NFSUN

Nordiske Forskersymposium om Undervisning i Naturfag

Abstracts

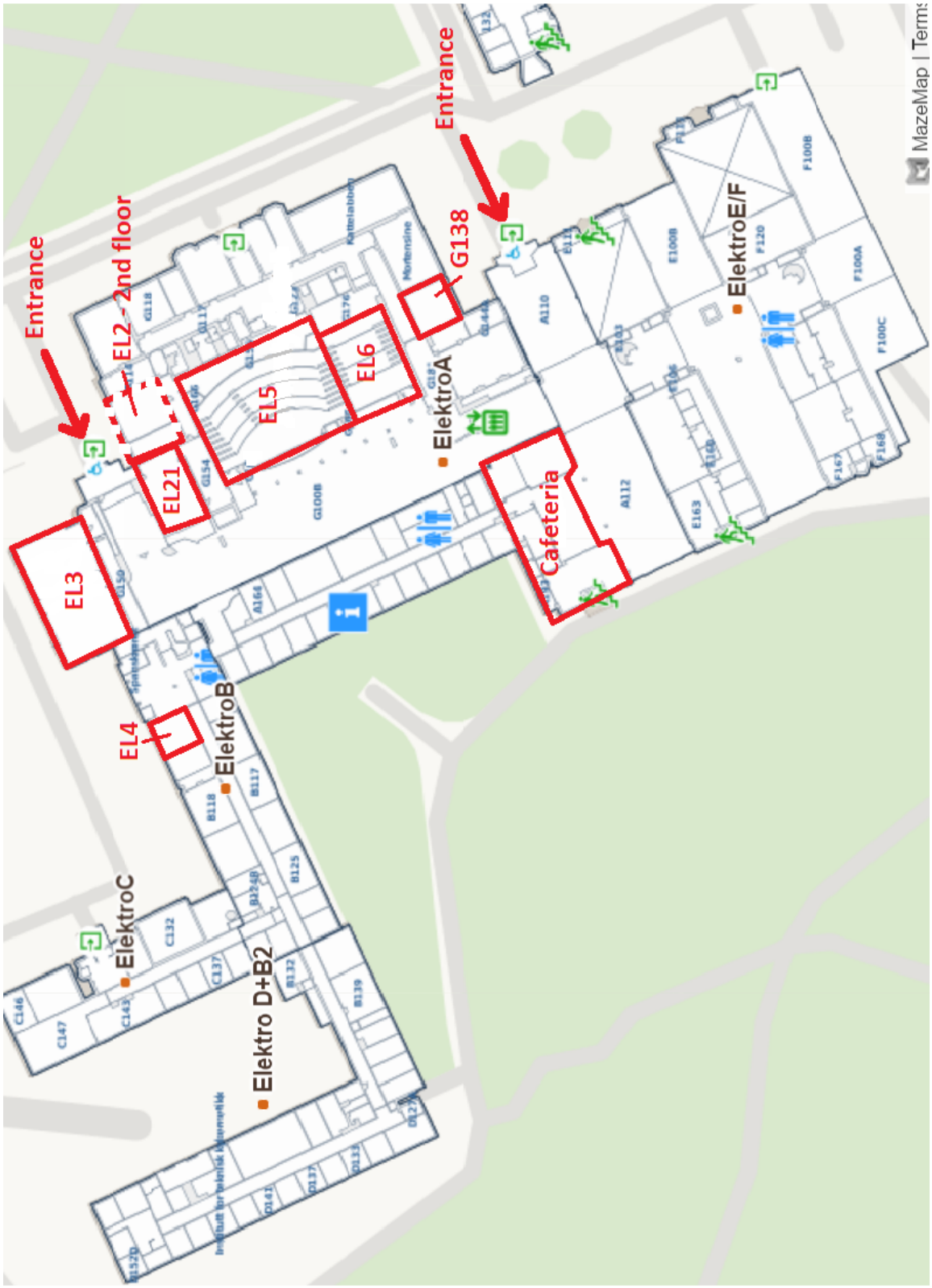
NTNU

Norwegian University of Science and Technology

Trondheim, 7-9 June 2017

Map of locations – Electro Building

Gløshaugen Campus (O.S. Bragstads plass 2e)



NFSUN

Nordiske Forskersymposium
om Undervisning i Naturfag
Nordic Research Symposium
On Science Education

12th Symposium

Trondheim 7 - 9 June 2017

Abstracts

NTNU
Institutt for lærerutdanning
Department of Teacher Education

NFSUN 2017 – Organisers

Trondheim Committee

Jardar Cyvin (chair)
Berit Bungum
Unni Eikseth
John Magne Grindeland
Astrid Johansen
Ragnhild Lyngved Staberg

Nordic committee

The representatives from the other Nordic countries have contributed in an exceptional way for the NFSUN 2017 conference, and we thank them warmly for their great efforts and for the good collaboration.

