läraren med utgångspunkt i organiserande syften planerar aktiviteter som eleverna ser ändamålet med i tillägg till aktiviteter som stödjer eleverna i att överbrygga görande i aktiviteten till de långsiktiga lärandemålen. I annat fall kan görandet i sig eller kontexten hamna i fokus och den naturvetenskapliga kunskapen förbli dold för eleven. Ifall vi identifierar vilka överordnade och närliggande syften som betonas i en aktivitet kan detta därför säga något om vilket potentiellt lärandemål som uppenbarar sig och vilket som aktualiseras av lärarna i planeringen.

Termen undersökande arbete refererar till minst tre olika idéer inom naturkunskapsundervisning: en uppsättning färdigheter som ska läras, begreppslig kunskap om vad som karaktäriserar naturvetenskapliga arbetssätt och en pedagogisk strategi för att undervisa naturvetenskapens produkt

(Bybee, 2000). I enlighet med dessa idéer kan lärandemålen vara förknippade med: a) att lära att göra undersökningar, b) att lära om undersökningar och c) att lära begreppsligt ämnesinnehåll. Ämnesinnehåll ska här tolkas i bred förstand och innefattar allt som inte rymmer inom kategori a) och b). Sammanfattningsvis kan vi dra slutsatsen att olika lärare kan betona olika syften och lärandemål när de gör en och samma undersökande aktivitet. Det har visat sig att vilket innehåll som görs explicit i undersökande arbete är avgörande för vad eleven lär sig (Lederman, 2007). Därmed blir det avgörande att läraren är medveten om vad syftet är med en aktivitet och planerar för hur detta innehåll ska synliggöras för eleverna. Vi såg ovan att ifall läraren inte

3 Forskningsmetod

Studien tog avstamp i ett fortbildningsprogram som arrangerades inom ramen för ett EU FP7-projekt: PROFILES (http://www.profiles-pr). Projektet kretsade kring kontext- och undersökandebaserad undervisning i ett allmänbildningsperspektiv. I projektet fanns en undervisningsmodul i tre steg som struktur för lärarna att planera kontext- och undersökande undervisningssekvenser. Sjutton högstadielärare deltog och omfattningen var 40 timmar fördelade på fem träffar. Lärarna var indelade i fyra grupper som skulle utveckla en modul vardera. Lärarna fick under fortbildningen delta i föreläsningar och genomföra gruppreflektioner.

Data som använts som underlag för analysen är transkriberade audioinspelade gruppreflektioner samt en gruppintervju i tillägg till den skriftliga planeringen av modulen. Överordnade och närliggande syften som framträder i det skriftliga materialet, samt det som framkommer implicit och explicit i det muntliga datamaterialet har identifierats. Överordnade syften är det som lärarna, implicit och explicit, framhäver som lärandemål med aktiviteten. Lärandemålen som fungerar som överordnade syften har kategoriserats i enlighet med Bybee (2000) uppdelning.

a) att lära att göra undersökningar,
b) att lära om undersökningar
c) att lära ämnesinnehåll

Närliggande syften är det som avses att fungera som syfte för den som deltar i aktiviteten. Närliggande syften är identifierade i relation till den kontext som fungerar som inramning och i relation till vad som framkommer som syfte i de olika aktiviteterna som ingår i modulen.

4 Resultat

Resultatet är preliminärt och redovisas i tabell 1. Lärarna betonade, implicit eller explicit, olika lärandemål, något som enligt forskningslitteraturen medför att olika lärande möjliggörs och gynnas. Alla lärargrupper betonade kunskaper i att göra undersökande arbete. I två fall blev även själva kontexten gjort till ett lärandemål: det vill säga att det närliggande syftet blev ett innehåll i sig (G2; G3). En av grupperna (G1) betonade inte alls traditionellt begreppsligt ämnesinnehåll, men fokuserade i ställe på den naturvetenskapliga processen som ett lärandeinnehåll i sin egen rätt.

***Tabell 1**: Översikt över preliminära resultat.*

	Grupp 1 (G1)	Grupp 2 (G2)	Grupp 3 (G3)	Grupp 4 (G4)
Kontext för det undersökande arbetet	Sjunkande skolresultat	Risker med mobilstrålning	Risker med UV-strålning	Effektivisering av flygplan
Närliggande syften	Undersöka om frukostvanor	Undersöka strålning från mobiltelefoner	Undersöka hur UV-strålning	Undersöka faktorer som kan göra

	påverkar skolresultat, ta ställning till om det ska tillåtas försäljning av subventionerad frukost på skolan	Ta ställning till vilka risker som finns med mobilen	påverkas av olika material Ta reda på vilken risk det finns med solning	flygplan effektivare Rekommendera hur ett flygbolag kan effektivisera sina flygplan
Överordnade syften (se kategorier i metoddelen)	a), b)	a), c)	a), c)	a), c)

5 Diskussion

Studien visar att medveten reflektion kring val av kontext och undersökande aktivitetet i relation till överordande syften kan vara avgörande för att synliggöra bestämda aspekter och därmed kunskaper relaterade till den naturvetenskapliga processen, något som annars riskerar att inte uppmärksammas eller riskerar att framstå på ett icke-fruktbart sätt i relation till läroplanens syfte om att utveckla ett kritiskt tänkande hos eleven (Gyllenpalm et al., 2010; Lunde et al., 2015). Kopplingen mellan närliggande och övergripande syften var ibland otydlig och medför förmodligen att det blir svårt för eleverna att uppfatta de långsiktiga lärandemålen med aktiviteterna.

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52. SAMHÄLLSFRÅGOR MED NATURVETENSKAPLIGT INNEHÅLL OCH DEMOKRATISK FOSTRAN

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Abstract

The purpose of this paper is to present a framework of how science teachers can approach socio-scientific issues (SSI) and what the role of science knowledge is in SSI. A pluralistic teaching approach is advocated based on Deweys view on democracy and his concept of reflective moral. The teaching framework is inspired by Deweys model for moral reflections – Dramatic Rehearsal – encouraging us to reflect about the consequences of different choices. By viewing SSI as both an interest conflict and as a value conflict and by separating this two dimensions it is argue that SSI could be structured in a way that support students in handling SSI in a systematic way both in the factual and the value dimension. The framework contain five aspects the students need to handling when working with SSI: What standpoints are possible? Which interests are in conflict? How is different conflicts influenced by different standpoints? Whose interests should be prioritised? Why should these interests be prioritised?

1. Introduktion

Förmågan att använda naturvetenskap i privat- och samhällsliv har de senast decennierna fått ökad uppmärksamhet inom både naturvetenskaplig undervisning och den ämnesdidaktiska forskningen (Roberts & Bybee, 2014, Reiss, 1999). Ett sätt att arbeta med detta på är att i undervisningen utgå ifrån kontroversiella samhällsfrågor med naturvetenskapligt innehåll som rör till exempel energi, teknik, miljö och samhälle. Eleverna måste då förhålla sig till båda etiska, estetiska, sociala, ekonomiska och politiska dimensioner av en frågeställning, i tillägg till den naturvetenskapliga. Med bakgrund i litteraturen sammanställer Levinson (2006) följande kännetecken för vad som karaktäriserar en kontroversiell frågställning med naturvetenskapligt innehåll.

1) När människor utifrån olika premisser gör olika ställningstaganden och dessa var för sig är rimliga utifrån de givna premisserna.
2) De involverar många människor och grupper.
3) Frågeställningen kan inte lösas med hänvisning till evidensbaserad kunskap.

Vi ser utifrån punkterna ovan att dessa frågeställningar går långt bortom vad som traditionellt har ansätts tillhöra en naturvetenskaplig undervisningsram, något kan uppfattas som utmanande och problematisk av lärare med mer ämnesdjup än ämnesbredd (Christenson, 2015). Frågan blir vad denna typ av aktiviteter ska syfta till och vad läraren ska betona i undervisningen och bedömningen, med risk för att det blir en överbetoning på naturvetenskapens roll för att hantera kontroversiella frågor och underbetoning på andra kunskapsformer samt värderingarnas roll (Roberts & Bybee, 2014). Detta aktualiserar frågor kring vad som är skolans uppdrag och vilken roll de naturvetenskapliga ämnena ska spela i utbildning av framtida medborgare. Det övergripande syftet att fostra demokratiska medborgare är, med bakgrund i Deweys förståelse av demokrati, ett av huvudargumenten som lyfts här för att involvera elever i samhällsfrågor med naturvetenskapligt innehåll. Enligt Dewey (2009) handlar demokrati om hur vi möter varandra och därmed vårt förhållningssätt till andra människor. All kommunikation bör syfta till att skapa förutsättningar för att nya perspektiv, tankar och idéer ska kunna formuleras och kritisk granskas så vi kan växa både som individer, som kultur och samhälle. I skolan möts människor med olika erfarenheter och bakgrunder i ett gemensamt meningsskapande. Därmed blir skolan en viktig arena för att främja demokratisk kommunikation. Men detta skapar nya utmaningar för lärare i planering och genomförande av undervisning: hur kan eleverna stödjas i att utveckla denna typ av reflektionsförmågor, vad är naturvetenskapens roll och hur förhåller den sig till andra kunskapsformer och till värderingar? Syftet med detta bidrag är att diskutera hur detta kan ske med utgångspunkt i Deweys förståelse av reflektiv moral.

2. Intressekonflikter och värdekonflikter

Inom miljöundervisning har det identifierats tre olika traditioner: *den faktabaserade*, *den normativa* och *den pluralistiska* (Skolverket, 2002). Medan det två första fokuserar på undervisning kring fakta respektive normer så är betoningen i den pluralistiska traditionen att vetenskapen kan identifiera problem, men inte ge vägledning i hur de kan lösas. Miljöproblem anses här bero på intressekonflikter. Detta konfliktperspektiv gör att demokratiska frågor hamnar i fokus. Elever behöver värdera olika alternativ och därigenom utveckla ett kritiskt och reflektivt förhållningssätt. Fler intressen står mot varandra och någons intresse måste prioriteras framför andras. Därmed uppenbarar det sig en annan konfliktdimension, nämligen värdekonflikter. Kontroversiella frågeställningar är frågeställningar som har två dimensioner – dels rymmer de en *intressekonflikt* och dels en *värdekonflikt*. Därför behöver vi dels lära elever identifiera intressekonflikter och dels identifiera värdekonflikter och uppöva förmågan att hantera dessa på ett reflektivt sätt.

3. ’Dramatic Rehearsal’ och undervisning i samhällsfrågor med naturvetenskapligt innehåll

I samband med moraliska överväganden lanserar Dewey (2003) en reflektiv simuleringsprocess – ’Dramatic Rehearsal’ – som syftar till att i förväg granska möjliga konsekvenser av aktuella handlingar. Den innebär att i tanken ge sig iväg i olika handlingsriktningar, så deras möjliga konsekvenser kan förutses. Tillgänglig fakta beaktas, konsekvenser förutses, samt hur dessa konsekvenser påverkar omgivningen och vår karaktär. I processen måste man ta hänsyn till andras intressen, sätta sig in i andras situation, kommunicera och pröva deras ståndpunkter, samt pröva konsekvenserna av värderingar genom moraliska överväganden. Men vi kan inte bara tänka på vad vi bör göra, utan också på vilka vi vill bli. Med inspiration från Deweys metod för moralisk övervägande kan vi nu diskutera hur läraren kan stödja elever i att på ett systematiskt sätt engagera sig i kontroversiella samhällsfrågor med betoning på att uppöva ett demokratiskt förhållningssätt där naturvetenskapens roll i relation till andra kunskapsformer och värdefrågor synliggörs.

1) Vilka handlingsalternativ är aktuella?

I en moralisk problemsituation måste vi välja handlingsinriktning, men för att göra detta måste handlingsalternativen vara synliga. I en kontroversiell samhällsfråga med naturvetenskapligt innehåll kan det finnas två eller fler aktuella handlingsalternativ. Det första steget för att handskas med en kontroversiell samhällsfråga är att skapa sig en bild av vilka handlinsalternativ som finns. Dessa fungerar sedan som utgångspunkt för den vidare reflektionen kring olika handlingsriktningar och vad dessas konsekvenser blir.

2) Vems och vilka intressen står i konflikt med varandra?

För att hantera kontroversiella frågeställningar behöver man initialt inventera vilka möjliga intressen som är involverade och som därmed står i konflikt med varandra. Detta kan vara egna, andra individers, gruppers eller även andra levande varelsers intressen och måste ses både i ett nutida och framtida perspektiv.

3) Hur påverkas olika intressen av olika handlingsalternativ?

För att göra välgrundade ställningstaganden behöver vi göra en *konsekvensanalys* som kartlägger vilka faktiska konsekvenser ett beslut får. I detta avseende får naturvetenskap en avgörande roll genom att bidra till att skapa större klarhet i vilka möjliga konsekvenser olika val ger. I detta skeende kommer eleverna behöva kunskaper i och om naturvetenskap, förmågan att söka och använda naturvetenskaplig information eller att kritisk värdera kunskapspåståenden från forskningsfronten.
Men medan naturvetenskaplig kunskap i regel är nödvändig, så är det inte tillräcklig för att få översikt över konsekvenserna i en intressekonflikt. Vi måste även använda kunskaper från andra kunskapsområden som rör till exempel ekonomiska, sociala, kulturella eller politiska dimensioner.

Därmed aktualiseras olika former för kunskapsområden parallellt som var för sig belyser situationer ur olika ämnesperspektiv. Ifall elever till exempel ska kunna vara kritiska till kunskapsanspråk på rätt premisser blir det till exempel nödvändigt att komma in på frågor om de olika vetenskapernas karaktär.

4) Vilka intressen ska prioriteras

Vetenskap kan identifiera problem, men inte ge vägledning i hur de bör lösas; vi inte gå direkt från *är* till *bör,* för då gör vi det naturalistiska felslutet. Ett ställningstagande i en kontroversiell samhällsfråga innebär att prioritera någons intresse framför andras. Ifall man gjort en konsekvensanalys har man förhoppningsvis skapat större klarhet i vilka värdekonflikter som föreligger. Nu aktualiseras kunskaper från det humanistiska fältet för att skapa större klarhet i frågan kring värdkonflikter, till exempel kunskaper som rör religion, etik, filosofi.

5) Varför ska de prioriterade intressen prioriteras framför andra intressen?

I en demokrati behöver vi uppöva en vana att inta andras perspektiv och uppmärksamma andras intressen, inte bara se saker ur den egna synvinkeln (Dewey, 2009). Dialogisk kommunikation är en förutsättning för att nya perspektiv, tankar och idéer kan formuleras och kritisk granskas så vi kan växa både som individer, kultur och samhälle. Genom att låta elever gå i dialog med varandra kan undervisningen synliggöra olika perspektiv, dess premisser samt konsekvenser och eleven tränas i att artikulera egna samt förhålla sig till andras, värderingar. Ett nav som reflektionen kring värden måste förhålla sig till är *principen om lika hänsyn till intressen* – att man inte bör bortse från någons intressen eller favorisera en grupp på bekostnad av andra (Singer, 1992). Jämlikhetsprincipen säger att vi måste fästa lika vikt vid allas intressen, men inte att alla alltid måste få sina intressen tillgodosedda. Konsekvenser av olika värderinger kan då lyftas då upp och synliggöras i relation till principen om lika hänsyn till intressen, och i slutändan om vems intressen som ska prioriteras och hur man legitimerar detta moraliskt. Eleven tvingas värdera egna värden och tränas då i att utveckla metavanan att reflektera över sina egna grundantaganden och värden – det vill säga utveckla en reflektiv moral.

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54. A PRESCRIPTIVE MODEL FOR HOW TO USE DIALOGUES TO STIMULATE STUDENTS' LEARNING PROCESSES IN INQUIRY-BASED AND TRADITIONAL SCIENCE TEACHING

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Abstract

This theoretical paper suggests a set of six basic types of learning dialogues suitable for stimulating learners to enter phases of reflection needed to develop conceptual understanding. Both in traditional and inquiry-based methods of teaching, learners have to create and test interpretations of observations and information. Such processes might be stimulated by the use of appropriate questions and tasks. Moreover, discussions and articulation of thoughts, knowledge and interpretations are prerequisite for feedback and for collective reasoning. The main purpose of this prescriptive model of basic types of dialogues is to act as a guide for teachers when designing questions for group- and whole class discussions in different phases of a learning sequence. The model is based on Dewey's conception of a *complete act of though,* Bakhtin's theory of *dialogism*, and the concepts of *open questions* and *authenticity* in use of language. Dialogues from different classroom examples of inquiry-based science teaching supports the validity of the variety of learning dialogues identified.

1 Introduction

Many students talk little in class. Learning processes might of course still be going on, but these are not accessible for the teacher or peers. Students' tentative interpretations of observations, explanations, examples etc. are not available for feedback and follow up, unless they present their interpretations orally or in written form. Kind (2013, p. 530) states that *"the "positivist" view of science dominating classroom practices, placing emphasis on factual recall and confirmatory experiments"*. One answer to this challenge (among others), is inquiry-based science teaching, e.g. the 5E learning cycle (Fiskum & Korsager, 2013). However, although 5E emphasis reflection and discourse, it gives the teacher less guidance on what characterise tasks and questions that might stimulate students to enter into appropriate forms of discussions during learning. The aim of this theoretical paper is to develop a prescriptive model for guiding teachers on how to stimulate learners to enter into different types of individual and collective reasoning processes needed for the development of understanding.

The basic idea is to identify basic types of dialogues suitable for stimulating students to enter into the different kinds of reflections involved in Dewey's (1909) conception of a *complete act of thought*. However, Dewey's theory does not include an explicit analysis of the role of collective reasoning involved in learning. Shared meanings are necessary to communicate and build on each other's ideas. Bakhtin's (1981) theory of *dialogism* will be used to include collective aspects of the development of personal views. Finally, in classroom situations teachers also experience that it might be hard to design questions and situations which makes most learners willing to share points of view in the classroom. Wallace (2004) concept of *authenticity* of language use and Nystrand's (1997) concept of authentic or *open questions* will be included in the model.

2 Theoretical framework

Dewey (1909) states that learning involves *a double movement of reflection*, where an initial tentative interpretation of observations or information is followed by a deductive phase where the tentative interpretation is tested against further evidence. Moreover, he identifies five elements involved in a *complete act of thought*: *(i) a felt difficulty; (ii) its location and definition; (iii) suggestion of possible solution; (iv) development by reasoning of the bearings of the suggestion; (v) further observation and* *experiment leading to its acceptance or rejection; that is, the conclusion of belief or disbelief (Dewey, 1909, p. 73).* One of Dewey's claims is that a process of reflection always starts with a felt problem, e.g. a discrepant observation or surprising information.

In his theory of dialogism, Bakhtin (1981) states that all utterances builds on others' ideas and ways of talking, and that utterances are at the same time formed by anticipated responses from others. Also, individuals' utterances are always influenced by the specific ideas, thinking and history of the utterer. The presence of different views and perspectives in different utterances, and often also within an utterance, he calls *polyphony* (*multi-voice)*. This multi-voicedness appears also when learners tries to express the ideas of their teacher. The multi-voicedness represents a resource of ideas for further discussion on a topic. Bakhtin also coins the concept *heteroglossia*, describing how different groups typically develop specialised ways of talking in order to express specialised views on some area, e.g. ways of talking within science or football.
Studying American classrooms, Nystrand (1997) developed the concepts of *open questions* as questions where the teacher does not hold the answer. Consequently, such question calls for students' views, interpretations and knowledge contributions. Along the same line of thinking, Wallace (2004) claims that learners need to use language in authentic ways. She claims that, to move from vernacular authenticity to subject matter authenticity, the learner need to express themselves in in ways that are meaningful for them, i.e. in for them authentic ways of using language.

3 Research methods

The proposed model is developed through inspecting examples of inquiry-based science teaching involving modelling and improvement of models, using the mentioned theories of Dewey, Bakhtin, Nystrand and Wallace as theoretical perspectives.

4 Results

Dewey's description of a complete act of thought do not explicitly mentions the learner's prior knowledge. However, stage (ii) (se theory section) includes a clarification of the specific character of the problem. Moreover, the inductive leap leading to an interpretative idea draws upon additional facts and concepts the situation brings to the mind of the learner. Consequently, the learner's prior knowledge and experiences enables and constrains the interpretative inferences to be generated. Thus, the model developed redefines stage (ii) to explicate activation and identification of *relevant prior knowledge*. Stage (v) contains in fact two aspects; identify further observations (e.g. through experiment) and to make a conclusion on whether the new observations are consistent with the proposed solution or interpretation. Consequently, these two aspects are separated in our model, which therefore includes six basic types of dialogues.

According to Dewey (1909), reflective thinking is needed also when information (versus observations) is encountered. Although he states that "*thinking is impossible without language*" (Dewey, 1909, p. 181), collective aspects of language are not explicated in his descriptions. However, Bakhtin (1981) describes how discussants in general incorporate ideas and perspectives of others in their own *answering words*. Thus it is possible to describe how learners might share interpretative ideas, and how tensions between different ideas might spark discussions and clarify strong and weak points.

Also, by formulating questions explicitly focusing on different kinds of reasoning, learners might be guided to consider these aspects. According to dialogism, answering words will always be idiosyncratic, but authoritarian situations can foster mimicking responses. Thus it's important to ensure authenticity in learners' use of language, as this is prerequisite for reasoning. Moreover, by using open or authentic question, the teacher can stimulate learners to express own thoughts. Consequently, by using open question focusing on elements of involved in a *complete act of thought*, the teacher can stimulate student's thinking. In practical terms, the teacher can signal interest in the students' knowledge and thinking, in contrast to an anticipated correct answer, by using the personal pronoun "you". The resulting model consists of six elements based on *a complete act of thought* (to the left below), a set of indicative guiding questions (to the right below) and the visual representation in figure 1:

- A felt discrepancy: - What did you find surprising?
- Relevant prior knowledge: - What do you know about …?
- Generate interpretations: - How might you try to explain …?
- Infer consequences: - How might you/we test whether this hold?
- Identify further information: - What more relevant facts did you find?
- Evaluate consistency: - How do this fit with…do you think?

Figure 1 indicates how three of the basic types of dialogues focus on observations and information, while the three shaded elements focuses on reasoning processes. The four arrows indicate that evaluation of consistency involves the generateded and identified observations and information. One might identify a circular path through the different dialogues, starting with the felt discrepancy. In practice, the sequencing of the dialogues might be mixed, and a concrete dialogue might include several of these basic types due to current needs in the dialogue.

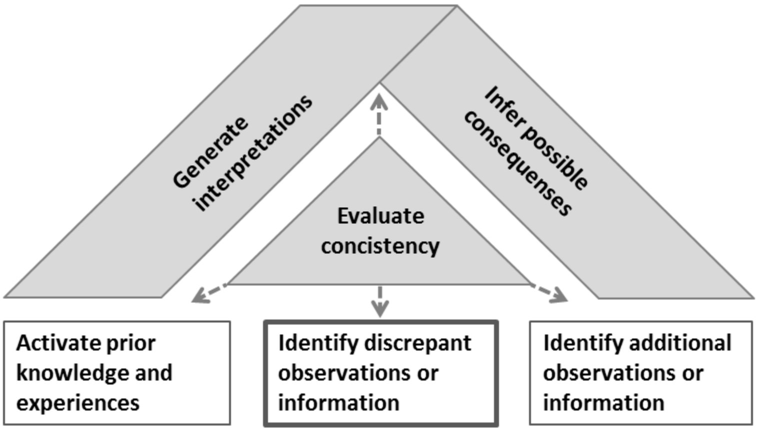

Figure 1. Six suggested basic types of multi-voice learning dialogues based on open questions focusing on students' contributions, one for each main element in a complete act of thought. As reflective thought is triggered by identification of descrepant observations or information, this element is marked with a thicker line.

4 Discussion and conclusion

The presentation of the 5E learning cycle by the Norwegian Science Centre (Fiskum & Korsager, 2013) states that students are supposed to "communicate and discuss" in the exploration phase and "formulate and make arguments" in the explanation phase. One purpose of the proposed model is to provide more specific guidance for teachers on what kind of dialogues might be useful in different phases of inquiry learning. More traditional teaching is based on presentation of science content followed by different kinds of seatwork. The proposed model provide guidance on what type of dialogues teachers might run in order to develop learners interpretations of presented concepts. The indicative questions in the proposed model are believed to be applicable for formulation of questions for group- and whole class discussions, and for supervision of groups and single students.

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55. TEACHER’S STORIES OF ENGAGING SCIENCE TEACHING. A DELPHI STUDY ON TEACHERS' VIEWS ON THE FACTORS THAT CREATE ENGAGEMENT IN A SCIENCE CLASSROOM

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Abstract

The purpose of this study (in progress) is to highlight teachers’ perspective on students’ engagement in science class. Teachers’ perspective is important because teachers’ experiences of students’ engagement in science class influence teaching and the selection of content. Teachers’ beliefs about the concept “engagement” also affect their interpretations of students’ behaviour. This view is a necessary complement to earlier research that mostly focus on students’ attitude towards science education and the need of changing the direction in science education, away from mainly focusing on the scientific content to a larger focus on scientific literacy. The findings are based on a three-stage Delphi survey distributed to 39 expert science teachers. The primary outcome of the survey shows that teachers do not perceive any direct connection between specific science content and the students’ engagement. It also shows that teachers to a high level interpret students’ emotional expression and academic behaviour as engagement rather than their cognitive behaviour.

Finally, the primary results point out the importance of students’ participation and science teaching with a strong connection to student’s reality.

1 Inledning

Lärares erfarenhet av elevernas engagemang i skolarbetet på NO-lektionerna påverkar undervisningen och undervisningens innehåll. Lärarnas uppfattningar om begreppet engagemang påverkar också deras tolkning av elevernas beteende.

Elevers engagemang anses vara en viktig variabel då den förväntas leda till ökat lärande (Wang 2014). Finn & Zimmer (2012) ger flera anledningar till varför engagemang är viktigt. Det är ett begrepp som lätt att förstå för de som har praktiskt inflytande i skolan (t ex lärare, rektorer och beslutsfattare). Man kan följa elevers engagemang över tid och tidigt upptäcka om det finns en risk att elever inte klarar sin utbildning. Förmågan att upprätthålla engagemang är en värdefull egenskap i sig (uthållighet) och det är viktigt att ta hand om elevers engagemang från början. Slutligen är elevernas engagemang ett tecken på hur väl skolan fungerar vilket kan användas som ett sätt att påverka och förbättra utbildningen.

Syftet med min studie är att undersöka lärares egna berättelser om undervisning som de anser skapat engagemang hos eleverna. De deltagande lärarna har fått reflektera över och resonera om vad engagemang innebär och vilka faktorer som skapar engagemang.

2 Bakgrund

I min studie har lärarna själva att få beskriva vad de uppfattar som engagemang och därmed också ge sin beskrivning av vad engagemang innebär. Det kan dock vara intressant att koppla det till de studier som finns dokumenterade i litteraturen. Wang et al. (2014) beskriver elevers engagemang i klassrummet som ”a student´s active involvement in classroom learning activities” och refererar till Reeve et al (2004) som har undersökt kopplingen mellan lärares uppmuntran av elevers självständighet och deras engagemang och beskriver engagemang som ”Engagement refers to the behavioral intensity and emotional quality of a person´s active involvement during a task”. Wang refererar till andra författare, bland annat Fredricks et al. (2004), som beskriver begreppet engagemang med hjälp av tre dimensioner: affective (emotionellt) behavioral (beteende) och cognitive (intellektuellt). Emotionellt engagemang innebär bland annat att eleven visar intresse, glädje och entusiasm. Engagemang kopplat till beteende handlar om uppmärksamhet, delaktighet, tid som används till att lösa uppgifter mm. Elever som är intellektuellt engagerade använder strategier, processar innehåll och är medvetna om sitt lärande. Definitionerna av de tre dimensionerna är ganska breda vilket innebär att de tenderar till att överlappa andra begrepp (Fredricks et al 2004). Finn et al (2012) sammanfattar flera författare och ger en beskrivning av engagemang bestående av fyra dimensioner:

- *Academic engagement* beskriver beteende kopplat till lärandeprocessen t ex uppmärksamhet, slutförandet av uppgifter, deltagande i andra aktiviteter kopplat till skolan mm.
- *Social engagement* handlar om att följa regler, även oskrivna, t ex komma i tid, delta i undervisningen och inte störa andra etc.
- *Cognitive engagement* innebär t ex att använda strategier, koppla samman med tidigare kunskap, skaffa bredare överblick än vad som krävs för att öka förståelse, värdera kunskap.
- *Affective engagement* är ett känslomässigt engagemang där eleven känner sig involverad i skolan och skolans aktiviteter.

Ovanstående beskrivning av engagemang är kopplat till att engagemanget tar sig uttryck i olika handlingar och/eller känslor. Ett annat sätt att se på begreppet är en modell som grundar sig på motivationspsykologi och SDT, Self-determination Theory (Deci & Ryan 2002). SDT bygger på antagandet att människor har en inneboende strävan att utveckla sig själv. Detta kan de göra om omgivningen uppfyller tre grundläggande behov:

Competence	Att ha möjlighet att interagera med sin omgivning på ett effektivt sätt och att ha möjlighet att uttrycka och utöva sin fulla kapacitet.
Relatedness	Känna samhörighet med andra personer och känna tillhörighet med gruppen.
Autonomy	Att själv kunna agera utifrån egna intressen, eller intressen och värderingar som man delar med andra. Autonomy betonar självständighet, inte oberoende.

Om dessa behov uppfylls innebär det att man engagerar sig i aktiviteter som bidrar till ens personliga utveckling. En elev kan få sina behov uppfyllda (eller inte) av skolan som institution, lärare, klasskamrater, föräldrar, social situation mm. Enligt Skinner & Pitzer (2004) är engagemang ”the outward manifestation of motivation” och kan visa sig på olika sätt, både som beteenden och känslor. I skolan kan det visa sig genom att eleven tar kontroll över sitt eget lärande.

3 Metod

Undersökningen bygger på Delphimetoden (Dalkey, Helmer 1963) och datainsamlingen utgår ifrån en tredelad enkätundersökning där en grupp lärare har fått beskriva sin undervisning och utifrån några givna frågeställningar resonera om elevers engagemang. I de uppföljande enkäterna har deltagarna fått ta del av resultat och analys från föregående enkät och getts möjlighet att värdera, kommentera och svara på fördjupande frågor. Lärarna som deltagit är alla förstelärare och undervisar naturvetenskap i årskurs 4-9 i svensk grundskola. Förstelärare är en grupp lärare som definieras av de kriterier som fastställts av skolverket i Sverige. Delphi är en metod för att etablera konsensus bland experter genom att varva flera enkäter (eller intervjuer) med feedback. Jämfört med exempelvis gruppdiskussioner främjar metoden självständigt tänkande samtidigt som deltagaren får hjälp av återkopplingen att utveckla sin uppfattning i olika frågor. Metoden har visat sig användbar när man vill ha ett expertutlåtande i en specifik fråga eller en prognos om ett framtida tillstånd inom ett område. Delphimetoden har använts inom många områden, till exempel utbildningsfrågor (flera exempel ges av Clayton, 1997) men även i forskning om undervisning i naturvetenskap (Osborne 2003, Lund Nielsen, Brandt & Swensen 2016).

4 Preliminära resultat

Det preliminära resultatet indikerar att de deltagande lärarna inte anser att det specifika naturvetenskapliga innehållet påverkar elevernas engagemang i någon högre grad. Istället lyfts lärarens metoder och läraktiviteter fram som viktiga faktorer tillsammans med ledarskap, delaktighet samt undervisningens relevans för eleven.
Resultaten visar också att lärarna tolkar elevernas deltagande (t ex utföra arbetsuppgifter som avtalat, svara på frågor, ställa frågor, komma med förslag mm) och känsloyttringar (glädje, ansiktsuttryck, etc.) som engagemang snarare än hur och med vilken kvalité eleverna medverkar i undervisningen.

Figur 1. Exempel på resultat från enkät två där deltagarna har värderat vilka tecken på engagemang som eleverna uppvisar som viktiga. Varje deltagare (sammanlagt 39 deltagare) fick välja tre tecken vilka var hämtade från deltagarnas svar i enkät ett.

5 Diskussion

De preliminära resultaten pekar på att de deltagande lärarna inte ser ett direkt samband mellan det specifika naturvetenskapliga innehållet och elevernas engagemang. Däremot verkar det som att det vetenskapliga innehållet påverkar undervisningens form, t ex läraktiviteter, vilket i sin tur kan påverka elevernas engagemang. En viktig faktor för engagemanget verkar vara mångfalden av metoder (t ex när det gäller att åskådliggöra begrepp), graden av elevmedverkan och kopplingen till elevernas verklighet. När det gäller tecken på engagemang verkar deltagarna i större utsträckning uppmärksamma det engagemang som kan kopplas till känslomässigt beteende snarare än kognitiva kvalitéer hos eleven.

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56. ARGUMENTATION IN UNIVERSITY TEXTBOOKS: COMPARING BIOLOGY, CHEMISTRY AND MATHEMATICS

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Abstract
Argumentation is a key skill in most school subjects and academic disciplines, including science and mathematics. This study compares explicit argumentation in first-semester university textbooks in biology, chemistry and mathematics in order to increase the understanding of how similarities and differences between disciplines can contribute to, or disrupt, students' transferrable argumentation skills. Results show that there is significantly more explicit argumentation in the mathematics textbook compared to the biology and chemistry textbooks, and significantly more explicit argumentation in the chemistry textbook compared to the biology textbook. Further, the biology textbook contains less argumentation marked by classical argumentative markers such as "since" and "because" and more marked with other, less clear, types of markers such as "which is why" and "when" compared to the other two textbooks. The mathematics textbook contains more complex (recursive) argumentation than the science books. Thereby, the subject-specific languages in the disciplines have potential to offer students different examples of argumentation. The results will be discussed in relation to students' development of scientific literacy.

1 Introduction
Argumentation is a key skill in most school subjects and academic disciplines. Reasoning and argumentation are central within mathematics, according to national curriculum documents and international frameworks for school mathematics (e.g., NCTM, 2000). Similarly, argumentation is a central concept in science education (e.g., Fischer et al., 2014; Konstantinidou & Macagno, 2013). In the Swedish national curriculum, aspects such as argumentation and reasoning were highlighted in science and in mathematics in 2011 (Skolverket, 2011a; b). However, it is not always clear what argumentation and reasoning mean. The lack of clarity is particularly important, since science and mathematics often are characterised differently. Mathematics is frequently described as based on deductive reasoning, logic and exact answers, while science is founded on experimentally based inductive reasoning. Such differences might contribute to differences between the subjects regarding the type of argumentation that is present and valued in, for example, textbooks. However, empirical evidence to support claims regarding different types of texts in different subjects is often lacking (Österholm & Bergqvist, 2013). Recently, an empirical study presented evidence for linguistic differences in Swedish secondary school textbooks in science and mathematics (Riebeck, 2015). The differences include that mathematics texts contain more logical connections and exclamatory sentences compared to science texts, and that science texts contain more declarations of subject knowledge and a higher degree of nominal phrases compared to mathematics texts. These results indicate that there could be differences in the types of explicit argumentation between subjects, but we have not found any studies focusing on such comparisons. In addition, the quality of students' reading comprehension of a text is connected to the coherence of the text (e.g. McNamara, Kintsch, Butler Songer & Kintsch, 1996). The types of argumentation, for example, how different phenomena are connected in the text, is therefore highly relevant to examine.

The purpose of this study is to further the understanding of the role of argumentation in science and mathematics texts. This is approached by comparing the explicit argumentation in first-semester university textbooks in biology, chemistry and mathematics. The research questions posed are:

- What are the similarities and differences concerning the ***amount of*** explicit argumentation between biology, chemistry and mathematics textbooks?

- What are the similarities and differences concerning the ***type of*** explicit argumentation between biology, chemistry and mathematics textbooks?

2 Analytical framework

In this study we define argumentation as: "the act or process of giving reasons for or against something" (merriam-webster.com). The analytical framework was developed by Bergqvist & Österholm (manuscript in preparation) to be used for analysis of educational texts and spoken language, and is a simplified framework building on the model for argumentation by Toulmin (1958). The key components of the analytical framework for argumentation are the conclusion, the premise and the marker. In an argument, there is a direction from something (premise) and/or towards something (conclusion). The existence and components of an argumentation is indicated with an explicit marker, for example "since" or "therefore". Focus on the explicit markers allows us more operationalized definitions of the components and enables us to study a broad range of connections between statements and characterize argumentation in science and mathematics.

3 Research methods

One book each in biology, chemistry and mathematics was selected to represent what a student can meet at a Swedish first semester University course. According to the following criteria: a) written in English, b) used in Swedish basic level university courses, c) used internationally, the books selected were: Campbell Biology (Reece et al., 2013), Chemistry (Chang, 2010) and Calculus: A Complete Course (Adams & Essex, 2013). From each book, chapters representing five weeks full time studies were selected based on authentic schedules and reading instructions from Swedish universities. From the included chapters, 20 pages from each book were randomly selected for analysis.

"Arguments per declarative sentence" was used as comparable measurement between the books. This will mirror what proportion of the statements in each book that are explicitly backed up by arguments. Therefore, for each page, the total number of declarative sentences was counted and commands, questions and exclamations were excluded. After this, arguments were analysed in the remaining text on each page. Each declarative sentence was read and scanned for structures that contained a) a clear statement/conclusion, b) a marker for the argument ***and*** c) one or more premis(es) for the conclusion. The marker was classified as type 1 or 2:

1. Classical word markers, defined as words that clearly signal a logical property between statements. Such words are in a dictionary defined as referring to cause or reason, as their main meaning. These include for example: since, because, thus, therefore, if…then and hence.
2. Other word markers, defined as words that *can* be used to signal a logical property between statements, however, it is not their only meaning. These include for example: that is, according to, consistent with, as, when and which is why.

It was also noted if the argument had objectified premise(s), i.e. premises referred to using a noun or noun phrase such as a formula, figure or chemical reaction, and if it was involved in a recursive structure, i.e. nested into other arguments.

To compare the ***amount of*** explicit argumentation in the biology, chemistry, and mathematics textbooks, preliminary analysis using independent samples t-tests was performed with textbook page as unit of analysis. To evaluate similarities and differences between the ***type of*** explicit argumentation in the biology, the chemistry and the mathematics textbook, three factors were used. The first was proportion of type 1 vs type 2 markers, the second was proportion of arguments with objectified premises and the third was proportion of arguments in recursive structures. All were calculated in % of total amount of arguments for each book.

4 Results

Table 1 shows the amount of explicit argumentation in biology, chemistry and mathematics textbooks. There are significant difference in use of explicit arguments between chemistry and biology (p=0.01), between mathematics and chemistry (p=0.01), and between mathematics and biology (p= 0.0001).

