Abstracts

1st European Regional IHPST Conference

Posters Presentations

Name: Linda Ahrenkiel

Title: Achieving Scientific Literacy through science camps

Abstract text: In Denmark as well as in many other European countries, there exist a general consensus that it is essential to make an extra effort to engage more young people in science and technology to ensure the future need for citizens educated within this field (OECD; Osborne & Dillon, 2008). To meet this one of the activities towards higher recruitment to STEM education is science camps (Bischoff, Castendyk, Gallagher, Schaumloffel, & Labroo, 2008; Yilmaz, Ren, Custer, & Coleman, 2010). An implicit goal with many science camps is to affect the participants´ attitude toward scientific literacy (Sjøberg, 2012). The aim of this proposal is to link the historical development of science camps with the implicit goal of scientific literacy by attending a science camp. Results from case studies will provide insight into how science camps have an impact

Name: Linda Ahrenkiel

Title: An inquiry approach and science activities in kindergarten

Abstract text: In European context the Rocard report (European Commission (EC), 2007) there has been a severe focus on inquiry based science education (IBSE) in European projects and in development of new science activities. The aim of this proposal is to link the thoughts of an inquiry approach with the curricular theme "nature and natural phenomena" in Danish kindergartens (Broström, 2004). Results from case studies with pre-service and in-service pedagogues' workshops will illustrate how they look at science activities and the nature of science. These thoughts will be held against the thoughts of an inquiry approach in science activities. Furthermore this proposal will illustrate how pre-service and in-service during professional development workshops change their view on science activities and the nature of science and how this thinking can contribute to science activities with an inquiry approach in kindergarten.

Name: Christina Ehras, Prof.Dr.Arne Dittmer

Title: Explaining Biological Phenomena - A Question of Understanding the Nature of Bioscience and Interactive Skills

Abstract text: Biological explanations differ from those in other disciplines (Wouters, 2012) due to the specificity of the research subjects and the raised questions, respectively. The ambition of the project FALKE (explaining as a subject-specific teacher competence) is to explore the characteristics of explaining and to draw a comparison between the disciplines. The aim of the biology education's subproject is to investigate the teacher competence in explaining biological phenomena and concepts. On the one hand, "explaining" in an educational context is conceptualized as an interactive process between teacher and students, which is influenced by subject-specific teaching styles and the internalized scientific culture. On the other hand, the upcoming study takes into account that explaining biological phenomena applies, among other things, functional, historical, ideographic or nomothetic structures of explanations (Mayr,

2002; Wouters, 2012). Based on this, developing a model of teacher competence of explaining in the field of biology education refers to (i) essentials of the nature of biological explanations, (ii) principles of communication and social interaction, which are relevant for the process of explaining, and (iii) the prevailing subject-specific culture of teaching and learning. Data for the construction are collected through videography and interviews within the framework of seminars for preservice teachers.

Name: Shu-Sheng Lin, Ling-Kuan Teng Ching-Hsi Li

Title: The Experiences of Two Elementary School Teachers' NOS Instruction through Historical Science Stories

Abstract text: The purpose of this study was to explore two elementary school teachers' understanding of nature of science (NOS), their design and implementation of NOS instruction through historical science stories, and the difficulties and problems they encountered. The participants were two science teachers of elementary level and one of their classes. The teaching experiences of the two teachers respectively were 25 and 7 years. The data were collected from discussions with the researcher, teacher's individual interviews, classroom observations, the lesson plans and teacher's journals. The results revealed that at the beginning the two case teachers showed sporadic understandings of NOS,especially focusing on the nature of scientific knowledge. They had difficulties on designing NOS teaching even both of them were familiar with the skills of telling stories. Owing to lack of the experiences of NOS instruction, they had less knowledge about students'learning NOS and assessment of NOS learning. In addition to reading papers, understanding instructional cases of NOS and discussing NOS with the researcher mainly had fostered them to begin to develop the approaches to integrating historical science stories, NOS aspects and instructional knowledge to design and implement NOS instruction. They adjusted their NOS teaching based on the constant reflections on their own implementation and the performance of the students'NOS learning. Without the supports and help from the researcher, they could not complete NOS instruction smoothly.