Berit Bungum (chair), Department of Teacher Education, Norwegian University of Science and Technology
Jardar Cyvin, Department of Teacher Education, Norwegian University of Science and Technology
Birgitte Lund Nielsen, Teacher Education, VIA University College, Denmark
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Photos of Keynotes provided by keynotes themselves.

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Welcome to Trondheim and NFSUN 2017!

Dear Science colleagues!

Very welcome to Trondheim and this year's NFSUN symposium.

This symposium in Trondheim is the 12th, and it is the third of these events to be held in Norway. 33 years ago the 1st Nordic Research Symposium on Science Education was arranged in Sweden, and from 1987 on it was renamed as a science symposium. From then on, these symposia have been arranged every third year; you can find the list of previous places on page 4 in this booklet and at the NFSUN permanent net site: http://nfsun.org. We hope that you will find the new net site useful and we hope to find a way to maintain this net site in the future in order to maintain the NFSUN history and as a place for information between symposia.

We hope you will all enjoy these three days of scientific program, use the opportunities to meet your Nordic colleagues, build new networks, take care of old networks, and hopefully return home with new inspiration for science teaching and research. We also hope you will enjoy our historic city, founded in 997 by the king Olav Trygvason. Trondheim was a former capital of Norway, and is today the third largest city in Norway and an important city of the middle part of Norway. We recommend you to take a walk through the narrow streets ("smug") of the old part of the city to feel the atmosphere of the medieval city "Kaupangen in Nidaros" which was the name of the city at that time.

Once again, welcome to Trondheim, to the Norwegian University of Science and Technology (NTNU) and to the 12th NFSUN symposium.

On behalf of the scientific and practical committee

Berit Bungum and Jardar Cyvin

List of Previous Symposia

NFSUN 2014, 11th symposium. Helsinki, Finland

NFSUN 2011, 10th symposium. Linkøping, Sweden

NFSUN 2008, 9th symposium. Reykjavik, Iceland

NFSUN 2005, 8th symposium. Aalborg, Denmark

NFSUN 2002, 7th symposium. Kristisansand, Norway

NFSUN 1999, 6th symposium. Joensuu, Finland

NFSUN 1996, 5th symposium. Kristianstad, Sweden

NFSUN 1993, 4th symposium. Gilleleje, Denmark

NFSUN 1990, 3rd symposium. Lillehammer, Norway

NFSUN 1987, 2nd Nordic Research Symposium on Science Education. Lindås, Sweden.

1984, 1st Nordic Research Symposium on Physics Didactics. Ebeltoft, Denmark.

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Norway

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Keynote 1

Astrid T. Sinnes

Associate Professor
Norwegian University of Life Sciences

Astrid T. Sinnes main research interest is education for sustainable development. For several years she has conducted research on how schools and teacher education institutions can transform in order to prepare students and teachers to contribute to the "green shift" in education. Astrid Sinnes has been a visiting scholar at Earth Institute, Columbia University. She has recently published a book on education for sustainable development for teachers and teacher educators. more: www.nmbu.no/ans/astrid.sinnes

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Science education for a sustainable future; what competencies do young people need?

In the talk, Astrid Sinnes will use current research on the situation for the global environment as a point of departure to discuss what competencies young people will need to live sustainable lives and become active citizens in world marked by climate change and other environmental threats. The talk will present research on how education systems can change in order to prepare students for this future. Research within education for sustainable development challenge the content and working methods of science education but also the way schools are being run in order to accommodate and teach students and teachers sustainable practices. In the talk Sinnes will argue that knowledge about the environment is not enough to develop competencies necessary to contribute to sustainable development. Connections must therefore be established between theoretical knowledge presented through the curriculum and the sustainable practices that the students experience in school.

Keynote 2

Wolff-Michael Roth

Lansdowne Professor of Applied Cognitive Science, University of Victoria, Canada

Wolff-Michael Roth is Lansdowne Professor of Applied Cognitive Science at the University of Victoria. His empirical work focuses on knowing and learning across the life span, with a concentration on learning in science and mathematics. His theoretical work focuses on dialectical materialist approaches that informed Vygotsky, Leont'ev, Il'enkov, and Bakhtin. He is author/editor of 58 books, 450+ articles in peer-reviewed journals, and 200+ book chapters. With many awards, he received an honorary doctorate from the University of Ioannina, Greece.