***Table 1**: Amount of explicit argumentation in the textbooks*

Book	Number of statements	Number of arguments	Arguments per statement M (±sd)
Biology	590	105	0.15 (± 0.11)
Chemistry	365	100	0.26 (± 0.14)
Mathematics	262	110	0.45 (± 0.28)

Table 2 shows the type of explicit argumentation in biology, chemistry and mathematics textbooks. Classical markers indicated a higher proportion of the arguments in the chemistry and the mathematics textbooks compared to the one in biology. All three textbooks contained similar amounts of arguments with objectified premises. Recursive structures, where more than one argument was nested into another, were more common in the mathematics textbook compared to the biology and chemistry books.

***Table 2:** Types of markers: classical vs other markers, objectified premises and recursive structures*

Book	Classical markers	Other markers	Objectified premises	Recursive structures
Biology	35%	65%	9%	18%
Chemistry	62%	38%	14%	16%
Mathematics	57%	43%	10%	32%

5 Discussion

From this study we can conclude that both the amount and type of argumentation differ between the textbooks in biology, chemistry and mathematics. In line with the results from Riebeck (2015), there are more similarities between chemistry and mathematics than between biology and mathematics. Further, this study shows that the mathematics textbook contains more argumentation per sentence, and clearer logical connections through a larger proportion of type 1 markers. Based on these differences we draw the conclusion that science teachers can use students' knowledge from mathematics as well as from the different science disciplines to enrich students' argumentation skills. Biology, chemistry and mathematics textbooks contribute with examples that can enrich students' transferrable argumentation skills in different ways.

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57. FINNS "FÖRMÅGORNA"?

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Abstract
The current Swedish national curriculum is often interpreted as if distinct abilities exist, that can be assessed. During 2013-2015 national tests in science subjects for grade six was carried out. One clear assignment was then to provide information about students' scientific knowledge in relation to three so-called abilities: communicate, explore and explain. But is it possible to empirically distinguish the so-called abilities from one another in the students' answers? Exploratory and confirmatory factor analysis was used on more than 60,000 students´ answers to investigate this. The results show that an overall ability is a more reasonable option. There is thus no empirical support for providing grades with special conditions linked to so-called abilities. This will jeopardize test validity and thus also the valid basis for grading. A more reliable option is probably to let the student's strong and weak performances in relation to different parts of the syllabus compensate each other.

1 Inledning

1.1 Bakgrund
Inför införandet av den nu gällande läroplanen (Skolverket, 2016) för grundskolan, förskoleklassen och fritidshemmet var en av ambitionerna att ge lärarna ett bättre stöd för att sätta rättvisa och likvärdiga betyg. Detta skulle ske genom att göra målen i kursplanerna "konkreta och ämnesinriktade” (Davidsson, 2007) och därmed uppnå ökad tydlighet när det gäller mål och betygskriterier. Det nuvarande betygssystemet kan betraktas som ett icke-kompensatoriskt system, genom att goda prestationer på ett område inte kan uppväga mindre goda prestationer på ett annat. Ordalydelsen för exempelvis betyget D ”Betyget D innebär att kunskapskraven för betyget E och till övervägande del för C”, har öppnat för en uppdelning av kunskapskraven i delar, utan att regelverket ger någon tydlig anvisning om vilka delarna är. Att döma av den debatt som speglats i olika media har kunskapskraven och deras olika delar tillmätts en ökande betydelse för såväl undervisning som bedömning. Graden av uppdelning har varierat, allt från att man betraktar varje enskild sats i kunskapskraven som en egen del till att se hela kunskapskravet som en odelbar helhet. Särskilt frekvent tycks det vara att betrakta de punktsatser som utgör en sammanfattning av syftet med undervisningen i varje kursplan som en grund för hur kunskapskraven kan delas upp och benämna dessa *förmågor*. För exempelvis ämnet kemi är lyder formuleringen på följande sätt:

Genom undervisningen i ämnet kemi ska eleverna sammanfattningsvis ges förutsättningar att utveckla sin förmåga att

1. *använda kunskaper i kemi för att granska information, kommunicera och ta ställning i frågor som rör energi, miljö, hälsa och samhälle,*
- *genomföra systematiska undersökningar i kemi, och*
- *använda kemins begrepp, modeller och teorier för att beskriva och förklara kemiska samband i samhället, naturen och inuti människan.*

Punktsatserna tolkas ibland som att det finns tre distinkta förmågor där varje förmåga ska prövas. Ett exempel är Skolverkets nationella prov för grundskolan där eleverna i vissa ämnen, vid varje uppgift, får information om vilken förmåga som prövas.

Under åren 2013 till 2015 genomfördes nationella prov i NO-ämnena för årskurs sex. En uttalad ambition med dessa prov har varit att formulera uppgifter för att pröva elevernas kunskaper i förhållande till de tre så kallade förmågorna så oberoende av varandra som möjligt. Nu när proven har genomförts finns en hel del data för att studera hur ambitionen har fallit ut.

1.2 Forskningsfråga

Går det att empiriskt urskilja de s.k. förmågorna från varandra i elevernas svar på de nationella proven i NO-ämnena i årskurs 6?

2 Teoretiskt ramverk

Explorativ och konfirmatorisk faktoranalys har använts för att undersöka i vilken utsträckning de ”tre förmågorna” är urskiljbara från varandra så som proven har konstruerats. Explorativ faktoranalys är en teknik som går ut på att bestämma det minsta antalet faktorer som på ett rimligt sätt beskriver sambanden mellan ett antal observerade variabler. Målet med explorativ faktoranalys är att hitta det minsta antal tolkningsfaktorer som på ett rimligt sätt förklarar sambanden mellan variablerna.

Den konfirmatoriska faktoranalysen utgår i motsats till exploratorisk faktoranalys från i förväg givna faktorer för en given population. I vårt fall utgörs faktorerna av de formuleringar som finns runt det som brukar omnämnas ”förmågor” i kursplanerna för NO-ämnena i grundskolan. Uppgifter som är tänkta att pröva elevernas kunnande i förhållande till de delar av kunskapskraven som möter upp mot ”förmågorna” definieras till att höra till de olika faktorerna. Utöver dessa faktorer definieras också en faktor som utgörs av de tre faktorerna. Denna används för att studera i vilken utsträckning det finns en övergripande faktor som förklarar mycket av de tre definierade faktorerna.

3 Metod

Data utgörs av mer än 60000 elevers resultat på uppgifter i nationella prov i de naturvetenskapliga ämnena för årskurs 6, åren 2013, 2014 och 2015.

Tabell 1: Antal elever i vårt urval i förhållande till det totala antalet elever som gjort proven.

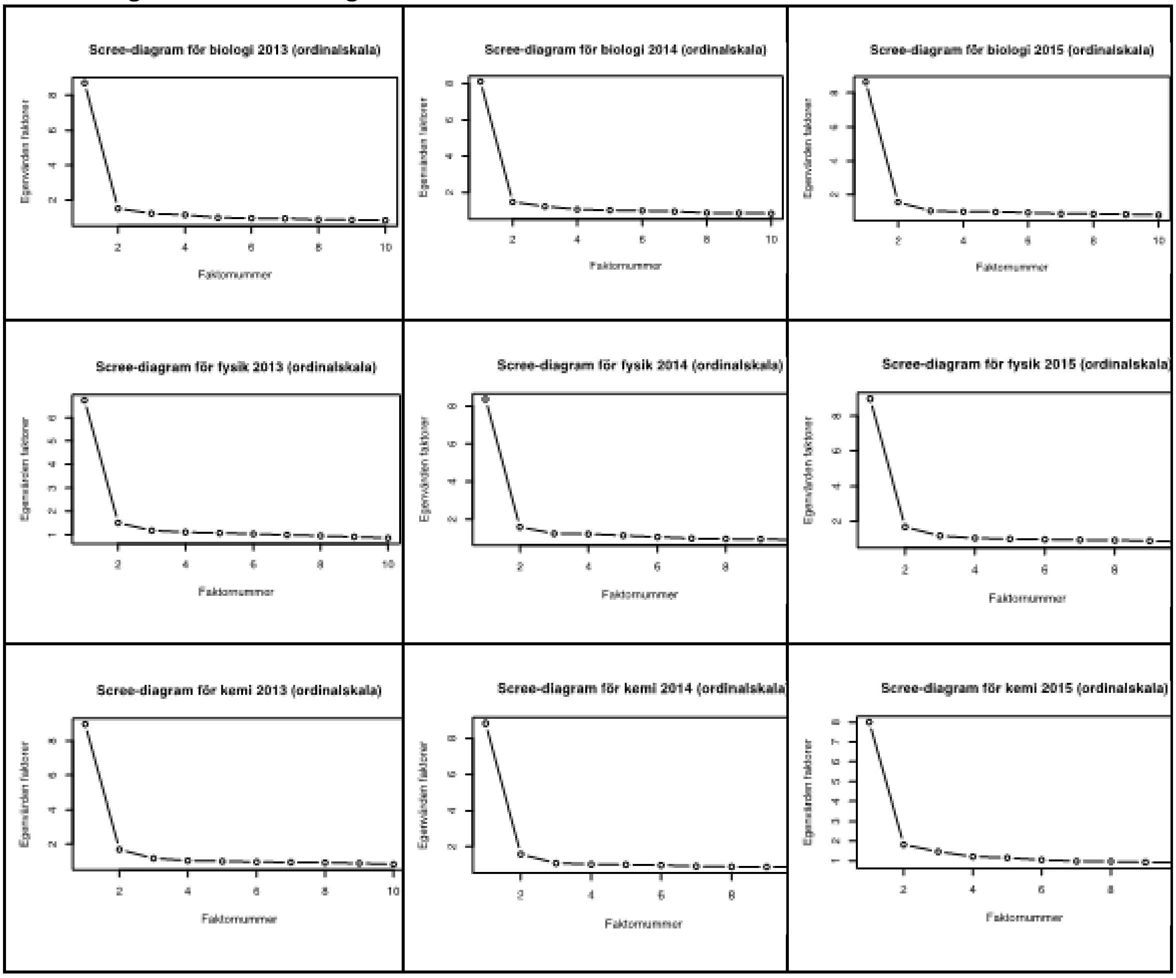
	Antal elever		
År	Vårt urval	Totalt	Andel (%)
2013	29931	92473	32,4
2014	23138	93712	24,7
2015	10298		

Data har funnits tillgängliga för lärares bedömning av elevernas prestation för samtliga uppgifter i varje prov. Faktoranalyserna har gjorts i Mplus (Muthén & Muthén, 2016) med inställningar för ordinalskala.

4 Resultat

4.1 Explorativ faktoranalys

För varje av de nio proven har en explorativ faktoranalys genomförts, vilket har resulterat i nio s.k. scree-diagram som visas i figur 1



Figur 1: Scree-diagram för nio Nationella prov i NO-ämnen för årskurs 6 2013-2015

Scree-diagrammen uppvisar ett liknande utseende för alla nio proven. Det finns **en** tydlig faktor och därutöver en mindre tydlig.

Med enstaka undantag passar uppgifterna en enfaktormodell i alla de nio undersökta proven. Av den anledningen är det intressant att kontrollera om en faktor räcker för att modellen skall passa data? Således har en enfaktormodell kontrollerats, vilket har lett till följande resultat.

Tabell 2: Sammanställning av hur data passar en enfaktormodell för nio nationella prov i NO-ämnen för årskurs 6

Prov	χ^2	*df*	CFI	TLI	RMSEA	SRMR
Biologi 2013	5096*	434	0,95	0,95	0,034	0,040
Biologi 2014	3581*	377	0,97	0,96	0,032	0,037
Biologi 2015	1660*	405	0,96	0,96	0,031	0,036
Fysik 2013	4844*	350	0,94	0,94	0,034	0,038
Fysik 2014	8684*	560	0,90	0,90	0,043	0,043
Fysik 2015	4103*	434	0,91	0,91	0,049 (0,047-0.050)	0,045
Kemi 2013	7890*	405	0,93	0,93	0,044	0,044
Kemi 2014	3856*	464	0,96	0,96	0,032	0,036
Kemi 2015	11347*	464	0,91	0,90	0,083	0,105
Kemi 2015 (-C13)	1685*	405	0,96	0,96	0,030	0,041

Not: χ^2 = chi-kvadrat goodness of fit statistic; df = degrees of freedom; CFI = Comparative Fit Index; TLI = Tucker Lewis Index; RMSEA = Root Means-Square Error of Approximation; SRMR = Standardised Square Root Mean Residual. * χ^2 är statistiskt signifikant.

I kemiprovet 2015 finns en uppgift i Delprov C, C13, som inte passar in i modellen. Genom att ta bort den passar modellen till data bättre. Sammantaget för alla proven betyder detta att den enklast tänkbara modellen som explorativ faktoranalys ger för de nationella proven för årskurs 6 i NO-ämnen består av en faktor.

4.2 Konfirmatorisk faktoranalys

De uppgifter som har utvecklats för att pröva elevernas kunnande i förhållande till de tre förmågorna fördes till varsin faktor. En andra ordningens faktor som består av de tre övriga definierades också i modellen. Relationen mellan andra ordningens faktor och tre faktorerna av första ordningen redovisas i tabellen.

Tabell 3: Laddningar i andra ordningens faktor

Prov	Förmåga A	Förmåga B	Förmåga C
Biologi 2013	0,937	0,937	0,896
Biologi 2014	0,925	0,921	0,923
Biologi 2015	1,031	0,906	0,921
Fysik 2013	0,866	0,948	0,885
Fysik 2014	0,811	0,964	0,855
Fysik 2015	0,781	0,997	0,888
Kemi 2013	0,839	0,977	0,862
Kemi 2014	0,905	0,922	0,894
Kemi 2015	0,915	0,947	0,877

De höga värdena i tabellen visar på att andra ordningens faktor influerar mycket på de tre faktorerna i första ordningen. Detta tyder på att det handlar om en övergripande förmåga hos eleverna som ger utslag i de övriga.

5 Diskussion och slutsats

De nationella proven i årskurs 6 för NO-ämnena, så som de kom att konstrueras, särskiljer inte de s.k. förmågorna från varandra. Istället framstår en övergripande förmåga som ett rimligare alternativ. Det finns således inte något empriskt stöd för att förse provbetygen med särskilda villkor kopplade till de olika förmågorna eller till olika delar av kunskapskraven. Det skulle äventyra mätsäkerheten i proven på ett helt avgörande sätt.

En större fråga är om det är rimligt för lärare att försöka på ett icke-kompensatoriskt vis försöka urskilja olika aspekter i elevers kunnande i förhållande till olika delar av kunskapskraven. Resultaten från proven antyder att det vare sig är lätt eller rimligt. Det är trots allt möjligt att läsa syftestexten som att det handlar om att undervisningen skall ge eleverna att utveckla **en** förmåga genom att det är formulerat i singularis.

Det är också möjligt att förstå texten om att hela kunskapskravet skall vara uppfyllt som att en lärare ska göra en helhetsbedömning utifrån hela kunskapskravet och inte kontrollera om innebörden i varje enskild mening är uppfylld. Det är trots allt mycket rimligt att det råder höga korrelationer mellan de olika kompetenserna som beskrivs.

Som situationen är nu riskerar lärarna att, på grund av för låg säkerhet i bedömningen, ge eleverna onödigt osäkra betyg. Om många olika komponenter skall bedömas som om de vore oberoende av varandra (icke-kompensatoriskt) med tillräckligt hög säkerhet behöver många indikatorer samlas in för varje komponent som skall bedömas. Med begränsad undervisningstid och många meningar i kunskapskraven blir ett sådant arbete med nödvändighet av låg kvalitet.

Ett bättre alternativ är sannolikt att låta elevens starka och svaga prestationer i förhållande till olika delar av kunskapskraven kompensera varandra. Det skulle sannolikt, med utgångspunkt i resultaten i denna artikel, utgöra ett säkrare underlag för betygssättning.

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58. TOWARDS A THEORETICAL MODEL FOR APPROACHING MOTIVATION IN THE SCIENCE CLASSROOM

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Abstract

Motivation cannot be measured directly but has to be evaluated through other indirect measurements, of which questionnaires are the most common. During the work with my doctoral thesis, I needed a theoretical model that took both motivation measured with questionnaires and motivation as observed in the classroom into account. This paper presents the developed model for approaching motivation in the science classroom from multiple theoretical perspectives and allows a holistic view of motivation in complex classroom situations. The model emerged from the Hierarchical model of intrinsic and extrinsic motivation by Vallerand, and the process model of motivation by Dörnyei. Both models take aspects of motivational dynamics into account. The combined holistic model contributes to motivation research by being a tool to align motivation as measured with questionnaires with motivation as seen through students' actions in the classroom. With this paper I would like to invite discussion of possibilities and limitations with motivation research from different perspectives in science education.

1 Motivation in science education

Motivation is often defined as "an internal state that arouses, directs and sustains students' behaviour" (Koballa & Glynn, 2007, p. 85). As an internal state, motivation cannot be observed directly, but must be studied through one or more other aspects that are perceived as being related to motivation. Research on motivation in science education has, like research of motivation in most other educational disciplines, relied heavily on quantitative evaluations of student self-reports. There are advantages to much research being done with the same platform, but also limitations. For example, Potvin and Hasni (2014) argue that: "the use of questionnaires [in motivation research] is so common that it is not impossible that researchers have somehow lost sight of its limitations" (p. 111).

When reviewing literature for my thesis (Hellgren, 2016), I was surprised to see how weak the connection was between students' motivation and classroom studies, and the difficulty with linking the two since they traditionally start in different theoretical perspectives. However, recently, some researchers (e.g. Nolen, Horn & Ward, 2015; Potvin & Hasni, 2014; Turner 2001; Turner & Nolen, 2015) have addressed the limitations of the narrow focus in motivation research and argued for more research taking a starting point in other perspectives. This suggestion creates potential for extending motivation research towards classroom settings, which was something I needed for my work. Therefore, I aimed to elaborate on a model from multiple theoretical perspectives, combining motivation as measured with questionnaires with students' actions in the classroom–a model that allows a holistic view of motivation in complex classroom situations. With this paper I would like to suggest a holistic model for motivation in the science classroom and open up for discussion of possibilities and limitations with motivation research in science education.

2 Theoretical perspectives

I chose to combine two theoretical starting points to suggest a model for connecting motivation as described by conventional motivation theories with students actions in the classroom. The first was the Hierarchical model of intrinsic and extrinsic motivation (HMIEM; Vallerand, 2000) and the second was a process model of motivation by Dörnyei (Dörnyei & Ottó 1998; Dörnyei 2000). Both models take aspects of motivational dynamics into account.

HMIEM builds on self-determination theory (SDT; Deci & Ryan, 1985) and includes intrinsic and extrinsic motivation as well as acknowledging that intrinsic motivation is dependent of the fulfilment of the three basic needs –competence, autonomy and relatedness. The contribution of the model is that it divides motivation into three different levels of generality: Global motivation, a person's general motivation tendencies when they engage in an activity and interact with their environment; Contextual motivation, which is a person's motivation towards a specific domain such as science; and Situational motivation that represents motivation here and now in the specific current situation, for example in a specific science lesson (Lavinge & Vallerand, 2010). Lavinge and Vallerand (2010) also suggest interaction between the different levels of generality, both in terms of top-down and bottom-up (recursive) effects. Further, each level in the model motivation is affected by contextual factors, mediated through competence, autonomy and relatedness.

Dörnyei and other researchers in the field of second-language learning theorized motivation as a "complex dynamic system" and explored motivation in the classroom in ways that acknowledge motivation as a dynamic and interactive process. For example, they developed a process-model to study motivation in the classroom (Dörnyei & Ottó 1998, Dörnyei 2000). It differs from the other views of motivation by adding a clear time perspective and drawing on the dynamic aspects of motivation that ought not be neglected in a complex classroom environment. They describe their approach as "a situated and process-oriented account of motivation" that inevitably leads us to a dynamic conception of the notion of motivation that integrates the various factors related to the learner, the learning task and the learning environment into one complex system whose ultimate outcome can be seen as the regulator of learning behaviour (Dörnyei & Ushioda 2011, p. 89). The time dimension divides the complex dynamic system into 3 stages; the pre-actional, the actional and the post-actional stage. The pre-actional stage involves setting goals, forming intentions and launching action before the actional stage, which represents the learning situation. The post-actional stage is retrospective and evaluating. This model provides a framework to relate individual motivation, such as goals and attitudes, to what happens in the complex dynamic classroom setting.

3 Suggesting a holistic model for motivation in the classroom

Combining the two theoretical models (see Figure 1) allows us to combine a broader range of methods for studying motivation and align and discuss the outcomes from a holistic perspective. For example, Global motivation and contextual motivation can be measured with questionnaires. Situational motivation can be measured with questionnaires or stimulated recall interviews, or with techniques for data collection via for example mobile phones in real time during a science lesson. Pre-action, action and post-action motivation is possible to access through a combination of interviews and observations. The indicators selected (Figure 1) are based on Dörnyei's (2000) model and Andersen & Nielsen's (2013) detailed classroom observation study of motivation in the science classroom.

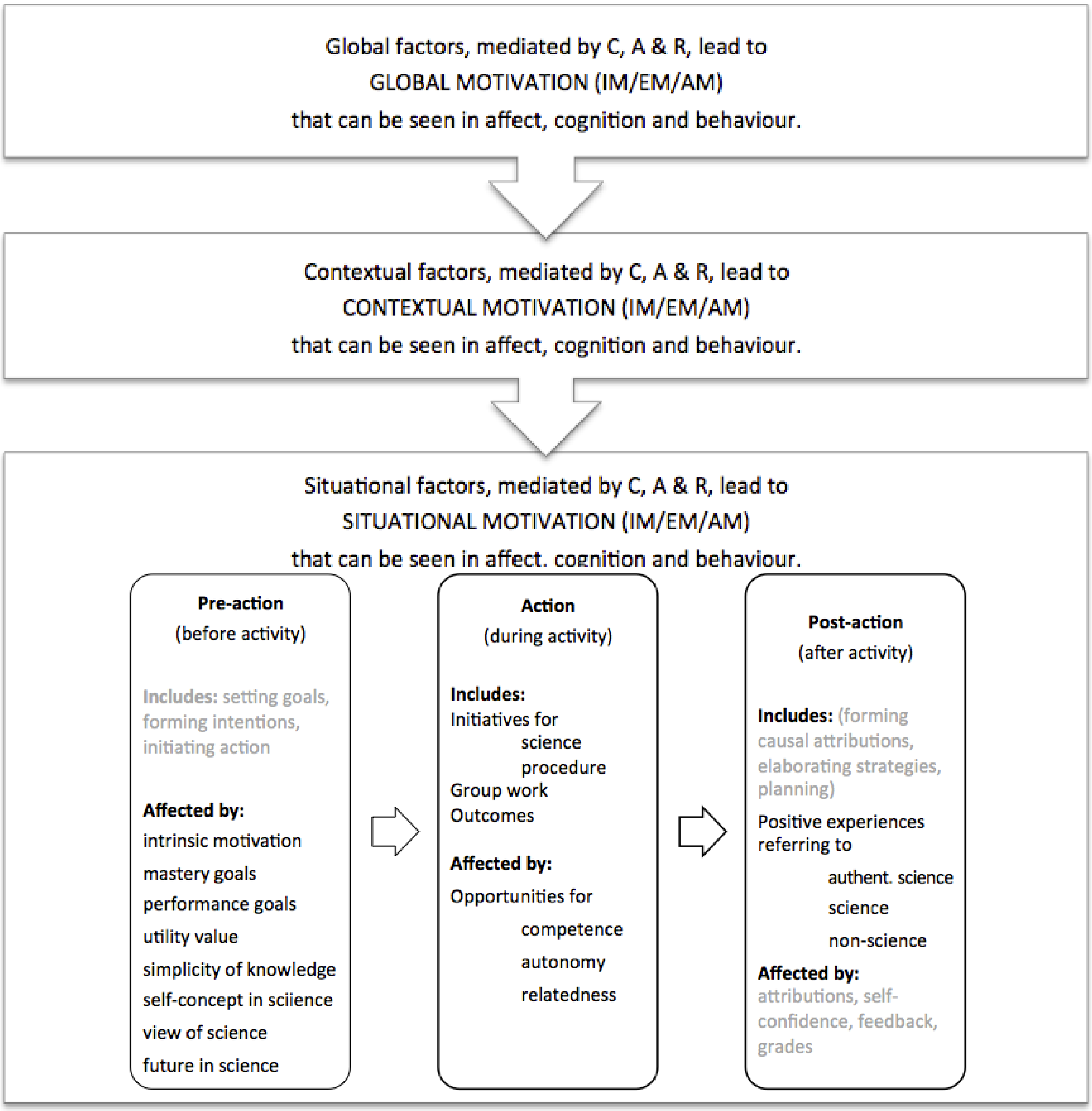

Figure 1. *A holistic theoretical model for students' motivation for science.*

4 Discussion and conclusion

The combined model to consider motivation as dynamic contributes to motivation research by being a tool to align motivation as measured with questionnaires with motivation as seen through students' actions in the classroom. By combining the two results in my thesis, I could draw the conclusion that in my particular study, situational (classroom) factors were of greater importance than contextual and global motivation factors for students' experiences in the science classroom. This strengthened my view of the importance of more research on motivation from a situational perspective. It also made me extend the definition of motivation used in my thesis to "an interplay between internal and external factors that stimulate peoples' energy, commitment, interest and effort to start up and continue to work towards different goals" (Hellgren, 2016, p. 2). This definition allows the context a more central role and includes contributes to highlighting the complexity of motivation as a process in the classroom.

For further studies and better understanding of students' motivation for science, my suggestions go in line with those of for example Potvin and Hasni (2014), Turner (2001) and Turner and Nolen (2015): more research must start in different perspectives and use other methodological approaches than questionnaires. For these reasons, I posit that we can learn more about for example relationships between motivation and actions, and between what happens in classroom and students long-term contextual and global motivation. This could further clarify and develop the suggested model and lead to improved practices in science teaching.

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59. IMPLEMENTERINGEN AF FLIPPED LEARNING I FYSIK/KEMI-UNDERVISNINGEN I GRUNDSKOLEN

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Abstract
This paper presents the preliminary findings and methodological framework from a study on the implementation of Flipped Learning in science classrooms in the Danish elementary school system. As a mixed methods case study consisting of observations and interviews, three science classrooms have been documented over the course of 15 weeks; prior to-, during- and after the implementation of a Flipped Learning approach to teaching and learning. Although ideas of Flipped Learning and Flipped Classroom have gained increased popularity amongst practitioners within different levels in the educational system and cultural contexts, the empirical contributions are few. The purpose of this study is to gain insight into the experiences and practice of teachers and students when engaging in Flipped Learning. The preliminary findings suggest that the implementation of Flipped Learning does not necessarily make way for changes in classroom practices as expected. However, the experience of Flipped Learning by students and teachers offers a different and more optimistic set of narratives.

1. Indledning

I dette paper præsenteres de foreløbige fund og metodologiske greb fra et igangværende forsknings- og udviklingsprojekt, der har fokus på implementeringen og udviklingen af en Flipped Learning-didaktik for fysik/kemi-undervisningen i den danske grundskole. Projektet er gennemført som et interventionsstudie henover 15 uger på tre danske folkeskoler, hvor undervisningen er fulgt før, under og efter implementeringen af Flipped Learning. Projektet er konstrueret som et mixed methods casestudie, der kombinerer kvantitative og kvalitative data fra klasserumsobservationer og interview med lærere og elever i tre 8. klasser. Om end Flipped Learning i stigende grad har vundet udbredelse og omtale i Danmark, såvel som internationalt, er det begrænset hvad der er lavet af empiriske undersøgelser af tilgangen (Abeysekera & Dawson, 2015: 2). Dette casestudie har til formål at få større indblik i læreres tilegnelse og praktisering-, og elever og læreres oplevelse af didaktiske principper fra Flipped Learning i forhold til fysik/kemi-undervisningen i grundskolen.

1. Hypoteser forbundet med Flipped Learning

Flipped Learning - eller Flipped Classroom - er fællesbetegnelser for undervisningsformer præget af en grundlæggende ambition om at fremme elevaktiverende undervisning og læring ved at transformere dele af læreroplæg til digitalt tilgængelige undervisningsvideoer som eleverne bruger især, men ikke kun, *før* undervisningen starter. Med især Bergman &Sams (2012), Mazur (2013) og Khan (www.khanacademy.org) som ophavsmænd, og forskellige videreudviklinger i dansk sammenhæng, som fx Hachmann & Holmboe (2014), Levinsen m.fl. (2016) og Schunk (2016), ligger der med Flipped Learning bl.a. nogle hypoteser om at kunne understøtte mere elevcentreret undervisning på et højere forståelsesniveau, via en ændret lærerrolle hen imod mere differentieret facilitering, og derudover skabe større 'undervisningsparathed' hos eleverne (Hachmann & Holboe, 2014: 15, Levinsen m.fl., 2016: 45).

2. Forskningsspørgsmål og undersøgelsesdesign

Forskningsspørgsmålene for denne undersøgelse lyder:

A) Hvordan influerer implementeringen af Flipped Learning på fordelingen af tid brugt på henholdsvis lærercentreret og elevcentreret undervisning?

B) Hvordan opleves og fortolkes Flipped Learning af lærere og elever efter implementeringsfasen?

Da projektet skal indfange forskellige dimensioner af Flipped Learning - både den målte såvel som den oplevede undervisningspraksis - er det konstrueret som et mixed methods casestudie, hvor kvalitative og kvantitative data skal komplementere hinanden (Yin 1991, Frederiksen, 2015:201). Datamaterialet der ligger til grund for de to forskningsspørgsmål og empiriske nedslag i dette paper, består af: 1) videooptagelser fra fysik/kemi-undervisningen, og 2) interviews med fysik/kemi-lærerne, samt fokusgruppe-interviews med elevgrupper fra tre klasser.

De tre klasser er fordelt på forskellige skoler udvalgt med en socio-demografisk placering (nord, vest og syd-øst for København). De tre lærere er udvalgt med variation ift. køn, alder, anciennitet, og forudgående erfaring med principper fra Flipped Learning inden de blev en del af projektet (Flyvbjerg, 2015: 507).

3. A) Hvordan influerer implementeringen af Flipped Learning på fordelingen af tid brugt på henholdsvis lærercentreret og elevcentreret undervisning?

Det første empiriske nedslag har fokus på tidsfordelingen i undervisningen. Baggrunden for dette fokus har rod i at et af de oprindelige argumenter for at skabe en undervisning efter Flipped Learning-principper, har handlet om at allokere mere tid fra læreroplæg over til elevernes aktive læretid, ved at flytte formidlings-dele ud af klasserummets tid/rum-begrænsninger (Bergman & Sams, 2014: 25, Abeysekera & Dawson, 2015: 2, Levinsen m.fl., 2016: 37).

Et kvantitativt orienteret fokus på tidsfordelingen refererer til et teoretisk paradigme, hvor det er den 'målte klokketid' der gør en forskel (Duncheon & Tierney, 2013: 237). Det reproducerer på sin vis en snæver forståelse af Flipped Learning, idet fokus på den målte tidsfordeling implicit angiver at en ændret fordeling til fordel for en mere elevcentreret undervisning vil være et succeskriterium i sig selv (Abeysekera & Dawson, 2015: 2). Tidsfordelingen handler imidlertid også om grundforståelser af læring, og antagelser om at øget tid til elevernes aktive arbejde er en forudsætning for læreprocesser på et højere forståelsesniveau (Helmke, 2013: 155, Barak & Shakhman, 2008).

Der er på baggrund af videooptagelserne før, under og efter implementeringen, foretaget kodninger af data med afsæt i nedenstående fire analytiske kategorier. Disse kategorier er bl.a. behæftet med analytiske forbehold i kraft af at de i nogen grad kan være overlappende (Berliner, 1990).

- **Lærercentreret undervisning** *(undervisningstid hvor læreren er i centrum, typisk med lærer-oplæg)*
- **Elevcentreret undervisning** *(undervisningstid hvor elevens aktiviteter er i centrum)*
- **Lærer-elev-interaktion** *(undervisningstid hvor lærer og udvalgte elever interagerer/kommunikerer)*
- **Ikke-faglig aktivitet** *(undervisningstid hvor eleverne er optaget ikke-faglige forhold)*

Tidskodningerne viser helt overordnet, at der på tværs af de tre klasser ikke kan ses et fald i tiden anvendt på lærercentreret undervisning *under* og *efter* implementeringen af Flipped Learning, sammenholdt med *før* implementeringen af Flipped Learning. Tilsvarende ses der ikke en øget mængde tid iværksat til elevcentreret undervisning efter implementeringen af Flipped Learning. Forskellene i tidsforbruget i undervisningen er imidlertid større *imellem* de enkelte lærere.

Resultaterne af tidskodningerne er således ikke i tråd med den intenderede Flipped Learning-praksis. Det kan der være flere forklaringer på:

Forandring og træghed i kompetenceudvikling

De deltagende lærere i projektet har gennemført et sammenhængende fire-dages kursus, men ikke et forløb over længere tid, eksempelvis under kontinuerlig supervision. Resultaterne kan i det lys måske i højere grad give os information om en kompetenceudviklings-proces end om påvirkningen af Flipped Learning i sig selv. Bourdieus habitus-begreb (Bourdieu & Wacquant, 2001: 111) kan her hjælpe til at forstå træghed i pædagogiske sammenhænge, samt kaste lys over potentielle udfordringer med at skabe *transfer* (Bottrup m.fl., 2008) mellem teori og praksis, og mellem læreres læring og socialiseringsprocesser. Habitus forstået som en 'kropsliggjort historie' betyder her at lærerne trækker på erfaringer, forestillinger og vaner skabt over lang tid i samspil med den konkrete hverdag i skolen. Disse vaner er ikke uforanderlige, men kræver en længerevarende praksis-forankring.

At måle på forholdet mellem *før* og *efter* implementering

Et andet forhold af potentiel betydning for resultaterne handler om udvælgelsen af lærerne. Her melder sig et spørgsmål om, i hvilken grad, og på hvilke måder implementeringen af en Flipped Learning-praksis kan ses som et brud med - eller forlængelse af de pågældende læreres vante pædagogiske stil. Med andre ord, kan resultaterne også være udtryk for at de deltagende lærere i forvejen havde en forholdsvis stor vægtning af elevcentreret tid i deres undervisning.

4. B) Hvordan opleves og fortolkes Flipped Learning af lærere og elever?

Inddragelsen af interviews har til formål at undersøge betydningen af Flipped Learning fra et deltagerperspektiv. Det skal skabe grundlag for at belyse hvorvidt og hvordan lærere og elever oplever ændringer i forhold til hypoteser om bl.a. mere elevcentreret undervisning, aktivitet og fagligt fokus. Ved afslutningen af forløbet er udvalgte lærere og elever blevet interviewet via en kvalitativ semistruktureret tilgang. For både at indfange perspektiver relateret til hypoteserne, og skabe rum for øvrig information, er interviewdata blevet tolket deduktivt suppleret med en mere datastyret kodning (Kristiansen, 2015: 485).

Tid til elevcentreret undervisning

Når spørgsmålet om hvorvidt implementeringen af Flipped Learning øger tiden til elevcentreret undervisning besvares via et andet teoretisk paradigme, nemlig via aktørernes *subjektive* oplevelse af tid (Duncheon & Tierney, 2013: 237), tegner der sig et andet billede end via målingerne. Elever giver i interviews udtryk for en oplevelse af at læreren bruger mindre tid på at gennemgå stof og fremgangsmåder i undervisningen, at de har mere tid til at arbejde med stoffet, og at de når mere og vanskeligere stof i undervisningen end tidligere.

Kvalificeret aktivitet og fokus

Lærere og elever betoner også at indførelsen af videoen påvirker elevernes forberedelse, faglige fokus og kvalificeringen af deres aktivitet i undervisningen. Begge parter oplever at eleverne er bedre forberedte og 'tunet' ind på fysik/kemi-faget, når de møder op til undervisningen; dels i forhold til det faglige indhold, og dels i forhold til aktiviteterne og formålet med dem.

Videoen som motivationsfaktor

Eleverne fremhæver desuden særligt videoen som et funktionelt medie, der tilbyder et motiverende alternativ til læreroplæg, hvilke ellers beskrives med oplevelsen af at være lange og kedelige. Videoerne beskrives med kvaliteter i forhold til at være korte, at de kan afspilles på forskellige tidspunkter og forskellige steder. Disse oplevelser taler ind i et perspektiv på brugen af digitale medier i undervisningen som motiverende for børn og unge i kraft af potentialet i at gøre eleverne til deltagere, mere end modtagere (Sørensen, 2013: 90).

5. Foreløbige konklusioner og udviklingsperspektiver

De foreløbige konklusioner fra casestudiet viser at implementeringen af Flipped Learning ikke nødvendigvis øger mængden af elevcentreret undervisning sådan som ventet. Klasserumsobservationerne fortæller derimod at en Flipped Learning-tænkning fortolkes og implementeres individuelt væsensforskelligt fra lærer til lærer. Udsagn fra interviews kontrasterer klasserumsobservationerne. Her er oplevelser af øget tid til aktiviteter, samt et mere kvalificeret fokus i kraft af videoerne fremtrædende. Oplevelserne giver også information om lærere og elevers fortolkning af Flipped Learning i en tidlig implementeringsfase. Begge parter forbinder i særlig grad videoen som det afgørende anderledes element i deres fysik/kemi-undervisning. I et udviklingsperspektiv giver de foreløbige konklusioner anledning til i højere grad også at betone øvrige elementer i kompetenceudviklingen af lærere i forhold til Flipped Learning i fysik/kemi-undervisningen.

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60. PROFESSIONAL DEVELOPMENT OF SCIENCE AND MATHEMATICS TEACHERS FOR BUILDING STUDENT DIGITAL COMPETENCE: EXPERIENCE OF LATVIA

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Abstract

In order to be successful in building student digital competence, teachers have to improve their personal ICT using skills, exchange best practices, opinions, analyze and reflect on their own and colleagues' learning, collaborate in planning targeted use of ICT in teaching/learning process. Teachers acquire the above mentioned practice at professional development sessions. Lesson observation data reveal that technical skills, modelling of separate lesson segments and acquiring best practices is insufficient to enable purposeful teacher application of ICT in building student digital competence. The current professional development models help teachers improve their ICT usage skills and identify available resources, as well as lead and organize lessons utilizing pre-developed support materials. In order for teachers to acquire the professional capacity of building student digital competences, a next stage of a professional development model must be designed. This article describes teacher professional development (CPD) models for building student digital competences in science and mathematics in Latvia over a period of 10 years and points out recommendations for the next stage of a learning study based teacher CPD model.

1 Introduction

Key competencies specified by the European Commission (2006) include digital competence: the set of knowledge, skills, attitudes that are required when using ICT and digital media to perform different tasks (Ferrari, 2012). In order to be able to develop student digital competence, a teacher must improve his/her own professional performance. One of the focus areas is using ICT with effective teaching strategies to expand learning opportunities and content knowledge for all students (AITSL, 2011).

EU funding for several projects (2005 – 2011) helped supply schools with modern equipment for science classrooms: ICT equipment and methodological support materials in schools (grades 7-12). Professional teacher development classes organized within the European Structural Fund projects (ESF) helped them learn working skills with the ICT equipment through model lessons using multiple learning methods, while they concurrently acquired ICT application skills during their teaching/learning.