Name: Vasiliki Psoma

Title: Comparative study of science centres in Greece and Germany according to statements of their representatives

Abstract text: This comparative study is centered on the way that a number of science centers in Greece and in Germany operate according to statements of their representatives, with the aim to give an answer to the following research questions: Is there any focus of Science Centers on education or entertainment? Is there a feedback after a visit in a science centre? Is there any evaluation of the outcome? The empirical research started in August 2014 and was conducted in 8 science centers located in Germany and Greece. The views of their representatives for each one of these questions were investigated during 8 semi-structured interviews and a qualitative content analysis methodology was used to analyze the data collected. Data analysis shows that predominant views from informants point out an emphasis on the educational element, without this implying the absence of the entertaining part, since in many cases epistemic play is considered an integrated part of the learning process. Notable is the fact that a non-systematic evaluation scheme is undertaken by the majority of science centers and which, in many cases,

does not derive from a specific evaluation program, but from the feedback which is provided under many forms by the visitors.

Name: Aline Schoch

Title: Development of gender sensitive physics teaching units with a human body contextualisation

Abstract text: Physics is usually taught as a rather abstract body of knowledge, often lacking societal contextualisation and is still mainly illustrated by technical materials. This can be seen as one aspect of a traditional disciplinary physics habitus. This holds for Switzerland as well as it might for other European countries. International research on interest and motivation has shown that the context of physics is of great importance. Female students are rather interested in broader societal, non-technical contexts such as climate change or the human body (cf. e.g. ROSE project). Therefore, we aim to foster interest and motivation for school physics among students in upper secondary schools in Switzerland through a medical contextualisation of school physics. The goal of our project is twofold 1) Development of gender sensitive physics teaching units with a human body contextualisation 2) Understanding of the connection between medical contextualisation and variables such as disciplinary habitus, gender, interest, motivation, sense making, grades, and science didactics Qualitative interviews with teachers and students testing the unit at different development stages (eight classes) will deliver important knowledge for a thorough adaptation of the teaching unit. The accompanying research will deliver an in-depth understanding of the interconnectedness of the variables mentioned under point 2. This will be complemented by quantitative data (August 2016) and with explorative testing in one German and one French school class. The poster presents first analytical insights of the impacts of a medical context in school physics on gender, disciplinary habitus, interest, motivation, sense making, grades and science didactics. It will also tackle the question whether a medical approach in physics teaching could make a contribution to change a disciplinary habitus and culture which might contribute to the dislike of school physics of students.

Name: Maria Skjutare, Lena Hansson, Susanne Thulin

Title: Messages about Nature of Science in public service films aiming at preschool children

Abstract text: Research and policy documents emphasize the importance of children meeting science early on in their education. This can occur in many different ways (media, parents, preschool etc.). Research also shows that children often have stereotypical images of science and scientists. In the science education research literature, there are a large number of studies on how students and teachers view NOS (Nature of Science) and how messages about NOS are communicated in e.g. science teaching and teaching materials. However most studies have been focused on compulsory and upper secondary school, while there is a lack of research focusing on NOS at the preschool level. In this study, we analyze public service materials (in the form of short webcasted films, N=57) with an educational purpose and aiming at preschool children (1-6 year old). The films have a physics or chemistry content. The overall aim of the project is to contribute to a discussion about NOS perspective at preschool level. More specifically the aim is to develop an understanding of how the webcasted films communicate messages about what characterizes science as a subject/field and scientists as persons.

Name: Michael Wade

Title: Examination of how a community of international pupils viewed science in a school in England, wiht pupils from many countries from 1957 to 1960

Abstract text: How the Day and Boarding Co-educational facilities gave an international educational environment 25 years or more ahead of existing practice. Use of new recording technology in 1958 to improve singing, and how pupils' viewed television programmes to improve interest in science. How the different backgrounds of pupils ensured that science was seen by them as cultural, as when a transistor radio was brought from Kuwait in 1958, and the first pocket sized transistor record player from the US in 1959. With some pupils being from conflict areas of the British Empire, how pupils also became aware of the dangerous outcomes of science. With the strong international context, how the curriculum was advanced by giving pupils sixth form General Studies from ten years old, thereby assisting science learning to be balanced with learning about literature and life. How this raised questions about an appropriate future language curriculum in an international environment, and how this affected choices and outcomes for pupils approach to employment.