More: web.uvic.ca/~mroth/

Dwelling: Toward a Phenomenological Foundation for Science and Environmental Education

In conceptual change approaches to science education, the environment is but another aspect represented in the mind and therefore constitutes but an external factor that mediates mental constructions. The notion "sense of place" and the Bakhtinian concept "chronotope" have been proposed as alternatives to provide a cultural-historical approach to science education that places a primacy on the everyday experiences that learners have with their environment. However, both concepts presuppose the existence of place and space and therefore cannot, from phenomenological perspectives, constitute the ground from which emerge our experiences of the environment or the learning of science. To ground and exemplify an alternative theory of learning that overcomes the problems of conceptual change approaches and their more recent alternatives I draw on a database established in the course of over a decade of research within one community concerning the relationship of science, knowing, and the environment. This alternative is grounded in the phenomenological insight that we always already find ourselves in a familiar world that we inhabit. "Hence, Levinas writes, the subject contemplating a world presupposes the event of dwelling." Dwelling (habiting) immediately grounds this approach to knowing and learning in the environment because sociologically, habiting implies not only habitus, habits, inhabitation, and habitat but also labor, the body, and consciousness. That is, dwelling leads us to a practice-theoretical foundation of science and environmental education.

Keynote 3

Kristiina Kumpulainen

Professor, Department of Teacher Education, University of Helsinki, Finland

Kristiina Kumpulainen is a Professor of Education at the Department of Teacher Education at the University of Helsinki. She is also the founding member and scientific director of the Playful Learning Center. Professor Kumpulainen has worked for many years within a sociocultural research paradigm conceptualising and analysing tool-mediated learning and communication in various educational arrangements in and out of school. Her current research centers on creative STEM learning, digital literacy, socio-materiality, learner agency and identity, resilience, as well as visual research.

More: kristiinakumpulainen.fi

A sociocultural analysis of the educational potential of "makerspaces" for STEM learning and teaching

Lately, there has been an increased interest in makerspaces as a new sociomaterial arrangement for young people's creative and personally meaningful engagement in STEM learning. Educational makerspaces have also attracted growing interest in Finland as they resonate well with the new Finnish core curriculum that introduces a phenomenon-based learning model, emphasizing real-life problem-solving, students' agency, digital literacy, collaboration and entrepreneurship. Drawing on socio-cultural theorizing, in her talk professor Kumpulainen will critically analyse the educational potential of makerspaces for young people's agency, learning and identity development in STEM. She will also address how teachers make sense and manage their role in makerspaces as a new learning arrangement. In doing so, she will consider the developmental potential of makerspaces for professional learning, as well as for institutional transformation.

Keynote 4

Pernilla Nilsson

Professor, Halmstad University, Sweden

Pernilla Nilsson is a professor in Science Education at Halmstad University in Sweden. During the last decade, she has focused her research on teachers´ and student teachers´ development of Pedagogical Content Knowledge (PCK) both in primary and secondary science education. She has worked with different tools and activities such as Content Representations (CoRe), Learning Study, video and digital portfolios to stimulate reflection and to help teachers and student teachers engage in their own professional learning. She has also been working on scientific literacy, formative assessment and self-study. She has a genuine interest in teacher professional learning and aspects within teachers´ practice that make a difference for students´ engagement and learning in science.

More: www.hh.se/english/research/professors/pernillanilsson.65441212.html

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When teaching matters - Developing science teacher knowledge through collaboration and reflection

The inherent complexity of teacher knowledge, and hence teacher learning, has been well documented in science education research literature. In order to teach science in ways that promote students' understanding, Shulman claimed that teachers need pedagogical content knowledge (PCK), a special kind of knowledge that teachers have about how to teach particular content to particular pupils. But how can teachers develop their understanding of PCK in order to make a difference in students' learning? One way for teachers to develop their professional knowledge with a focus on specific science content and the ways students learn such content is through being involved in researching their own practice in different collegial settings. This talk aims to discuss the perspectives about science teacher knowledge by referring to a project in which three teachers were engaged in collaboration and critical reflection on their teaching of science in a learning study. The talk will provide evidence on how teacher collaboration, and particularly interactions between teachers, may underpin the development of PCK. As such, the talk will raise how teachers' professional knowledge of teaching is enhanced and, further, how students' learning might be developed as a consequence.

Invited Plenary Symposium

National Centers: Opportunities and challenges in disseminating from research to practice and the other way around

The national science resource centers in the Nordic countries play a crucial role in the day-to-day work of maintaining and mediating networking in the field of science, technology and health education, therefore a representative from each of these centers has been invited to contribute to a symposium addressing the following question:

How can we qualify "knowledge circulation", and create more "collaborative rooms" between all the different actors in the field of science, technology and health education – with a particular focus on teaching and research & development collaboration?