In the first stage (15 hours out of 72) of CPD classes teachers of physics, chemistry, biology and mathematics (grades 10-12) were introduced to the multiple ICT application possibilities; they improved their skills of using ICT advantages in teaching/learning. The next stage of CPD (6 hours out of 36) provided teachers (grades 7-9) an opportunity to perfect their ICT tools usage skills and focused on purposeful application of ICT by introducing examples of best practices.

2 Theoretical framework
UNESCO`s Framework (UNESCO, 2011) emphasizes that teachers need to be able to help students become collaborative, problem solving, creative learners through using ICT. Teachers need to be active agents, not just in the implementation of innovations, but also in their design (OECD, 2015).

Following analyses of teacher progress in Latvia of transferring CPD provided knowledge and skills about purposeful ICT usage to the classroom, we have concluded the following: 1) teachers have acquired the basic skills of application of ICT tools; 2) teachers possess knowledge of purposeful usage of ICT in teaching/learning, although the actual performance in the classroom often fails to support it; 3) a different solution for a format in CPD classes has to be sought (Dudareva, Namsone, 2016). Developing new types of CPD would be a good way to support teachers in learning more about ICT, helping them purposefully integrate ICT into their teaching.

3 Research methods
3.1. Research question
1. What stages can be identified in teacher professional development on the focused area: building of student digital competence in Latvia over a period of 10 years?
2. What should the next stage CPD model of building student digital competence be like?

3.2. Participants involved
The research involves a group of 35 science and mathematics teachers who participated in teacher-leader group (2013-2016) organized by the Center for Science and Mathematics Education, University of Latvia. Participants have completed CPD classes offered by ESF projects. They have acquired similar previous experience and understanding of ICT usage.

3.3 Data collection and analysis
3.3.1 Teacher continuing professional development stages
Methods of the research: analysis of CPD programs, program evaluation and lesson observation.

3.3.2 Teacher professional development model, learn by using lesson examples
The Centre for Science and Mathematics Education organised workshops (6 x 6 hours over one school year) to study how development of lesson examples help teachers improve their own professional performance. Each seminar included input sessions on a particular issue: knowledge construction, meaningful use of ICT, etc.), then joint lesson planning, reflection on others group lesson plans, adapting to a teacher’s own classes. Every subsequent seminar started with reflection on the lessons planned during the previous seminar and lessons lead between the seminars.

To identify the level of engagement with ICT by students in the classroom, availability of ICT tools for active construction of knowledge and development of new products an adapted rubric was used to analyse the planned 23 lessons: (Table 2) Use of ICT for Learning (Microsoft Partners in Learning, 2012).

Methods of research: analyses of the developed model, teacher`s developed lesson plans by using Usage of ICT for Learning Rubric.

4 Results

4.1 Stages of teacher CPD on the focus area: development of student digital competence

***Table 1**: Goals of content ICT classes for teacher professional development*

Criteria	Stage I (15 h)	Stage II (6 - 8 h)
Usage of ICT tools and resources	To acquire the technical skills to use various ICT tools. Teachers identify the resources available for the organization of the teaching/learning process.	To use the developed teaching materials, ICT tools and resources in the teaching/learning process. To learn from colleagues' 'best practices' examples. Students identify the resources available for the learning process: videos, virtual labs etc.
	Basic learning model	Support system model
The aim of teaching/learning	To use ICT in the teaching/learning process for visualization, to demonstrate content to students, to deliver information.	To enhance ICT skills for organizing the teaching/learning process, to plan according to the achievable outcomes, to engage students with content, to facilitate cooperation during and beyond lessons.

4.2. ITC usage level for improving student digital competence

Outcome of analyses of teachers developed 23 lessons according to ICT usage goals (Table 2).

***Table 2**: Usage of ICT according the Learning Rubric.*

Level	Criteria	Number of lessons, %
1	Students do not have the opportunity to use ICT for this learning activity	35
2	Students use ICT to learn or practice basic skills or reproduce information, but they are not constructing knowledge.	26
3	Students use ICT to support knowledge construction, but they could also construct the same knowledge without using ICT.	13
4	Students use ICT to support knowledge construction and the ICT is required for construction of this knowledge.	9
5	Students do create an ICT product for authentic users.	17

5 Discussion and conclusion

5.1. First stage of teacher CPD: a basic learning model

Our previous research showed that since 2006, ICT tools and resources have been incorporated in teaching/learning at schools. (Dudareva, Brangule, Nikolajenko, Logins & Namsone, 2011). The first stage of CPD on using ICT for science and math teachers focused on introducing technologies and practical skills of ICT usage in the classroom.

5.2. Second stage of teacher CPD: a support system model

The second stage of CPD focused on the modelling of lesson fragments to acquire skills to plan purposeful ICT usage in the classroom, where apart from learning ICT application skills, students would master solving problems, model processes, find and access information, develop and improve their collaboration skills etc. However, lesson observation showed that students had access to ICT in only 22% of the observed lessons, while 40% of the lessons revealed that the choice of ICT was not the best means to reach the goals set for the lessons (Dudareva, Namsone, 2016). Student answers to OECD PISA research from 2015 (Geske, Grīnfelds, Kangro, & Kiseļova, 2016, p. 112) on the frequency of using ICT at school and outside it show a negative connection between the intensity of ICT usage at school and student average success in all content aspects of the test – mathematics, science and reading.

The availability of technology does not automatically ensure a change of a teacher's pedagogical approach (Campbell & Martin, 2010). The use of ICT promotes improving student learning outcomes only when teachers have the knowledge about the efficient and purposeful use of ICT in the teaching/learning process (Ertmer & Ottenbreit-Leftwitch, 2010).

5.3 Next stage of teacher CPD: a deeper learning model

Our current research focuses on developing the next stage of teacher CPD. It`s should focus: 1) on ICT tools that encourage personalised learning and immediate feedback; 2) on developing assignments and problems that require usage of ICT and thus facilitate construction of knowledge and/or development of new products by students. Analyses of the data obtained during the research and evaluation of continuing education classes (I and II stage) help us develop the next stage of professional development (Table 3).

***Table 3**: Goals and content of next stage ICT classes of teacher CPD*

Criteria	Stage III
ICT tools and resources	To acquire technical skills to use ICT tools for personalized learning (tablets, mobile phones etc.) To identify and acquire new generation ICT education tools and resources for CPD, for example: Learning Designer (http://learningdesigner.org), InstaGrők (https://www.instagrok.com) etc.
	Deeper learning model
The aim of teaching/learning	To design a teacher own lessons with purposeful use of ICT tools and resources: - to encourage students to think in new ways, to persist in the face of challenges - to help students actively construct knowledge, to solve complex problems - to encourage students to communicate effectively, to collaborate - to develop student skills to monitor and direct their own learning

The model corresponds to recommendations found in sources of literature: 1) CPD needs to be designed on the basis of meeting teacher individual needs as a priority; 2) collaborative approaches should be core to designing ICT CPD (Daly, Pachler, Pelletier, 2009). This model should help teachers overcome one of the challenges regarding CPD: that teachers need to be at the centre of their own learning if they are to change their deep-seated beliefs and habits regarding the use of technology.

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62. CONNECTING ORCHESTRATION AND FORMATIVE ASSESSMENT IN THE TECHOLOGY RICH SCIENCE CLASSROOM

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Abstract

This paper focuses on orchestration types in relation to formative assessment strategies in a set of science lessons in a grade 5 class and a grade 7 class in two Norwegian primary schools. The theme of the lessons was "How to prevent micro-organisms from spreading". Lesson study was the model used for implementing the lessons. A great range of approaches for formative assessment was employed, digital and non-digital. We agree that effective teaching requires the skillful orchestration of several tools. The lens of orchestration offers deeper insights in the effect of particular blends of tools and particular usages of tools. We raised the question on how we can orchestrate the combination of digital and non-digital tools to make students' thinking visible. Our analysis lead to the necessity of extending the existing orchestration theory. We argue that innovative use of digital and non-digital technology to collect immediate feedback at individual, group or whole-class level, should figure as new ways of orchestrating the tools/artefacts, when we have formative assessment in mind.

1 Introduction

The research reported in this paper was conducted as part of the EU Fasmed project[4], which brought together eight countries, researching the use of formative assessment (FA) and technology in mathematics and science education. Part of each country's work has been done in the form of case study interventions in ordinary classrooms in close cooperation with school teachers. In this paper we focus on a particular set of science lessons concerning microorganisms, and how orchestration of different types of technological tools can serve as FA strategies and thus make students' thinking visible.

2 Theoretical frameworks

It has been argued that the development of digital technology puts institutionalised learning activities under increasing pressure. As Säljö (2010, p.53) says, "the technologies do not merely support learning; they transform how we learn and how we come to interpret learning… What we know and master is, to an increasing extent, a function of the mediating tools we are familiar with."

The research literature also refers to an international paradigm shift with regard to assessment; the concept FA has challenged the concept of summative assessment. The reason for an explicit focus on improving assessment practice is the huge impact it has on the quality of learning (Boud, 2010).

There is no doubt that digital technologies are changing our teaching practices, but there are no collective patterns of how teachers use digital technology in their assessment practices (Fossland, 2015). Within the Fasmed project we have combined educational technology tools and FA, and researched the role of technologically enhanced FA methods in raising the attainment levels of students in science and mathematics.

The main theoretical perspective used in this paper is the notion of *instrumental orchestration*. It is widely acknowledged that student learning needs to be guided by the teacher through the orchestration (McKenzie, 2001) of situations or artefacts. By using the instrumental approach (Trouche, 2004) as a theoretical lens, we analyse the teacher's role in guiding the use of technology by students. Drijvers et

[4] Fasmed = Improving Progress for Lower Achievers through Formative Assessment in Science and Mathematics Education, see https://research.ncl.ac.uk/fasmed/

al. (2013) extended Trouche's theory and they identified the following types of orchestrations which were added to by Carlsen et al. (2016) (Table 1):

Table 1. A summary of orchestration types as presented in Drijvers et al. (2013) and Carlsen et al. (2016).

Orchestration type	**Description**
Technical-demo	Demonstration of technology/techniques by the teacher
Discuss-the-screen	Whole class discussion about the digital output
Explain-the-screen	Whole class explanation by the teacher, guided by the digital output
Guide-and-explain	Similar to Discuss-the-screen but closed/teacher-led discussion
Link-screen-board	Teacher links the digital output to paper/book work
Spot-and-show	Interesting student work is used to stimulate classroom discussion
Sherpa-at-work	A student presents her/his work and/or carries out actions at the teacher's request
Board-instruction	Teacher writes on the board with no link to technology
Technical support	Supporting individual students with issues concerned with technology

To stress the connections between the functionality of technology, the orchestrations and FA strategies, we were inspired by the theoretical Fasmed framework[5] and Figure 1.

Lesson study was the model used for implementing the lessons. Lesson study is "a systematic investigation of classroom pedagogy conducted collectively by a group of teachers rather than by individuals, with the aim of improving the quality of teaching and learning" (Tsui and Law 2007, p. 1294).

Our research question is:
How can we orchestrate the combination of digital and non-digital tools in the science classroom in order to make students' thinking visible?

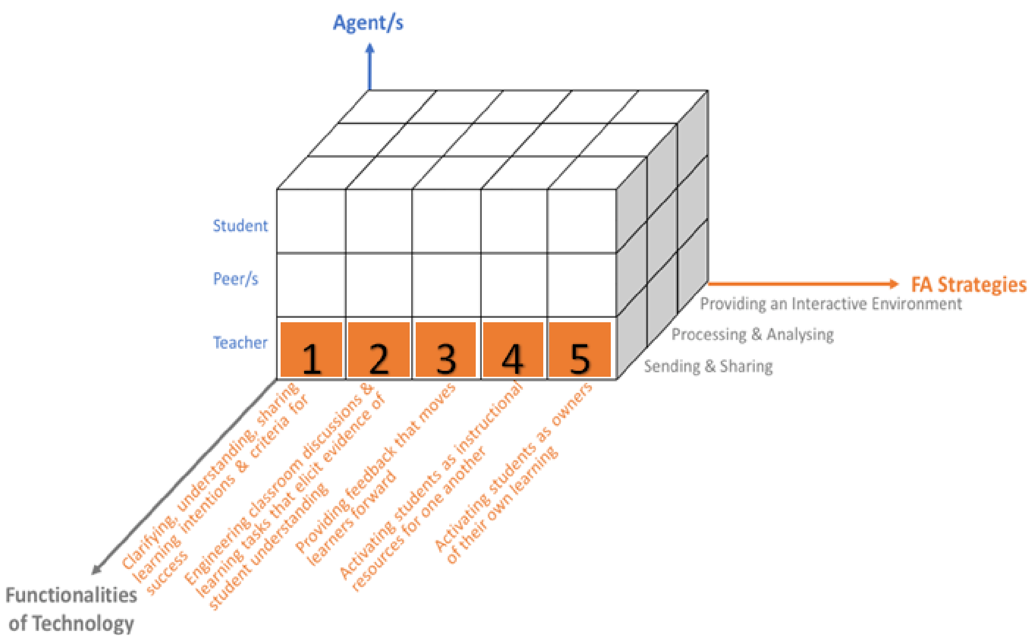

Figure 1. The theoretical Fasmed framework. FA strategies are highlighted with nr 1-5.

3 Research methods

Lessons

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[5] https://research.ncl.ac.uk/fasmed/deliverables/

This study is based on a series of lessons on the particular topic „How to prevent micro-organsims from spreading“. The lessons were first developed for school B (5th grade) and subsequently redesigned for a different group of students at school S (7th grade). Lessons were planned and performed within a lesson study concept, with a group of five teachers and four teacher educators. Students were supposed to explore how far a sneeze is spread and how to best prevent it spreading by performing practical experiments and record their results. The non-digital technologies comprised of post-it notes, whiteboards and blackboard. The digital ones comprised of computers, IPads, interactive whiteboards (SmartBoard and Smartnotebook), data analysis software (Excel), student response system (Socrative). Regarding FA, whole class-, group- (incl.peer) and self-assessement were used.

Data and analysis

Multiple data sources were collected from the lessons to insure in-depth analysis: lesson plans, teacher pre- and post-interviews, student tasks, teaching material, observation sheets, student interviews and q-sorting results, student workbooks and classroom pictures.

We found it meaningful to analyse and categorise use of technology through the lenses of the instrumental orchestration theory (Trouche, 2004), and initially used categories from Drijvers et al. (2013). However, as we ran through the data material, we inductively conducted free coding approaches, creating additional categories and tried to connect orchestration categories with FA-strategies and targets from the Fasmed framework.

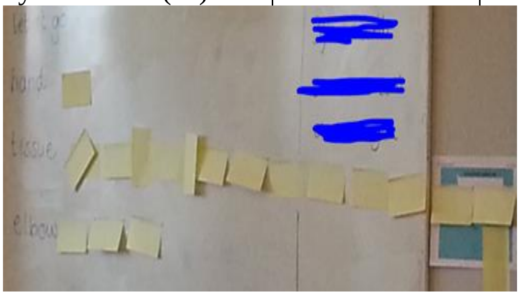
4 Results

Observed orchestration types and FA strategies are given in Table 2. Figure 2 gives examples on how students' thinking was made visible through innovative use of non-digital and digital technology. The analysis shows that while some examples fit with the existing categories (Drijvers et al., 2013) (e.g. *spot-and-show* using post-it notes, Figure 2a), others do not belong to any category in the orchestration theory, hence the need to create new categories (e.g. *request non-digital feedback* using mini whiteboards (Figure 2b), *request digital feedback* using Socrative (Figure 2c) and *Explain-the-screen-by student* using Smartboard (Figure 2d)).

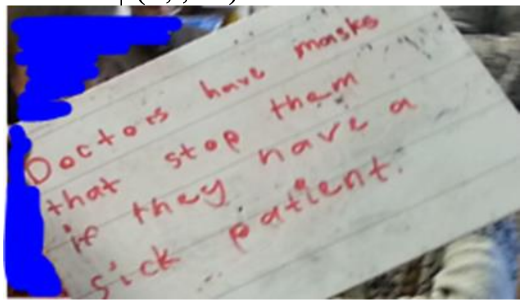
Table 2. A summary of orchestration types and their connections to FA strategies and targets, as given in Drijvers et al. (2013), developed by the authors** and observed in lessons. S=School S, B=School B, W=whole-class orchestration/assessment, G=group orchestration/assessment (incl.peer), I=individual orchestration/assessment. N.R.=Not relevant. N.P.=Not present. Numbers 1-5 refer to assessment strategies in the Fasmed framework (Figure 1).*

Orchestration type	Potential FA strategies	Potential FA targets	Observed orchestration types and FA strategies
Technical-demo* (I&W)	N.R.	N.R.	Excel introduction (S,W)
Discuss-the-screen* (I&W)	2,3,5	W	Discussing Socrative results (B,W,2,3,5), representations (B,S, W,2,3,5)
Explain-the-screen* (W)	N.R.	N.R.	Presenting Socrative results (B,W)
Guide-and-explain* (I&W)	2,3,4,5	W,G,I	Guiding students while making representations (B,S,G,2,3,4,5)
Link-screen-board* (I&W)	N.R.	N.R.	N.P.
Spot-and-show* (W)	1,2,3,4,5	W,G	Individual answers on Socrative used for group- and classroom-dicussion (B,W,G,1-5), Discussing presented graphs (B,S,W,1,2,3,5), Student groups analysing presented arguments

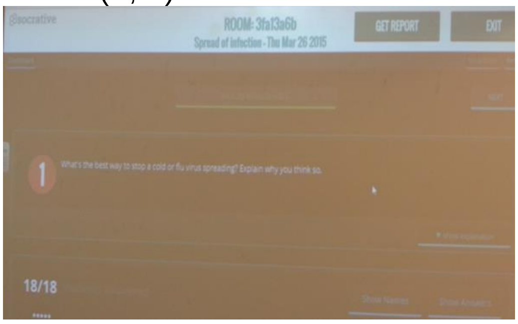
			(B,S,G,2,4,5), Student groups posting hypothesis with post-it on smartboard (B,G,2,5), Students recording results on smartboard (B,G,2,5)
Sherpa-at-work* (W)	1,2,3,4,5	W,G,I	Selected student presentations during working phase (B,S,W,G,I,1-5)
Board-instruction* (W)	N.R.	N.R.	Explanations (S)
Technical support* (I)	1,2,3,4,5	G,I	Support while using Excel, IPads and Socrative (B,S,G,I,1-5)
Request digital feedback** (I&W)	1,2,3,4,5	W,G,I	Students answer questions using Socrative, teacher and students get immediate digital feedback (B,S,W,I,2,3,5)
Request non-digital feedback** (I&W)	1,2,3,4,5	W,G,I	Students answer questions using non-digital whiteboards (B,S,W,I,2,3,5)
Explain-the-screen-by student** (W)	1,2,4,5	I	Students explaining graphmaking (B,I,1-5)



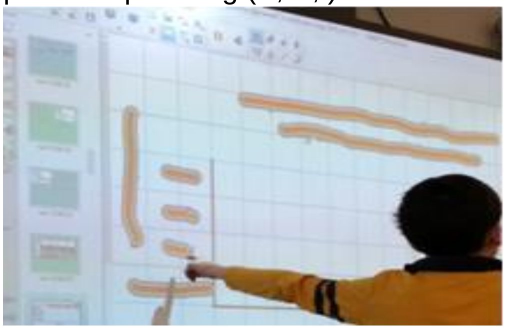
a. Post-it notes: Students’ hypothesis (B,W)



b. Whiteboard: Students’ idea on how to prevent spreading (B,W,I)



c. Socrative: Request digital feedback (B,W,I)



d. SmartBoard: Explain-the-screen by student (B,I)

Figure 2. Examples of non-digital (a,b) and digital (c,d) technology in FA.

5 Discussion and conclusions

In our study, a great range of approaches for FA was employed, digital and non-digital. We agree that effective teaching requires the skillful orchestration of several tools. The lens of orchestration offers deeper insights in the effect of particular blends of tools and particular usages of tools. Our analysis lead to the necessity of extending the existing orchestration theory. We argue that innovative use of digital and non-digital technology to collect immediate feedback at individual, group or whole-class level, should figure as new ways of orchestrating the tools/artefacts, when we have FA in mind.

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64. TEACHING SCIENCE USING UNDERDETERMINED REPRESENTATIONS: ILLUSTRATION AND IMPLICATIONS

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Abstract

In this theoretical paper we argue that the inherent partiality of representations can make representations less apt for the teaching of particular objects of learning. We call such representations underdetermined with respect to the object of learning. We define an underdetermined representation as one from which it is impossible to tell if something potentially educationally relevant is the case or not. We present an illustrative example from a teacher who is attempting to improve a representation that is used in a textbook to teach about the greenhouse effect. The example serves to illustrate the point that in order for students to learn which aspects are relevant and which are not, underdetermined representations will need some improvement in order to do the job. Further, involving students in the process of improvement can make underdetermined representations into opportunities for learning. Implications for teaching include that teachers should be open for input from research and other teachers in order to identify underdetermined representations, and that there is a range of possible ways by which one can work with representations in the classroom to make students aware of relevant aspects.

1 Introduction

There is a wide recognition in the science education research literature that representations play many important roles for student learning (see, for example, Airey & Linder, 2009; Knain, 2015; Tytler et al., 2013). One of these roles is to provide students with access to different aspects of science knowledge (see Fredlund, Airey, & Linder, 2012). Because of this, it is important for students to select appropriate representations for the task at hand (see, for example, Ainsworth, 2006). However, even if students do select representations appropriately, the purposeful use of these representations is often challenging (Kohl & Finkelstein, 2008). In such cases students will sometimes prefer visual illustrations to writing, especially when the content is difficult to understand (see, for example, Carney & Levin, 2002). High quality visual illustrations are therefore important in order to make learning possible. However, due to the inherent partiality of representations (Bezemer et al., 2012) it is difficult to produce good educational visual illustrations (Benson, 1997). In this theoretical paper we present an illustrative analysis where a teacher attempts to make a visual illustration from a textbook more useful to the students. Implications for teaching are proposed.

2 Underdetermined representations

When a scientist produces a scientific representation, the number of science content aspects that are actually represented is very small compared to the innumerable options available (Fredlund, Linder, & Airey, 2015). In many cases a reader with little experience of the content at hand cannot know which selections have been made. For example, research shows that when a plane electromagnetic wave is depicted as a sine curve moving in a given direction, many students do not realize that the electromagnetic field varies only in the direction of propagation and not in any of the other directions (Ambrose et al., 1999). For the purpose of this paper we characterize a representation that leaves educationally critical aspects out in this way as “underdetermined” in relation to enabling a certain way of knowing. We define an underdetermined representation as one from which it is impossible to tell if something potentially educationally relevant is the case or not. At the same time we argue that underdetermined representations can be turned into opportunities for learning. In order to do so, some of the different options that were initially left out of the production of the representation need to be pointed out to students. This argument is in line with the variation theory of learning, which states that in order to learn about an object of learning one has to become aware of its critical aspects. A critical aspect can be noticed if one experiences “variation in a dimension corresponding to that aspect, against the background of invariance in other aspects of the same object of learning” (Marton & Pang, 2006, p. 193).

3 Data collection

Our illustration is taken from the teaching of the greenhouse effect. Video data was collected in a science classroom as part of the REDE project (Representations and participation). In the two selected excerpts the teacher attempts to help the students see things that could previously not be seen in a visual representation from the textbook. In our terminology, this representation was underdetermined with respect to the learning of those aspects of the greenhouse effect.

4 Results

Figure 1 shows the textbook representation that the teacher was engaging with.

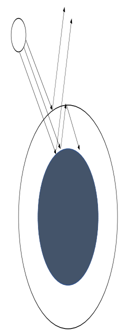

Figure 1*: A stylised version of the textbook illustration showing the Earth, the atmosphere, the sun, and short- and long-wave radiation. (Copyright of the original pending.)*

In this paper we focus on two of the important improvements that the teacher made to the representation. The first is about where in the atmosphere infrared radiation is absorbed:

Teacher: [Pointing in the picture] Here it looks as if this long-wave radiation reaches a thin layer in the atmosphere and is sent down again. […] Some long-wave radiation goes straight out, and some long-wave radiation it... The greenhouse gases are everywhere in the atmosphere. [Drawing radiation that is absorbed and re-emitted at different places in the atmosphere.] It is not like there is only reflection (sic) here outermost in the atmosphere. It happens everywhere.

The second important improvement that we focus on is the direction of propagation of emitted IR-radiation:

Teacher: And it doesn’t even have to send things back to the earth. It can send out radiation that way too [drawing radiation that is propagating away from earth but changing direction in the atmosphere and then continuing out into space].

Thus, by not displaying sufficient variation the textbook representation was at first underdetermined with respect to learning that (1) infrared absorption takes place everywhere in the atmosphere, and that (2) IR-radiation can be emitted in any direction.

4 Discussion and conclusion

In the whole-class discussion, the teacher amended the textbook representation with a number of aspects that was at first not visible to the students. We have focused on two of these. The first aspect was that absorption can take place anywhere in the atmosphere. This aspect is also part of the distinction between greenhouse gases and ozone – a distinction that students sometimes find difficult to make (Niebert & Gropengießer, 2013). The second aspect was that emitted radiation can propagate in any direction. This is an important difference between absorption/emission and reflection, and could thus help students differentiate between those concepts. From these observations, we argue that to learn that an aspect *can* vary is as important as to learn that an aspect is rule-bound (of course, variation too can be rule-bound). For example, in the case of the greenhouse effect, it is as important to learn that the direction of emitted light can vary, as that the direction of reflected light is rule-bound. Similarly, it is as important to learn that the absorption of infrared radiation can take place anywhere in the atmosphere, as that it is rule-bound that the absorption of ultraviolet light largely takes place in the ozone layer.

We see the following implications for teaching stemming from this argument:

1. Teachers need to figure out which representations might be underdetermined with respect to a particular object of learning by drawing on research and their own and other's teaching experience.
2. Including students in inquiry into how a particular representation might be underdetermined could enhance learning further. This is in line with research that shows that by comparing and contrasting representations and evaluating the appropriateness of representations given the phenomenon and argument at stake students often benefit from constructing representations themselves (Tytler et al., 2013). This approach is also consistent with the variation theory of learning (e.g., Marton & Pang, 2006) in that certain aspects are varied while others are kept invariant.

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66. WHY MANY CHEMISTRY TEACHERS FIND IT DIFFICULT TO ASK GOOD QUESTIONS

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Abstract
The present study explored how chemistry teachers perceive the oral questions they use in their teaching and which functions they ascribe different questions types. Semi-structured interviews with eleven chemistry teachers from Norway indicate that the teachers hold a dichotomous system of question types that they apply in whole-class situations. This system is simpler than most of the question classification systems used in research, and the two types, facts questions and thinking questions, are used flexibly in different situations for different purposes. Conflicting purposes with asking a question seem to be an important reason for why teachers still ask many facts questions. More cognitively challenging instruction needs to reduce the number of questions in whole-class situations and provide challenges in different settings like for example group work.

1 Introduction
Questions are an indispensable part of teaching. Various studies over many decades have found that teachers of all subjects use them in large numbers. Stevens (1912) found that there were up to 200 questions in typical review lessons. A recent study of science lessons from all grade levels in Israel found a considerably lower number. The average number of questions per lesson was 22 (Eshach, Dor-Ziderman, & Yefroimsky, 2014). More uniform are research findings concerning the cognitive level of the questions used. Gall (1970) concluded in a review that over six decades teachers asked about 60 % low-level and only 20 % high-level questions. The rest were organisational questions. Eshach et al. (2014) found that their teachers asked more than 80 % low-level questions on average.

The cited research led to criticism of teachers being poor questioners lacking skills and training in questioning (Hannel, 2009). However, sociolinguistics offers a more detailed picture of the problem. Counting questions and assigning cognitive levels does not take into account that a question is affected by the context of the question (rules governing the speech acts), the content of the question (what it is about), and how students react to it (Carlsen, 1991).

2 Theoretical framework
The current paper wants to shed light on why teachers continue to ask many questions and especially many low-level questions. Therefore, we had to collect teachers' own views about their questioning practice. We suppose that teachers are able of describing and explaining how they use questions in their teaching. We also believe that the account a teacher gives can be trusted if the answers are consistent. This is at least a sign for that the teacher understands how the questioning is functioning in his or her class.

The current study addresses the following research questions:

- How do teachers themselves describe the types of questions they use in instruction?
- Which are the functions of these question types in different teaching situations?

3 Research methods
To learn about teachers views on questioning, semi-structured interviews were conducted with 11 science/chemistry teachers working with grades 8-13. Before the interview started each teacher was

shown to short video sequences from a science classroom (taken from the 1999 TIMS-video study, www.timssvideo.com)). The first clip showed the review of the previous lesson, whereas the second clip showed the introduction of a new topic. The interviewees were asked to comment on the video sequences with a focus on the questions asked. This technique was used to contextualise the interview questions and to trigger more concrete answers. Further, the interview contained questions about the teachers' own questioning practice, types of questions they use, reactions to students' answers, and what influenced the development of the teachers' questioning practice.

The interviews were recorded and transcribed verbatim. For the analysis, two researchers read the transcripts independently and formulated interpretations of the teachers' answers. The interpretations were shared and alternative interpretations formulated. In case of differing views, we read the relevant material again and compared possible interpretations with other sequences of the interview until we agreed on the interpretations.

4 Results

The teachers in our sample talked mostly about whole-class situations. In these situations the teachers use mainly two types of questions: facts questions and thinking questions. Facts questions require students to reproduce knowledge which was addressed in previous lessons. Thinking questions on the other side require the use of knowledge, for example relating own experiences to a scientific concept or describing how a scientific phenomenon is imagined to function. Some teachers also mentioned questions in group situations or with individual students focusing on students struggling with tasks. In these cases, teachers use heuristic questions (i.e. What is the problem? What do you know? How can that help you to solve the problem?) to help the students finding the solution on their own.

Teachers are aware of that they ask many facts questions. They wish to ask more thinking questions, but say that these are difficult to ask. The difficulty seems to be meeting the appropriate level of thinking challenge for the students. If the demand is too high and the students cannot answer, the classroom dialogue will no longer function.

Facts questions are easy to use ("they come naturally"). The most important reason is that teachers know which answers they expect, making it easy to ask exactly for that. Also students know that the teacher wants a specific answer which was given in previous instruction.

Our teachers mentioned mainly three reasons to ask questions to a whole class. One is to have a dialogue and involve the students in the lesson. This is to prevent students from becoming passive. The second is initiating thinking and by this moving forward the learning process. The last reason is assessing students' knowledge.

The teachers mentioned different situations where it is useful to ask facts questions.

- When starting a new topic, asking for what students already know helps the teacher to adjust the following instruction.
- By asking for previously taught knowledge, teachers can establish what students have understood. This knowledge can be used to discuss issues requiring more thinking.
- If a thinking question does not work, asking for the relevant facts actualises the factual knowledge that is supposed to be used to produce a new relation between the items.

4 Discussion and conclusion

The teachers in our study hold a two-type question category system that is simpler than most of the question category systems used in research. The system seems to be appropriate for an on-the-spot development of questions and for keeping a dialogue with the whole class going.

The described category system seems to be similar to the one developed by Nystrand (1997) which includes test and authentic questions. The test question seems to match with the facts question – both asking for known information – and the authentic question with the thinking question. However, Nystrand defines a test question to serve only one purpose, assessing knowledge, whereas facts questions described in this paper can be used in different situations with varying purposes. An authentic question is defined by the answer a teacher is expecting, whereas our teachers' thinking questions are characterized by the action that they are intended to trigger in the students. This shows that Nystrand's system is more static, whereas our teachers conceptualise questions depending on their communicative function.

The current research found that teachers regard facts questions useful in different instructional situations. This indicates that a substantial change in the proportion of facts question cannot be expected to happen without a major change in instructional practices. Trying to promote student learning in whole-class situations requires teachers to ask questions for different and often conflicting reasons. Appropriate questions aim at recalling known facts and making rather obvious connections between experiences and topical scientific concepts. Hence, the communicative role limits the learning function of a question because more time demanding cognitive processes like developing ideas of how something functions or why certain phenomena are observed cannot take place. Such processes have to be initiated in a different instructional format and organizational form (i.e. group work to develop tentative explanations for a phenomenon). Instead of asking more thinking question in whole-class situations like it is recommended in the literature (Treagust & Tsui, 2014), the number of questions should be reduced in favor of exchanging the results and ideas from previous activities, discussing and evaluating the ideas, and planning further steps.

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68. ANALYSING REPRESENTATIONS OF CONCEPT IN PHYSICS TEXTBOOKS FOR LOWER SECONDARY SCHOOL IN SWEDEN – THE CONCEPT OF PRESSURE

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Abstract
Representations of scientific concepts are important tools for creating understanding of science. In connection with the scientific concepts mentioned in textbooks it is common to use many other forms of representation to clarify them. In this study, we focus on physics textbooks for lower secondary school and more specifically, how the concept of pressure is presented. The examination of the textbooks will be divided into in two parts. In the first part we study the representations that occur from a quantitative perspective. The representations will be sorted into three main categories (Liu & Khine, 2016). For each category there are sub-categories. In the second part of the study, representations will be studied from a qualitative perspective and described with respect to how they are used and interconnected in the textbooks. In this second part, the representations are analysed and sorted into four main categories (Slough, McTigue, Suyeon, & Jennings, 2010). Preliminary results from the first part of the study show that textual representations dominate together with graphical representations in all textbooks, while the mathematical representations only occur occasionally. The second part of the study is on-going and preliminary results will be presented and discussed, together with implication for teaching.

Introduction and Background
When concepts are introduced and described in textbooks different representations are often used to amplify their meaning. Concepts in printed books are mainly represented by visual representations (text, diagrams, mathematics, etc.). Visualizations of concepts can be used either as a clarification of information or as a tool for understanding and interpretation. They do not appear in isolation but as a part among others, e.g. written arguments can be supported by graphical representations (Evagorou, Erduran, & Mäntylä, 2015).

Although representations should help the reader to understand the content, a previous study of school textbooks in biology show that is not always the case (Ferlin, 2014). On their own, some representations may complicate understanding and pupils need guidance to better understand the scientific content (Eriksson, 2014; Ferlin, 2014). Learning science can be seen as learning to combine different representations, or modes; what Airey and Linder (2009) refer to as “a critical constellation of modes” (p. 27). Understand scientific concepts from textbooks involve an appreciation for combining different representations, for example written language and visual representations. In school textbooks both text (written language) and visual representations are chosen to present key concepts but the interconnections are not always clear (Slough et al., 2010).

Based on the above, the overarching purpose of this study is to examine the representations used when physics concepts related to pressure occur in textbooks in physics for lower secondary school. This study therefore focus on the following research questions:

1. What kinds of representations are used to present the concept of pressure in concepts in physics textbooks for secondary school in Sweden?

1. How are the representations interconnected and used in the textbooks when presenting the concept of pressure?

Method and Analysis

With this study, we intend to study and analyse representations of concepts in physics textbooks directed to lower secondary school pupils in Sweden.

In Sweden there are four major publishers of school textbooks. Gleerups, Liber, Natur and Kultur and Sanoma. To cover the major part of the textbooks used in Swedish schools, this study will consist of five textbooks from these publishers. This means one from each, except Gleerups who publish two books, which both are included. Where textbooks are used by schools it will, in majority, be one of these books.

Table 1: Textbooks included in this study

Title	MACRO Fysik 7-9	Titano	Spectrum Fysik	PULS Fysik 7-9	Fysik Direkt
Publisher	Gleerups	Gleerups	Liber	Natur och Kultur	Sanoma

The arrangement of the pressure chapter in these five textbooks carries similar structures, hence making them suitable comparison. Hence our chosen research focus aim at comparing the pressure chapters in these textbooks. By this choice other chapters are excluded.

The analysis of the textbooks will consist of two parts. First a quantitative analysis of representation occurring in the selected chapter of each book and second a qualitative analysis to see in what ways the representations interact. All types of representations will be analysed, e.g. text, diagrams and mathematics. The reason for the two parts of this study is that we are interested in both the distribution of the various representations and also how they are used in the textbooks to communicate the concept of pressure.

To answer the first research question, what representations occur, and how often, we use the division presented in table 2 for our analysis. The framework for category 2 and 3 is developed by Liu and Khine (Liu & Khine, 2016).

Table 2. Division of representations occurring in textbooks (Liu & Khine, 2016).

1. Textual representation	***2. Graphical representation***	***3. Mathematical representation***
a) Variation in style, font, size	a) Photograph	a) Tables
b) Clarification of text	b) Sketch	b) Chart
	c) Iconic image	c) Formulas

To answer the second research question, part two of the study aim at analysing the way textbooks combine and integrate different representations in an effort to facilitate and simplify learning possibilities, similar to Airey and Linders´ “critical constellation of modes” (Airey & Linder, 2009). The chosen model for our analyses is developed by Slough, McTigue & Jennings. Classification takes place in four major categories and subsequent sub-categories as shown in table 3 (Slough et al., 2010).

Table 3. Categories for analysing the way textbooks encourage the reader (Slough et al., 2010).

Form and Function	**Help to Build a Mental Model**	**Text and Figure Physically Integrated**	**Text and Graphics are Semantically Integrated**
Decoration- Affective but do not support the text	Guide to create an abstract model of a concept	Figure included in the text	Reference in the text to the image

Representational- Directly enlighten the textual content	Describe complex processes or systems	Figure before text	Engaging the reader with e.g. captions, questions or additions made to the text
Organisation Create coherence between text and graphs		Figure next to the text	Guide the reader to take advantage of the graphics
Function- Add information to support understanding		Figure on page other than the text	
Transformation- Convert into forms easier to remember			

Result

Preliminary results of the first part of the study show that there are a large proportion of textual representations and the large number of graphical representations in all textbooks, while the mathematical representations only occurs occasionally. The distribution of the representations is shown in table 4. The analysis is on-going during the first half of 2017.

Table 4. Numbers of representations in textbooks

		Textual-representation		**Graphical representation**			**Mathematical representation**		
		Variation in stile, font, text	*Clarification of text*	*Photograph*	*Sketch*	*Iconic image*	*Tables*	*Chart*	*Formulas*
Title	*MACRO Fysik 7-9*	19	1	21	3	13	0	0	2
	Titano	19		11	7	8	2	0	0
	Spectrum Fysik	25		27	3	6	1	0	3
	PULS Fysik 7-9	6		4	5	8	1	0	1
	Fysik Direkt			6	6	12			

Discussion and conclusions

Because this study is in its early state, no conclusions can be drawn at this state. However, the tendency that visual representations are used to illustrate concepts is clear. Results for both research questions will be presented at the conference, together with a discussion and implications for teaching.