Name: Carina Wöhlke, Dietmar Höttecke

Title: Science teachers' noticing and nature of science

Abstract text: Teaching and learning about nature of science (nos) has been discussed widely. Ruhrig and Höttecke (2015) have shown that science teachers respond in various ways to critical incidences in the context of nos. Now we have started a project to investigate science teachers' abilities to notice and to respond to critical incidences, which might emerge during teaching. Our study is based on the PID-Model (perceive-interpret-make decision) (Kaiser et al. 2015), which aims at bridging the gap between teachers' cognitions and motivations on the one hand and their teaching performance on the other. Such processes take place within very short time. Several factors seem to influence teachers' noticing like teaching experience, content knowledge (ck) and pedagogical content knowledge (pck). Therefore, our study asks a) whether pre-service science teachers' noticing is domain-specific, b) if and how it develops during a University training course, and c) which parameters influence the advancement of competencies to notice and to respond to critical situations during class. The wide concept of noticing will be limited to teaching and learning nos. The training course will be based on video vignettes of critical incidences. Data will be collected in classes of pre-service physics and chemistry teachers. Pre-post-data will be related to differential effects measured with tests about pck, nos beliefs and further parameters with a theoretical potential to influence noticing.

Oral Presentations

Name: Oya Aglarci

Title: Nature of science instruction to prospective chemistry teachers: What has changed after 5 years?

Abstract text: One of the major components of scientific literacy is an informed understanding of nature of science (NOS). Teaching NOS increases students' understanding of and interest in science. Therefore, science education programs and teachers play a key role in this process, as they are mostly responsible for educating people. This study aimed to examine freshmen prospective chemistry teachers' views about NOS and develop their views with explicit-reflective NOS activities. Also, it was aimed to investigate their views after 5 years when they became seniors. 18 prospective chemistry teachers participated in the study and longitudinal study was adopted. Views of Nature of Science-version C (VNOS-C) and interviews were conducted with the participants before and after the instruction when they were freshmen. VNOS-C and interviews were conducted again so as to map out whether their views regarding NOS changed after 5 years. The freshmen prospective teachers held inadequate views prior to the intervention. After the NOS instruction, most of the participants' views became informed. After 5 years, their views were found to be returned to the naive and inadequate as they were like before the intervention. Recommendations for teacher education were given to improve views' of nature of science.

Name: Douglas Allchin, Eduardo Cortez, Maria Elice Prestes

Title: Teaching Nature of Science to Teachers

Abstract text: This is a report on a course at the Univ. of Sao Paulo (Fall, 2015) aimed at teaching teachers about nature of science (NOS) and also how to teach NOS. Several factors were identified (through student comments and by expert participant-observers) as contributing to the particular efficacy of this 15-week experience - a series of inquiry style historical cases cases primary among them, including well framed NOS questions.

Name: Çiçek Dilek Bakanay, Mustafa Çakir

Title: Teachers´conceptualization of science education and their usage of history of science

Abstract text: The purpose of this phenomenological case study was to investigate the relationship between teachers' educational orientations and their purposes of using they utilize when integrating the history of science in their instruction. Nine high school science teachers, ranging in experience from 6 to 23 years, comprised the sample for this investigation. This study was based on the national project which aims to promote the use of the HOS in secondary school science lessons.Thus, instructional materials based on the history of science which was developed for the project and the interviews conducted with participants of the project were used in this study. Data were collected during and after three-year project through semi-structured interviews and reflective diaries and instructional plans and materials. Using analytical induction, multiple data sources were analyzed independently and together to triangulate data while constructing teachers' science orientation profiles. Analysis revealed that the way science teachers use the history of science differs in accordance with their approach to teaching and learning. Analysis also showed that teachers' understanding of nature of scientific knowledge have an important effect in integrating the history of science in their instruction. Results indicate that while teachers with traditional orientation consider the history of science as an additional source reinforcing learning after traditional teaching

process, teachers who have process orientation tends to use the history of science in teaching scientific concepts. On the other hand, results show that only teachers with an effective understanding of nature of scientific knowledge use the history of science for contextual purposes.

Name: Anna Beniermann, Prof. Dr. Dittmar Graf

Title: Measuring attitudes towards evolution as related to religious faith and dualistic thinking

Abstract text: Despite the broad explanatory power of the theory of evolution and its general acceptance within the scientific community, it remains rejected by several distinct segments of human societies. In large part, this scepticism arises because the theory of evolution challenges religious and esoteric ideas like no other scientific principle, making evolutionary theory a central issue in the context of human self-conception and world view. Thus, a detailed understanding of the relationship between the acceptance of the theory of evolution and religious faith could enable these factors to be better incorporated into science teaching and further research. To do so, novel, statistically robust measuring instruments for attitudes towards evolution, religious faith and dualistic thinking were developed. They were tested within two comprehensive surveys in Germany: a heterogeneous online-sample (N = 4562) as well as a sample of pupils (aged 11-18), university students and trainee biology teachers (N = 927) via paper questionnaires. Based on these measures, two key results of this research are the lesser acceptance of the evolutionary origin of one's own personality compared to the phylogenetic development of biodiversity and the ability of the new measures to tease apart these two aspects regarding the acceptance of evolutionary theory.