Contributors:

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Merethe Frøyland, Naturfagsenteret (National Centre for Science Education), Norway
Dorthe Salomonsen and Mikkel Bohm, ASTRA, Denmark
Karin Stolpe, NATDID, Sweden
Anna Uitto, LUMAT, Finland

The Church of Our Lady. The oldest parts date from 12th century.

Oral Presentations

12. To flip or not to flip – Students' use of the learning material in a flipped university organic chemistry course

Karolina Broman, Dan Johnels

Umeå University, Umeå, Sweden

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.

13. Collaboration between university and school – How do we make use of each other's competencies?

Karolina Broman

Umeå University, Umeå, Sweden

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.

14. Developing a learning progression for students: from everyday to scientific observation in geology

Kari Beate Remmen[1], Merethe Frøyland[2]

[1]*University Of Oslo, Department of teacher education and school research, Norway*
[2]*Norwegian Center for Science Education, Oslo, Norway*

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.

15. Elaboration and negotiation of new content. The use of meaning-making resources in multilingual science classrooms

Monica Axelsson, **Kristina Danielsson**, Britt Jakobson, Jenny Uddling

Stockholm University, Sweden

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.

16. Teknikämnet i svensk grundskolas tidiga skolår sett genom forskningscirkelns lupp

Peter Gustafsson, Gunnar Jonsson, Tor Nilsson

Mälardalen University, Eskilstuna and Västerås, Sweden

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.

18. Student responses to visits to researchers' night events

Susanne Walan

Karlstad University, Sweden

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.

19. Relevance or interest? Students' affective responses towards contextual settings in chemistry problems

Karolina Broman[1], Sascha Bernholt[2]

[1]*Umeå university, Sweden*
[2]*Leibniz Institute for Science and Mathematics Education, IPN, Kiel University, Germany*

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.

Kristiansten Fort was built in 1681.

20. Why do preschool educators adopt or resist a pedagogical model that concerns science?

Sofie Areljung

Department of Science and Mathematics Education, Umeå University, Sweden
Umeå Centre for Gender Studies, Umeå University, Sweden

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.

22. Making the invisible visible across modes and representations

Erik Knain, Tobias Fredlund, Anniken Furberg

University of Oslo, Norway

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.

23. Self-efficacy as an indicator of teacher success in using formative assessment

Robert Evans

Department of Science Education, University of Copenhagen, Denmark

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.

24. Vejledning i længere-varende fællesfaglige forløb i naturfag - værktøjer og artefaktbasering

Lars Brian Krogh, **Pernille Andersen**, Harald Brandt, Keld Conradsen, Benny Johansen, Michael Vogt

Læreruddannelsen i Aarhus, Via University College, Denmark

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.

25. Students as producers of Augmented Reality in science - developing representational competence trough scaffolded dialogue

Birgitte Lund Nielsen[1], **Harald Brandt**[1], Hakon Swensen[2], Ole Radmer[3], Mogens Surland[3], Diego Nieto[4], Matt Ramirez[5]

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[4]*Cesga, Santiago de Compostela, Spain*
[5]*Jisc, Manchester, United Kingdom*

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.

26. Once again? - How an upcoming vaccination debate is portrayed in (Swedish) media

Mats Lundström[1], Karin Stolpe[2], Nina Christenson[3]

[1]*Malmö University, Sweden*
[2]*Linköping University, Sweden*
[3]*Karlstad University, Sweden*

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.

27. Disciplinary discernment from Hertzsprung-Russell-diagrams

Urban Eriksson[1,2], Maria Rosberg[1], Andreas Redfors[1]

[1]*LISMA, Kristianstad University, Sweden*
[2]*NRCF, Lund University, Sweden*

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.

28. Naturfaglæreres vurderingspraksis, med et særskilt fokus på læringsprosesser knyttet til argumentasjon

Tanja Walla

Nord Universitet, Nesna - Mo i Rana, Norway

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.

The wharves (Photo: Geir Hageskal)

29. Contemporary science in the lower secondary physics classroom

Lena Hansson[1], Lotta Leden[1], Ann-Marie Pendrill[2]

[1]*National Resource Center for Physics Education, Lund University & Kristianstad University, Sweden*
[2]*National Resource Center for Physics Education, Lund University, Sweden*

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.

30. Danish geography teachers thoughts concerning own teacher professionalism

Søren Witzel Clausen

Via University College, Denmark

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.