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69. ELEVERS MOTIVATION OCH ENGAGEMANG I EN FÖRÄNDRAD LÄRMILJÖ

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Abstract

The aim of this study is to contribute to an increased understanding of how changes in the learning environment can influence students' motivation and engagement in school. The research is conducted in a Swedish primary school in which the learning environments for science have been developed during the last year and the teachers have had in-service training regarding science education. Data has been collected in the form of students' questionnaires, which are answered by the students every month, and teacher's diaries of their work in the science classroom. Motivation is closely related to feelings of competence, autonomy and relatedness and students' questionnaire included questions about such feelings. Results presented here show that students find their own learning of science and technology to work fairly well, that they get opportunities to solve problems in science and technology together with peers to some extent and that they have positive feelings for their school. The results also show that teachers have started to use the new learning environment, but also that the content in the science and technology lessons have yet changed only to a limited extent.

1 Introduktion

Detta konferensbidrag presenterar en följeforskning av nya lärmiljöer i teknik och naturvetenskap på en F-6 skola i Sverige. Syftet med de nya lärmiljöerna är att öka motivationen och engagemanget för naturvetenskap och teknik hos eleverna. Syftet med följeforskningen är att undersöka hur de nya lärmiljöerna tas emot av både elever och lärare. Resultaten från denna forskningsstudie kommer sedan att ligga till grund för en utveckling av lärmiljöerna i en samskapande process som omfattar både elever och lärare.

De senaste PISA- och TIMSS-studierna (OECD, 2016a, 2016b; Skolverket, 2016) visar att likvärdigheten försämrats i svensk skola, men också ökade skillnader mellan olika elever där vissa elever uppger ett ökat intresse och en ökad motivation i förhållande till skolan och till skolans naturvetenskap medan en annan grupp elever uppger minskat intresse och minskad motivation. Oskarsson (2012) visar vidare stora skillnader i intresse och ambitioner hos olika elevgrupper.

Vi har studerat en skola i en medelstor stad mitt i Sverige. Jämfört med andra kommuner i samma län finns i den undersökta kommunen både de skolor som har högst medelbetyg i länet och de skolor som har lägst. Kommunen har beslutat om olika insatser för att höja betygen och öka måluppfyllelsen på den aktuella skolan. Tillsammans med skolledningen har man organiserat fortbildning för pedagoger, planerat för skolutveckling genom förändrade arbetssätt och förändrad organisation och byggt upp nya lärmiljöer för exempelvis idrott, naturvetenskap och teknik.

2 Teoretiskt ramverk

Studien kommer bygga på två perspektiv. Det ena är en studie av motivation, såväl inre som yttre, hos den enskilde eleven. Det andra perspektivet är en förståelse av hur bakgrund och grupptillhörighet formar identiteten hos en ung människa.

Människors motivation kan förändras om kontexten förändras eller när människans känslor påverkas. Forskningsresultat som rör motivation i undervisningssammanhang härrör nästan uteslutande ur tre huvudkategorier: den sociala miljön där lärandet sker; den enskildes självtillit i lärsituationen och de värden som knyts till uppgiften (Brophy, 2008). Håkansson och Sundberg (2012) skriver i en forskningsöversikt att även om vi ofta föreställer oss att motivation är en inre, psykologisk faktor så visar forskning att den i stället beror av relationer mellan människor, att den är kontextbunden och även relaterad till känslor. Författarna skriver också att forskning visar att bristen på känsla av tillhörighet, sociala band och klassrummet som lärandemiljö är direkt motivationssänkande och att motivationen kan öka om lärare överlåter mer ansvar åt eleverna för deras eget lärande.

Motivation definieras i vår studie i likhet med Koballa och Glynn (2007) som “ett inre tillstånd som väcker, riktar och vidmakthåller elevers beteende”. En teoretisk inramning av studien utgörs av *self-determination theory* vilken säger att lärande är aktiva, nyfikna och utforskande om tre psykologiska grundförutsättningar är uppfyllda. Dessa förutsättningar är känslor av kompetens, autonomi och tillhörighet (Ryan & Deci, 2000). Alla tre kan förändras och påverkas hos eleverna genom hur undervisningen utformas och vilket bemötande eleverna får från läraren. Vi ser utvecklingsarbetet som ett arbete där både elever och lärare är lärande och alltså omfattas av detta perspektiv på motivation.

Det andra teoretiska perspektivet i studien handlar om att förstå hur identiteten formas i interaktion med andra. Att studera den enskilda eleven räcker inte och olika satsningar som riktas mot enskilda elever är också ofta otillräckliga. Identitet är en social konstruktion som bygger på historiska och kulturella traditioner, sociala strukturer och de sammanhang man möter. Det handlar inte om vad man vill bli utan mer om vem man är och vem man vill bli. Vilken flock är min och vilka regler gäller där? Det blir en lins genom vilken man ser och förstår världen och den skapar regler för hur man interagerar mot andra (Harwood, 2006; Yep, 2016). Kollektiva identiteter är centrala i denna interaktion och en förståelse av hur dessa formas är nödvändig för att förstå intresse, motivation, ambition och prestation hos dagens unga.

3 Syfte

Syftet med följeforskningen är att undersöka i vilken utsträckning utvecklingsarbetet ger de önskade resultaten i fråga om ett ökat engagemang och en ökad motivation hos elever och lärare. Studiens forskningsfrågor är: Hur uttrycker elever och lärare sin upplevelse av implementeringen av de nya lärmiljöerna? och Vilka faktorer kan identifieras som viktiga för att deltagarna ska uttrycka ökad motivation och ökat engagemang?

4 Metod

För att besvara forskningsfrågorna kommer eleverna som har undervisning i de nya lärmiljöerna att svara på enkätfrågor om motivation och intresse för skolan en gång varje månad under implementeringen. Ytterligare data kommer att samlas in genom att lärarna skriver veckovisa loggböcker och genom fokusintervjuer av elever och lärare. Observationer av lärsituationer kommer också att göras under implementeringen.

I december 2016 samlades grunddata in från eleverna. Denna grunddata kommer att fungera som referens till de data som samlas in varje månad under utvecklingsarbetet och på så sätt kan en eventuell förändring i elevernas engagemang och motivation under arbetet upptäckas. Lärarnas loggböcker kommer att ge information om vilka moment och arbetssätt man använt vid olika tillfällen vid undervisningen i naturvetenskap och teknik och den informationen kan kopplas till eventuella förändringar i data från eleverna.

5 Resultat

Eleverna svarade på en första enkätomgång i december 2016. De elever som svarade går i grundskolans årskurs tre till sex och i särskilda undervisningsgrupper för årskurs fem till nio. I de särskilda undervisningsgrupperna går elever med neuropsykiatriska funktionsnedsättningar. Svarsfrekvensen för enkätens första omgång var 91 % (108 av 119 elever).

Frågorna i elevenkäten är utformade som en övergripande fråga där eleverna får ta ställning till flera påståenden. Ett exempel på resultat från en fråga som rör elevernas syn på sin egen kompetens ges i tabell 1. I frågan undersöks vad eleverna tycker om sin egen möjlighet att lära sig NO och teknik.

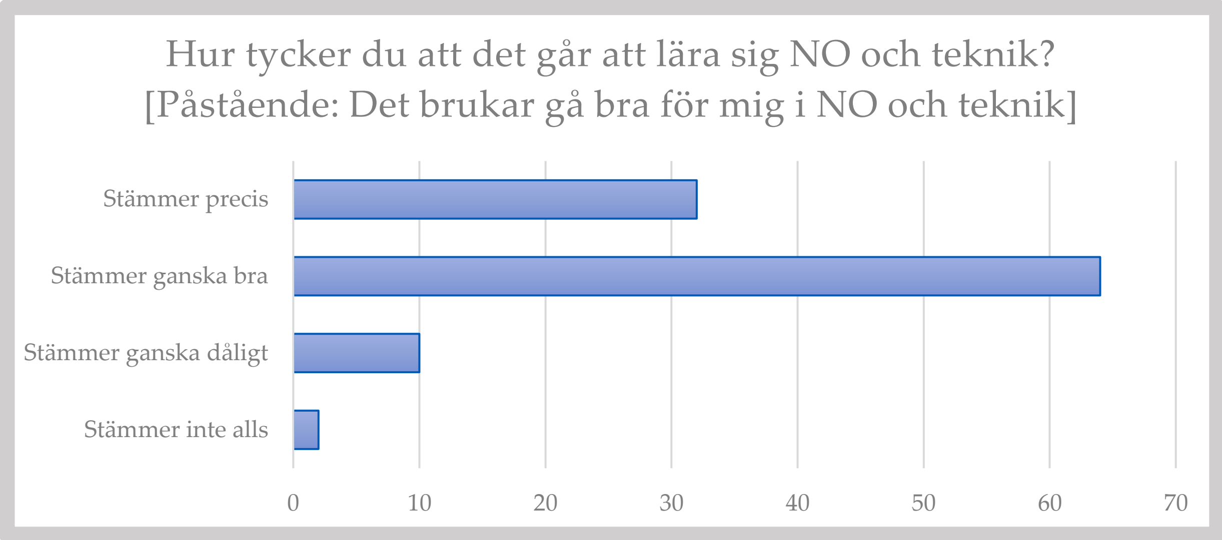

Fig 1. *Fördelningen av elevsvar på frågan om hur de ser på sin förmåga att lära NO och teknik.* (Siffrorna anger antal elever, n=108.)

Arbetssätten i undervisningen undersöks i enkätens frågor. Frågorna handlar om olika arbetssätt med olika grad av självständigt arbete. Resultatet från enkätfrågan i tabell 2 visa hur ofta eleverna arbetat med problemlösning tillsammans med andra elever.

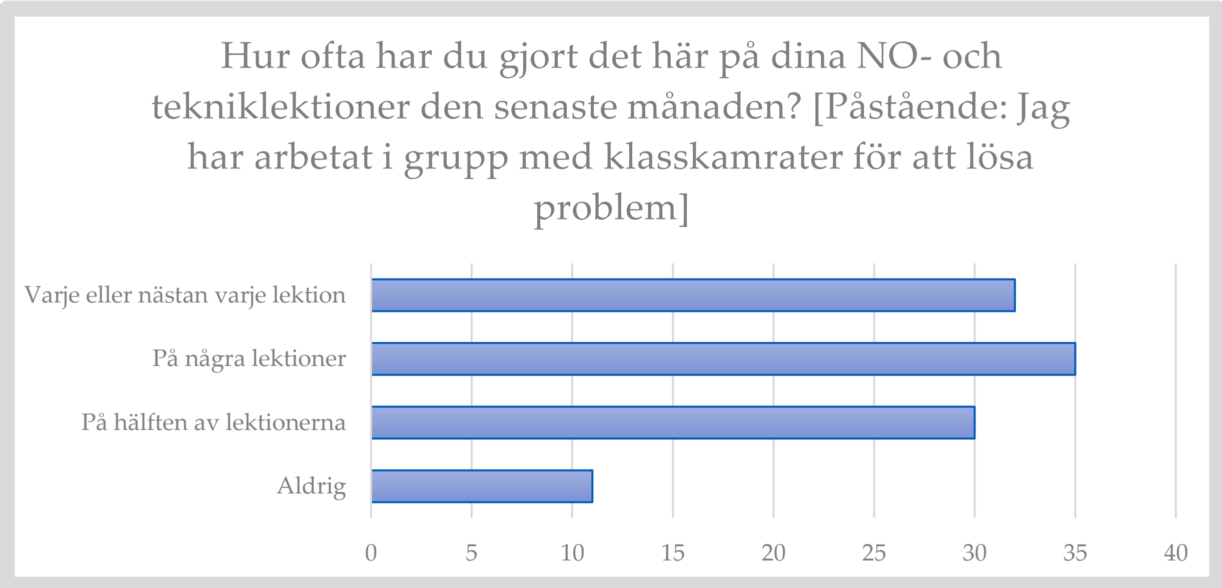

Fig 2. Fördelningen av elevsvar på frågan om hur ofta de arbetat med problemlösning tillsammans med andra elever. (Siffrorna anger antal elever, n=108.)

I enkäten finns också frågor om vad eleverna tycker om sin skola som helhet. Resultatet av en sådan fråga finns redovisat i tabell 3.

Fig 3. Fördelningen av elevsvar på frågan om vad de tycker om sin skola. (Siffrorna anger antal elever, n=108.)

En första omgång av lärarenkäten har besvarats av 21 lärare. Endast en lärare har angett att man arbetat på ett nytt sätt tack vare de nya lärmiljöerna. Ytterligare sex lärare anger att de haft nytta av nytt material från lärmiljöerna, men i övrigt arbetat på samma sätt som innan dessa kom till.

6 Diskussion

Resultaten i elevenkäten kan speglas i teori och tidigare forskning om motivation. Känsla av kompetens, autonomi och tillhörighet är förutsättningar för motivation enligt self-determination theory. Elevers upplevda förmåga att lära NO och teknik (tabell 1) kommer att säga något om deras syn på sin egen kompetens. Eleverna vid den undersökta skolan har ganska god tilltro till sin egen kompetens och skulle därför kunna ha goda förutsättningar för att vara motiverade. Arbetssätten i undervisningen (tabell 2) kan säga något om i vilken utsträckning eleverna arbetar självständigt med uppgifter, vilket kan bidra till en känsla av motivation. Många elever tycker om sin skola (tabell 3) och det skulle kunna vara ett tecken på en känsla av tillhörighet.

Enkäten och loggbokens resultat ska följas av intervjuer och observationer för att få en fördjupad förståelse för faktorer som bidrar till känslor av tillhörighet, tilltro till sin egen förmåga och värden som undervisningen kan bidra med. Enkätens resultat kommer också att granskas närmare för att undersöka om grupper av elever (exempelvis flickor och pojkar) eller olika elever med socioekonomisk bakgrund besvarar frågorna på olika sätt under utvecklingsarbetet.

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71. ATTITYDMÄTNINGAR MED Q-METHODOLOGY

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Abstract
A method almost never used in education research is the Q-methodology(Stephenson, 1953). In this method, informants are sorting and ranking criteria or propositions according to their own subjective believes. The sortings are analysed statistically and, using factor analysis, some resulting groups of similar types of believes may be identified. It has been used mostly in psychology and sociology but also to analyse teachers and students believes upon things like Physics education, Simulations, and Teacher training. When compared to surveys using Likert scales it has been shown to better measure subjectivity. The method could be used with a small number of informants and still give useful results. In this paper the Q-method will be introduced and results from several studies presented. Student's attitudes in physics relating to space and astronomy, students assessment of sex education in biology, and results from a study on university teachers use of criteria assessing student theses.

1 Introduktion
En allt större del av den ämnesdidaktiska forskningen handlar idag om att mäta elevers attityder till olika ämnen och ämnesinnehåll, olika arbetsformer, olika typer av examination men även för att undersöka lärares egen syn på sitt ämne. Ett exempel på en sådan undersökning är ROSE (Schreiner & Sjøberg, 2004). Intressant är också att söka vilka kriterier som används, exempelvis vid bedömning och betygssättning av elevers arbeten. Då attityder är subjektiva och ibland dolda för informanten själv, ställs speciella krav på de datainsamlingsmetoder som använts.

2 Bakgrund
Det är vanligt att man vid attitydstudier använder enkäter, ofta med en Likertskala(Likert, 1932) där informanten värderar en grupp av påståenden genom att välja, på en skala, hur väl man håller med om påståendet eller hur viktigt man tycker det är. Fyra, fem eller sju steg är vanliga i skalan men data tolkas allmänt av statistiker som ordinaldata. De är rangordnade men intervallerna mellan stegen är inte lika stora. Det innebär att om man använder sig av medelvärde och varians för att analysera data utsätts man ofta för kritik. Det är dessutom tveksamt om respondenten använder samma dynamiska skala för de olika påståenden i enkäten vilket gör det svårt att jämföra dessa data med varandra. Ett annat vanligt problem är att informanterna endast använder de högsta eller lägsta omdömena vid sin värdering.

3 Forskningsmetod
En för utbildningsvetenskap ganska ny metod som verkar mycket lovande för den här typen av studier är den så kallade Q-metoden(Stephenson, 1953). I den sorterar informanterna ett stort antal påståenden utefter om de är positiva och håller med eller är negativa till, eller förhåller sig neutrala till påståendet. Sorteringen kan ske via ett webbaserat gränssnitt där påståenden skall placeras inom en begränsande ram och utefter en värderingsskala med exempelvis 11 steg. Varje påstående måste då det sorteras in, vägas och jämföras med omkringliggande påståenden vilket ger en mer sann bild av informantens subjektivitet(Van Exel, 2005) än vid exempelvis användning av Likertskalor(ten Klooster, Visser, & de Jong, 2008). I Q-metoden analyseras data med avseende på de individer som besvarat enkäten. Vanligen genomförs en faktoranalys för att finna profiler/typsorterare i datamaterialet och med hjälp av viktningen av de påståenden som är kopplade till varje profil skapas en beskrivning av dessa. Analysen kräver endast ett fåtal, men stratifierat urval av informanter. Ofta räcker 20-30 respondenter för en användbar analys(ten Klooster, et al., 2008). Om informanter är sinsemellan helt unika i sin sortering så ger dock faktoranalysen ingenting. De påståenden som skall värderas och rangordnas ska i möjligaste mån återspegla en mångfald av åsikter och attityder i ämnesområdet och uppgår vanligen till 40-50.

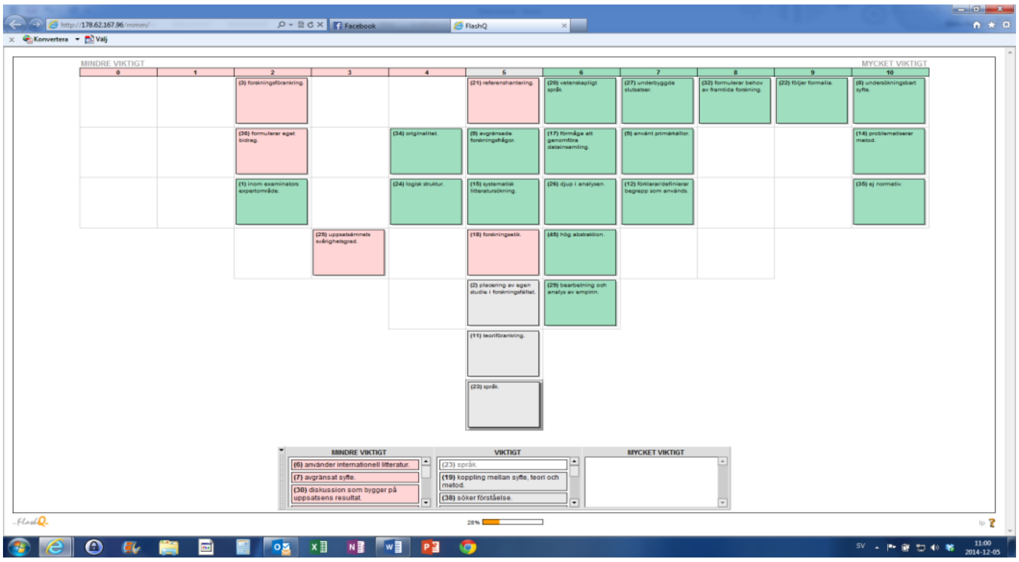
4 Resultat

Presentationen presenterar metoden och ger exempel på och resultat från några aktuella studier där Q-metoden har använts:

- Examinatorers bedömningskriterier i VR projektet ”Med Mitt Mått Mätt” (Björklund, Lundström, & Stolpe, 2016)
- Elever och lärarstudenters perspektiv på astronomi (Olsson, 2016)
- Vad elever tycker är viktigt inom området sex och samlevnad.(Valtersson, 2017)

4.1 Examinatorers bedömningskriterier

I ett VR-finansierat forskningprojekt med syfte att undersöka hur examinatorer på lärarutbildningar bedömer och betygssätter examensuppsatser fick 65 universitetslärare från tre lärosäten i Sverige sortera 45 olika bedömningskriterier i en Q-metodenkät. Kriterierna hade insamlats, dels genom RepertoryGridTechnique-intervjuer, dels från lärosätenas formella kurskriterier. Exempel på kriterier var: Koppling mellan syfte, teori och metod. Underbyggda slutsatser, Bearbetning och analys av empirin, Undersökningsbart syfte, Diskussion som bygger på uppsatsens resultat, Forskningsfrågor besvaras etc. Informanterna fick på en webbaserad enkät ta ställning till och sortera och rangordna kriterierna från ”Minst viktigt”(-5) till ”Mest viktigt”(+5) i elva steg. Kriterierna skulle placeras inom den ram som Figur 1 angav, så att informanten var tvungen att prioritera de högst och lägst värderade positionerna.



Figur 1 Den webbaserade enkätens plan på bildskärmen

Data från de enskilda examinatorerna samlades in, korrelerades och faktoranalyserades för att finna eventuella profiler/typsorterare i materialet. Tre faktorer A,B och C kunde urskiljas som tillsammans beskrev 58% av alla svar. I analysen framgick att dessa tre profiler delade sin syn på ett mindre antal kriterier som redovisas i Tabell 1.

Tabell 1 Kriterier som bedöms på liknande sätt av de tre profilerna

KRITERIE	Faktor A	Faktor B	Faktor C
Koppling mellan syfte, teori och metod.	4	5	4
Använder relevant forskningslitteratur.	3	3	3
Forskningsfrågor besvaras.	3	4	4
Avgränsade forskningsfrågor.	2	1	3

Yrkesrelevant.	-1	-1	-2
Muntligt försvar av uppsatsen.	-2	-2	-3
Uppsatsämnets svårighetsgrad.	-4	-3	-3
Originalitet.	-4	-5	-4

Den första profilen som bygger på faktor A, karakteriseras av ett fokus på text, språk och struktur i uppsatsen, se Tabell 2. Logiken och kvaliteten i själva texten är avgörande för bedömningen. Faktor A förklarar 22% av variationen i insamlat data och 14 informanter har en stark koppling ("loading") till denna faktor.

Tabell 2 Kriterier som karakteriserar faktor A

Nr	KRITERIE	VÄRDE
8	Undersökningsbart syfte	+5
24	Logisk struktur	+5
33	Röd tråd	+5
27	Underbyggda slutsatser	+4
44	Text struktur	+3
39	Genusperspektiv	-5
1	Inom bedömarens eget expertområde	-5
45	Hög abstraktionsfaktor	-5

Examinatorer inom den andra profilen som bygger på faktor B, har ett metaperspektiv på uppsatsen och vill att studernten ifråga ska ha en medveten syn på forskningsprocessen. Det anses viktigt att studenten problematiserar sina val av metod och analys under forskningsprocessen. Faktor B förklarar 20% av datamaterialet och 7 informanter har en stark koppling till denna faktor.

Tabell 3 Kriterier som karakteriserar faktor B

Nr	KRITERIE	Värde
18	Forskningsetik	+5
3	Forskningsförankring	+5
21	Referenshantering	+3
28	Underbyggda slutsatser	+2
29	Bearbetning och analys av empirin	+2
5	Använt primärkällor	+1

10	Spännande forskningsfråga	-4
38	Söker förståelse	-4
1	Inom bedömarens eget expertområde	-5
42	Stark berättarröst	-5
41	Spännande	-5

Faktor C beskriver den tredje profilen som värdesätter de kriterier som har med slutresultatet, produkten att göra, se Tabell 4. Resultatet i en uppsats ska besvara forskningsfrågorna och vara väl i linje med vald teori och metod. Faktor C förklarar 16% av dataaterialet och 15 informanter har en stark koppling till denna faktor och profil. Detta är den enda profil där bakgrundsfakta ger någon antydan till förklaring av resultatet, en oproportionerlig stor andel av dessa lärare arbetar med naturvetenskap.

Tabell 4 Kriterier som karakteriserar faktor C

Nr	KRITERIE	Värde
27	Underbyggda slutsatser	+5
30	Diskuterar uppsatsens resultat	+5
19	Koppling mellan syfte, teori och metod	+5
29	Bearbetning och analys av empirin.	+4
28	Besvarar forskningsfrågorna	+4
31	Problematiserar resultatet	+4
26	Djup i analysen	+3
34	Originalitet	-5
42	Stark berättarröst	-5
41	Spännande	-5

Analysen visar på tre grupper av examinatorer som värderar och prioriterar olika aspekter av vetenskaplig kvalitet. Detta är ett resultat som kan förklara de skillnader vi ser vid bedömning av vetenskapliga uppsatser. Inte bara för examensarbeten utan också inom peer-reviewsystemet.

4.2 Elever och lärarstudenters perspektiv på astronomi

I en uppföljning till ROSE har en fördjupande studie gjorts för att visa vad som elever uppfattar som intressant i ett fysikavsnitt om rymden. Till enkäten insamlades en uppsättning av 28 olika objekt(områden) inom området astronomi. De var dels inhämtade från ROSE-studien dels från artiklar, böcker och i diskussioner med andra studenter och handledaren. Exempel på objekt var Svarta hål, Vad hände vid Big bang, Planeterna i solsystemet, Hur det är att vara tyngdlös, Vad händer när det går hål i rymddräkten etc. Informanterna, totalt 40 stycken, bestod av mellanstadieelever samt en grupp lärarstudenter. I den webbaserade enkäten där objekten rangordnades från -3 till +3 ställdes dessutom några bakgrundsfrågor om ålder, kön, fritidsintressen och det gavs möjlighet att lämna skriftliga kommentarer. I analysen kunde påvisas tre profiler av elever som fick arbetsnamnen BIOLOGEN, FYSIKERN och ÄVENTYRAREN, se Figur 2. Elever är som ROSEstudien tidigare visat intresserade av rymden, men av olika anledning.

Figur 2 Tre faktorer som påvisar tre typer av elever i deras syn på undervisning om rymden

State Num	Distinguishing Statements for Factor 1 (BIOLOGEN)	Factor 1	Z-score
22	Finns det liv på andra planeter.	3	1,969
6	Hur man kan göra om en planet så vi kan leva där.	2	1,73
13	Vad behövs på en planet för att vi ska kunna leva där.	2	1,671
7	De fysikaliska processerna i solen.	-2	-1,089
24	Hur högt kan man hoppa på månen.	-3	-1,223
26	Vilka personer som har varit betydande för astronomins framfar	-3	-2
State Num	**Distinguishing Statements for Factor 2 (FYSIKERN)**	**Factor 2**	**Z-score**
7	De fysikaliska processerna i solen.	3	1,666
12	Hur en stjärna dör.	3	1,42
27	Månens påverkan på Jorden.	2	1,347
3	Planeterna i solsystemet.	2	1,216
26	Vilka personer som har varit betydande för astronomins framfar	-2	-1,408
24	Hur högt kan man hoppa på månen.	-3	-1,792
20	Hur man blir astronaut.	-3	-1,799
State Num	**Distinguishing Statements for Factor 3 (ÄVENTYRAREN)**	**Factor 3**	**Z-score**
1	Svarta hål.	3	2,066
8	Hur stjärnorna kan säga oss något om framtiden.	2	1,524
22	Finns det liv på andra planeter.	2	0,961
5	Vad händer när det går hål i rymddräkten.	2	0,949
4	Hur det är att vara tyngdlös.	1	0,826
13	Vad behövs på en planet för att vi ska kunna leva där.	-2	-0,907
3	Planeterna i solsystemet.	-2	-1,225
19	Varför vi har årstider,	-3	-1,751
18	Varför det blir mörkt på natten.	-3	-1,83

5 Q-metoden

- Mäter subjektivitet och personliga attityder
- Medger anonymitet för informanten
- Kräver relativt få informanter (15-50)
- Ger som resultat en beskrivning av grupper med liknande attityder.
- Administreras enkelt via internet och kan utföras på dator, surfplatta och t.o.m. mobil

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73. DEVELOPMENT OF A CHEMISTRY CONCEPT INVENTORY FOR GENERAL CHEMISTRY STUDENTS AT NORWEGIAN AND FINNISH UNIVERSITIES

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Abstract

A Chemistry concept inventory has been developed for assessing students learning and identifying alternative conceptions that students may have in general chemistry. The inventory presented here aims at functioning as a tool for adjusting teaching practices in chemistry and is mainly aimed at assessing students learning during general chemistry courses. The inventory has been administered as a post test in a general chemistry course at the Norwegian University of Science and Technology (NTNU), and evaluated using different statistical tests, focusing both on item analysis and the test as a whole. The results from this analysis indicated that the concept inventory is a reliable and discriminating tool in the present context. In this presentation, we present preliminary results from the test being administered in general chemistry courses at both University of Jyväskylä, Finland (JYU) and NTNU. The results from these tests are compared to evaluate the test as a tool for investigating students' individual learning and to assess the applicability of the test in different university contexts.

1 Introduction

Learning natural sciences can be described as a process where the learner develops and revises concepts of how the nature works based on intuitive ideas, observations and theoretical models. The continuous process of developing and revising these concepts may be induced by formal education or informal, individual observations. In both cases, the concepts already held will be the starting point. (Smith et al. 1994).

A chemical concept inventory (CCI) was developed for use in general chemistry courses at Nordic universities as well as in upper secondary schools (Eggen & al. submitted). The inventory is aimed to serve two purposes: to map students´ understanding of concepts in chemistry and as an independent tool for evaluation of learning activities. Together with reviews of common alternative conceptions in chemistry, concept inventories may constitute a basis for understanding students' learning difficulties and achievements. The inventories may also display differences in learning outcomes when comparing students from different learning institutions.

CCI is used as a pre-test in the beginning of first university chemistry course to gain information on students' chemistry conceptions at the beginning of their university study. These conceptions are assumed to be either acquired in the school subject (such as the mole concept) or in daily life, such as the belief that matter disappears when something burns. One purpose for using the CCI as a pre-test may be to obtain information about about which concepts students hold after completing the secondary school chemistry education. Another purpose with the pre-test may be to map students' starting point before the university courses. Knowledge about student's understanding of concepts may be used for individual guidance, for designing a pre-course or for adjusting the first-year chemistry education to specific student groups. If the CCI results indicate unfortunate conceptions, it may be possible to address specific parts of the course content that need to be improved. However, the observed problems may also stem from other related issues such as focus on exam rather than understanding the course content, or a suboptimal study strategy. These issues are not directly assessed in the CCI but their effect can be evaluated combining the data with for example learning attitudes test such as CLASS-Chemistry (Adams et al. 2008).

On the other hand, CCI as a post-test shows students' conceptions after the university course. The results from the post-test can be used as an indication of specific areas where students have problems with their conceptual understanding, which will help in reforming courses to address these problems. The results from different universities provide a possible tool for comparing study programs and identify strengths and weaknesses of the courses given. Since the knowledge students possess must be assumed to be a result of both primary, secondary and university education, one could aim at addressing all these levels to improve the overall outcome of the chemistry study.

In the Nordic countries, there has not been any study published regarding student's conceptual knowledge in chemistry. There are some studies published from US. Most of them use the concept inventories which we used as template and get the initial bank of questions (Krause et al. 2004, Mulford and Robinson 2002).

2 Theoretical framework

Concept inventories are aimed at describing the concepts held by students, and are known to be used in the fields of Science, Technology, Engineering and Mathematics (STEM). Concepts are developed from early age, and children form intuitive ideas of natural phenomena. Concepts not consistent with the established consensus are sometimes called misconceptions (Smith et al 1994) or alternative conceptions. Beliefs of chemistry students have been mapped in several studies, where alternative concepts concerning chemical behavior are described. (Nakhleh 1992, Bowen & Bunce 1997, Stavy 1995, Gabel & Bunce 1994, Wandersee et al. 1994, Stavy 1991, Krajcik 1991)

A concept inventory consists normally of a series of multiple-choice questions, based on qualitative problems. It aims to measure deep understanding and conceptual knowledge rather than a student's ability to solve problems. The Force Concept Inventory (FCI) for use in physics education was created by Hestenes et al. (Hestenes et al: 1992). Chemical concept inventories are also developed, although they do not seem to be commonly used in Nordic chemistry studies.

Tools for mapping and analyzing students' conceptions may help the teacher to adjust their practice to facilitate deeper understanding. The students are assumed to build conceptual understanding from their present conceptions, and they might find it difficult to accept new information that does not fit into their existing beliefs. This conflict between student's established views and the new information can be disbelieved and rejected, or accepted with minor or more extensive changes in the student's conception.

Compared to a teacher-centered lecturing, a more student-centered model of education using more hands-on and inquiry-based approach, is believed to increase the student's knowledge and conceptual understanding of a subject. (Taber 2009) Assessment tools, such as the CCI, can be useful for comparing different methods and to measure the students' conceptual understanding as well as to understand what conceptions and background limitations the students have when entering a class.

3 Research methods

The CCI test was developed at NTNU based on existing chemistry concept inventories and by adding questions and concepts based on personal experience of the developers and on literature references. (Krause et al. 2004, Mulford and Robinson 2002). The concept inventory CCI 3.0 presented here, consisting of 40 questions was developed gradually from a larger set of questions by evaluating the discriminatory power and difficulty of the questions and taking into account the time needed for completing the test. As the aim was to use the test to evaluate chemistry concepts held by first year chemistry students, the test was mainly developed to cover main topics introduced in undergraduate chemistry courses rather than the majority of all chemical concepts. CCI 3.0 was administered at NTNU as a posttest in general chemistry course during the spring semester 2015 and analyzed using statistical tests for reliability and discrimination power (Eggen & al. submitted).

In a following study, CCI 3.0 was administered as both pre- and posttest in general chemistry courses in JYU and NTNU during autumn semester 2016. The results from CCI 3.0 will be further analyzed and results will be presented in both scientific papers and other presentations.

4 Results

The consistency and discriminatory power of CCI 3.0 was analyzed using five statistical tests: three focusing on individual items (item difficulty index, item discrimination index, item point biserial coefficient) and two on the test as a whole (Kuder-Richardson test reliability and Ferguson's δ). (Kuder & Richardson 1937, Kline 1986). The results from both universities were found to be similar, and the CCI 3.0 is thus considered reliable and discriminating tool in the present contexts. The test can be considered a useful tool for evaluating the student progress during the first semester and the effect of different teaching methods and learning environments.

4 Discussion and conclusion

The chemical concept inventory developed has been administered at two different universities and evaluated using statistical tests. The results indicate that the concept inventory is a reliable and discriminating tool in the context of both Finnish and Norwegian universities. The inventory aims at functioning as a tool for adjusting teaching practices in general chemistry courses. The results of the tests can also be used to identify strengths and weaknesses in the students understanding, thus helping students to focus on the areas in need for improvement. Statistical analysis of the reliability and discriminatory power of the chemical concept inventory show that it can be applied within the context of general chemistry courses at NTNU, JYU, and possibly other Scandinavian universities. The present form of the chemistry concept inventory is thus a useful tool and will serve as a template for future versions as well as an inventory suitable for longitudinal studies.

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74. PILOTING A COLLABORATIVE MODEL IN TEACHER EDUCATION – AN OVERVIEW OF A TEACHER PROFESSIONAL DEVELOPMENT PROJECT

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Abstract

In our research and development project we developed an educational model intended to support teachers' professional development in science education. In the model pre-service teachers, in-service teachers, and teacher educators formed teams to collaboratively plan teaching and produce material for inquiry-based and integrative science instruction in primary schools. The results are based on three design cycles of the model. Thus far, ten schools, 24 in-service teachers, 30 pre-service teachers, and 560 pupils have participated. The results, which are based on the qualitative content analysis of participants' open answers to a questionnaire, indicate that the developed collaborative model for science education supported pre-service teachers and in-service teachers' professional development in many ways. Participants reflected on theory and practice. They experienced increased knowledge about inquiry and integrative approaches, collaborated in teams to some extent, and found this to be supportive during the project. In general, careful goal setting, collaboration between the participants, and guidance by teacher educators during the initiation of the project were found to be crucial to the further success of the project. The designed model was developed between the cycles and must be further developed in the future, especially in terms of supporting collaboration.

1 Introduction

In research-based theories of teacher education, research methodologies and practice are important parts of pre-service teacher preparation programs in Finland (Kansanen, 2006; Jyrhämä et al., 2008). However, students' experienced that the research-based approach was not realized to as great a degree in practicums as in studies of subject didactics (Jyrhämä et al., 2008). The goals of the new Finnish core curriculum require teachers to be able to apply research-based methodologies in practice. In our research and development project, *From training to teaching*, we have designed a model for a professional development program for both as pre-service teachers and in-service teachers. The goals of the PD model are to promote an inquiry approach in science teaching, an integrative approach in science education, and team teaching.

In order to be successful, *Teacher Professional Development Programs* (PDPs) must recognise teachers as active agents who are responsible for their own professional development (Juuti et al., 2016). According to the multinational Teacher and Learning International Survey (TALIS) (OECD, 2016), supporting peer networks and collaboration and providing opportunities to apply their learning to classroom practise are important for teachers' professional development.

In our PDP model we aim to promote pre-service teachers', in-service teachers', and teacher educators' abilities to collaboratively plan and develop science teaching and product material for inquiry-based and integrative science instruction. The participants collaboratively apply the chosen theme for a specific school and plan and implement the instruction (Figure 1).

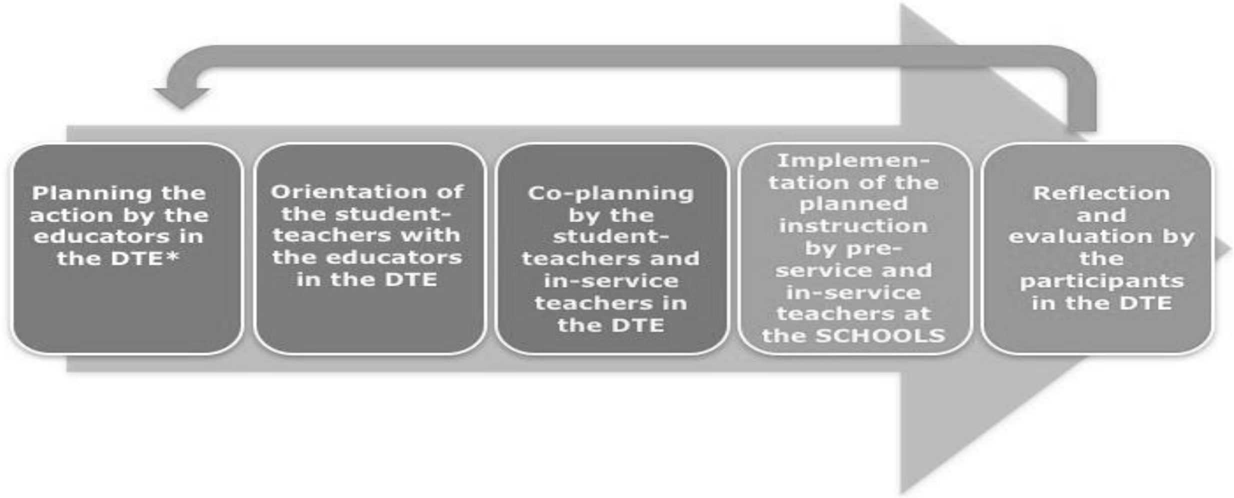

*Figure 1. The model designed for the project. *DTE = Department of Teacher Education*

Our research question is as follows: According to pre-service teachers, in-service teachers, and teacher educators, how does the pedagogical model designed in this study support teachers' professional development in inquiry- integrative, and team teaching approaches in science teaching?