31. Towards bildung-oriented science education – framing science teaching with moral-philosophical-existential-political perspectives

Jesper Sjöström

Malmö University, Sweden

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.

32. Evaluering af ny tværfaglighed i naturfagene.

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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.

33. Designing an ice cream making device: an attempt to combine science learning with engineering

Katrin Vaino[1], Toomas Vaino[2], Christina Ottander[1]

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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.

St. Olav Cathederal. The new Roman Catholic church, inaugurated in November 2016.

35. Language interference in understanding of Newton's 3rd law: case of Norwegian primary school pre-service teachers

Maria I. M. Febri, Jan Tore Malmo

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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.

36. Unpacking students' epistemic cognition in a problem solving environment

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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.

37. Fra visjon til klasserom: Hva slags støtte trenger lærere for å fremme dybdelæring i naturfag?

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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.

38. Finnish mentor physics teachers' ideas of a good physics teacher

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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.

39. Snapping stories in science - lokale hverdagskulturer og sosiale medier som inngang til naturfag og bærekraftig utvikling

Marianne Ødegaard, **Eugene Boland**, **Mysa Chu**, Thea-Kathrine Delbekk, Heidi Kristensen

Universitetet I Oslo, Norway

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.

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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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.

41. Building science teacher identity for grades 8-13 at the University of Oslo

Cathrine Tellefsen, Doris Jorde

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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.

Old Town Bridge (a.k.a. "Portal of Happiness"). The present bridge dates from 1861.

43. Grubletegninger som verktøy for å skape økt naturfaglig forståelse for elever og lærerstudenter

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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.

44. Achievement goal factor structure among chemistry students in grade 5 – 11: a comparison between Sweden and Germany

Anders Hofverberg, Mikael Winberg

Umeå University, Sweden

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.

45. Uskarp forståelse: analyse av elevsvar knyttet til partiklers bølgeegenskaper og uskarphets-relasjonene

Henrik Ræder, Carl Angell, Ellen Karoline Henriksen

Universitetet i Oslo, Norway

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.

46. Sjøuhyret - et tverrfaglig undervisningsopplegg om marin forsøpling innenfor utdanning for bærekraftig utvikling

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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.

48. Developing awareness of illustrative examples in science teaching practices: the case of the giraffe-problem

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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.

49. The concept of scientific literacy and how to realize contemporary science education practice discussed from an international perspective

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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.

50. Pre-service teacher understanding of buoyancy: case of primary school science teacher

Kristin Elisabeth Haugstad, Maria I. M. Febri

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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*.

51. Lärares syften med kontextbaserade undersökande aktiviteter utvecklade under en lärarfortbildning

Torodd Lunde

Karlstad Universitet, Sweden

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.

Munkholmen Island lies in the harbour area, approx. 2 km from the town center.

52. Samhällsfrågor med naturvetenskapligt innehåll och demokratisk fostran

Torodd Lunde

Karlstad Universitet, Sweden

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?

54. A prescriptive model for how to use dialogues to stimulate students' learning processes in inquiry-based and traditional science teaching

Stein Dankert Kolstø

Universitetet i Bergen, Norway

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.

55. Teacher's stories of engaging science teaching. A delphi study on teachers' views on the factors that create engagement in a science classroom

Cristian Abrahamsson

Institutionen för Utbildningsvetenskap, Lunds Universitet, Sweden

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.

56. Argumentation in university textbooks: comparing biology, chemistry and mathematics

Jenny Sullivan Hellgren, Ewa Bergqvist, Magnus Österholm

Umeå University, Sweden

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 signify-cantly 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) argument-ation 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' dev-elopment of scientific literacy.

57. Finns "Förmågorna"?

Frank Bach, Birgitta Frändberg, Mats Hagman, Eva West, **Ann Zetterqvist**

Göteborgs Universitet, Sweden

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.

Kristiansten Fort as viewed from the town center.

58. Towards a theoretical model for approaching motivation in the science classroom

Jenny Sullivan Hellgren

Umeå University, Sweden

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.

59. Implementeringen af Flipped Learning i fysik/kemi-undervisningen i grundskolen

Stine Karen Nissen, Henrik Levinsen

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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.

60. Professional development of science and mathematics teachers for building student digital competence: experience of Latvia

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University of Latvia, Riga, Latvia

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.

62. Connecting orchestration and formative assessment in the technology rich science classroom

Ragnhild Lyngved Staberg[1], **Maria I. M. Febri**[1], Jardar Cyvin[1], Svein Arne Sikko[1], Øistein Gjøvik[1], Birgit Pepin[2]

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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.

64. Teaching science using underdetermined representations: illustration and implications

Tobias Fredlund, Erik Knain, Anniken Furberg

University of Oslo, Norway

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.

66. Why many chemistry teachers find it difficult to ask good questions

Matthias Stadler, Festo Kayima

University of Bergen, Norway

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.

Bakklandet, an area of old wooden houses on the eastside of the river. From Lower Bakklandet.

68. Analysing representations of concept in physics textbooks for lower secondary school in Sweden – the concept of pressure

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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 ongoing and preliminary results will be presented and discussed, together with implication for teaching.

69. Elevers motivation och engagemang i en förändrad lärmiljö

Anna Karin Westman, Magnus Oskarsson

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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.

71. Attitydmätningar med q-methodology

Lars Björklund, Karin Stolpe

Linköping Universitet, Sweden

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.

Nidaros Cathederal as viewed from Bakklandet.

73. Development of a chemistry concept inventory for general chemistry students at Norwegian and Finnish universities

Tiina Kiviniemi[1], Per-Odd Eggen[2], Jonas Persson[2], Bjørn Hafskjold[3], Elisabeth Egholm Jacobsen[3]

[1]*University of Jyväskylä, Finland*
[2]*Department of Teacher Education, NTNU, Trondheim, Norway*
[3]*Department of Chemistry, NTNU, Trondheim, Norway.*

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.

74. Piloting a collaborative model in teacher education – An overview of a teacher professional development project

Anttoni Kervinen, Anna Uitto, Arja Kaasinen, Päivi Portaankorva-Koivisto, Kalle Juuti, Merike Kesler

University of Helsinki, Finland

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.

79. Hva legger lærere vekt på i begynneropplæringen i naturfag?

Charlotte Aksland, Inger Kristine Jensen, Aase Marit Sørum Ramton

Høgskolen i Oslo og Akershus, Oslo, Norway

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.

82. The design and implementation of an assessment method combining formative and summative use of assessment

Jens Dolin

University of Copenhagen, Denmark

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.

The wharves as viewed from the Old Town Bridge. The oldest date from the 18th century.

84. Does school science provide answers to "everyday life" questions? Student choices of information sources in open-ended inquiry

Erik Fooladi

Volda University College, Norway

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 profess-sions.

88. Teachers' use of the outdoor environment in teaching young children about living beings

Kristín Norðdahl

University of Iceland, Reykjavík, Iceland

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.

90. Should we sacrifice inquiry-based science education in order to climb on PISA-rankings?

Svein Sjøberg

University of Oslo, Norway

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.

91. The size of vocabulary and relations to reading comprehension in science

Auður Pálsdóttir, Erla Lind Þórisdóttir, Sigríður Ólafsdóttir

University of Iceland, Reykjavik, Iceland

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 schoolbook 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 comprehendsion and literacy in science and math has declined.

93. The relation between subject teachers' universal values and sustainability actions in the school

Anna Uitto, Seppo Saloranta

University of Helsinki, Finland

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.

Symposium
42. Nordisk modul for kompetanseheving av lærere i undervisning for bærekraftig utvikling

Majken Korsager[1], **Eldri Scheie**[1], Ole Kronvald[2], Maiken Rahbek Thyssen[2], Jens Bak Rasmussen[3], Daniel Olsson[4], Annika Manni[5], Helena Näs[5]

[1]*Norwegian Center For Science Education, Oslo, Norway*
[2]*Astra, Det nationale center for læring i natur, teknik og sundhed, Denmark*
[3]*Aalborg kommune, Denmark*
[4]*Karlstads universitet, Sweden*
[5]*Umeå universitet, Sweden*

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.

Symposium
72. Teknologiämnets innehåll i skenet av etablering av teknik tekniskt kunnande

Markus Stoor[1], **Liv Oddrun Voll**[2], Peter Vinnervik[1]

[1]*Umeå Universitet, Sweden*
[2]*Høgskolen i Oslo og Akershus, Norge*

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).

Workshop 1
From single neuron to brain function – a brain building kit developed to fill in the missing link in school

Pål Kvello[1], Trym Sneltvedt[2], Kristin Haugstad[1], Kari Feren[1], Jan Tore Malmo[1], Jardar Cyvin[1], Trygve Solstad[1]

[1]*Department of Teacher Education, NTNU, Trondheim, Norway,*
[2]*Department of Electronic Systems, NTNU, Trondheim, Norway*

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

Workshop 2
Augmented reality i naturfagene – elever som produsenter av digitale, naturfaglige modeller

Harald Brandt[1], Birgitte Lund Nielsen[1], Håkon Swensen[2], Ole Radmer[3], Mogens Surland[3], Diego Nieto[4], Matt Ramirez[5]

[1]*VIA University College, Denmark*
[2]*Høgskolen i Oslo og Akershus, Oslo, Norway*
[3]*Skolen i Midten, Hedensted, Denmark*
[4]*CESGA, Santiago de Compostela, Spain*
[5]*JISC, Manchester, United Kingdom*

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.