2 Theoretical framework

It is agreed that science education should involve an inquiry approach and scientific practices in order to promote students' scientific understanding and critical thinking (e.g., Crawford, 2014; Osborne, 2014). By engaging students in scientific practises, such as asking questions, carrying out investigations, analysing data, and constructing and evaluating explanations, it is possible to promote students' procedural and epistemic knowledge, as well as their interest in science (Osborne, 2014). Previous studies provide ample evidence that inquiry approach in science teaching can have positive impacts on students' learning of scientific concepts and understanding of the nature of scientific inquiry (see review in Crawford 2014).

In Finland, *Environmental studies* is an integrated subject group composed of biology, geography, chemistry, physics, and health education in the grades one to six (FNBE, 2014). Integrative science teaching is commonly argued for by stating that real-world phenomena are integrated in nature and that interdisciplinary learning contexts are thus authentic (Petrie, 1992). To promote integrative teaching, Mason (1996) emphasizes the importance of teamwork in teacher educational programs because collaborative processes are often necessary in integrative teaching.

Team teaching is regarded as an important approach in meeting the collaborative goals of education. In general, team teaching can be defined as a pedagogical method in which two or more teachers teach a single group of students together, and it can be implemented in various ways (Davis, 1995). Collaborative teaching has been found to help teachers learn from one another (Shibley, 2006), and such teaching encourages and motivates teachers´ professional development (Birrell & Bullough, 2005). In our study, team teaching means that teacher educators, in-service teachers, and pre-service teachers collaborate in various ways when planning teaching, carrying out teaching, and evaluating and reflecting on the theory-based goals of teaching and their own professional development.

3 Research methods

By the spring of 2016, three cycles of the PDP model had been carried out. In all, ten schools, 24 in-service teachers, 30 pre-service teachers, and 560 pupils have participated. One school has participated three times, one school has participated twice, and five teachers have participated twice. After each cycle, pre- and in-service teachers answered a questionnaire about how they experienced the project, what they appreciated the most, and whether they experienced professional development. Their answers were analysed qualitatively via inductive content analysis (c.f. Elo & Kyngäs, 2008).

The iterative development of the model can be characterised as design research, in which a new understanding of educational phenomena is developed while designing practical educational solutions (Edelson, 2002). In our research, we articulate how the theoretical conjectures of our model are embodied in practise and how the practises lead to desired outcomes through mediating processes, as suggested by Sandoval (2014) in order to validate the outcomes of the design-based research.

4 Results

Most participants experienced that they developed professionally in some way after every cycle. Most commonly, they mentioned that their gained the knowledge and courage to apply hands-on teaching, experimental teaching, or inquiry-based teaching; or they gained new ideas for teaching activities in general.

Collaboration within the teams was highlighted in the answers. Several participants mentioned positive experiences in terms of participating in teamwork or learning from it. However, most pre-service teachers found that collaboration with teachers did not work as well as it should have, and the majority of the positive experiences in the collaboration were related to team planning and team teaching with other pre-service teachers.

The model was developed between the cycles according to the results and will be further developed in the future. The results indicate that the goals of model were clarified during the cycles.

5 Discussion and conclusion

According to the results, this kind of model seems to have significant potential to develop both pre-service and in-service teahcers' team teaching skills, as well as an understanding of and the courage to pursue an inquiry approach and integration in science teaching. Our finding that collaboration was highly emphasized by the participants in the professional development project is in line with previous studies that highlight the importance of an active role on the part of teachers in PDPs and providing chances for collaboration and the sharing of ideas (e.g., Juuti et al., 2016, OECD, 2016). This study indicates that when developing teacher education and professional development, it is necessary to pay particular attention to creating concrete opportunities for collaboration and supporting teachers in these collaborates.

In the future, the main objectives in designing this model should be ensuring collaboration and participants' reflection on inquiry approaches and integration in teaching activities. In order to better understand the underlying processes that define the realization of these objectives, the teams' planning meetings, as well as the introduction and reflection sessions, should be studied in more detail.

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79. HVA LEGGER LÆRERE VEKT PÅ I BEGYNNEROPPLÆRINGEN I NATURFAG?

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Abstract
From an early age many children have positive experiences with nature. This includes hiking with their parents and the kindergarten. They have observed plants and animals, the weather and the physical properties of water and air. Children have many experiences that are linked to natural science, and a curiosity about phenomena in the nature that should be further developed.
Natural science is traditionally characterized by its many practical activities, like laboratory experiments and excursions, compared to other subjects. One of the challenging aspects of science learning is "the language of science". To internalize knowledge in natural science, the students need to practice the language in a social context in the classroom. The teacher could, through good questions and targeted activities, get the students to reflect and thus support their knowledge and conceptual understanding. We will present results from a project where we have examined what is typical for the science education of primary school, and how science teachers support the conceptual learning of the youngest students. The results are based on observations of teachers in different teaching situations, and semi-structured interviews with teachers. The teachers have different educational backgrounds and experiences as teachers in natural science.

1 Introduksjon
Fra de er små har mange barn positive opplevelser med naturen. De har blant annet vært på tur med foreldrene og barnehagen, de har observert planter og dyr, vær og vind, de fysiske egenskapene til vann og luft, i tillegg til at de har erfaring med matlaging. Barna har mange erfaringer som kan knyttes til oppstarten i skolens naturfag, og en nysgjerrighet på fenomener i naturen som bør videreutvikles. (Harlen, 2011). Klarer lærere å utnytte barnas naturlige nysgjerrighet i undervisningen sin? Hvordan legger de til rette for læring i naturfag?

2 Teori
Naturfag skiller seg fra mange andre skolefag ved at man gjør eksperimenter og praktiske aktiviteter både inne og ute. Barn flest synes en utforskende arbeidsmåte er engasjerende, og det har lenge vært kjent at læring gjennom erfaring er viktig hos de yngste elevene. Dette danner grunnlaget for elevers refleksjon og diskusjon (Thorsheim, Kolstø, & Andresen, 2016).
Språket er sentralt i all læring, også i naturfag. I følge Bakhtin (1935) har alle grupper et eget sosialt språk, og på den måten kan vi se på naturfagets språk som et språk som er utviklet i et vitenskapelig samfunn. For å kunne tenke og internalisere naturvitenskapelig kunnskap må man øve på dette språket i en sosial sammenheng, klasserommet, før man kan gjøre kunnskapen til sin egen.
Det er derfor viktig at også de yngste elevene gis mulighet til å bruke de naturvitenskaplige begrepene i samtaler med andre barn og med kunnskapsrike voksne. De minste elevene vil i naturfag kunne få et stadig økende naturfaglig vokabular gjennom bruk av muntlig aktivitet (Johnston, 2011, ss. 25-33). Uten dette naturvitenskapelige vokabularet vil ikke elevene kunne formidle sin forståelse i faget.
Howard Gardner (2006) skriver at det å mestre en konseptuell forståelse skapes over tid. Man trenger mange repetisjoner, og den beste måten å gjøre det på er ved å bruke mange ulike tilnærminger i flere kontekster. En forståelse av grunnleggende begreper kan bedre nåes hvis tilnærmingen til dette skjer på ulike måter slik at man tar i bruk flere av de multiple intelligensene (Gardner, 2006). Det å se på mange mulige tilnærminger til naturfaget slik Gardner snakker om, ser Frøyland på i sin bok Mange erfaringer i mange rom (2010). Russel og McGuigan (2016) vektlegger også multimodale representasjoner i naturfagundervisningen med de yngste.

En slik forståelse av nytten av variert læring støttes av nevrovitenskapen, for eksempel:

> Learning by the brain depends on the development of multi-sensory networks of neurons distributed across the entire brain. For example, a concept in science may depend on neurons being simultaneously active in visual, spatial, memory, deductive and kinesthetic regions, in both brain hemispheres. (Goswami & Bryant, 2007, s. 23)

For barn er det viktig at den tematiske sammenhengen naturvitenskapen inngår i er engasjerende. Elevene må føle at det har betydning for dem i deres liv (Driver, Asoko, Leach, Mortimer, & Scott, 1994). Lærerens rolle er sentral i begrepslæringen og gjennom gode spørsmål, vil hun, som kunnskapsrik voksen, kunne få elevene til å reflektere. Slik kan elevenes konstruksjon av kunnskap støttes. Å lage mening er en dialogisk prosess hvor elevene er i en prosess hvor de stadig sjekker egen forståelse i samhandling med andre (Mortimer & Scott, 2003).
Sett i lys av dette fokuset på variert og engasjerende undervisning vil vi forsøke å danne oss et bilde av hvordan ”den gode læreren” legger til rette for elevenes læring i begynneropplæringen i naturfag.

3 Metode

Det er gjort observasjoner av lærere og undervisning i og utenfor klasserommet på 1.-3. trinn, og 6 lærere er intervjuet om begynneropplæring i naturfag. Formålet med undersøkelsen er ikke å si noe om naturfaglærere generelt, men å gi eksempler på hvordan lærere støtter opp om og styrker de yngste elevenes læring i naturfag.
Utvalget er et hensiktsmessig strategisk utvalg av lærere som underviser i naturfag på småskoletrinnet. Det er gjort ut fra eget kontaktnett av lærere i Østlandsområdet i Norge. Utvalget kan vurderes som et bekvemmelighetsutvalg, men det styrkes ved at det baserer seg på en kriteriebasert utvelgelse av lærere – lærere som underviser naturfag i 1.-3. klasse. Lærerne i utvalget hadde ulik formell naturfaglig kompetanse og ulik undervisningserfaring. De hadde enten lang erfaring med undervisning i naturfag, formell kompetanse i naturfag fra lærerutdanningen eller både formell kompetanse og lang erfaring. Ingen av informantene hadde kombinasjonen ingen formell kompetanse i naturfag og kort erfaring med undervisning i faget.
Observasjonene ble brukt til å fokusere spesielt på prosessene som foregår mellom lærer og elev og mellom elever i arbeid med naturfaglige begreper og temaer i undervisningen inne og ute. Det ble observert hele undervisningsdager, 1-2 dager på hver skole. Observasjonsformen var i hovedsak tilstedeværende observasjon med liten deltakelse i den ordinære samhandlingen i undervisningen. I situasjoner med stor elevaktivitet gikk observatørene inn i en mer aktiv rolle som observerende deltakere (Johannessen, Tufte, & Christoffersen, 2010). Det vi så mest etter var læreres arbeid med begreper og naturfaglig forståelse.
Det meste av materialet kom fra intervjuer med lærere. Intervjuene var semistrukturerte (Johnston & Toplis, 2012, Kvale & Brinkmann, 2015). Intervjuguiden hadde 5 nøkkelspørsmål med oppfølgingsspørsmål. Nøkkelspørsmålene var:

1. Fortell litt om bakgrunnen din som lærer, og spesielt som naturfaglærer.
2. Fortell litt om hva du vet om barnas naturfaglige erfaringer og interesser (utenfor skolen/barnehagen).
3. Tenker du at det er noe som kjennetegner begynneropplæring i naturfag framfor andre fag?
4. Hvordan arbeider du med begreper i naturfag?
5. Kan du fortelle om dine erfaringer med å ta med barn til andre læringsarenaer (uteundervisning, museer og vitensentra m.m)?

Gjennom en utfyllende intervjuguide stilles de samme spørsmålene til alle intervjuobjektene, og dette sikrer at intervjuene blir så nøytrale som mulig.
I denne presentasjonen vil vi fokusere mest på det lærere sier om begynneropplæringen.

4 Resultater

Lærerne kartlegger i liten grad systematisk elevenes forkunnskaper og erfaringer i naturfag, annet enn en oversikt over hvem som har gått i friluftbarnehage. I undervisningssituasjoner hvor barna bidrar med sine erfaringer og forkunnskaper, ved at de tar med steiner og insekter, deltar i klassesamtaler og lager felles tankekart, blir disse i stor grad fulgt opp.
Naturfag oppfattes av noen lærere som et opplevelsesfag de første årene, med fokus på blant annet uteundervisning, enkle forsøk og aktiviteter (slik som å lage smør, fallskjerm og propell), samt bruk av sansene. Dette står i motsetning til andre fag hvor bøker og klasseromsundervisning står mer sentralt. Den ene læreren bruker bevisst historier, bilder og leker fra egen barndom, for eksempel i arbeid med gårdsdyr, for å gjøre naturfagundervisningen levende for elevene. For å oppnå et størst mulig læringsutbytte av uteundervisningen og sikre at det ikke bare blir lek, vektlegges forarbeidet i klasserommet, å gi elevene et konkret oppdrag, samt arbeid med repetisjonsspørsmål på slutten av undervisningen.
Alle informantene vektlegger riktig begrepsbruk, for eksempel ikke blande begrepene "atomer" og «molekyler», og fordelene av å introdusere fagbegrepene tidlig, for deretter å repetere dem mange ganger. Den ene informanten tar til orde for å introdusere utvalgte begreper fra ungdomsskolens pensum allerede i 1. klasse, og begrunner dette med at det er morsomt å kunne noe ikke alle kan, samtidig som elevene vil ha en fordel når det skal læres senere. Lærere arbeider med begreper og fenomener på mange ulike måter, gjennom tankekart, lek og bruk av sansene, samt arbeid med oppgaver, tekst, konkreter og halvkonkreter (bilder). Det er vanskelig å beskrive hva «bittert» er, uten å smake på noe som er bittert.
Ivrige naturfaglærere arbeider med naturfaglige temaer i de andre fagene i løpet av skoledagen. For eksempel ved å fortelle om og lage flaggermus i kunst og håndverk og lære de engelske glosene for dyr og grønnsaker omtrent samtidig som det er tema i naturfag. Og i uteundervisning kan ulike naturmaterialer, slik som steiner, kongler og blader, brukes til å telle i matematikk og til å forme bokstaver i norsk.

5 Diskusjon og konklusjon

Vår undersøkelse er ennå i en tidlig fase og alle resultatene er ennå ikke bearbeidet. Det har betydning for denne diskusjonen og det er for tidlig å trekke noen form for konklusjon.
Vi har sett at lærere ofte reflekterer rundt variert undervisning som innfallsport til naturfaget. De ønsker i stor grad å bruke konkreter, naturen selv og en erfaringsbasert tilnærming i sin undervisning. De peker på mange ulike måter de kan nå læringsmålene og de har kunnskap om betydningen av dette. Flere påpeker likevel at en slik tilnærming krever mer tid til forberedelse enn de har tilgjengelig, samt at det kan være utfordrende rent organisatorisk med elevaktiviteter. Det kan for eksempel være vanskelig å ta med elevene ut i naturen når du er alene med 25 fem- og seksåringer. Skolene har i ulik grad ordninger og økonomi til å sette inn ekstra voksne.
Det kan synes som om lærerne er kjent med fordelene ved bruk av en variert tilnærming til naturfaget, men at de i mindre grad klarer å ta hensyn til dette i en hektisk lærerhverdag.

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82. THE DESIGN AND IMPLEMENTATION OF AN ASSESSMENT METHOD COMBINING FORMATIVE AND SUMMATIVE USE OF ASSESSMENT

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Abstract
The two key purposes of assessment, formative and summative, are often in a contradictory position if they are used concurrently. The summative assessment of learning will normally prevent the formative assessment for learning to be realised (Butler, 1988), meaning that the learning potential of the assessment will often be minimal. It is therefore a central challenge to find ways to combine the dual use of assessment.
Such an assessment method, called a Structured Assessment Dialogue (SAD), has been developed by a Danish research team as part of a European research project Assess Inquiry in Science, Technology and Mathematics Education (ASSIST-ME). The method has been tested in classes in three European countries and the results are currently being analyzed.

1 Introduction
There is a strong tradition in the Danish school system for classroom dialogue, so it felt natural to try to design an assessment method that structures and formalises the dialogue in the classroom. Most formative assessments within the typical classroom are quite informal in nature, used differently by different teachers (Shinn, 2013). But in order to be effective and to make it possible to be used for summative purposes, the assessment method must provide a standardized approach to how it is administered. A SAD is such a structured assessment format. It follows three well-defined phases with clear instructions for the teacher and the students of their role. The three phases each have their specific formative and summative function:

1. 5 minutes of dialogue between the teacher and one student in focus, chosen before the lesson
2. 5 minutes of peer feedback from a group of students to the focus student
3. 3 minutes student self-assessment for all students

The SAD concept will be described detailed in the presentation.

2 Theoretical framework
Paul Black and Wynne Harlen are both partners in the ASSIST-ME project, and both have formed the project's theoretical conceptualization of formative assessment (Black and Wiliam, 1998; Harlen, 2012). We see summative and formative assessment as part of the same cycle, but with formative assessment involving the students, judging their performance both on subject specific and on personal criteria and with the aim of finding the next learning step (Harlen, 2013).
Our design of a dialogue-based assessment draws upon the Norwegian researcher Olga Dysthe (1996), seeing dialogue as a central way to learning. Dysthe is inspired by the Russian linguistic Bakhtin (1981), and the key point is to open a room for student reflection in a non-authoritative environment.
The feedback-formats are theoretically based on Hattie and Timperley (2007). In order to be able to give and receive formative feedback, the ability to establish a learning progression within a specific domain became an important competence for teachers as well as students (Alonzo and Gotwals, 2012).
Two research questions will be answered in this presentation:
What are the main challenges related to the uptake of SAD in the daily practices in science, technology and mathematics in primary and secondary schools?
What are the relations between the quality of the teacher-student dialogue and the students' final self-assessment?

3 Research methods

The SAD method was implemented by teams of teachers and researchers in Denmark, Finland, and England, and the research was done in close collaboration with teachers as action research (Zeichner and Nofke, 2001).
In Denmark teachers from lower and upper secondary school (level 7 – 12) in the subjects technology, math, biology and physics participated. A total of 20 SAD sessions were subject to research. Data were collected using written teacher self-reflections via an online questionnaire, group discussions led by researchers, observations of SAD, videotape of selected sessions and students' self-assessments. The narrative data was systematically analyzed using SurveyMonkey's Text Analysis tool and the categories were validated by the teachers. The 5 minute video clips for the teacher-student dialogue were coded using categories describing a dialogue. The coded data was transformed into a network. These networks were grouped according to various network characteristic in order to be able to compare the characteristic of a dialogue with the quality of students' self-assessments.

4 Results

The strict 5-minutes limit on the dialogue posed a challenge to most teachers. They found it difficult to choose learning objective that they could assess formatively during five minutes. By doing SADs more than once, the teachers learned how to focus on smaller parts of the overall learning objectives. Furthermore, they found it hard to construct and implement learning progressions. It became clear that most teachers did not find the students' learning path following the steps in a standard generic taxonomy (like Bloom or SOLO). So, the teachers formulated concrete, domain specific taxonomies, inspired by Alonzo and Gotwals (2012).
Most teachers experienced that in the first peer feedback sessions students tended to praise the focus student more than challenging each other's understanding. Renegotiating the purpose of the feedback session worked to make students' discussion more productive, while teachers who did not renegotiate did not see any improvement in student feedback quality. Thus, it seems that discussing the nature and purpose of feedback with students improved the quality.
The teachers could see the value of the self-assessment phase at the end of the SAD as a strong formative tool, but many had reservations when it came to using the self-assessment as a basis for summative assessment. Many of the teachers noted that their students awarded themselves higher grades than they would think they should get. Again, working with the students' self-assessment improved the reliability of their judgements.

The networks constructed on basis of the teacher-student dialogues gave a clear, graphical representation of the dialogue. It was possible to categorize the networks, thus representing various forms of dialogues, and to establish links between these groups of dialogues and the quality of student self-assessment.

5 Discussion and conclusions

In general teachers found the SAD a useful method for both formative and summative purposes. The 5 minutes dialogue was quite similar to oral examination and gave both students and teacher a clear overview of the demands of the specific part of the subject. The peer feedback session was the most difficult to introduce and to become productive but it was also potentially very important in preparing students for peer assessment. The final student self-assessment gave all students a clear idea of their own level of competence and some ideas for their next learning step.
Besides having established an assessment method with a big potential for improving assessment practice the project also developed a new research method providing researcher with a tool to categorize dialogues.

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84. DOES SCHOOL SCIENCE PROVIDE ANSWERS TO “EVERYDAY LIFE” QUESTIONS? STUDENT CHOICES OF INFORMATION SOURCES IN OPEN-ENDED INQUIRY

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Abstract
It is a common claim within science education that science education should, or even will, prepare the learner for “everyday life” or informed citizenship. Hence, it is of interest to investigate whether knowledge from science education is actually used when dealing with matters outside the science classroom. Herein, students from introductory courses in science and home economics engaged in interdisciplinary open-ended inquiry sequences to investigate claims about food and cooking (e.g. “Chewing parsley removes garlic breath”, “Bananas turn brown quicker when stored in the fridge”). Students’ written accounts were analysed in terms of the information sources used: in which *domains of knowledge* was the information found, which *types of sources* were used, and which role scientific knowledge played in providing relevant information. Results indicate that scientific knowledge provided some answers to the claims investigated, but that much of the knowledge was sought elsewhere. This underlines the importance of balancing declarative knowledge with promoting knowledgeable second-hand inquiry in science education. Thus, in such inquiry, basic scientific knowledge must be seen as a starting point rather than the end. These findings suggest use of caution when claiming usefulness of general science knowledge, declarative or procedural, outside formal education settings or STEM-related professions.

1 Introduction and background
It is a common claim among science educators and policy bodies that science education should have relevance in “everyday matters” and societal issues, i.e. having an impact outside the science classroom and STEM-related professions (e.g. Aikenhead, 2006; Hazelkorn et al., 2015). Hence, it is of interest to investigate whether these are realistic claims, and whether knowledge from science education is actually used when dealing with matters outside the science classroom. The present study investigates university college students’ choices of information sources when collecting first- and second hand information in an open-ended argumentation and inquiry teaching sequence on issues from “everyday life”, namely claims about food and cooking.

The teaching sequence was developed as part of a design-based research study at a Norwegian university college. Organised as a 2 + 2 week interdisciplinary project, students were recruited from a 60 ECTS beginner’s course in science for pre-service teachers, and 30/60 ECTS home economics beginner’s courses. Groups of 2-4 students were asked to collect a number of claims about food and cooking from sources of their own choice, and subsequently select one claim suitable for in-depth investigation (Table 1).

Table 1. *Claims investigated by the 15 student groups (translations by author).*

Claim

1	Adding fresh pineapple to jelly will result in the jelly not setting	Home economics students
2	Bananas turn brown more rapidly when stored in the fridge	
3	Chewing parsley removes garlic breath	
4	Kiwi can be used to tenderise steak	
5	A steak becomes more juicy if the meat is left in room temperature for two hours before cooking	
6	Extra added salt in full-grain bread results in a more fluffy loaf	
7	Shaking a packet of cream will produce butter	
8	Oven-baked omelette becomes more fluffy if carbonated water is used	
9	Using fresh eggs results in a less fluffy sponge cake	
10	Rubbing butter in the inside rim of a pan prevents milk from boiling over	
11	Pineapple can be used to tenderize meat	Mixed
12	Apples turn brown more slowly if cut with a ceramic knife	Science students
13	Sticking a knitting needle into the potatoes will reduce the boiling time	
14	Kiwi can be used to tenderise steak (variant of former experiment)	
15	Using a beer glass for milk, even only once, will permanently ruin the utility of the glass for beer	

The first two-week phase required the students to analyse and construct a plausible argument for the collected claim, regardless of whether the claim was initially considered true, false or ambiguous. Toulmin's argumentation pattern (Figure 1) was used as argumentative scaffold (Toulmin, 1958/2003). The students were required to collect second-hand evidence as well as suggest how the claim could be tested first-hand through experiment. In the subsequent two-week inquiry phase, the students evaluated the credibility of the information sources used, designed and carried out the experiment, and reported the results in a wiki.

The work reported herein describes the students' choice of information sources in this process. Research questions are thus:

When university college students investigate claims about food and cooking:

- From which *domains of knowledge* do students source their information?
- Which *types of information* sources do students use?
- Which role does scientific knowledge play in providing answers in these issues?

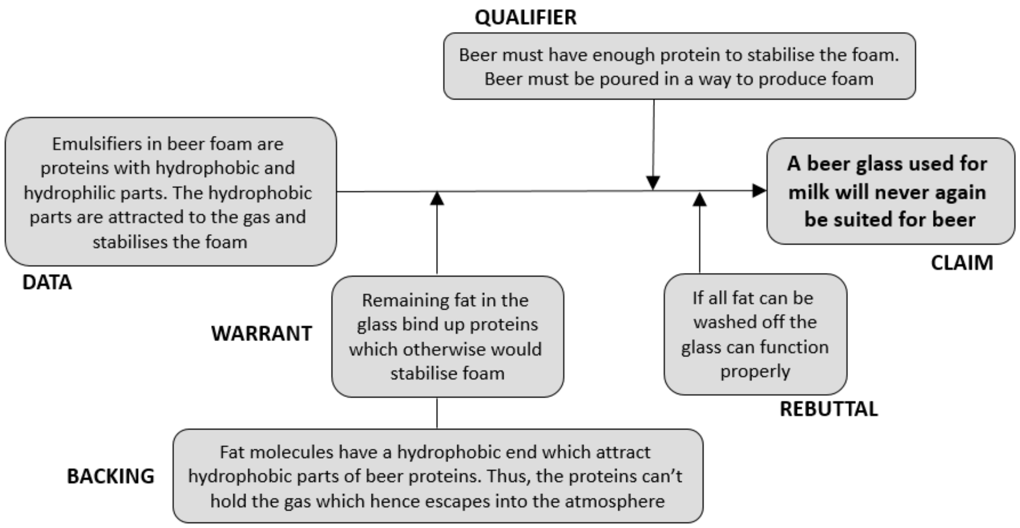

Figure 1. *Toulmin's argumentation pattern applied as scaffold for investigating a claim about using beer glasses for milk. Students had to provide information source for each box.*

2 Theoretical perspective – the epistemology of "everyday life" matters

Catch phrases such as "kitchen chemistry" are common means to motivate for science learning. However, food and cooking is a complex and multidisciplinary field, drawing on knowledge from scientific disciplines spanning natural sciences, social sciences and humanities (Fooladi & Hopia, 2013). Also, relevant knowledge resides outside or in the fringes of formal scientific domains, such as that passed down from master to apprentice in practical action (Sutton, 2006). It might thus be said that questions on food and cooking can *potentially* find relevant answers within the natural sciences, but not necessarily. It is therefore justified to investigate the degree to which knowledge from science education is of actual use, and where those seeking to answer questions *actually* turn for knowledge when it comes to food and cooking.

3 Methods

Results were extracted through a documentary analysis (Denscombe, 2010) of 15 project reports over a three-year period. The information sources chosen by the students were coded in two categories: *subject domain* and *type of source* (Figure 2). For both categories, a limited number of codes were pre-defined. Constant comparative method was applied in an iterative process in order to refine the codes, and include new ones as seen necessary. Nine texts, with a total of 108 coded items, were analysed by two coders and interrater agreement was calculated to give Cohen's kappa value of 0.72 ($p < 0.001$). The codings were subsequently compared and negotiated, reaching an agreement level of 0.99 ($p < 0.001$). Guided by the preceding negotiation the remaining six texts were coded by one researcher.

4 Results

Each group initially collected 8-12 claims, and then went on to select one claims to be subjected to argumentative analysis and experiment (Table 1). Results from the analysis are summarised in Figure 2.

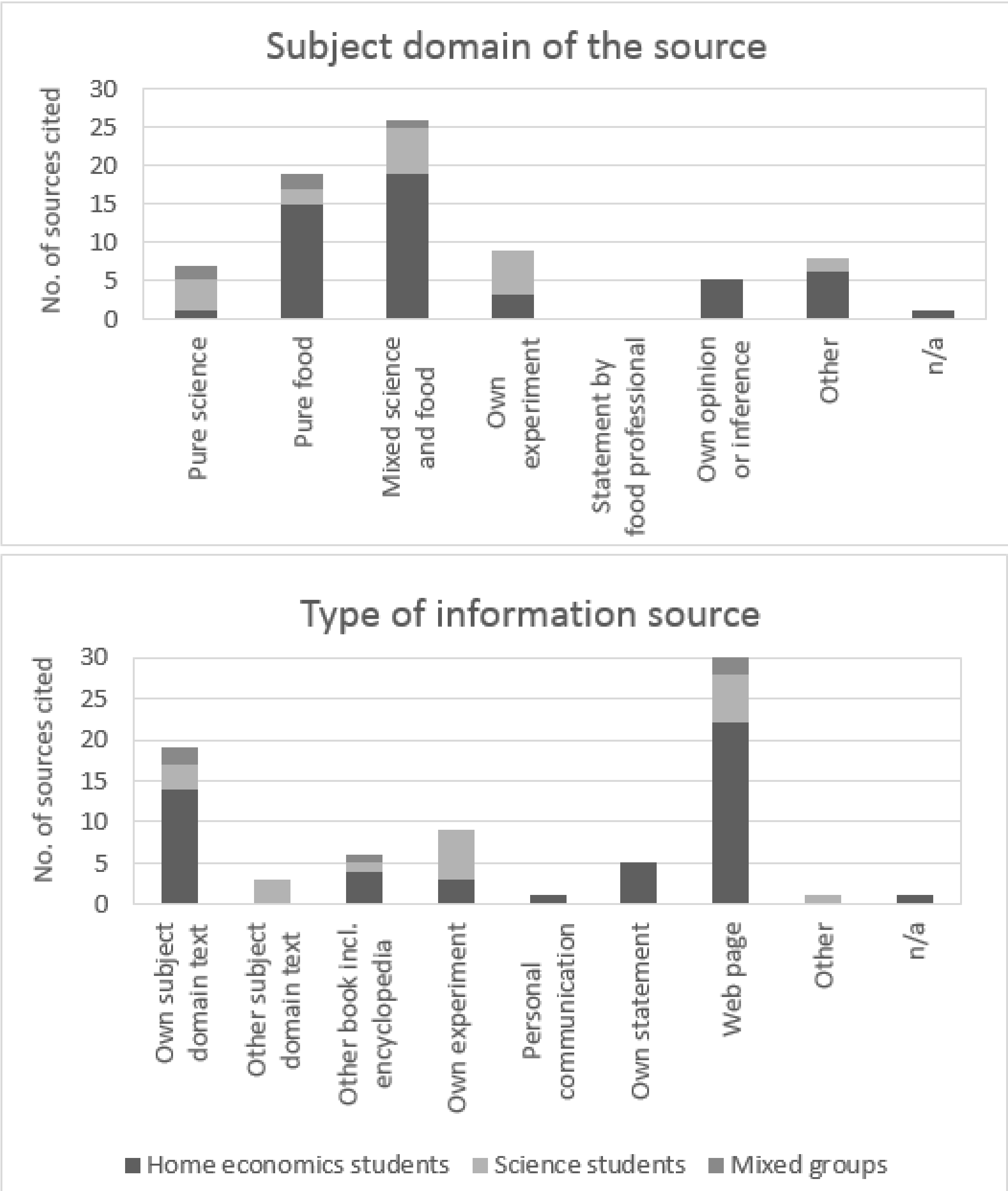

Figure 2. *Coding results from the students' choice of sources*

The results show that the students predominantly found their information through internet searches. While most groups used a variety of sources, the home economics students tended to use their own course material more than the science students. Both groups predominantly sought information within their own subject domain, although non-course literature (mixed science & food) were widely used. Despite conducting experiments, students often valued second-hand evidence more strongly than their own experience. However, the science students appear to have higher confidence in their own experiments than the home economics students.

5 Discussion and conclusion

Although uncontroversial, many of these everyday questions on food and cooking were not answered using the body of knowledge within the science course. Several interpretations may be given for these findings, in which more than one may be in operation simultaneously: (1) Basic science education does not necessarily provide knowledge needed for answering everyday questions of potentially scientific nature unless the topic is explicitly included in the course. E.g., claims 7, 10 and 15 relate to disperse mixtures of matter, emulsions, suspensions and foams, a topic found within food science but not necessarily in national science curricula and textbooks. (2) The science course *does* include the necessary information, but students are not able to transfer knowledge between science class and the practical life of the kitchen. E.g. claims 1, 2, 4, 11 and 14 refer to enzymatic processes in plants and animals, enzymatic browning and protease action, commonly taught in science. (3) Many food and cooking issues are not yet investigated in science because food science has historically given priority to industrial perspectives over home- and small-scale cooking (This, 2009). Consequently, students will be investigating questions in the frontiers of science rather than the established science often found in science courses.

Thus, when carrying out such inquiries students must engage in second-hand investigations into sources outside their usual educational context. Such cycling between second-hand and first-hand investigations, and between contexts, requires background knowledge in order to seek out key information, draw links between context-independent scientific knowledge and the concrete food-related issue in question, and finally make sound credibility judgments of information sources.

In conclusion, the results described herein indicate that notions such as “science education for everyday life” and “science for informed citizenship” as outcome of basic science education are probably overly optimistic, perhaps even best described as slogans. This is not by itself a surprising conclusion, but underlines the need to be cautious towards claiming usefulness of general science education. Although knowledge from basic science education is *necessary*, it is often not *sufficient*, when dealing with “everyday problems”. Such knowledge, declarative and procedural, may thus be seen as the starting point for inquiry rather than as the goal.

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88. TEACHERS' USE OF THE OUTDOOR ENVIRONMENT IN TEACHING YOUNG CHILDREN ABOUT LIVING BEINGS

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Abstract

The aim of the study is to illustrate how preschool and primary school teachers in Iceland used the outdoor environment in an action research project about teaching and learning about living beings. Dewey's theory of experience and education, place-based theories, and Vygotsky's socio-cultural theory form the theoretical framework of the study. Three teachers from one preschool and two teachers from one primary school participated in the study as well as ten five year old preschool children and twenty, six year old, primary school children. The teachers were interviewed at the beginning of the project as well as during the end about their use of the outdoor environment. Participant observations were conducted when the teachers were using the outdoor environment in their teaching. Regular meetings were held with the teachers and minutes from these were also used as data. The analysis of the data reviled that the teachers used the outdoor environment as a source of experience of living beings, as a ground for discussion with children, as an arena for children's play and freedom and as a topic for children's creative work.

1 Introduction

Outdoor learning is a concept used for many different organised educational activities taking place in different environments outside the school building (see, for example, Rickinson et al., 2004). Here it is used in the context of regular preschool- and compulsory school-based activities in the local outdoor environment. In the Icelandic national curriculum guidelines for preschools and compulsory schools, the outdoor environment is perceived as beneficial in children's lives; it is viewed as a rich environment for play and learning, an arena for exercise and healthy lifestyles, and a place that fosters positive attitudes towards the environment (Norðdahl & Jóhannesson, 2015). The curriculum guidelines also emphasise fostering children's positive attitudes and interest in science (Ministry of Education, Science and Culture, 2011; 2014). Even if the curricula for preschool and compulsory schools differ, they have many similarities. Children should be encouraged to explore nature, to ask questions, and to search for diverse solutions. Enjoyment of and respect for nature are emphasised in the curricula, as is reflection on how human behaviour can affect nature. Both curricula also mention gaining experience with and learning about living beings (Ministry of Education, Science and Culture, 2011, 2014).

2 Theoretical framework

The importance of interaction and experience with the physical environment is often emphasised as an important part of children's education. This has been the core of outdoor education for a long time, drawing on Dewey's theory of experience and education (Quay & Seaman, 2013). Dewey (1916/1966) saw learning from experience as a practical process involving children's activities as well as their reflections on the consequences of their activities. The importance of where the learning takes place and children's experiences and explorations of these places is emphasised in place-based theories of learning (Gruenewald, 2003). The sociocultural theory of learning draws on Vygotsky's (1978) work, which emphasises that children learn through interactions with other children and adults and through the culture we live in.

3 Research methods

The research was part of an action-research project in pre- and compulsory schools conducted in collaboration with specialists from the university. Five teachers participated in the research—three from the preschool and two from the compulsory school—along with 10 preschool children and 20 compulsory school children. The study is based on data from interviews with the teachers before and after the project and from regular meetings with them. It is also based on participant observations of the teachers working on the project and on their diaries from the project.

4 Findings

The findings showed that the teachers used the outdoor environment in multiple ways. They used it to further children's experiences of living beings by focusing children's attention on them. They used the experiences gained outdoors as a source of discussion. They also used the outdoors as a place for play and freedom, and the compulsory school teachers mentioned that this time was good for children who had difficulty sitting still for a long time; being outdoors meant they could move around without disturbing other children. The teachers used visual arts for further children's opportunities to investigate living beings, and to reflect on what they had seen and experienced in the outdoors.

5 Discussion and conclusion

An important finding from this study is that the outdoor environment offered multiple opportunities for the children to experience living beings even in the midle of the winter. The experience of living beings in the wood as well as the teacher-led enquiries was fundamental as the teachers were good at focusing children's attention on things of interest. This exploration made it possible for the teacher to combine the experience of the environment with the learning of scientific knowledge. This is in line with place-based theories (Gruenewald, 2003) as well as Dewey's (1938/2000) theory of experience, in which children's experiences in the local environment serve as a basis of their learning. This is also consistent with previous research findings in various countries (Fägerstam, 2013; Kernan & Devine, 2010; Óskarsdóttir, 2014; Szczepanski & Dahlgren, 2011) indicating that teachers value the experiences the outdoors offers for children's learning.

Another important finding was the emphasis the teachers put on discussing with the children the experience provided in the outdoor environment. They did not believe that children would learn about the living beings only by experience, as teachers in several other studies have done (Ejbye-Ernst, 2012; Fleer, 2009). Instead they supported the children in their learning by discussing the same things over and over again. They emphasised discussing children's own ideas as well as using scientific explanations. With this method, children had opportunities to explore different ideas and develop their scientific understanding, though the teachers expressed that they would like to follow up with activities better in the future. This aligns with Dewey's (1916/1966) theory about the importance of reflecting on experience and Vygotsky's (1978) theory about the importance of language and communication for learning and that learning takes place in a socio-cultural context. As Scott et al., (2007) point out, scientific knowledge is created in a community of natural scientists, and children cannot obtain this knowledge from their own experiences without support from someone who has mastered this knowledge. Therefore, the quality of the discussions between children and their teachers about scientific concepts is seen as important in children's learning (Gustavsson & Pramling, 2014; Tulin, 2011).

The third important findings of the study is how differently the preschool teachers and compulsory school teachers approached the teaching. On one hand, the preschool teachers liked to highlight knowledge the children themselves presented, or to use the outcome of an experiment or investigation that the outdoor environment offered to discuss a relevant scientific concept or explanation. On the other hand the compulsory school teacher, who was confident about using the outdoors in her teaching, often presented such knowledge herself. Here, these teachers could learn from each other because both of these approaches have educational value. The value of listening to children, supporting their enquiries, and discussing their hypotheses about subjects has been emphasised in young children's science learning (Harlen, 2006). However, sometimes children will not come to a conclusion or find an answer to a question they have asked, and then it is the teacher's task to support their learning by explaining and answering their questions.

The fourth finding of the study is that it indicates that the teachers see using the outdoors as a way to work simultaneously on children's learning and their overall development through the opportunities the outdoors offers for children's physical and social development as well as using creative means in their learning such as the visual arts.