Intented audience: Science teachers, teacher educators and teacher students
Educational context: Science, lower and upper secondary school
Language: Nordic (Norwegian/Danish), occationally English
What to bring to the workshop: Computer and tablet or smartphone

Workshop 3
Cella som system

Aud Ragnhild Skår, Øystein Sørborg

Norwegian Center for Science Education, University of Oslo, Norway

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.

Intented audience: Science didactics and teachers
Educational context: Science, lower secondary (biology)
Language: Norwegian

River Nidelva making one of its last turns. Ilen church and Munkholmen. (Photo G. Hageskal)

Workshop 4
Skolevirksomhedssamarbejde – elever der løser autentiske problemer i samarbejde med en virksomhed

Anders Vestergaard Thomsen, Nina Troelsgaard Jensen

Metropolitan University College, Danmark

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.

Intented audience: Researchers, developers and science teachers
Educational context: Lower secondary, school – business collaboration in science
Language: Danish/Nordic
What to bring to the workshop: Fantasy, humour and curiosity on how pupils solves real science problems in collaboration with businesses outside school

Workshop 5
Creating a material solution to a socio-scientific issue: making in the science and technology classroom

Sofie Areljung[1,2], Anders Hofverberg[1], Peter Vinnervik[1]

[1]*Department of Science and Mathematics Education, Umeå University, Sweden*

[2]*Umeå Centre for Gender Studies, Umeå University, Sweden*

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: Science and Technology, secondary school (both lower and upper secondary), higher education, including teacher education
Language: English
What to bring to the workshop: smartphone or other device (for information retrieval)

Poster
11. Educative curriculum materials and chemistry: a match made in heaven?

Tor Nilsson

Mälardalen University, Eskilstuna, Sweden

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.

Poster

47. Becoming a chemistry teacher – expectations and reality in chemistry education courses

Sabine Streller, Claus Bolte

Freie Universität Berlin, Germany

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.

Poster
75. Dybdelæring og progresjon i elevers forståelse av stoffer og kjemiske reaksjoner

Anne Bergliot Øyehaug, Anne Holt

Høgskolen i Innlandet, Hamar, Norway

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 implement-ation 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 in-complete 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.

Poster
78. Lærerstudenters erfaringer med bruk av representasjoner i praksis

Mai Lill Suhr Lunde, Ketil Mathiassen, Tobias Fredlund, Erik Knain

Department of Teacher Education and School Research, University of Oslo, Norway

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.

Poster

80. Teaching in the rain forest. Student teachers meaning – making in an informal science learning environment

Alexina Thoren Williams, Maria Svensson

University of Gothenburg, Sweden

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.

Poster

83. New teaching practice – teacher students evaluate their work effort and motivation

Stig Misund, Jo Espen Tau Strand, Inger Wallem Krempig, Tove Aagnes Utsi

UiT - The Arctic University of Norway, Alta, Norway

Initiators of this project have developed an innovative teaching practice at primary school- and early childhood teacher education. In a multi-disciplinary 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.

Bakklandet, an area of old wooden houses on the eastside of the river. From Upper Bakklandet.

Poster
86. The teachers choise for preparing students for out-of-school settings

Mona Kvivesen

UiT - The Arctic University of Norway, Alta, Norway

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).