It was also interesting to see how the preschool teachers viewed children's free play and its role in children's learning. Although the teachers regarded free play as the children's main mode of learning, they did not always want to use it in goal-directed learning. This aligns with the contradictory ideas seen in other research findings about the role of the teacher in children's play, which see children's free play either as something the teacher should not interfere with or control or as an objective-driven learning process in which teachers can be involved (Hreinsdóttir & Einarsdóttir, 2011; Ärlemalm-Hagsér, 2008). This has to do with teachers' roles in children's play, in supporting children's learning, and in using the learning opportunities that play offers (Pramling, Samuelsson, & Carlsson, 2008). Further consideration and investigation into how we can increase and enhance children's learning in areas such as science in play-based activities in outdoor settings would be worthwhile.

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90. SHOULD WE SACRIFICE INQUIRY-BASED SCIENCE EDUCATION IN ORDER TO CLIMB ON PISA-RANKINGS?

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Abstract

Since the first publication of PISA results in 2001, the PISA scores have become a kind of global "gold standard" for educational quality - a single measure of the quality of the entire school system. In many countries, school reforms are introduced based on what is perceived to be failing results in PISA. While great attention is given to the PISA scores and country rankings, little attention is given to some of the findings that are surprising, unexpected and problematic. The focus of this paper is to address some of these findings. The most important and problematic finding is that PISA-scores correlate negatively with nearly all aspects of inquiry-based science teaching (IBSE), the kind of teaching that is currently recommended by scientists as well as science educators, and also endorsed by funding agencies for grants, for instance the EU Horizon 2020. Other paradoxes are abundant: Money and resources spent on education do not seem to matter for the PISA scores. Class size does not matter. PISA-scores correlate negatively with investment in and the use of ICT in teaching. PISA science scores also seem unrelated to the time given to science in school. Whether one "believes in PISA" or not, these results need to be discussed critically by science educators.

Introduction

International comparative studies of students' achievement have been around since the 1960's, mainly organized by the IEA (International Association for Educational Achievement). Acronyms like TIMSS and PIRLS have become widely known. Results are reported in the media, and they have over the decades been used by policymakers to inform national reforms and initiatives.

The scene changed dramatically when the OECD entered the scene with its PISA-project in 2000. Since the first publication of results in 2001, the PISA-results have become a kind of global "gold standard" for educational quality - a single measure of the quality of the entire school system. An OECD-report on the policy impact of PISA, proudly states that *"PISA has become accepted as a reliable instrument for benchmarking student performance worldwide, and PISA results have had an influence on policy reform in the majority of participating countries/economies"* (Breakspear 2012).

Similarly, Andreas Schleicher (2012), director of PISA and recently also of Directorate of Education and Skills in OECD, in a TED talk starts his presentation by stating that PISA is *"really a story of how international comparisons have globalized the field of education that we usually treat as an affair of domestic policy."*

The well-documented and increasing global influence of PISA, in particular the PISA-scores and country rankings gives reasons for serious concerns. Other studies, closer to actual school curricula and national priorities and concerns, are pushed aside, and PISA is also enlarging its scope and influence with studies like PIAAC (often called "PISA for adults), "PISA for schools" and "PISA for Development". The now annual OECD publication "Education at a glance" brings indicators and statistics from these and other sources, and is used by policymakers in all countries.

By these studies and products, the OECD exerts what scholars describe as "soft power", they "govern by numbers and indicators". The main concern from critical academics is that school policies, which used to be the core aspect of all nations' cultural heritage, values and identity has become the subject of external and global influence, where the prime perspective is the economic competitiveness in a harsh global race.

The most important critique is what makes PISA different from most other studies: its highly political, normative and prescriptive nature, also noted in anthologies like Meyer and Benavot (2013).

PISA is also been criticized for its methodology and for its unwarranted conclusions and recommendations. (Rutkowski and Rutkowski 2016).

Some of the surprising and problematic results have received less attention. Among the problematic results are that money and resources spent on education do not seem to matter for the PISA scores. Class size does not matter. PISA-scores correlate negatively with investment in and the use of ICT in teaching. PISA science scores also seem unrelated to the time given to science in school.

This paper addresses only one problematic finding that is of particular importance for science educators, the finding that PISA-scores correlate negatively with nearly all aspects of inquiry-based science teaching (IBSE).

Science literacy according to PISA

The PISA assessment framework constitutes the basis for PISA-testing. Its (renewed) definition of science literacy for the PISA 2015 is the following:

"Science literacy is defined as the ability to engage with science-related issues, and with the ideas of science, as a reflective citizen. A scientifically literate person is willing to engage in reasoned discourse about science and technology, which requires the competencies to explain phenomena scientifically, evaluate and design scientific enquiry, and interpret data and evidence scientifically. (OECD 2016c p. 28)

This short version is expanded, explained and well anchored in research literature the Assessment Framework (OECD 2016a). Most science educators are likely to be find this definition and its wider explanation fruitful and even progressive. As one can see, the definition also includes affective dimensions and stresses aspect that today are known as inquiry-based science education (IBSE), argumentation and socio-scientific issues (SSI). They also use the term "epistemic beliefs" about aspects that are similar to what is often termed Nature of Science" (NOS). Epistemic beliefs play an important role in the framework.

One might assume that the PISA science score also includes these aspects of science literacy. But, although they are part of the definition, they are not addressed by the test items. The published PISA science score is based solely on the test items.

Attitudinal aspects and questions related to teaching and learning experiences, epistemic beliefs etc. are, however, addressed in the PISA student background questionnaire. On the basis of the questionnaire, certain constructs that are part of the above science literacy definition are calculated. PISA reports provide the details, and also how these constructs relate to the PISA test score (OECD 2016c).

PISA and Inquiry-based science education (IBSE)

The concept of science as inquiry has a long history (Roth 1995; Flick & Lederman 2006). In recent years it has again been lifted as if it was a newcomer. IBSE is now an acrononym and a slogan, and is the key recommendation in the influential EU-document "Science Education Now", the Rocard-report (EU 2007). The term IBSE has been adopted as the key concept in calls for EU-funding in FP7 as well as for the current Horizon 2020-prgramme. It also plays a majour role in the recommendations in the International Council for Science reports to the Science Unions world-wide (ICSU 2006).

In PISA 2015, nine statements in the student questionnaire are combined to an Index of inquiry-based index. Some of the statements are these: “Students spend time in the laboratory doing practical experiments”; “Students are required to argue about science questions”; “Students are asked to draw conclusions from an experiments they have conducted”; “Students are allowed to design their own experiments” and “Students are asked to do an investigation to test ideas”.(OECD 2016c, p 69).

Among the interesting findings is that in most of the "PISA-winners" (Japan, Korea, Taiwan, Shanghai, Finland) students report very little use of inquiry-based teaching.

For the variation within the same country, the PISA finding is that *"in no education system do students who reported that they are frequently exposed to enquiry based instruction [….] score higher in science."* (OECD 2016c, p 36)

But, although the relationship between IBSE and PISA test score is negative, IBSE relates positively to interest in science, epistemic beliefs and motivation for science-oriented future careers:

"However, across OECD countries, more frequent enquiry-based teaching is positively related to students holding stronger epistemic beliefs and being more likely to expect to work in a science-related occupations when they are 30" (OECD 2016c, p 36)

One of the questions in the Index may be of special interest for science educators. Experiments play a crucial role in science, and have always played an important role in science teaching at all levels. But when it comes to PISA, the report states that: *"activities related to experiments and laboratory work show the strongest negative relationship with science performance"* (PISA 2015c, p 71).

Discussion and conclusion

As we have seen, the published PISA science score does not address fully the aspects that are given in their definition of science. Aspects that relate to engagement, interests, attitudes, doing experiments and other enquiry-oriented learning experiences are addressed in the students' questionnaire, but not included in the calculation of PISA score. (Such an inclusion would also be psychometrically problematic, since they do not correlate positively to legitimize a composite, single construct of science literacy.)

The tension between the PISA definition of science literacy and what this measure includes and excludes is not clearly communicated in PISA reports.

In many countries, increasing the PISA-score has been officially stated as a prime goal for the nation and its schools. This is also the way OECD uses PISA data as indicator and standard for quality. Given the above examples, the obvious way to increase test scores will be to abandon the kind of teaching that the science community as well as the science education community recommends. Not only because it mirrors "authentic science", what it means to do science, but also because it promotes motivation, recruitment and lasting interest in science.

The alternative to strive for higher PISA-score is to warn against the current celebration of PISA-scores and -rankings as valid measures for the quality of the school in general and school science in particular. This rejection should be based on a thorough knowledge of the details and limitations of PISA. In any case, educators should address the problematic findings of PISA in an informed and critical way.

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91. THE SIZE OF VOCABULARY AND RELATIONS TO READING COMPREHENSION IN SCIENCE

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Abstract
This research focuses on children´s level of understanding of science texts used in Icelandic schools. The aim was to research what percentage of known words in a science text is needed by Icelandic 9–12 years old students for comprehension of the school book text. Recent research indicate strong relations between reading comprehension and vocabulary. Also, evidence suggest that the size of vocabulary predicts the rate of growth of students' progress in reading comprehension.

Data was collected by providing participants with text from a widely used science books for their age. They underlined words they could not explain verbally and then answered comprehension questions based on same text. Analysis included calculating the percentage of underlined words and the percentage of correct answers of comprehension.

Preliminary results point to similar results for Icelandic children age 9–12 as in other research i.e. that about 95% of words in a text needs to be understood by the reader to comprehend the content for deep understanding and/or fun. These results will be discussed in relation to results of PISA 2015 for Iceland which suggest that general reading comprehension and literacy in science and math has declined.

1 Introduction
Poor results of Icelandic students in PISA has captured attention of the Icelandic public recent years. The results of PISA 2015 for Iceland indicate that general reading comprehension and literacy in science and math has declined (Menntamálastofnun, 2017). As reading comprehension is the aim of reading and the key for further education it is seems clear that students that have low level of reading comprehension have less opportunity to learn and thus less possibility for quality life than others (Hart & Risley, 2003; Ólafsdóttir, 2015).

Recent research indicate that nothing seems to have as strong relations with reading comprehension as vocabulary (Birgisdóttir, 2016; Hoover & Gough, 1990; Laufer og Ravenhorst-Kalovski, 2010; Ólafsdóttir, 2015). Also, within Icelandic context, evidence suggest that the size of vocabulary predicts the rate of growth of students' progress in reading comprehension (Ólafsdóttir, Birgisdóttir, Ragnarsdóttir & Skúlason, 2016; Stanovich, 1986).

With recent PISA 2015 results for science in mind this research aims at mapping and research further the relations of word understanding and reading comprehension within the context of science learning.

2 Theoretical framework
When discussing word understanding some distinctions must be kept in mind. First is the breadth and depth of vocabulary. The breadth refers to how many words an individual knows and the depth refers to the quality of the knowledge and understanding of the concept. Second, is the input (understanding) and output (use) of the words which are distinguished as receptive vocabulary and productive

vocabulary (Laufer, 2003; Nation, 2001; Ólafsdóttir, 2010, 2015). Third, words have been categorised by frequency. Words that are met and used for daily communications are those who are learned first (Hart & Risley, 2003) and are called high-frequency words and form the base of everyday language (Nation, 2001). Vocabulary that builds on high-frequency words is sufficient for learning in the first years of compulsory schooling. After the first years the learning becomes more difficult (Chall & Jakobs, 2003) and students have to deal with more complicated words, i.es low-frequency words. Such words are mostly met in written texts and cover the majority of words in each language (Cummins, 1982; Nation, 2001).

Beck et al. (2002) further explain high- and low-frequency words in languages. They divide words in three categories; daily vocabulary (Tier 1) where all words used fall into the group of high-frequency words; higher-order vocabulary (Tier 2) and specialised vocabulary (Tier 3). The last two include low-frequency words. Specialised vocabulary includes words and concepts that are based on particular definitions which is a broad consensus about. In science this could be words like *cell* and *photosynthesis*. Higher-order vocabulary is at the other hand not usually based on concise definitions. These include various types of multiword-conjunctions (connectives) like *inspite of*, *neither … nor* which are used instead of coordinating conjunction such as *like, and, or* and *but* that fall into the category of daily vocabulary. Research on vocabulary indicate that if students don´t master higher order vocabulary their progress in reading and writing is in danger (Beck, et al., 2002; Laroussoue, 2016).

The concept of lexical threshold has proved to be useful in research being the proportion of known words in a text for comprehension of a text. In recent research on lexical threshold results indicate that about 95–98% of words in a text needs to be understood for the reader to comprehend the content for deep understanding and/or fun (Laufer & Ravenhorst-Kalovski, 2010; Schmitt, Jiang & Grabe, 2011). Schmitt et al (2011) further researched the lexical threshold and found that their participants needed to understand 95% of words to gain 60% comprehension, 98–99% words to comprehend 70% of the text, and all words to gain 75% comprehension. This is in line with Laufer and Ravenhorst-Kalovski (2010) results who focused on bilingual students.

In our knowledge, lexical threshold has not been researched in Iceland, and in particular not in the context of science textbooks used in schools. Therefore following research question was formed: What is the percentage of known words in a science text needed by Icelandic 9–12 years old students for comprehension.

3 Research methods

Participants in this research were 9–12 years old Icelandic school children in south-west region of Iceland. Children were provided with text from a widely used science books for their age. Their task was to underline words they could not explain verbally. Then answered comprehension questions based on same text. Analysis included counting the number of underlined words and calculating the percentage of underlined words of total number of words in the text. Also, the percentage of correct answers of comprehension was calculated. Descriptive analysis of these results gave information about the mean percentage of words known and correct answers given. Following correlation analysis provided answer to the research question.

4 Results

Preliminary results indicate that same applies to Icelandic children age 9–12 to the participants of Laufer and Ravenhorst-Kalovski (2010) and Schmitt, Jiang & Grabe (2011) found. These results will be discussed in relation to results of PISA 2015 for Iceland which suggest that general reading comprehension and literacy in science and math has declined.

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93. THE RELATION BETWEEN SUBJECT TEACHERS' UNIVERSAL VALUES AND SUSTAINABILITY ACTIONS IN THE SCHOOL

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Abstract
Education for sustainable development (ESD) is included in school curricula into all education around the world. However, there is not much research on the factors contributing the success of ESD in the schools and teachers' engagement in sustainability actions. To fill the gap, this study investigates secondary school teachers as educators for sustainable development in terms of their basic values and sustainability actions in the school. A survey was used to study the perceptions of 442 subject teachers from 49 schools in Finland. The questionnaire included the shortened version of Schwartz's Value Survey and items that measured teachers' perceptions on their sustainability actions (SA) in the school. Exploratory factor analysis (EFA) was used to find different value and SA dimensions. In SA there was five different dimensions, expressing three ecological and two social sustainable action dimensions. Statistical analyses showed that there were significant differences between the gender, subject teachers groups, age groups and schools in the value and SA factor dimensions. Only the universalistic human and nature values correlated significantly with the different SA dimensions. The results indicate that teachers' values are important background factors that influence their own motivation and engagement to act sustainable way in the whole school sustainability activities.

1 Introduction
During the decade, sustainability education (SE) has been increasingly taken into account in the formal education of comprehensive schools around the world (UNESCO, 2014). SE emphasizes the consideration of ecological, economic, social, and cultural aspects of sustainable development. Accordingly, human rights, equality, democracy, natural diversity, preservation of environmental viability are included in the underlying values of basic education in Finland (NFBE, 2004). The curriculum also included "Responsibility for the environment, well-being and a sustainable future" as a cross-curricular theme. The curriculum was renewed in 2014 (NFBE, 2014), with seven main areas of students' transversal competences that has to be taken in into account in all subjects. One of these new competence areas is "Participation, agency and the building of a sustainable future". In the school SE is recommended to be implemented as a whole-school approach (Henderson & Tilbury, 2004. This approach requires pedagogical content knowledge and action competences in the area SE of the teachers. Thus, teachers' values and perceptions as well as actions within the school are important focus in the SE research.
However, there is not much research on the factors contributing the success of ESD in the schools and teachers' engagement in sustainability actions (Authors, 2017). To fill the gap, this study investigates secondary school teachers in terms of their universal values and sustainability actions in the school. The aim of the study was to find out what is the relationship between teachers' sustainability-related values and actions in the school.

2 Theoretical framework
Values are crucial in influencing personal attitudes and behaviour (Schwartz, 2012). Values can be defined as deeply rooted, abstract motivations that guide, justify or explain attitudes, norms, opinions and actions. According to the theory of basic values, there are ten motivationally distinct basic values (Schwartz, 2012) (Table 1).

Table 1. The basic human values.

Value dimension	Value description, defining goals

Universalism	Understanding, appreciation, tolerance, and protection for the welfare of all people and for nature.
Benevolence	Preserving and enhancing the welfare of those with whom one is in frequent personal contact (the ‘in-group’).
Tradition	Respect, commitment, and acceptance of the customs and ideas that one's culture or religion provides.
Conformity	Restraint of actions, inclinations, and impulses likely to upset or harm others and violate social expectations or norms.
Security	Safety, harmony, and stability of society, of relationships, and of self.
Power	Social status and prestige, and control or dominance over people and resources.
Achievement	Personal success through demonstrating competence according to social standards.
Hedonism	Pleasure and sensuous gratification for oneself.
Stimulation	Excitement, novelty, and challenge in life.
Self-direction	Independent thought and choice of action, creating, exploring.

The basic values include into the four opposing dimensions; Self-transcendence (universalism, benevolence) versus Self-enhancement (achievement, power) and Openness to change (hedonism, stimulation, Self-direction) versus Conservation (tradition, conformity, security) (Figure 1).

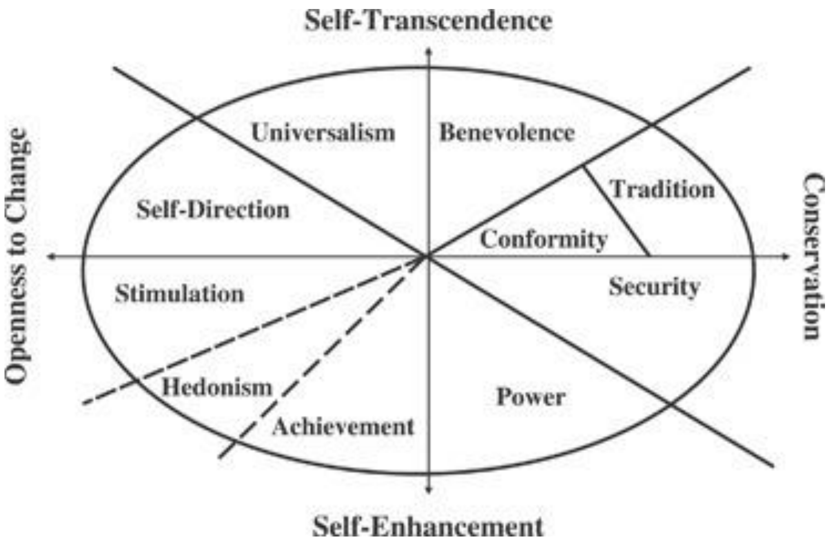

Figure 1. The universal value dimensions and four higher order value dimensions grouped according to the Theory of Basic Human Values (c.f. Schwartz, 2012).

3 Research questions

This study aims to find out what is the relationship between teachers’ basic values and sustainability actions in the school. The questions for our research are:

- What kind of basic values the teachers have?
- How often teachers are engaged in SA in the school?
- What is the relationship between the values and actions?
- What is the relative importance gender, age and the teacher’s subject in explaining the results?

4 Research methods

The study was carried out during the a research project (Authors, 2015, 2017) in Finland. A survey was used to study the perceptions of 442 subject teachers from 49 schools in Finland. The questionnaire included the shortened version of Schwartz's Value Survey (The Portrait Values Questionnaire, PVQ see Schwartz, 2012). Instead of 21 items' PVQ, we used 22 items to find out the contribution of human values (two items) and nature values (two items) in the Universalism value dimension, thus we had 11 value dimensions in our study.

Exploratory factor analysis (EFA) was used to find different value and SA dimensions. For more detailed explanation about the research methods, see Authors (2015; 2017). Differences between the groups were studies with t-test (gender) one-way ANOVA (age groups), MANOVA (subject teacher groups) and Kruskal- Wallis test (schools). Pearson correlation analysis was used to study the relationship between value factors and action factors.

5 Results and discussion

Each value dimension was calculated as the means of two items, ranging from 1 to 6 (Schwartz et al. 2012).

***Table 2**. Main results of statistical analyses of value factors.*

Value dimension	M (SD)	Gender	Age (5 age groups)	Subject of the teacher	School
Universalism – human	4.1 (1.2)	*	NS	NS	NS
Universalism - nature	3.2 (1.3)	*	***	***	NS
Benevolence	4.4 (1.1)	***	NS	**	NS
Hedonism	4.7 (1.1)	NS	***	NS	NS
Stimulation	4.4 (1.1)	NS	*	NS	NS
Self-direction	4.3 (1.0)	NS	*	***	NS
Achievement	4.0 (1.2)	NS	**	*	NS
Power	3.4 (1.2)	NS	***	NS	NS
Security	3.6 (1.2)	NS	NS	NS	NS
Conformity	3.1 (1.2)	NS	NS	NS	NS
Tradition	2.8 (1.1)	NS	NS	NS	NS

Note 1 : * p <0.05, ** p <0.01, *** p <0.001
Note 2: x p <0.05 in nonparametric test

Table 3. *Results of the EFA for sustainability action items.*

Action dimensions	No of items	Range of factor loadings	Gender	Age (5 age groups)	Subject of the teacher	School
Cooperation within and outside the school	4	0.33-0.80	NS	***	***	NS
Social sustainability actions: caring of wellbeing	5	0.33-0.64	**	NS	NS	NS
Social sustainability agency: enhancing sustainability policy	2	0.66-0.82	NS	***	**	NS
Ecological sustainability actions: material recycling and acquisition	2	0.48-0.78	NS	**	***	NS
Ecological sustainability actions: saving materials and energy	2	0.53-0.68	***	NS	NS	NS

Note 1 : * p <0.05, ** p <0.01, *** p <0.001

There was significant differences within the studied groups, excepting the schools (Tables 2-3). It is likely, that there are also interactions between the studied variables. The Pearson correlation analysis showed that *universalistic human values*, *nature values* and *self-direction* correlated significantly with all SA dimensions (r = 0.15-0.31, $p < 0.01$). There was also some positive correlation with *stimulation* and social sustainability agency (r = 0.14, $p < 0.01$). *Power* and *conformity* correlated slightly negatively with SA dimensions (r = - 0.12-0.13, $p < 0.05$). The preliminary results indicate that for instance biology, home economics, arts and crafts teachers had often high factor scores in human and nature values and they also were often most active in SA.

6 Conclusions

Basic values are very deeply rooted (Schwartz, 2012). The values of the teachers' are important background factors that influence their own motivation and engagement to act sustainable way in the whole school sustainability activities. *Human and nature values* in *universalism* as well as *self-direction* and *stimulation* indicate Self-transcendence and Openness to Change. Our results suggest that these dimensions could be regarded to resemble value goals of ESD (UNESCO, 2014), because they were connected to pro-environmental and pro-social actions of the teachers.

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Symposium

72. TEKNOLOGIÄMNETS INNEHÅLL I SKENET AV ETABLERING AV TEKNIK TEKNISKT KUNNANDE

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Abstract
When compared with traditional science subjects, technology has a more fragile position in both Norway (Sanne et al., 2016) and Sweden (Hallström, Hulten & Lövheim, 2013). One way this is displayed in Sweden is through teachers' uncertainty regarding subject content (Skolinspektionen, 2014). In Norway, many teachers feel that they lack the skills required to teach technology (Sanne et al., 2016). This symposium consists of three contributions each dealing with the problem of establishing a common subject content. The first contribution addresses the relationship between teaching science and technology and presents results from a project where teaching has been designed for the parallel development of scientific and technical knowledge. The second contribution examines the conditions for teaching about technology and society in the form of technology teachers' intentions with their teaching.The final contribution highlights the inclusion of programming in school, a specific example of subject content surrounded by great uncertainty amongst policy makers and teachers. All build upon a way of dividing technological knowledge in three main categories as used by, among others, Dahlin, Svorkmo & Voll (2013), Sanne et al (2016) and Skolverket (2011a).

Gemensam introduktion
Jämfört med de klassiska naturvetenskapliga ämnena är teknik ett ämne med en mer osäker position i både Norge (Sanne et al., 2016) och Sverige (Hallström, Hultén & Lövheim, 2013). På svensk sida tar det sig bland annat uttryck som en osäkerhet om ämnesinnehållet (Skolinspektionen, 2014) och som att ämnet domineras av ett naturvetenskapligt perspektiv (Klasander, 2010). I Norge upplever många lärare att de saknar den kompetens som krävs för att undervisa i teknologiämnet. Resultatet blir att ämnet systematiskt nedprioriteras och att dess egenart överröstas av det aktuella naturvetenskapliga ämnets väletablerade traditioner och ämneskultur (Sanne et al., 2016)

Det här symposiet består av tre bidrag som vart och ett behandlar problematiken med ämnesinnehållet. En del av det större problemet är relationen mellan undervisning för naturvetenskapligt kunnande och undervisning för tekniskt kunnande. Liv Oddrun Volls bidrag behandlar detta och redovisar resultat från ett projekt där undervisning som syftar till att tekniskt och naturvetenskaplig kunnande skall utvecklas parallellt och integrerat utvecklas och testas. Sambandet mellan naturvetenskap och teknik utgör också exempel när Markus Stoor tar upp förutsättningarna för undervisning om teknik och samhälle i form av tekniklärares intentioner med sin undervisning. Att även programmering är ett ämnesinnehåll där särskild osäkerhet råder syns i Peter Vinnerviks bidrag. Han redovisar en undersökning om lärare som föregått den kommande svenska kursplaneförändringen och redan börjat undervisa om programmering.

Symposiet i sin helhet speglar problematiken med ämnesinnehåll ur perspektivet tekniskt kunnande. Tekniskt kunnande beskrivs på olika sätt i litteraturen (Ropohl, 1997; Staudenmaier, 1985, Rossouw, Hacker, & de Vries, 2011). Bidragen använder sig av den indelning i tre huvudkategorier som många gjort tidigare (Dahlin, Svorkmo & Voll, 2013; Sanne et al, 2016; Skolverket 2011a):
Praktisk och begreppsmässig kunskap. Kategorin omfattar kunskap och färdigheter som bara kan läras genom övning och en kognitiv kunskapsmängd som vi kan kalla «ingenjörskunskap».
Kunskap om utveckling av tekniska produkter är kunskap om processen från idé till en färdig produkt, ofta kallad designprocess eller problemlösningsprocess.

Kunskap om teknik och samhälle handlar om att förstå den tekniska utvecklingen och de omfattande konsekvenser den har för hur vi lever.

Bidrag 1: Utvikling av kompetanse i naturfag og teknologi i norsk skole

Teknologi og naturvitenskap
Et teknologisk produkt eller system kjennetegnes ved at det er et redskap, skal fylle en oppgave eller ha en funksjon. Svært mye av dagens teknologi er basert på naturvitenskapelig kunnskap ved at teknologien ofte utnytter ulike naturvitenskaplige prinsipper. Men teknologi og naturvitenskap to fagområder med utgangpunkt i ulike fagtradisjoner og mål. Teknologi blir ofte betraktet som anvendt naturvitenskap, men dette er både begrensende og forenklende (Bungum, 2003). Naturvitenskap utgjør bare ett av mange elementer i en kompleks og sammensatt teknologisk kunnskapsbasis og det er ofte ingen direkte vei fra naturvitenskapelig erkjennelse eller teorier til anvendelsen som ligger i et teknologisk framskritt. Teknologihistorien er like lang som menneskeheten. Ofte har teknologisk kunnskap kommet først, og i etterkant har man klart å forklare virkemåten ved hjelp av naturvitenskapelige prinsipper (Sanne et al, 2016).

Teknologi i norsk skole
I Norge undervises teknologi i skolen som integrert del av skolefaget naturfag. I LK06 ble teknologi og design innført som ett av seks hovedområder i læreplanen for naturfag for 1.-10.klasse. Innføring av emnet ble blant annet begrunnet med behovet for en praktisk arena for bedre læring i naturfag. Men forskning viser at det er utfordrende å overføre kunnskap fra ett kunnskapsområde til et annet (Pellegrino & Hilton, 2012). Elevene kan ikke forventes å avlede teknologisk innsikt ut fra kunnskaper i matematikk og naturfag, siden kunnskapen er i en annen form.
Naturfagsenteret har utviklet et undervisningsopplegg for elever på 5.-7.trinn innen emnet elektrisitet som integrerer både naturfaglig og teknologisk kompetanse parallelt. Opplegget bygger på prosjektet Forskerføtter og leserøtter (Ødegaard, Haug, Mork & Sørvik, 2016) og Ludvigsensutvalgets prinsipper om dybde og progresjon (NOU, 2015). Det skal prøves ut i en klasse i løpet av våren 2017. Erfaringene fra klasseromsstudien vil bli analysert og presentert på NFSUN i juni 2017. Presentasjonen vil beskrive intensjonen bak utviklingen av opplegget og i hvilken grad man kan se om eleven har tilegnet seg både naturvitenskapelig og teknologisk kompetanse.

Bidrag 2: Räcker de svenska tekniklärarnas kunnande för att undervisa om teknik och samhälle?
Skolämnet teknik är den svenska grundskolans yngsta ämne. Som obligatoriskt ämne har det funnits med sedan läroplanen från 1980, först inom ramen för de naturvetenskapliga ämnena och sedan 1994 som eget ämne. Ute i klassrummen är dock tekniken till stor del dominerad av ett naturvetenskapligt perspektiv (Klasander 2010) och delar också undervisningstid med de naturvetenskapliga ämnena. Samtidigt har det i Skolinspektionens ämnesgranskning visat sig att speciellt den del av ämnet som behandlar samhälleliga och historiska aspekter av teknik, ofta undervisas på en alltför låg ämnesnivå (Skolinspektionen 2014). Några år tidigare visade en registerundersökning att det då endast var 7 % av de lärare som undervisade i teknik på högstadiet som hade tillräcklig utbildning (definierat som minst 45 hp teknik), ytterligare drygt 25 % av de undervisande lärarna hade åtminstone någon teknikutbildning på högskolenivå medan detta helt saknades hos återstoden av tekniklärarna. (Skolverket 2013).

Med den här bakgrunden kan man fråga sig om de svenska tekniklärarnas reella tekniska kunnande vad avser kunskap om teknik och samhälle är tillräckligt för att kursplanen ska vara möjlig att realisera i undervisning. Den här undersökningen bygger på hypotesen att så definitivt inte är fallet i meningen att en betydande andel av de svenska tekniklärarna inte har en utvecklad uppfattning om vad undervisning inom området teknik och samhälle kan syfta till. För att undersöka detta har ett exempel hämtats från den nuvarande svenska kursplanen där kunskap om teknik och samhälle sammanfattas med två förmågor varav den ena är att analysera drivkrafter bakom teknikutveckling och hur tekniken förändrats över tid. Det enda obligatoriska undervisningsinnehåll som är direkt knutet till den här förmågan under högstadiet (skolår 7-9) enligt Skolverkets kursplanekommentarer (Skolverket 2011b) är "Sambandet mellan teknisk utveckling och vetenskapliga framsteg." Under våren 2017 kommer därför tekniklärare intervjuas om deras syn på vad de vill att deras elever ska lära sig om sambandet mellan teknik och vetenskap, hur deras undervisning på området ser ut och om de själva upplever sig ha tillräcklig kompetens. Intervjusvaren kommer att analyseras med utgångspunkt ur missuppfattningen om teknik som tillämpad naturvetenskap (Bungum 2003) som även exempelvis Vincenti (1990) och Arthur (2009) vänder sig emot. Resultaten av undersökningen ska presenteras på NFSUN 2017.

Bidrag 3: Erfarenheter hos grundskollärare som introducerat programmering i sin undervisning

Under det senaste decenniet har ett ökat intresse för datalogiskt tänkande (Papert, 1980) och programmering i skolan uppstått både på europeisk nivå (Balanskat, Engelhardt, 2014) men också globalt. Befintliga strategier för digital kompetens i skolan har reviderats för att i större utsträckning fokusera på eleven som innovatör, designer och producent. England är ett av de mer uppmärksammade exemplen på förändrad ansats. Sedan 2014 finns ett separat ämne, *Computing*, som undervisas från och med fem års ålder och i vilket programmering ingår. I Sverige har man valt en delvis annan väg och låter programmering ingå i redan befintliga skolämnen. I juni 2016 redovisade Skolverket ett förslag till ny IT-strategi för det svenska skolväsendet i vilket programmering omnämns, dock i begränsad utsträckning. Huvudargument för införande handlar i första hand om framtida anställningsbarhet. I förslaget ingår revisioner av kursplanerna för matematik och teknik, de två ämnen som i huvudsak ska utgöra hemvist för programmeringsrelaterade aktiviteter. I matematik handlar det om att använda programmering för att "undersöka matematiska problem, göra beräkningar samt presentera och tolka data". Kursplanen för teknik omnämner programmering främst som ett redskap för att styra och reglera apparater och system. Ingen av dessa kursplaner förefaller se färdigheter i programmering som ett mål i sig utan som ett medel för att nå andra ämnesspecifika mål. Detta kan ställas i jämförelse med den engelska kursplanen för ämnet *Computing* i vilken det anges att elever mellan 11-14 års ålder ska undervisas i minst två programmeringsspråk, varav ett textbaserat (Department of Education, 2013).

I dagsläget finns emellertid lärare i grundskolan som kan sägas vara *early adopters* (Rogers, 1962) och redan introducerar programmering i sin undervisning som hjälpmedel för att uppnå skolans lärandemål. Detta görs i flera olika ämnen, inte enbart matematik och teknik. Dessa lärares initiala insatser och erfarenheter kan visa sig bli betydelsefulla för Skolverkets strävan att tillhandahålla kunskaper om programmering till alla skolelever. Enligt Bocconi et al (2016) finns ett behov av att skapa en djupare förståelse för vilka dessa lärare är och vilka processer som ligger till grund för deras vägval och aktiviteter när det gäller skolans digitalisering. Under våren 2017 genomförs därför en studie i syfte att besvara frågor som bland annat gäller

- Vilka motiv och argument och vilken kunskap stödjer lärarna sig på när de väljer de att föregå nationella direktiv?
- Vilka faktorer påverkar läraktiviteternas utformning och hur tar de sig uttryck?
- Hur ser lärare på den kunskap dessa aktiviteter förväntas medföra och hur utvärderas detta?

Studien genomförs enligt blandmodell med både kvantitativ och kvalitativ datainsamling och analys sker bland annat med utgångspunkt i den tredelning av det tekniska kunnandet som redovisats i den gemensamma inledningen.

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Symposium

42. NORDISK MODUL FOR KOMPETANSEHEVING AV LÆRERE I UNDERVISNING FOR BÆREKRAFTIG UTVIKLING

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Abstract

In this symposium we present the preliminary result from piloting a Teacher Professional Development module in Education for Sustainable Development (ESD) in three Nordic countries; Denmark, Norway and Sweden. The module is the result of a Nordic corporation supported by Nordic Council of Ministers. The Nordic ESD module, builds on the elements from the Norwegian priory The Sustainable backpack which has been adjusted and further developed by the partners in the Nordic corporation. The aim of the module is to raise Nordic teachers' competence for education for sustainable development, so that they can prepare and implement teaching sequences and projects for sustainable development in their classroom.

The three papers in this symposium present results from piloting the first part of the module in in Denmark, Norway and Sweden. The results form the basis for discussing the extent to which the Nordic ESD module can be adapted to the Nordic countries' different national and regional contexts. Redesign and completion of the module will be based on this evaluation.

1. Introduksjon

FN utpekte 2005-2014 som et tiår for «Utdanning for bærekraftig utvikling» (UBU) med mål "å integrere prinsipper, verdier og praksis for bærekraftig utvikling i alle aspekter ved utdanning og læring"(UNESCO, 2005). Norge fulgte i 2005 opp med en nasjonal strategiplan for utdanning for bærekraftig utvikling som ble fornyet i 2012 (Kunnskapsdepartementet, 2012). Som en operasjonalisering av strategien ble det vedtatt å starte implementering i norsk skole gjennom prosjektet Den naturlige skolesekken (DNS).

DNS er en nasjonal satsing som skal bidra til at barn og unge gjennom opplæringen får kunnskap og bevissthet om bærekraftig utvikling og klodens miljøutfordringer.
Naturfagsenteret leder arbeidet med DNS på oppdrag fra Utdanningsdirektoratet og Miljødirektoratet. I samarbeid med lærerutdannere over hele landet har senteret utviklet et felles faglig didaktisk tilbud innenfor bærekraftig utvikling til lærere.

DNS-modellen består av tre samlinger i løpet av et skoleår der lærerne får oppdrag før og etter hver samling. På samlingene får lærene kompetanseheving i UBU-didaktikk samt veiledning på design av eget UBU-prosjekt. Det er et krav at til UBU-prosjektet er utforskende og flerfaglig. Skolene oppfordres til tre års deltakelse for at få prosjektet forankra og en del av skolens virksomhetsplan.

Med videreføringen av FNs tiår gjennom «Global action program» (E. UNESCO, 2015) har verdenssamfunnet vist en sterk intensjon om global satsning på UBU. Videre har 196 land, inkludert samtlige nordiske land underskrevet FNs 17 bærekraftsmål, en felles global arbeidsplan for bærekraftig samfunnsutvikling som inkluderer UBU. Men på tross av et langvarig og et stadig økende fokus på utdanning for bærekraftig utvikling, føler mange lærere manglende UBU-kompetanse (Borg, Gericke, Höglund, & Bergman, 2013, p. 18; Sinnes, 2015).

Siden oppstarten har DNS blitt regelmessig evaluert både eksternt og internt (Scheie & Korsager, 2015; Sjaastad, Carlsten, Opheim, & Jensen, 2014). Evalueringene har bidratt til en kontinuerlig utvikling av struktur og innhold slik at DNS nå kan defineres som en funksjonell etterutdanningsmodul for kompetanseheving av lærere i utdanning for bærekraftig utvikling. På bakgrunn av dette søkte DNS i 2015 om og fikk støtte fra Nordisk ministerråd for å utvikle satsningen til et nordisk nivå.

Resultatet ble et nordisk samarbeid mellom lærerutdannere fra fire institusjoner i tre land; Norge, Sverige, Danmark. Målet var å designe en felles nordisk modul for å heve nordiske læreres kompetanse for utdanning for bærekraftig utvikling, slik at de selv kan utarbeide undervisningsforløp og prosjekter innen bærekraftig utvikling.

I denne studien vil vi presentere evalueringen av den Nordiske UBU-modulen etter utprøving i de tre nordiske landende. Evalueringen danner grunnlag for redesign og ferdigstillelse av den Nordiske UBU-modulen.

2. Metode

Modulen legger opp til tre lærersamlinger med oppdrag etter hver samling. På samlingene får lærene kompetanseheving i UBU-didaktikk, didaktiske verktøy samt veiledning på design av eget UBU-forløp.

Under høsten ble første samling (pluss andre i Norge) i modulen prøvd ut med omlag 20 deltakere i Danmark, 400 lærere i Norge og 145 lærere i Sverige. Utprøvingen har blitt gjennomført av ni lærerutdannere (forfattere) som er prosjektdeltakerne i det Nordiske samarbeidet.

Prosjektet betegnes som utviklingsarbeid med elementer fra aksjonsforskning, uten at resultatene på nåværende tidspunkt har validitet som forskningsresultater.

Data materialet består av lærerutdannernes observasjoner og erfaringer fra utprøving samt refleksjonssamtaler og evalueringsskjema med deltakerne.

Resultatene danner grunnlag for å diskutere *i hvilken grad den Nordiske UBU-modulen har fungert i de nordiske landene* samt *hvilken nytteverdi de didaktiske verktøyene gir nordiske lærere i arbeidet med å designe egne UBU-forløp*. Redesign og ferdigstillelse av modulen vil baseres på denne evalueringen.

3. Resultat

Danmark

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Elementer af det nordiske UBU-modul blev afprøvet ved en workshop, hvor deltagergruppen bestod af lærere, pædagoger, skoleledere og serviceledere, samt rep. fra uformelle læringsmiljøer. Skolevist skal de udvikle aktiviteter, der støtter en helskole-tilgang, når de implementerer UBU, altså med sammenhæng mellem den enkelte lærers UBU-aktiviteter og skolens strategiske satsning på at styrke alle elevers læring om UBU. I denne forbindelse satte workshoppen fokus på at styrke elevinddragelsen i undervisningen.

Resultaterne af workshoppen er i sammenfatning disse:

- Der er behov for at tydeliggøre, at arbejde med UBU i undervisningen ikke behøver være et ekstra indhold, men kan understøtte de opgaver , lærerne løser i forvejen.
- Det er en fordel at koble UBU med andre kommunale dagsordener, men disse øvrige dagsordener er ofte ikke kendte af lærerne.

- Den ”menige” lærer er ikke bekendt med FN’s verdensmål og kender heller ikke det tredimensionelle bæredygtighedsbegreb, der opereres med i Nordisk UBU-modul.
- Der er behov for kompetenceudvikling af skolens personale, både fagdidaktisk omkring BU og UBU, samt organisatorisk med kobling af flere dagsordener.
- Deltagelsesbegrebet er vigtigt at udvikle i UBU-indsatsen, både for eleverne og for alle skolens faggrupper. Også her er der behov for kompetenceudvikling.
- De afprøvede elementer fra Nordisk UBU-modul er meningsfulde for deltagerne.

Norge

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Lærene kjente seg bedre forberedt og motivert til å undervise bærekraftig utvikling etter første samling. Under erfaringsdelingen på samling to rapporterte mange av lærene at elevenes engasjement hadde motivert både dem selv og kolleger til å jobbe med undervisningsopplegget. Elevinvolveringen hadde bidratt til nye spørsmål og fokus slik at noe av lærene hadde omdefinert problemstillingen.

Noen hovedfunn fra evalueringen etter samling to (n=44):

- 47,7 % endret problemstillingen i prosjektet til en mer wicked problemstilling.

De som ikke endret var enten fornøyd eller hadde ikke hatt tid å jobbe med det på skolen. Av de som gjennomførte oppdraget rapporterte de følgende positive effekter (i noen eller stor grad):

- 67,5 % mer elevinvolvering
- 86,8 % mer samarbeid med kolleger
- 85,7 % mer tverrfaglig samarbeid i gjennomføring av undervisningen

Mange av lærene hadde brukt tankekart med elever/kolleger, hatt diskusjoner og samtaler knyttet til konkrete undervisningsopplegg eller prosjektarbeid.

Sverige

Daniel Olsson[4]

[4]Karlstads universitet

Lärarna kom till träffen med väldigt olika förberedelse. Lärarna från en av skolorna var inte förberedda på vad dagen skulle innehålla och var till en början lite negativt inställda. Detta vände under dagen och mot slutet var alla entusiastiska över det kommande arbetet på skolorna.

Lärarna upplevde att verktygen de fick med generellt fungerade bra och att de var till hjälp i planeringsarbetet. De upplevde också att de fick med sig ett innehåll runt hållbar utveckling i form av FN:s globala mål och att de fick med sig en ny syn på att lärande för hållbar utveckling också innebär ett förhållningssätt.

I utvärdering (nettskjema) svarte 75 % av lærere (n=45) at verktøyen fra DNs fungerte mycket bra eller bra, mens 18 % av lærene svarte mindre bra.

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I Umeå har vi följt femton lärare från två högstadieklasser (åk 9) samt tre gymnasieklasser (åk 1 GY). Vårt fokus har varit lärarnas arbete i denna process då de alla fått mötas för planering, avstämning och utvärdering under projektarbetet med sina elever. Vi har initierat reflekterande frågor vid lärarmötena samt observerat arbetet i klasserna och intervjuat lärare på plats under arbetets gång.

Arbetsgången i detta projekt följer UBU-modellens struktur för samling och eget arbete på skolorna. Genom vårt pilotprojekt har vi uppmärksammat didaktiska aspekter av att arbeta projektbaserat med hållbarhetsprojket.

Alla lärare utom en anser att det blir lärande på längre sikt eftersom man kan ta upp och koppla till innehållet och arbetssätten i den kommande undervisningen, demokratiskt lärande.

4. Diskusjon og konklusjon

Det Nordiske samarbeidet har så langt resultert i design av en felles Nordisk UBU-modul. Gjennom samarbeidet har prosjektdeltakerne kommet fram til at innholds-fokuset i modulen bør være didaktisk og ikke tematisk, da Nordiske kontekster på tross av sine likheter representerer stor diversitet i relevante tema og problemstillinger knyttet til både nasjonale og regionale kontekster.

Resultatene viser at UBU-modulen er strukturert nok til at lærereutdannere fra ulike nordiske land kan gjennomføre modulen, likevel fleksibel nok at den kan tilpasses til nasjonale og regionale kontekster. Videre viser resultatene at de didaktiske verktøyene gir lærerne nytteverdi i arbeidet med å designe egne UBU-forløp.

På bakgrunn av resultatene vil modulen bli ferdigstilt og formildet til lærerutdannere i alle de nordiske landene: Danmark, Norge, Sverige, Finland og Island, samt Færøyene, Grønland og Åland. Intensjonen er at denne på sikt kan bidra til å heve nordiske læreres kompetanse for utdanning for bærekraftig utvikling.

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Poster

11. EDUCATIVE CURRICULUM MATERIALS AND CHEMISTRY: A MATCH MADE IN HEAVEN?

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Abstract

A pilot study on the use in chemistry education research of Educative Curriculum Materials (ECMs), as defined by Davis and Krajcik (2005) (D&K), is reported. The review shows that of 248 articles concerning curriculum material and/or development, 22 concern chemistry education research; however, when including only D&K's definition, the number drops to 16. Not one of the articles concern teacher guides. There are 28 categorised instances referring to D&K's work: 14 in existing knowledge bases, 7 using their actual definition of ECM, 3 arguments for own choices and 4 links between own results and ECM. In addition, a category, 'analytical framework', is proposed. This category indicates that no study include D&K's analytical framework. This review is limited to the work of Davis and Krajcik's (2005), which necessarily limits the findings. However, an analytical matrix with respect to ECMs is presented and the study shows a gap in chemistry education research. Suggestions for how to improve and/or expand the review are also made.

Introduction and aim

Bridging the gap between research and practice is important, and researchers should approach doing so in ways that are accessible to teachers (de Jong, 2000). This research stems from the personal experience of supervising a PhD student in mathematics education research (Hoelgaard, 2015). Her work concerned Educative Curriculum Materials (ECMs) (see Davis & Krajcik, 2005, D&K) and the potential for teacher guides to act as resources for teachers to learn about their own teaching. ECMs can be considered as in-service teacher training or developmental work, and all available resources and areas that teachers need to learn about fall within the definition of ECM (Davis & Krajcik, 2005). I became curious about what has been done in research in my field, chemistry, with respect to ECMs and teacher guides. As a first step, I have taken a more general approach, and the aim of this pilot study is to review the research on ECMs with respect to chemistry. The research question is: To what extent and in what ways has ECM, as defined by Davis and Krajcik, acted as a foundation in chemistry education research?

Methods and limitations

The following databases were searched: Discovery (151125), Scopus (160127, 160222), Web of Science (160127, 160222) and Eric ProQuest (160127, 160222). The search limitations were peer-reviewed research articles written in English between 2005 and 2016. First, any article using Davis and Krajcik (2005) as a reference was identified. Then, various search terms were used (e.g., 'educative curriculum' AND chemistry; 'Curriculum materials' OR 'Instructional materials' AND chem* (SU); 'Curriculum materials' AND chem* AND teach*). All search results were compiled in one EndNote library, and duplicates were removed, resulting in 296 articles. Despite limitations, a number of hits were retrospectively excluded (e.g., conference proceedings and not written in English), resulting in a final list of 248 articles, which were then searched for the presence of 'chemistry' anywhere within the text. This yielded 31 articles, of which 19 referred to D&K. After scrutiny of why these articles contained the word 'chemistry', the list was reduced to 22 articles, of which 16 referred to D&K (see Table 1 below). Articles were excluded if the science subjects were listed in the body of the text, for instance, biology, chemistry and physics but the article concerned biology.
Next, the articles were analysed using Evans's (2002) description of a systematic review, including a descriptive part (i.e., design, educational level, topic, methodology, sample, setting) and an interpretive

part (i.e. included studies and why, differences and similarities, label similarities and categorise, sub-themes and themes, validation and finally to describe). What is reported herein is only a small part of the analysis, addressing only how Davis and Krajcik's (2005) study has been used in chemistry education research. A sample of the analysis is included below.

McNeill (2009) presents teachers' use of an 8-week chemistry curriculum and the construction of scientific arguments through inquiry. The introduction contains the following reference to Davis and Krajcik (2005): 'Curriculum materials are an important tool to help teachers engage their students in inquiry, particularly educative materials that are specifically designed to promote teacher learning' (McNeill, 2009, p. 234). Taking into consideration the context of this quote, the labels assigned were 'argumentative' and 'providing definition of ECM'. It is argumentative due to the purpose of the study and its frame, and ECM is defined almost as D&K define it.

This review had limitations. On one hand, referring only to D&K's definition of ECM makes the review biased and fails to provide the entire picture of ECM and chemistry education research. On the other hand, D&K's work is a cornerstone in ECM research, and the entire purpose of this review was to discover what has been done in chemistry education research with respect to ECM and teacher guides. In addition, this is a pilot study, and one outcome of the data analysis is the analytical matrix. Therefore, to both validate the matrix and find patterns in ECM research, the larger study might include different subjects, a larger sample of articles and other researchers' definitions of ECM.

***Table 1**. Articles Reviewed**

My numbering	Article
1	Avargil, Herscovitz, and Dori (2012)
2	Avargil, Herscovitz, and Dori (2013)
3	Aydin, Friedrichsen, Boz, and Hanuscin (2014)
4	Coenders, Terlouw, Dijkstra, and Pieters (2010)
5	Deng (2007)
6	Hug and McNeill (2008)
7	McNeill (2009)
8	McNeill and Krajcik (2008)
9	Stolk, Bulte, De Jong, and Pilot (2012)
10	Stolk, Bulte, de Jong, and Pilot (2009a)
11	Stolk, Bulte, de Jong, and Pilot (2009b)
12	Stolk, De Jong, Bulte, and Pilot (2011)
13	Tsaparlis (2014)
14	van Duzor (2012)
15	Vos, Taconis, Jochems, and Pilot (2010)
16	Vos, Taconis, Jochems, and Pilot (2011)
17	Burmeister, Schmidt-Jacob, and Eilks (2013)
18	Coenders, Terlouw, and Dijkstra (2008)
19	Feierabend and Eilks (2011)
20	Roehrig, Kruse, and Kern (2007)
21	Strippel and Sommer (2015)
22	Tolvanen, Jansson, Vesterinen, and Aksela (2014)

* Articles 1–16 refer to search on Davis and Krajcik (2005).

Results

The review found that of the 248 articles concerning curriculum material and/or development, 22 addressed chemistry education research (8.9%). However, when only those articles that addressed Davis and Krajcik's (2005) work on ECM were included, the number dropped to 16 (6.5%). Table 2 below presents analysis of how D&K's work has acted as a foundation in chemistry education research. It must be noted that none of the articles included analyses of teacher guides.

The 16 articles contained 25 references to D&K's work, but because there are multiple categories, the sum in Table 2 equals 28. Half of the references recognized D&K's work as part of an existing ECM knowledge base. However, D&K's definition of ECM was addressed in only four articles: 3, 7, 8 and 12.

As Table 2 shows, arguments for own choice were found in only two articles (7 and 14), and links between own results and ECM were made in only three articles: 3, 4 and 11. To emphasize the outcomes of the data analysis, Table 2 includes the proposed category 'analytical framework'.

***Table 2**. How ECM Is Used in Articles Referring to Davis and Krajcik (2005)**

How ECM is used / Where in the article	Existing knowledge base	Argument for own choices	Definition	Analytical framework	Comparison to one's own results	∑
Introduction	1, 3, 4, 5, 12	7†, 14	7†			8
Literature review	2, 9, 10, 12, 13, 15, 16		12			8
Methodology/ Theoretical frame		7	7, 8			3
Discussion			3†, 7		3†, 4, 11	5
Conclusion and implication	5, 6		3†		3†	4
∑	14	3	7	0	4	28

* All table headings but 'Analytical framework' are data analytical. Each digit refers to a unique article. A digit equals one category present in the text of that article, whereas an † indicates two categories present at the same time.

Discussion and conclusions

Considering the developmental curriculum work actually taking place in chemistry education research, identifying only 22 articles is a bit surprising. However, I do believe there is more to the story than told by that, since curriculum development materials do not necessarily need to reference D&K. In addition, because of the fuzzy definition of ECM, many articles that do not explicitly refer to D&K still implicitly concern ECM according to D&K's definition and, indeed, provide supporting materials for teachers. However, since ECM and teacher guides were the reasons for conducting this pilot study, it is interesting to note that not a single article concerned teacher guides. Out of curiosity, I changed the search to include chemistry textbooks instead of teacher guides. This returned seven articles. In addition, no study included D&K's developed analytical framework as part of the research. Furthermore, only three articles used D&K's work as an argument for the researchers' own choices during the study. Instead, most of the references were generic and merely acknowledged D&K's work.

To conclude, there seems to be a gap in chemistry education research regarding ECM and teacher guides. Therefore, based on this pilot study, the next possible steps include the following.

1. To analyse various teacher guides in chemistry.
2. To conduct a more extensive analysis of the literature related to the work on ECM by Davis and/or Krajcik, probing and validating the analytical matrix and developing Evans's (2002) deductive analytical approach.
3. To conduct a more extensive review of all key players and sources in research on ECM with the aim of providing a fuller picture of the relationship between ECM and chemistry education research.
4. To analyse how various curriculum units and materials that have been developed and implemented were framed within existing knowledge.

Finally, I would like to return to de Jong's (2002) statement about bridging the gap between research and teaching practice, in which ECM may play an important role. Based on this review and extensive reading of the articles, I find it likely that local bridges between researchers and participants have been created, but in a general sense, no such bridges have been formed. So, the simple answer must be: No, ECM and chemistry are not a match made in heaven, at least not yet. However, it is beyond the scope of this review to pinpoint why that is.

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Poster

47. BECOMING A CHEMISTRY TEACHER – EXPECTATIONS AND REALITY IN CHEMISTRY EDUCATION COURSES

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Abstract

In principle, chemistry is a great subject. The problem is, however, that most pupils do not share this opinion. Chemistry is said to be difficult to understand and its topics seem irrelevant. This is why pupils are reluctant to study chemistry and are not necessarily interested to change their point of view.
A significant reason for this is how chemistry is taught at school. Chemistry lessons will only infrequently involve the pupils' interests and questions but focus on curriculum's topics and objectives. Bridges between science and teaching and between science and pupils' conceptions are fragile and difficult to cross for both pupils and teachers. Even in academic teacher training, chemistry as a science and chemistry as a subject at school do not come together very often. Difficulties in teaching chemistry are predetermined.
The division of chemistry education at Freie Universitaet tries to find a balance between chemistry education, pedagogy and the subject chemistry. Therefore, we started to investigate how students experience their studies, to consider their beliefs and needs in chemistry education courses. Since winter term 2012/13 149 students were surveyed on their opinions considering requirements they should have as future chemistry teachers, and on their expectations concerning chemistry education courses.

1 Introduction and goals

When university studies are reflected retrospectively by young in-service teachers, a majority of them expresses the feeling of not having been prepared adequately by university courses for the job of teaching chemistry. Many of these teachers describe having entered a state of shock when they started teaching at school, because everyday school life experience differed to a considerable amount from the standards taught in university courses. Just 6% of the beginners felt well-prepared (Schumacher & Lind, 2000, p. 25). Most, however, pointed out that they experienced unbalanced relations between aspects of chemistry science on the one hand and pedagogy and chemistry education on the other in subject-oriented teacher training courses: "*I feel pedagogically under-qualified and subject specifically over-qualified*" (Schumacher & Lind, 2000, p. 25). Teacher students often experience chemistry, science education and pedagogy as distinct areas in their studies – but the interaction of these fields is of major importance to support and enhance professionalism as a future teacher (Shulman, 1986).
The division of chemistry education tries to work against such students' estimations: Firstly, by getting insights in the expectations and beliefs students have regarding their future profession and their chemistry educational courses at university. Secondly, by considering theses expectations and beliefs in the chemistry educational courses to come – if necessary – to a more realistic view on their future profession. Thirdly, by optimizing the chemistry education courses to find a balance between subject, education, practical training, skills and methods, normative expectations and standards, pedagogy and the need of the students.

2 Theoretical framework

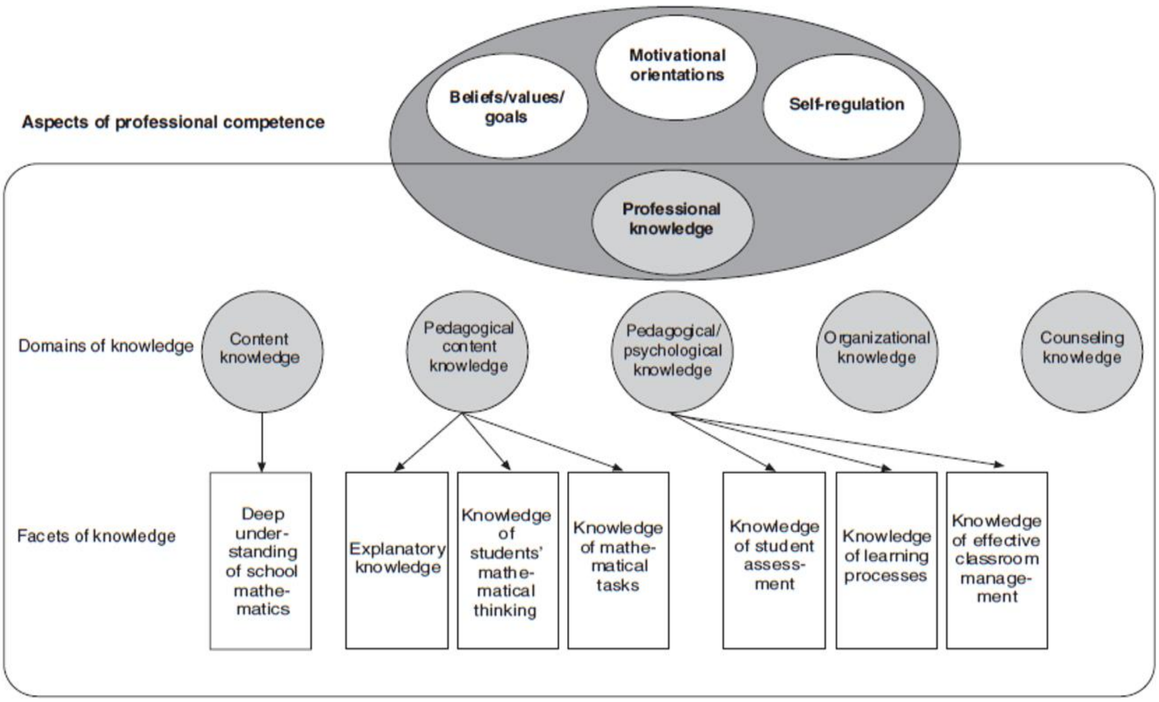
German school education and teacher training is based on standards, which are also important for study regulations at university. The standards define requirements teachers have to meet. The superior standard is:

Teachers are experts of teaching and learning. Their core task is the specific and scientifically reasoned design and reflection of teaching and learning processes. They perform their educational role properly, undertake advisory and assessment tasks, and teachers adapt their competences continuously (KMK, 2004, p. 6).

In addition to these general tasks more specific requirements for each subject in teacher education are described; e.g. in chemistry: basic knowledge in organic, inorganic, physical chemistry and biochemistry, as well as knowledge in chemistry education and practical teaching skills (KMK, 2008, p. 12).

Empirical educational research has investigated various aspects of the teaching profession to improve teacher recruitment and training (EC, 2013; Baumert & Kunter, 2013, p. 25). In the project COACTIV a model combining findings from various research perspectives were developed and empirically tested. This model contains aspects, domains and facets of professional competence in the context of teaching; facets are operationalized by indicators (Baumert & Kunter, 2013).

Fig. 1: COACTIV model of professional competence in the context of teaching (Baumert & Kunter, 2013, p. 29).



Beside the normative requirements and the results from research about professional competence it is helpful to consider research about professional development to find effective ways to optimize educational courses.

Focusing on effective professional development research there are aspects like prior knowledge, beliefs and expectations of learners which have to be known as a starting point and basis for developmental processes because these influences each learning process. However, *"too often the cognitive research on learning is forgotten when it comes to designing teacher's training"* (Loucks-Horsley et al. 2010, p. 53).

3 Research methods

To get an insight into the expectations and beliefs students have, students were asked two questions in an open questionnaire: *1. What do you think is expected of you as a teacher? 2. What do you expect from your studies, especially from your chemistry education courses?* at the beginning of their studies and the second time during the master programme.

To categorize the answers we developed a category system based on the COACTIV model: The category system contains all aspects, domains and facets as well as the concrete indicators to operationalize the facets. We added four categories to specify the aspect of motivational orientation and beliefs/ values/goals. These added categories comes from the data and the list of teachers' competence compiled by the European Commission (EC, 2013, p. 45f.). Finally, the system contains 51 categories (Fig. 1). The categorization proceeds with the program MaxQDA by at least two people to ascertain the interrater-reliability.

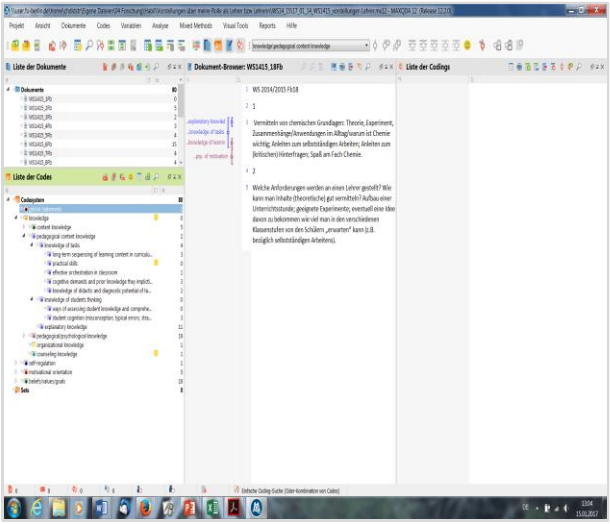


Fig. 1: Codesystem with special focus on PCK

4 Results

In the survey 110 students of the Bachelor programme who had just started their educational courses and 39 students of the Master programme took part.

students	winter term			
	2012/13	2013/14	2014/15	2015/16
Bachelor	37	26	18	29
Master		16	-	23

***Table 1**: Sample*

Our analyses show that a majority of the students who participated in this survey is of the opinion that they need to be experts of chemistry for being teachers (table 1, Cat. 1): "*I need to have an answer to everything my pupils are asking me*". Furthermore, they state that they need to be able "*to equip*" pupils with this knowledge of chemistry (2a) in an effective, creative, and fascinating way using various methods and teaching styles (3b) to motivate them (3c).

At this stage of our analyses we only focus on the first two cohorts (Table 2).

Table 2: First results of two beginner cohorts

			WS12/13 N=37		WS13/14 N=26	
Cat.		Number of statments	**181**	**100 %**	**136**	**100%**
1	**Knowledge**	**CK (content knowledge)**	**24**	13,3	**11**	8,1
2		**PCK (pedagogical content knowledge)**	**4**	2,2	**1**	0,7
2a		explanatory knowledge	**18**	9,9	**17**	12,5
2b		knowledge of students thinking	**11**	6,1	**3**	2,2
2c		knowledge of tasks	**18**	9,9	**18**	13,2
3		**PPK (pedagogical/psychological knowledge)**	**2**	1,1	**1**	0,7
3a		general pedagogical knowledge of instructional planning	**7**	3,9	**10**	7,4
3b		knowledge of effective classroom management	**23**	12,7	**17**	12,5
3c		knowledge of learning processes (esp. motivation)	**22**	12,2	**15**	11,0
3d		knowledge of student assessment	**5**	2,8	**3**	2,2
4		**organizational knowledge**	**0**	0	**2**	1,5
5		**counseling knowledge**	**4**	2,2	**3**	2,2
6	**self-regulation**		**1**	0,6	**2**	1,5
7	**motivational orientation**		**4**	2,2	**4**	2,9
8	**beliefs/values/goals**		**30**	16,6	**24**	17,6
9	*global statements*		***8***	*4,4*	***5***	3,7

A similar view is expressed in the expectations students have on their training courses in chemistry education. Here, they wish *"to be equipped"* with a catalogue of experiments and practical examples how to get the *"tools and techniques"* for lesson planning. Surprisingly, a central aspect of chemistry education courses was totally left out by the students: The aspect of science education research and its importance for teachers was not even mentioned once. The answers are characterised by subjective beliefs about teaching (8), a constructivist view on teaching and learning is barely mentioned.

4 Discussion, conclusion and outlook

1. The category system we developed is suitable to analyse the students' answers; nearly all answers match to the system. However, it is important to look further inside the categories because here we find rather simplified views and subjective theories, which have to be faced in chemistry education courses. Currently, we are still working on the other subsamples.

2. In our chemistry education courses we have started to consider explicitly the areas of chemistry, chemistry education and pedagogy to students in authentic learning situations. This means, the students get at an early stage of the bachelor study the opportunity to teach pupils in class to get a realistic view on their future profession. Futhermore, we introduce students in the bachelor programme to science education research in order to present this discipline as a practically-based and research-intensive counterargument to the simplified traditional beliefs of students.

3. The aim of the survey is to get insights in the expectations and beliefs students have regarding their future profession and their educational courses at the beginning of their studies. The answers from the master students we will use to get information about the impact of the chemistry education courses in order to optimize contents and topics. The results of the first survey show that students judge an expertise in chemistry, as well as the ability to impart knowledge about chemistry to students is of major importance. Further analyses will be done to reconstruct changes in these attitudes towards chemistry education and teacher roles in the process of their study.

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Poster

80. TEACHING IN THE RAIN FOREST. STUDENT TEACHERS MEANING – MAKING IN AN INFORMAL SCIENCE LEARNING ENVIRONMENT

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Abstract

Educational research shows that what happens in the classroom as to the teachers' content knowledge and performance is the most important factor towards achieving the expected learning outcomes (The Swedish National Agency for Education, 2012).The dimensions of the demands of learning science and to teach science are presenting major challenges for these future teacher's classroom performances, content knowledge and pedagogical content knowledge (PCK). To explore these challenges, a course module has been developed and implemented in collaboration between teacher education and a science center, an informal in Gothenburg, Sweden. Research has shown that informal learning environments offer unique learning opportunities for student teachers development of content knowledge and a possibility to practice their teaching (Gupta & Adams, 2012). The aim of this on-going study is to examine what considerations student teachers do when they plan and implement a lesson in science in a scienter center environment. How do student teachers' relate their teaching to content knowledge? In what way do they make pedagogical content knowledge considerations? In order to explore what the student teachers focus on and their considerations, video recordings were taken of the three categories of student teachers when they planned and implemented their science lessons in an assigned environment at the Universeum science center. The preliminary results indicate that the student teachers tend to focus on the activities and the organization (time schedule, in what order activities shall be conducted and where, and who should do what in the group) and less on considerations of science content in their planning. This applies especially to the students who are geared toward lower primary school teaching.

Introduction

Educational research shows that what happens in the classroom as to the teachers' content knowledge and performance is the most important factor towards achieving the expected learning outcomes (The Swedish National Agency for Education, 2012). In teacher education a central issue is to develop teacher students' knowledge about teaching and learning a specific content in interaction with their current experiences of the world. The dimensions of the demands of learning science and to teach science are presenting major challenges for these future teacher's classroom performances, content knowledge and pedagogical content knowledge (PCK). To explore these challenges, a course module has been developed and implemented in collaboration between teacher education and Universeum science center, an informal science learning environment in Sweden. Research has shown that informal learning environments offer unique learning opportunities for student teachers development of content knowledge and a possibility to practice their teaching (Gupta & Adams, 2012).

The aim of this on-going study is to examine what considerations student teachers do when they plan and implement a lesson in science in a scienter center environment. How do student teachers' relate their teaching to content knowledge? In what way do they make pedagogical content knowledge considerations?

The science center

The science center has a mixture of traditional science center exhibits and living nature and animals, which makes it a unique science learning environment. The living exhibits include models of Swedish habitats, South American rainforest, terrariums with reptiles and snakes and aquariums with both northern and tropical fishes. The science center also offers continuing training for teachers in science and technology.

Framework of the course module

During the first two days students are introduced to the science center setting and educational mission, pedagogical concept and school programs. They are then assigned an exhibit and a theme to plan and prepare a 30 minutes lesson in science or a technology within the exhibit. Students' preparations are carried out in groups of 4-5 students. The groups submit their planning to the course instructors (Teachers at Teacher Education) prior to the implementation of their lesson. The student groups are supervised by the Teacher Staff during their planning. The implementation of the lesson is done with a group of children (about 12-15 in each) and is carried out twice. The opportunity to reflect with the peers and the course teacher or the supervisor is given between the two lessons and after they are completed.

Research methods

In the present study Student teachers geared toward teaching ages 6-9 and 10–12, read 15 ECTS respectively 30 ECTS with the focus on Science and Technology. In this given time, the students are being prepared in pedagogical content knowledge to teach Chemistry, Physics, Biology and Technology. Another category of student teachers in the study, are students in the Supplementary Science Teacher Education. They are geared toward teaching ages 13-19 in one or two subjects in science and mathematics. Studies of the planning and implementation of course module were conducted in June and September 2016.

In order to explore what the student teachers focus and considerations, video recordings were taken of the three categories of student teachers when they planned and implemented their science lessons. The students had 2-3 days to plan and prepare their lessons. The observations of each student groups' planning meetings consists of 1, 5 -2 hours of video recordings and were taken in the beginning of their planning. All video recordings of the planning meetings took place in the science center, in a room designed for educational purposes. The groups were video recorded without anyone managing the camera, which meant that the students had to turn on and of the camera during the breaks. The student had the possibility to visit their assigned environment at any time during planning. The video recordings of the students teaching sequences were conducted by one to two persons, depending on whether an external microphone was used.

One of the student groups was assigned the Space exhibit with no special theme name. The second group was assigned the Rain forest and the third the tropical and subtropical aquariums. The theme of their assignment was Evolution.

Table 2: Information about the informants

Category of student teachers	**Pupils**	**Assigned environmen t**	**Theme**	**Point in time of education**
Geared toward teaching ages 6-9	Third grade (9 years old)	Space exhibit	No specific theme	Beginning of third semester
Geared toward teaching ages 10-12	Sixth grade (12 years old)	Rain forest exhibit	Eco system	Beginning of third semester
Geared toward teaching ages 13-19	Seventh grade (14 years old)	Aquariums (tropical and subtropical)	Evolution	Half way of their education

Tentative results

The video observations of the students planning meetings and their implementation of the science lessons are being transcribed and analyzed in writing through content analysis (Hsieh & Shannon, 2005). A coding schema is to be developed and refined in an iterative process to find themes that describes what considerations they do in their planning and implementation. In the poster presentation we will give a brief summary of the “course module” and tentative results of the content analysis. The preliminary results indicate that the student teachers tend to focus on the activities and the organization (time schedule, in what order activities shall be conducted and where, and who should do what in the group) and less on considerations of science content in their planning. This applies especially to the students who are geared toward lower primary school teaching. The results also indicate that the students have a firm opinion about the pupils’ prior knowledge and understanding of science content.

Key words: Science Teacher Education, Informal Science Education, Informal Learning Environment, Student Teachers, Teacher Performance, Pedagogical Content Knowledge, Qualitative Content Analysis.

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Poster

86. THE TEACHERS CHOISE FOR PREPARING STUDENTS FOR OUT-OF-SCHOOL SETTINGS

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1 Introduction

After several years of working with students and teachers from different schools in out-of-school settings with, I find that teachers approach out-of-school settings in very different ways; this also reflects how prepared the students are. Some students are well prepared for the work they are going to do. However, I often experience that the student do not know what they are going to do at the visit. Their teacher has not prepared them in the topic, and even some students did not know that they were going at a school trip before the same day. According to previous studies, teachers seldom prepare students before visiting out-of-school settings as museums and science centers (Frøyland & Langholmen, 1999).

This made me interested in what do teachers think of out-of-school settings. Are they contributive to the students learning of science and an integrated part of the topic the class are working with? If these settings are a part of the science learning for the students, it is important that the student should have the best opportunity to learn from these visits. Several previous studies show that students learning outcome of out-of-school settings is influenced by how they are prepared for these settings. (Bamberger & Tal, 2006; Falk & Dierking, 2005; Orion & Hofstein, 1994).

2 Theoretical framework

The aims of having and using out-of-school settings like science centers, festivals and museums have gone through major changes in recent decades. In the beginning they were institutions of authoritative knowledge, places of collecting, seeing, and knowing Today, they have become places that provide education for the public. Science centers have also become places that allow the visitor to interact with objects and use hands-on experiences to construct knowledge (Tal & Morag, 2007).

Learning science and technology in out-of-school settings is based on the idea that learners use personal experiences and interact with others to construct knowledge of the world. This is the main idea of the sociocultural view of intellectual development. Sociocultural mediation plays a critical role in personalizing the museum experience, as well as other out-of-school experiences, for visitors (Falk & Dierking, 2000).
My view of science learning is based on Vygotsky`s theory, that learning happens in social settings, and the internalization process goes from social context to individual context (Vygotsky, 1934; 1978). Most of the out-of-school settings, as science centers, museums and festivals are based on the idea of inquiry-based science teaching. This is seen as appropriate in science teaching (Keys & Bryan; 2001).

3 Research methods

This is a preliminary case study of how a teacher prepare the student for å trip to a science festival. I followed a teacher at 6th grade during a sequence of science lessons before the visit with the students at an out-of-school setting, a science festival. The teacher was interviewed before and after the filming.

Each lesson was videotaped with a go-pro camera at the teacher. The teacher was instructed to wear the camera and tape the lessons she meant were preparing for the topic they were going to work with at the visit.

To analyze the videos, I used the software Nvivo11. The science lessons were coded using a scheme based on works of Klette et al. (2005, Ødegaard & Arnesen, 2010). I focus on teaching and learning activities in science and the how they were connected to the topic in the out-of-school setting, and why the teacher choose these activities.

4 Results

The first level of analysis, which mainly concerns organisational patterns. It indicates that the teacher used whole class instruction as the most frequent activity. The main activities in whole classroom were the teacher presenting the topic to the students and were illustrating with demonstration activities in the topic with the students. Under the interview, the teacher said that it was a new topic and claimed that the students had to hear about it before they could work with it. The next organisational activity was group activity, and the class made posters presenting the topic. These hang at the classroom`s wall. They should hang there when they were working with task after the visit.

The teacher used two lessons and totally 85 minute to prepare the students to the out-of-school setting that lasted half a day. In the interview, the teacher said that more time than normally was spent on preparing the student pupils for this particular out-of-school setting. She gave several reasons for this. One of the main reasons was the information that she got from the science festival and the personal contact with festival. When she compared this out-of-school situation with other situations, she admitted that they often get information about topic and how to best prepare the students before visiting. The different here was the personal contact with the festival. She felt obligated to prepare her students cause of the personal contact.

5 Discussion and conclusion

My analyses of the science teacher`s preparation of students to a trip to out-of-school setting, as science festival reveal interesting information that may impact how we prepare students for out-of-school settings. The information schools and teacher get from science museums, centres and festivals influence the work teachers are doing with their class to prepare the students for a visit out-of-school. There are also some work to be done towards schools in order to increase awareness of the importance of preparations ahead of out-of-school activities.

When I compared the videotaping with the interview it was a good coherence between the statements from the teacher and what I could see from the video analyses. The main findings in this case study is the importance of how and when information to the teacher are given of which preparations that are needed ahead of out-of-school activities.

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Poster

75. DYBDELÆRING OG PROGRESJON I ELEVERS FORSTÅELSE AV STOFFER OG KJEMISKE REAKSJONER

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Abstract

This paper is based on two longitudinal studies, and aims to provide greater insight into how students' understanding of chemical reactions develops over time in a learning progression environment. Four case-study students in a Norwegian primary school were interviewed after two years of intervention at age 12-13, and six case-study students in a Norwegian lower secondary school were followed for three years (from age 12-13 to age 15-16). Researchers were responsible for implementation of science teaching promoting systematic development of students' understanding of the nature of matter and chemical reactions in many contexts across science disciplines. The case study students' in lower secondary school were interviewed several times, and their expressed understanding was recorded and analyzed throughout the period. Preliminary results indicate that students develop fragmented and incomplete understanding, and drawing wrong conclusions may be necessary steps in the learning process. Moreover, students seem to develop a somewhat more integrated and cohesive understanding of matter and chemical reactions, indicating that the students restructure and reorganize their knowledge structures.

1 Introduksjon

Teori om stoffer (på makro- og mikronivå) er et eksempel på en grunnleggende idé. Den er sentral for forståelse av en rekke fenomener på tvers av de naturvitenskapelige disiplinene, for eksempel er den fundamental for forståelsen av fenomener som trykk, temperatur og faseoverganger og sentral for forståelsen av kjemiske reaksjoner. Videre er god innsikt i teorien om stoffer nødvendig for å forstå nedbrytning, kretsløp i naturen og celleånding. Wiser og Smith (2009) hevder at for at læringen skal bli mest mulig effektiv og gi elevene den ønskede naturfaglige kompetansen, er det viktig hvilke kunnskapselementer som vektlegges, i hvilke sammenhenger de presenteres og hvordan det bygges opp en progresjon i læringen. Nasjonalt og internasjonalt snakkes det om å redusere stofftrengselen i skolefagene, identifisere fagenes 'sentrale byggesteiner' og vektlegge dybdelæring og progresjon (Harlen, 2010; Ludvigsenutvalget, 2014, 2015; NGSS, s.a.). Naturfaglærere i fremtidens skole må ha evne til å vurdere hva som er de sentrale byggesteinene i faget og legge til rette for optimal progresjon i elevenes læring. Et eksempel er å ha innsikt i kritiske punkt i elevens stadig mer avanserte forståelse for stoffer og kjemiske reaksjoner i løpet av mellomtrinnet og ungdomstrinnet.