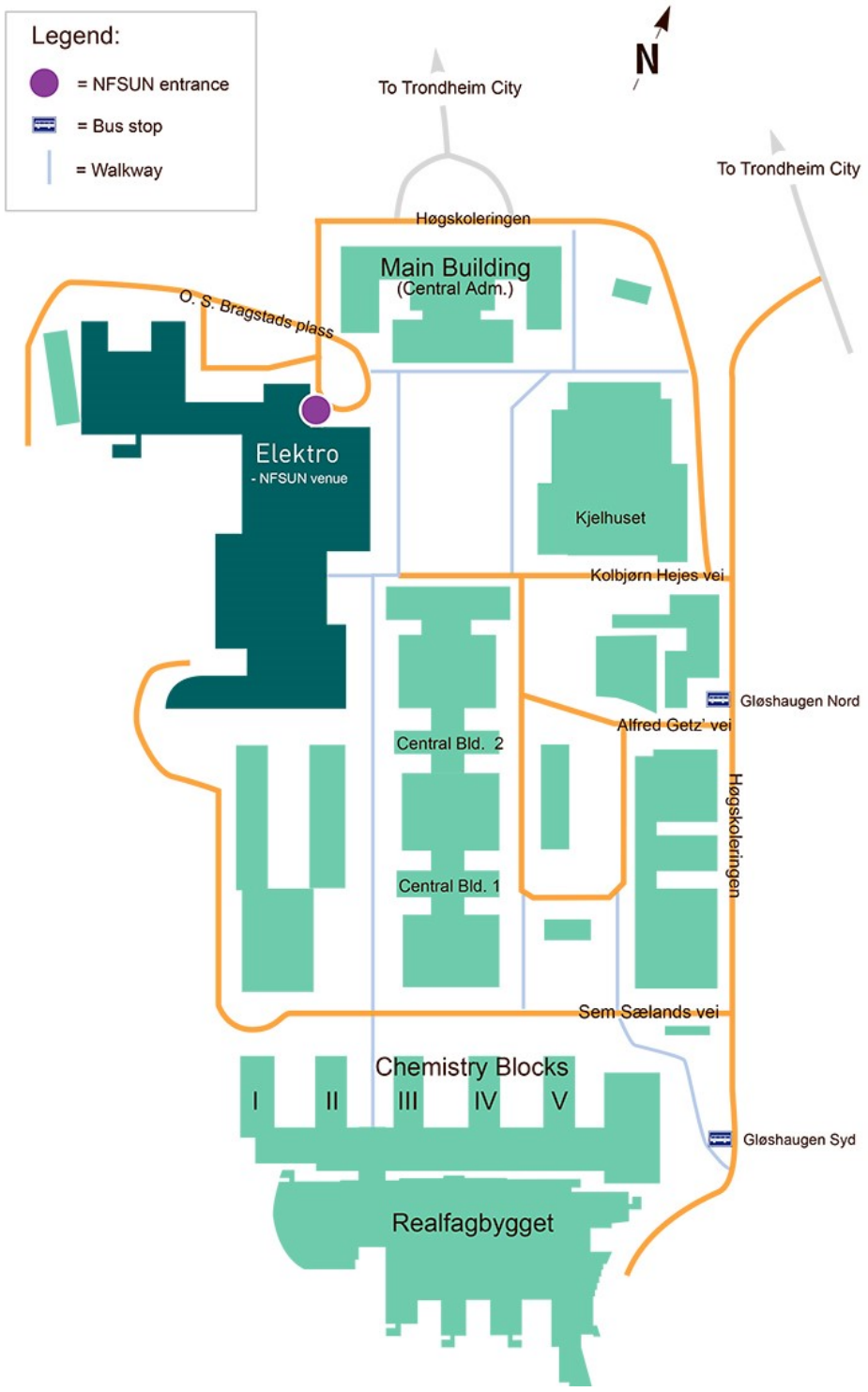
Index of contributors

General Program

Tuesday 6 June	
12:00-17:00	Preconference
17:00-19:00	Registration (Kalvskinnet campus)
19:30	Reception (Kalvskinnet campus)
Wednesday 7 June 08:00-09:00: Registration Gløshaugen campus	
09:00-10:00	Opening Popular Science Lecture: Alex Strømme, NTNU
10:00-10:30	Coffee Break / Registration
10:30-11:30	Keynote 1: Astrid Sinnes
11:45-12:45	Parallel Session 1
13:00-14:00	LUNCH
14:00-15:30	Parallel Session 2
15:45-17:15	Parallel Session 3
18:00-20:30	Excursion: Munkholmen
Thursday 8 June	
09:00-10:00	Keynote 2: Wollf-Michael Roth
10:15-11:15	Parallel Session 4
11:15-12:00	Poster Session & Coffee Break
12:00-13:00	Invited Plenary Symposium: National Centers
13:00-14:00	LUNCH with National Meetings
14:00-15:00	Keynote 3: Kristiina Kumpulainen
15:15-16:45	Parallel Session 5
18:00	Visit to Nidaros Cathedral with Organ Concert
19:30	Vintage Tram departs to Lian Restaurant
20:00	Conference Dinner at Lian Restaurant!
Friday 9 June	
09:00-10:00	Keynote 4: Pernilla Nilsson
10:15-11:15	Parallel Session 6
11:15-11:30	Coffee Break
11:30-12:30	Parallel Session 7
12:45-13:15	Closing Address
13:15-14:00	LUNCH

Map of Gløshaugen Campus

Venue street address: Elektrobygget, NTNU, O.S. Bragstads plass 2e, 7034 Trondheim, Norway



NTNU

NFSUN
Nordiske Forskersymposium om Undervisning i Naturfag