2 Teoretisk rammeverk

I denne artikkelen blir elevenes forståelse av stoff og kjemiske reaksjoner undersøkt i et longitudinelt perspektiv. Et perspektiv på konseptuell endring, definert som conceptual restructuring (Clark, 2006), brukes som teoretisk rammeverk i artikkelen. Conceptual restructuring er i stor grad basert på de tidligere omtalte knowledge-as-elements perspektivene (diSessa, 2006; Linn, Eylon, & Davis, 2004) som ser på elevenes kunnskaper som en samling av mange kvasi-uavhengige elementer. «Conceptual restructuring» forutsetter at elevers kunnskap består av kunnskapselementer på ulike nivåer. Disse elementene og ideene kan inkludere kunnskap, erfaringer, intuitive forestillinger som omtales som for eksempel p-prims (diSessa, 1993), som mentale modeller (Carey, 2000) og som forestillinger på ulike utviklingsstadier (diSessa, 1993; 2006; Linn, et al., 2004). Læring vil skje gjennom endring og omorganisering av disse elementene. Denne måten å tenke læring på er nært knyttet til dybdelæring. For å oppnå dybdelæring er det viktig at den lærende møter sentrale byggesteiner i ulike kontekster og i stadig mer komplekse sammenhenger (progresjon). De ulike kontekstene begrenser seg altså ikke isolert til tradisjonelle fagdisipliner. En relativt stor kunnskapsbase om hvordan en best kan oppnå dybdelæring av 'big ideas' er tilgjengelig, og det er foreslått mange læringsprogresjoner (Black, Wilson, & Yao, 2011; Neumann, Viering, Boone, & Fischer, 2013; Smith, Wiser, Anderson, & Krajcik, 2006; Stevens, Delgado, & Krajcik, 2010; Talanquer, 2009)

I en longitudinell studie av mellomtrinnselever (Øyehaug, 2014) så det ut til at elevene restrukturerte og omorganiserte sine kunnskapsstrukturer, for eksempel ved hjelp av differensiering (et begrep blir til to), koalesens (to ideer flettes sammen) og promotering (fremme en bestemt ide i mange sammenhenger). Dette og andre studier (Taber, 2004; Özdemir & Clark, 2007) indikerer at læreplanen bør introdusere stoffer i tidlig skolealder og deretter repeteres i mange sammenhenger, slik at elevene får muligheter til å anvende, utvide og raffinere sin forståelse i løpet av de neste skoleårene. Et sentralt spørsmål er videre hvordan elevers forståelse av stoffbegrepet og kjemiske reaksjoner endrer seg når elevene kommer på ungdomsskolen, og hvordan det kan legges til rette for dybdelæring i kjemi. Forskningsspørsmålet i denne studien er:

Hva er de kritiske punkt i utviklingen av elevers forståelse for stoffer og kjemiske reaksjoner?

3 Forskningsmetode

Elevene på en norsk barneskole ble fulgt i to år, fra de var 10-11 år til de var 12-13 år. Elevene på en norsk ungdomsskole ble fulgt et år lenger, fra de var 12-13 år til de var 15- 16 år. I begge intervensjonene ble undervisningen planlagt sammen med lærer, og det ble lagt vekt på progresjon av grunnleggende ideer knyttet til stoffer og kjemiske reaksjoner, samt utforskende arbeidsmåter. De fire elevene fra barneskolen ble intervjuet i slutten av den longitudinelle studien, og det er kun disse dataene som er benyttet i denne studien. Elevene fra ungdomstrinnet ble intervjuet i slutten av hvert periode (hver høst og vår i tre år). Barneskoleelevenes uttrykte forståelse i sluttintervjuene, og ungdomsskoleelevenes uttalelser fra intervjuene etter hver periode ble kodet etter bestemte kategorier.

4 Resultater

De fire elevene fra barnetrinnet uttrykte ideer om at stoffer består av partikler som beveger seg, og de uttalte seg om kjemiske reaksjoner. Intervjuene avdekket at elevenes forståelse og kom til uttrykk på forskjellige måter. Det var eksempler på at elever uttrykte ufullstendige og uferdige kunnskapselementer.

Foreløpige resultater fra elevene på ungdomstrinnet viser at de i varierende grad uttrykte ideer om at stoffer består av partikler som beveger seg. Imidlertid viste noen av dem etter hvert ganske avansert forståelse for kjemiske bindinger, for eksempel om hvordan bindinger ble brutt og om hvordan nye ble dannet. Intervjuene avdekket at elevenes forståelse og kom til uttrykk på forskjellige måter. Også blant ungdomsskoleelevene var det eksempler på at elever uttrykte ufullstendige og uferdige kunnskapselementer.

4 Diskusjon og konklusjon

Undervisningen vektla repetisjon, utvidelse og raffinering av begreper knyttet til stoffer og kjemiske reaksjoner, og det så ut til at elevene restrukturerte og omorganiserte sine kunnskapsstrukturer. Videre var det flere eksempler på at elever uttrykte forståelse av stoffer og kjemiske reaksjoner ulikt i ulike kontekster, men at de uttrykte relativt dyp forståelse for stoffer og kjemiske reaksjoner. Det var også indikasjoner på at studentene utviklet fragmentert og ufullstendig forståelse, og at de gjorde mer eller mindre gale konklusjoner som nødvendige trinn i læringsprosessen. Samtidig så det ut til at den fragmenterte og ufullstendige forståelsen faktisk kunne være viktige trinn på veien mot dypere forståelse. Sikorski og Hammer (2010) påpeker nettopp at ikke-korrekte ideer ofte har gitt opphav til naturvitenskapelige framskritt. Videre kan elevenes ikke-korrekte ideer være fornuftige når elever lærer naturfag (Strike & Posner, 1992). Det kan være viktige steg i elevenes konseptuelle omorganisering.

Sentrale ideer knyttet til stoffer og kjemiske reaksjoner ble uansett repetert, utvidet og foredlet over tid. En kan si at prinsippene bak læringsprogresjonen for stoffer på makro- og mikronivå utarbeidet av Smith et al. (2006) ble ivaretatt. En læringsprogresjon beskriver som nevnt på hvilken måte og i hvilken rekkefølge både innholdskomponentene og prosessaspektene bør organiseres for at elevene skal få en dyp og bred naturfaglig forståelse. Özdemir og Clark (2007) hevder at hvis elevers kunnskap består av fragmenterte elementer, så bør undervisningen fokusere på hvordan disse elementene aktiveres i relevante kontekster. I dette perspektivet så bør produktive undervisningsplaner konfrontere elever med det samme fenomenet i ulike sammenhenger.

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Poster

78. LÆRERSTUDENTERS ERFARINGER MED BRUK AV REPRESENTASJONER I PRAKSIS

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Abstract
Representations, such as written and spoken text, diagrams, models and simulations, are important tools for student learning in science. They are also important tools for teaching in that they make student learning visible, so that it can be shared, discussed, and supported. In this study, we have investigated teacher students' awareness of, and experience with, representations. We have also investigated how the teacher students' understanding of the construct "representations" has developed with their experiences from teaching practice. We carried out focus group interviews with two groups of students before and after their teaching practice. Results suggest that the students' knowing about representations is enhanced after the period of teaching practice, including a stronger awareness about what role representations play for student learning. The teacher students used several different representations in their teaching practice, and these can be tools for their future professional development and practice as teachers. The results further suggest that the students also became more aware of the challenges involved with using representations in teaching science.

1 Innledning
For å utvikle et naturvitenskapelig språk er ulike representasjoner som tekst, tale, grafer, diagrammer, modeller og simuleringer viktige verktøy (Knain, 2015). Utviklingen av literacy i naturfag er en forutsetning for å kunne delta i diskusjoner og kunne kommunisere naturfag (Norris & Phillips, 2003). Representasjoner er også viktig for elevers læring av begreper og fenomener i naturfag. Det å kunne se sammenhenger mellom ulike former for representasjoner, og å bli i stand til å lage egne representasjoner av fenomener og begreper bidrar til utvikling av elevers naturfaglige språk (Kress, Ogborn, & Martins, 1998).

For lærerstudenter er representasjoner et viktig verktøy for å kunne se en større sammenheng mellom teori og praksis, noe som er et tilbakevendende tema i lærerutdanningen. En større bevissthet hos lærerstudentene relatert til hvordan benytte representasjoner i undervisningen kan bidra til utvikling av deres lærerkompetanse.

Studien er del av prosjektet REDE (Representasjon og deltakelse i naturfag). Målet med studien er å undersøke hvordan lærerstudenter forholder seg til begrepet representasjoner, hvilken kjennskap de har til ulike representasjoner, og hvilken betydning representasjoner har for elevers læring i naturfag. Vi ønsker også å undersøke om studentenes oppfatning av representasjonsformer endrer seg etter at de har vært gjennom en praksisperiode.

2 Teoretisk rammeverk
Denne studien bygger på både teoretiske og empiriske perspektiver. Det teoretiske perspektivet står på to ben: et sosialsemiotisk perspektiv som omhandler representasjonenes betydning for læring (Ogborn, Kress, Martins, & McGillicuddy, 1996), og et dialogisk perspektiv som ser læring som noe som skjer i et "tredje rom" (Wallace, 2004).

Kress et al. (1996) var tidlig ute med perspektivet at læring ikke bare skjer gjennom bruk av talespråk. Fra sitt sosialsemiotiske perspektiv pekte de på nødvendigheten av å anvende ulike typer representasjonsformer for at læring skal finne sted. Flere studier har siden anvendt dette perspektivet for å peke på betydningen av å anvende ulike representasjonsformer for at læring skal skje (se f. eks. Fredlund, Airey, & Linder, 2012; Knain, 2015).

Wallace (2004) brukte betegnelsen «det tredje rom» for å beskrive hvordan kommunikasjon verken bestemmes av den som skaper representasjonen (for eksempel læreren) eller den som tolker den (for eksempel eleven). I stedet oppstår det i det tredje rommet en hybrid diskurs der begge får plass der det forhandles om mening. Knain og Klevenberg (2012) bygger på dette perspektivet og gir eksempel fra lærerutdanningen der et tredje rom skapes der studentene kan blande hverdagserfaringer og erfaringer fra skolepraksis med fagdidaktisk teori. I denne presentasjonen ser vi på elevers læring i praksis med et særlig fokus på betydningen av å bli bevisst på betydningen av å anvende ulike representasjoner. I denne studien blir intervjusituasjonen et «tredje rom» der lærerstudentene kan blande erfaringer fra sin praksis med teori fra undervisning på campus, slik at de kan begynne å se læring på en ny måte (jmf. Ahlberg, 2004).

3 Metode

Studenter ved PPU-studiet ved Institutt for lærerutdanning og skoleforskning ved Universitetet i Oslo ble invitert til å være med på to fokusgruppeintervju, ett før og ett etter praksis. Studentene hadde bakgrunn i realfag. Deltakelsen var frivillig. Gruppe 1 besto av 4 studenter, 1 falt fra og to kom til før intervjuet etter praksis. Gruppe 2 besto av sju studenter, 3 falt fra før intervjuet etter praksis. Intervjuene ble dokumentert ved lydopptak. Intervjuer stilte de samme spørsmålene til studentene i begge intervjuer. I denne eksplorerende studien er opptakene analysert tematisk for å undersøke hvordan møtet med representasjonsformer i teori og praksis arter seg.

4 Resultater

Foreløpige resultater peker mot at lærerstudentene har en klarere oppfatning av begrepet representasjoner, har konkrete eksempler, og er mer reflekterte i sine betraktninger om hvordan representasjoner kan fremme elevenes læring, og gi en mer variert undervisning. En student kommenterte at han hadde trodd at representasjoner var 3D-modeller og liknende, men hadde etter praksis forstått at det var mye mer, som han sa: ”det inngår mye mer inn i læresituasjon enn jeg trodde før. At matematiske likninger f.eks også er en representasjon.” Eksempler på konkrete representasjoner var etter praksis mer kjent for studentene. En student kom med følgende kommentar: ”For eksempel bruk av Google Earth, du kan nesten ha et helt undervisningsopplegg bare i Google Earth.”

Studentene ble etter praksis også mer bevisste i representasjoners betydning for læring, for eksempel uttrykte en student at ”Jeg tenker at, ofte, en representasjon viser litt om du har skjønt noe eller ikke. Hvis du leser en tekst og så prøver å tegne det ned må faktisk du tenke over hva er det jeg har lest, hvordan er det det her funker? ”. En annen student konluderte med følgende: ”Det er jo nesten umulig å forklare komplekse situasjoner bare med tekst. ”

I intervjuene snakker studentene også om at de ikke fikk inntrykk av at lærere var spesielt bevisste på bruken av representasjoner, selv om de benyttet ulike former for dette i sin undervisning.

5 Diskusjon og konklusjon

Arbeid med representasjoner for lærere og lærerstudenter handler i stor grad om å utvikle en bevissthet om sentrale redskaper og uttrykksformer i naturfag som mulighet for læring. Dette er i noen grad en metakognitiv bevissthet, når lærere blir oppmerksomme på betydningen av visuelle uttrykksformer som både utkomme fra- og redskaper for naturfaglig læring. Hvis lærerstudentene møter lite oppmerksomhet om bruk av representasjoner i skolens kan denne muligheten for læreren til å støtte elevenes læring bli oversett som taus kunnskap i stedet for å bli en eksplisitt bro mellom undervisningspraksis, fag, og lærerutdanning. Å skape arenaer for dette møtet i gjennom å designet ”tredje rom” hvor både fag, undervisningspraksis og lærerutdanning på campus blir ressurser for lærerstudentenes utforskning av egen praksis blir en viktig oppgave.

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Poster

83. NEW TEACHING PRACTICE – TEACHER STUDENTS EVALUATE THEIR WORK EFFORT AND MOTIVATION

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Abstract
Initiators of this project have developed an innovative teaching practice at primary school- and early childhood teacher education. In a multidisciplinary university course, students are encouraged to develop and test outdoor learning activities on groups of kindergarten children or primary school pupils. Main aim is to enhance their professional confidence and skills, and to provide them with learning outcomes where boreal nature is the arena for learning. Study focus is students' experiences from this practice, and emphasis on how it influences and stimulate their work effort and their motivation. Students own statements in course evaluations, clearly indicates that this teaching practice is raising their professional skills and increase their work effort.

1 Innledning
Ved UiT Norges arktiske universitet, campus Alta, er en ny undervisningsform utviklet og utprøvd. Utviklingsarbeidet har vært gjort i det flerfaglige utefaget «Arktisk natur som læringsarena», hvor praktiske læringsaktiviteter i naturen står i fokus (UiT, 2016). Emne er gitt som et valgfag eller fordypningstilbud for henholdsvis barnehagelærer-, grunnskolelærer-, idrett- og friluftsliv studenter, og som videreutdanning for yrkesaktive i barnehage og skole. Som en del av innholdet i emne, har studentene utført læringsaktiviteter i samhandling med barnehagebarn eller skoleelever. Dette samarbeidet med praksisfeltet, kommer i tillegg til den obligatoriske praksisen i de aktuelle utdanningene.
Studentene har blitt utfordret til å utvikle og utprøve didaktiske aktiviteter utendørs. Det faglige innholdet i aktivitetene har vært knyttet til pensum i emne og til læreplan eller rammeplan for skole og barnehage. Studentene har arbeidet i grupper under veiledning av faglærere i emne. Didaktiske planer har blitt presentert for medstudenter og faglærere, samt diskutert før gjennomføring. Etter gjennomførte læringsaktiviteter, har det vært gjort refleksjoner sammen med medstudenter og faglærere. Arbeidet med de didaktiske aktivitetene er presentert i skriftlige studentrapporter etter IMRaD metoden.
I denne studien ønsker vi å undersøke studenters vurdering av campusbasert undervisning hvor de aktiviseres og utfordres på nye måter, med særlig vekt på om deres arbeidsinnsats og motivasjon påvirkes.

2 Teorigrunnlag
I følge Haug (2010) er det få studier om hvordan lærerstudenter konstruerer sin kunnskap. Studenter ved institusjoner som tilbyr barnehagelærer- og grunnskolelærerutdanning skal tilegne seg omfattende fagteoretisk kunnskap, men også didaktisk kompetanse om hvordan de gjennom sin fagteoretiske innsikt kan bidra til læring hos barn og unge. Utdanningsforskning og evalueringsrapporter fra NOKUT, påpeker utilfredsstillende sammenheng mellom kunnskapsbygging i utdanningen og anvendelse av denne kunnskapen i praksisfeltet (e.g. Gloppen, 2013; Fosse, 2016; NOKUT 2006 og 2013). Gapet mellom det studentene lærer på campus, og arbeidsoppgavene de møter i barnehage og skole, kan ha innvirkning på studentenes motivasjon og arbeidsinnsats i utdanningen.
Studenters faglige læringsutbytte står i sammenheng med deres arbeidsinnsats i studiet (Opstad et al., 2013). Arbeidsinnsats påvirkes blant annet av om studentoppgaver er arbeidskrav som må gjennomføres og godkjennes (egne erfaringer), noe som er et eksempel på ytre motivasjon. Forebygging av lærerrolle-utøvelse hvor en fremstår som faglig usikker overfor elever, kan påvirke studenters

arbeidsinnsats positivt (Maehr & Braskamp, 1986; Deci & Ryan, 1985; 1991). I følge forskning av Børresen, Linseth og Tangen (2013) om lærerstudentenes arbeidsinnsats, mestring og fullføring, er veiledning fra øvingslærerne i praksis det de er mest fornøyd med. Dette kan indikere, at autentiske kontekster gjør studenter sterkere indre motivert for å erverve seg kompetanse.
Lillejord og Børte (2014) påpeker i sine studier at det i eksisterende partnerskapsmodeller mellom lærerutdanninger og praksisfeltet, er et tydelig behov for nytenkning og at studentenes læring blir satt i sentrum. Eksempel på slik nytenkning, kan være hyppigere og mer fleksibel bruk av didaktiske øvingssituasjoner i studentenes campusbaserte undervisning i samhandling med praksisfeltet.

3 Metode

Prosjektet er aksjonsforskning (Tiller, 1999; Christoffersen & Johannessen, 2012) av egne undervisningsformer i lærerutdanningene ved UiT Norges arktiske universitet, campus Alta. For å innhente informasjon fra studentene benyttes fagdidaktiske rapporter, emneevalueringer og svar fra studentene via digitale spørreskjema.

4 Resultat

Studentene viste god evne til å utfordre seg selv i ulike tema innenfor pensum. Dialog mellom studenter og faglærere resulterte i at deres læringsaktiviteter ble faglig og didaktisk utfordrende (Tabell 1). Studentevalueringer viser at studenter har jobbet mye i dette emne. De er fornøyd med at de har fått prøve ut didaktiske aktiviteter for elev- og barnegrupper. Imidlertid gir de signaler om at de ønsker mer forelesninger av pensum. Eksempler på studentenes vurderinger om denne undervisningsformen påvirker deres arbeidsinnsats, motivasjon, faglige- og fagdidaktiske læringsutbytte, er gitt i tabell 2.

Tabell 1: *Eksempler på didaktiske aktiviteter som ble utviklet, utprøvd og rapportert*

	Korte beskrivelser av tematikk
Didaktiske aktiviteter for barnehagebarn (5-6 åringer)	• Røyas formering – barna skal få utforske ytre og indre deler og organer på fisken. Undre seg over hvordan det blir flere fisk, få demonstrert hvordan fiskeformering foregår. Tilberede og smake på fisken. • Isfiske – barna skal få undre seg hvor fisken er om vinteren, hvordan fiske på isen og hva liker fisken å spise om vinteren. Barna deltar i å borre hull og velger agn. Dersom det blir fangst utforskes fiskens ytre og indre deler samt at den blir tilberedt til mat. • Fjellfloraens forunderlige verden – her blir det lagt mest vekt på mose og lav. Barna skal bruke sansene for å finne ulike arter. Snakke om forskjellen, dramatisere og lage noe med de ulike artene.
Didaktiske aktiviteter for skolebarn	• Jordprofiler - elevene skal planlegge og gjennomføre undersøkelser, registrere observasjoner og systematisere resultatene. De skal undersøke og diskutere noen faktorer som kan påvirke frøspiring og vekst hos planter (6. og 7. trinn). • Klatre etter tyttebær – elevene skal gjennomføre klatreøvelser for å plukke tyttebær, få oversikt over lokale bærsorter, næringsinnhold og hva de kan brukes til. De skal ved hjelp av oppskrift lage te og dessert av tyttebær (6. og 7. trinn). • På spor etter istid – elevene skal gjennomføre forsøk som viser hvordan U- og V daler, samt isskuringer dannes og kjenne på kreftene som må til for å flytte stein. Diskutere og reflektere over

	hvilke hendelser som har foregått i det landskapet hvor undervisningen foregår (10. trinn).

Tabell 2: *Sitat fra studentevalueringer om hvordan undervisningsformen påvirker deres arbeidsinnsats, motivasjon, faglige- og fagdidaktiske læringsutbytte.*

	Utvalgte sitater fra student evalueringer
Arbeidsinnsats	• Har vært mye slit • Med skriftlige oppgaver blir man nødt til å jobbe mye med pensum for å prestere, som er bra.
Motivasjon	• Studentgruppens engasjement i gjennomføringen av aktiviteter er gull verd. • Flott at vi studenter har fått prøve oss.
Faglig- og fagdidaktisk læringsutbytte	• Stor faglig utbytte med stor grad av metodevariasjon. • Bra læring i det å få prøvd ut ting i praksis. • Bra med mye evaluering underveis, hvor vi prater om hvorfor vi faktisk gjør det vi gjør og hva vi skal lære. • Er veldig glad for at vi har gjort ting praktisk da bli dørstokken mindre for å gjøre det selvstendig. • Vi har laget, gjennomført og evaluert didaktisk arbeid i samarbeid med lærere og studenter. Veldig lærerikt. • Skulle gjerne hatt flere forelesninger om pensum, men ikke på bekostning av det praktiske.

5 Diskusjon

Eksemplene på tematikk i de didaktiske aktivitetene, samt sitater fra studentevalueringene (Tabell 1 og 2), viser at campusbasert undervisning med didaktiske aktiviteter for barnehagebarn eller skoleelever og ledet av studentene, har påvirket både deres motivasjon, arbeidsinnsats og faglige- og fagdidaktiske læringsutbytte. Dette kan understøtte at realistiske kontekster er av positiv betydning i denne sammenhengen (Børresen et al., 2013). Hovedresultatene fra studien vil være data fra spørreundersøkelsen blant studentene, og funnene derifra vil da bidra til å fullføre studien og diskusjonskapitlet.

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Workshop, WS4.

SKOLEVIRKSOMHEDSSAMARBEJDE – ELEVER DER LØSER AUTENTISKE PROBLEMER I SAMARBEJDE MED EN VIRKSOMHED

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Abstract
This workshop starts with a short presentation of the project NEXT:GrEeN (Next Green Generation). The project centres on school-industry cooperation and six authentic problems that the participating company gave students to solve during a visit to the company. We present the six problems, describing how the students solved them and subsequently developed products to demonstrate those solutions on a small scale. The students worked together with the teacher and company employees to solve the problems within the framework of the three spaces described in the KIE model – the creative space, the innovative space and the entrepreneurial space. At the workshop, we reproduce some of the exercises that the students completed and discuss the possibilities and limitations. We also look at the four key science competencies specified in the Danish science curriculum: inquiry, modelling, communication and perspective. Finally, we examine how authentic issues, business cooperation and competency goals can be integrated into the new common practical/oral final examination in science now implemented in Denmark.

Målgruppe: Forskere, udviklere og undervisere i naturfag.
Uddannelseskontekst: Elever fra 7.-9. Klasse – skole-virksomhedssamarbejde i naturfag.
Sprog: Dansk/Nordiske sprog.
Deltagere tar med: Fantasi, godt humør og nysgerrighed på, hvordan elever løser ægte problemer i naturfag i samarbejde med en virksomhed og dens medarbejdere.

Baggrund
Skole-virksomhedssamarbejde ser i følge nyere forskning ud til at kunne bidrage til at øge elvernes interesse og forståelse for, hvad naturfagene kan anvendes til i samfundet. Også elevernes læringsudbytte ser du til at være højt, særligt når eleverne får mulighed for at skabe relationer til medarbejderne, der virker som faglige eksperter. Derfor har vi i dette projekt lagt vægt på, at virksomhedssamarbejdet er mere end blot et endags-besøg på virksomheden, men et samarbejde, hvor virksomhedens medarbejdere både besøger eleverne i skolen og også har eleverne på både rundvisning og arbejdsdag ude på virksomheden.
Eleverne løser de autentiske problemstillinger ved at arbejde i en ramme af tre rum, som de gennemlever i samarbejde med læreren og virksomhedens medarbejdere. De tre rum er beskrevet i KIE-modellen ogdrejer sig om det Kreative rum, det Innovative rum og det Entreprenante rum (KIE-rummene). På workshoppen gennemfører vi nogle af de samme øvelser som eleverne og diskuterer muligheder og begrænsninger. Vi ser også på de fire naturfaglige konpetencer, som er centrale i de danske fagbeskrivelser for naturfagene: Undersøgelseskompetencen, modellerings-kompetencen, kommunikationskompetencen og perspektiveringskompetencen. Herudover ser vi på, hvordan autentiske problemstillinger, virksomhedssamarbejde og kompetencemål kan tænkes sammen i den nye fælles praksisk/mundtlige afgangsprøve i naturfag, som er indført i Danmark.

Workshopens struktur
Vi lægger op til, at vi får en livlig debat og laver nogle spændende øvelser sammen. Vi starter med en præsentation af projektet og udfolder derefter de autentiske problemstillinger, som virksomheden har formuleret til eleverne. Herudover skal vi prøve at arbejde med nogle af de øvelser, som eleverne

gennemgår i de tre forløb fra KIE-modellen. I punktform tænker vi, at strukture vores tid sammen efter nedenstående tidsforløb:

20 minutter: Velkommen og introduktion til projekt NEXT:GrEeN
20 minutter: De 6 autentiske problemstillinger fra virksomheden og elevernes løsninger præsenteres. Plenumdiskussion af elevers løsninger på problemerne
30 minutter: Didaktiske perspektiver og diskussione afelevernes løsninger i relation til naturfagsundervisning.
40 minutter: De tre KIE-rum. Diskussion i grupper af kreative, innovative og entreprenante processer i naturfagsundervisningen. Vi arbejder selv med KIE-rummene.
10 minutter: Fælles opsamling af pointer. Disse nedskrives og deles på mail.

Deltagerne må meget gerne bidrage med erfaringer fra out-of-school projekter. Herudover må I meget gerne bidrage med alt hvad I kan i forhold til det udfordrende felt: Hvordan kombinerer vi innovative processer i naturfagsundervisningen? Hvilke fagligheder og kompetencer tilgodeses? Hvad er elevernes læringsudbytte?

Workshop, WS1.

FROM SINGLE NEURON TO BRAIN FUNCTION – A BRAIN BUILDING KIT DEVELOPED TO FILL IN THE MISSING LINK IN SCHOOL.

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Abstract

In this workshop, the participants get to try out a new teaching tool (prototype) developed for inquiry-based learning of neural networks. The aim of this tool is to facilitate an understanding of the link between neural network architecture and function. The tool is a neural network building kit comprised of individual, electrical conductible neurons, with connectable axons and dendrites. The tool has been designed both as a software version and as a physical, hands-on version. The physical version will be demonstrated during this workshop, whereas the software version will be available for interaction. Sketches of a few neural networks modeled from both vertebrate and invertebrate brains will be handed out for the participants to build.

Intented audience: Anyone interested in brain function

Educational context: From lower secondary school (13 years) and up.

Language: English

What to bring to the workshop: Computer

Introduction/background

The neuroscience topics taught in Norwegian elementary school science classes are commonly limited to the senses. At the middle-school level however, topics like the neuron and the brain are introduced. The brain is usually presented with the cerebral cortex divided into a few areas, each area representing a particular function, like speech, body movement, vision, hearing and all the other sensory qualities, knowledge primarily acquired more than a century ago. The neuron is usually presented by its structure and function, sometimes including the mechanism of action potential generation and propagation, a mechanism described already in 1952. However, the link between neuron function and brain function, which has been in the spotlight of neuroscience research ever since, is completely absent. How do neuron function lead to brain function? This is a black hole in the classroom that to needs be painted with the colors of knowledge. Why? Because this hole of black contains the network of neurons necessary to create an explicit bridge for the pupils from neuron function to brain function. Simple neural networks will provide for the pupils a platform on which comprehension about brain function can be build.

Workshop structure

First the participants will be given a short introduction to neuroscience. Second they will watch a demonstration of a physical, artificial neural network before (prototype). Third, they get to build a few well described neural networks of the brain using a new software (prototype). Some background knowledge on the nervous system will be useful.

Workshop, WS2

AUGMENTED REALITY I NATURFAGENE – ELEVER SOM PRODUSENTER AV DIGITALE, NATURFAGLIGE MODELLER

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Abstract

The aim of this interactive workshop is to give the participants the possibility to try out some newly developed Augmented Reality (AR) resources from a 3 year EU-project "ARsci" focusing on the use of AR for science education in lower secondary school. An overall aim in the project is to support students in being producers of AR animations and representations themselves. However, showcase material has been developed and tested by the ARsci-team in the first phase of the project. Besides trying this "ready to use" material participants will have the possibility to try out simple tools like BlippBuilder or Aurasma to create their own AR animations. Furthermore, we will share some experiences from piloting in Norwegian, Danish and Spanish classrooms. The target groups are science teachers and teacher educators. The language in the workshop will mainly be Norwegian and Danish, but English can also be used. Remember to bring you own computer and tablet or smartphone.

Målgruppe: Naturfagslærere, lærerutdannere og lærerstudenter
Utdanningskontekst: Naturfag, ungdomstrinnet og videregående skole
Språk: Nordisk (norsk/dansk), med innslag av engelsk.
Deltagere tar med: Datamaskin og nettbrett eller smarttelefon

Bakgrunn

Augmented Reality (AR) er mer enn Pokemon-go! Det kan også være potente læringsressurser i naturfag. I workshopen får deltakerne muligheten til å prøve nye AR ressurser, som er utviklet spesielt for naturfag på ungdomstrinnet. AR handler kort fortalt om, at et digitalt innhold på ett nettbrett eller en smarttelefon er ”lagt oppå” og dermed ”forsterker og utvider” forståelsen av et virkelig, naturfaglig fenomen. Det kan for eksempel være å se på undersiden av et grønt blad gjennom telefonens kamera og samtidig få vist et lag med en digital modell av en spalteåpning. Her kan fokus for eksempel være stofftransporten inn og ut av spalteåpningen illustrert med molekylemodeller på mikronivå.

Deltakerne vil også bli introdusert til, og kan prøve - verktøy som kan brukes i undervisningen for å la elever designe og produsere deres egne AR-ressurser. Dessuten deler vi noen erfaringer fra bruk av AR i naturfagundervisning i skolen – med data fra flere runder av pilot-utprøvninger på skoler i Norge, Danmark og Spania, som en del av EU-prosjektet AR-sci. Forskningsresultatene fra prosjektet blir også formidlet i en egen paper-presentasjon.

Workshopens struktur

Vi starter med en kort intro til AR som teknologi og som didaktisk verktøy: Hvorfor AR i naturfag - og hvorfor elevene som produsenter? Deretter får deltagerne mulighet for utprøving av eksemplariske AR-ressurser i naturfag som er utviklet i prosjektet – av både IKT-eksperter, lærere og elever - med tilhørende didaktiske refleksjoner. Her kan vi legge til rette for både et spor målrettet lærerutdannere og et spor målrettet naturfagslærere. Det vil også være mulighet for hands-on utprøving med utviklingen av enkle AR-resurser i et utviklerverktøy, som BlippBuilder eller Aurasma. Husk derfor egen datamaskin til formålet.

Til slutt vil vi legge opp til en oppsummering og diskusjon bl.a. med fokus på deltagernes ideer til AR i egen praksis.

Workshop, WS5

CREATING A MATERIAL SOLUTION TO A SOCIO-SCIENTIFIC ISSUE: MAKING IN THE SCIENCE AND TECHNOLOGY CLASSROOM

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Abstract
This workshop presents a format for working with socio-scientific issues in the classroom. A socio-scientific issue (SSI) is a complex social issue related to science. Students who deal with an SSI typically encounter incomplete and conflicting information and they must consider economical, ecological, ethical, and political dimensions – at local, national, and global levels. Attempting to promote students' engagement and scientific literacy, SSIs are typically integrated with classroom activities such as debates, role-playing, and cases. As an alternative to pre-defined SSI cases, the cases in this workshop are framed through "board game actions" and information retrieval. Further, the participants are expected to present a solution to a socio-scientific problem in the form of a material prototype. Thereby, the workshop format connects to the *maker movement*, which endorses learning through problem-solving and hands-on making. The session ends with a discussion of how teachers can draw on the workshop format in schools or higher education.

Intended audience: Teachers and researchers in technology and science education

Educational context: ***Level:*** Secondary school (both lower and upper secondary), Higher Education, including Teacher Education ***Subject:*** Science and Technology

Language: English

What to bring to the workshop: smartphone or other device (for information retrieval)

Introduction
A socio-scientific issue (SSI) is a complex social issue that relate to science. Typically, dealing with an SSI means dealing with incomplete and conflicting information as well as cost-benefit analysis that take into account economical, ecological, ethical, and political dimensions – at local, national and global level (Ratcliffe & Grace, 2003). SSIs can be integrated in classroom activities to promote students' ability to use science-related information in argumentation and to relate science to their own social and political lives (Zeidler, Sadler, Simmons, & Howes, 2005). Such activities are often organised in form of role-play and debates (Walker & Zeidler, 2007), and pre-defined cases (Ottander & Ekborg, 2012).

This workshop proposes an alternative to the pre-defined SSI case. First, the particular SSI case is roughly determined by three conditions, selected through "board game actions" such as rolling dice. Second, the participants need to seek information (using smartphones or other devices) to determine what aspect of the particular SSI case that they want to engage in.
Third, they come up with a solution to the problem and fourth, the participants produce a concept sketch and a simple prototype of their solution.

In the end of the workshop, the participants share their solutions with each other and discuss the workshop from a science/technology education perspective.

The hands-on and problem-solving features connects the workshop format to the *maker movement*, which broadly refers to "the growing number of people who are engaged in the creative production of artefacts in their daily lives and who find physical and digital forums to share their processes and products with others" (Halverson & Sheridan, 2014, p. 496). Learning through *making* pushes our thinking about how and where learning happens, and the *maker movement* is increasingly influencing the educational sector, for example through the implementation of pedagogical environments for making – e.g., *FabLabs* and *Makerspaces* –in formal and informal educational settings (ibid.)

Above: Two of the "game pieces": Tornado and ant. Below: Example of a solution to a tornado-related problem, inspired by a type of ant nest: A temporary house made of material from destroyed buildings.

The objective of the workshop is to display a form of teaching that involves:

1. Handling science-related information
- A "semi-determined" case where conditions are set by gaming principles and by the participants' information-seeking and preferences
- Making in the classroom

Further, the objective is to provide room for a pedagogical discussion about the suggested form of teaching – how could this form of teaching be used in school or higher education?

Workshop structure

The participants will work in pairs or groups of three to discuss, and create a material solution to, a socio-scientific problem.

No specific prior knowledge is required. While technology and design principles are core features in the workshop structure, it is possible for participants to target different aspects of the problem depending on their preferences, such as aspects more linked to physics, biology, environment, technology and chemistry.

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Workshop, WS3

CELLA SOM SYSTEM

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Abstract

In this workshop, participants get to explore and discuss a newly developed inquiry-based unit about cells for lower secondary school (www.naturfag.no/celler). The unit enables students in classrooms to use evidence to decide whether a structure in a meteorite has traces of life or not, and to distinguish between animal and plant cells. The students will also create a model of the cell. The unit was developed in collaboration with teachers in two schools. The workshop will include exploration and discussion of learning activities from the unit, and presentation and discussion of a suggested research design to investigate whether the unit leads to changed practice and more inquiry-based teaching in schools.

Målgruppe: Naturfagdidaktikere og lærere
Utdanningskontekst: 8.–10. årstrinn, naturfag (biologi)
Språk: Norsk

Innledning

Vi har utviklet et utforskende undervisningsforløp om celler for ungdomstrinnet: *Cella som system*. http://www.naturfag.no/celler . Gjennom opplegget settes elevene i stand til å kunne bruke bevis for å avgjøre om en struktur i en meteoritt har spor av liv eller ikke. Videre skal elevene kunne skille mellom dyre- og planteceller og lage en modell av cella. Opplegget er utarbeidet for ungdomstrinnet og er prøvd ut på 8. og 9. trinn.

Utviklingen av opplegget er en del av et samarbeidsprosjekt mellom Naturfagsenteret, Utdanningsetaten i Oslo kommune og to ungdomsskoler i kommunen. Utviklingen av opplegget har skjedd i samarbeid med lærere og minner om designbasert forskning og utvikling (Collins, A. Joseph, D., og Bielaczyc, K., 2004).

Alle naturfaglærerne ved skolene har deltatt på samlinger med oss der de har prøvd ut opplegget som elever, og reflektert og kommentert på bakgrunn av dette. Lærerne som underviste på de avtalte trinnene gjennomførte hele undervisningsforløpet, mens de andre lærerne og vi fra Naturfagsenteret observerte i timene. Opplegget har blitt revidert og kvalitetssikret ut fra kommentarer fra lærerne og utprøving med elevene. Lærersamlingene har også vært kompetansehevende for lærerne ved at vi har presentert og diskutert didaktiske problemstillinger og at hatt erfaringsdeling lærerne imellom.

Vi ønsker nå å se nærmere på hvordan dette samarbeidet med lærerne fungerer som kompetanseheving og i hvilken grad undervisningsmetodene implementeres i lærernes øvrige undervisning i etterkant. Det er også et viktig moment å se på i hvilken grad et slikt detaljert beskrevet opplegg på nett hjelper lærerne til å reflektere over sin egen undervisningspraksis.

Workshopens struktur

I workshopen vil deltagerne først få prøve aktiviteter fra opplegget i rollen som elever med en kort diskusjonsrunde i etterkant. Vi vil så presentere hvordan vi har tenkt å finne ut om undervisningsopplegget etablerer en endret praksis ved skolene, der lærerne blir bedre i stand til å jobbe utforskende med elevene. Til slutt ønsker vi å diskutere og få innspill på vårt foreslåtte forskningsdesign fra deltagerne på workshopen.

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