Name: Alexander Bergmann, Jörg Zabel

Title: Fostering students' Neuroscience Literacy by critically reflecting theri intuitive beliefs

Abstract text: The rise of neuroscience has led to controversial perspectives on the human brain. Often it is hard to separate science from science fiction, and the understanding of neuroscientific research results is influenced by a vast amount of myths and intuitive beliefs. Therefore we have to go beyond the mere accumulation of factual knowledge to promote Neuroscience Literacy in biology classrooms. Our students should critically reflect their intuitive beliefs and explore the ethical and philosophical dimensions that are undiscernibly connected to neuroscientific research.
The main objectives of our study were to identify and systematise the intuitive beliefs that students activate when talking about brain-related issues, and to analyse how these intuitions influence the students' discourse on neuroscientific and neuroethical questions. We conducted and videotaped eight group discussions in grade 9 and 10 of a German grammar school (N=32). The discussions were designed as thought experiments, in each of which four students had to discuss three imaginary neuroscientific research proposals as members of an ethical commission. We analysed the data based on the grounded theory methodology. At the conference we will present our results and discuss their implications for coping with socio-scientific issues in science education.

Name: Eugenio Bertozzi

Title: Re-tracing the transformation of research instruments for teaching purposes: the circulation of the cloud chamber as a teaching apparatus during the twentieth century

Abstract text: Issues related to experimental teaching of science will be addressed by investigating the transformation of research instruments into teaching apparatus. In particular, the presentation discusses the main results of a project - supported by the Humboldt Foundation and developed at the Europa-Universität in Flensburg - focused on a milestone of twentieth-century experimental physics: the cloud chamber. Historically known for being the first instrument allowing the visualization of particles trajectories, the cloud chamber has been introduced in Cambridge by CTR Wilson in 1911. The project shows that, in spite of the local character of the invention as an instrument for research, the circulation of it as an instrument for teaching assumed a global dimension and involved different countries. Moreover, the process of adaptation of the instrument for teaching purposes emphasizes local factors such as research and constructive issues faced by researchers and instrument makers at the time or different conceptions (or perceptions) of teaching put into play by scientists and teachers. The examination of the teaching models under the perspective of the procedure - skills and knowledge required and provided by these models to their users - completes the aim of the project and, from the history of experimental science teaching, opens up to current issues in science education.

Name: Nicholas Binney

Title: Practical experience of some ways by which integrated history and philosophy of medicine can be valuable to medical training

Abstract text: In this paper I argue that integrated history and philosophy of medicine can be used to inform the training of medical students in the diagnosis of disease. Since the autumn of 2015 I have been running a special study unit (SSU) offered as an elective module to medical students at the University of Exeter Medical School. I provide training in the reconstruction and analysis of arguments, to which the medical students would otherwise not have access. With this training, the students have been able to identify multiple instances of problematic forms of argument (particularly affirming the consequent and circular arguments) in medical literature on the diagnosis of many diseases (including shaken baby syndrome, rickets, and fibromyalgia, Munchausen syndrome by proxy and chronic kidney disease). We also noted the frequent use of medical history by medics in arguments about how best to diagnose disease. We found that these histories tended to be "whiggish", and how this made them unsuitable to the task of evaluating diagnostic practices in the present day. We discussed how the production of properly historical histories of diagnostic practices would provide information about how and why certain diagnostic practices had come to be accepted, and how this information is useful for the evaluation of diagnostic practices in the present day. I have encouraged the students to try to produce such histories themselves.

Name: Stefaan Blancke, Thom Scott-Phillips, Johan Braeckman

Title: The epidemiology of representations as an integrative framework for the history of science and science education

Abstract text: It makes intuitive sense that the history of science can be used to understand and improve science education, but why would this be the case? To answer this question, we suggest that both domains should be approached from, and can thus be integrated within, an epidemiological perspective. The epidemiology of representations, an increasingly popular model in the study of culture, predicts that, ceteris paribus, beliefs will converge and stabilize around intuitively appealing cultural attractors. Hence, to have people's representations converge on counter-intuitive scientific concepts; one needs to alter the factors of attraction. The means to this end include institutions, conceptual tools such as analogies, observational helps, collaboration and peer review, and so on. The study of how alterations in the cognitive

environment of scientists have enabled the development of science can then help us to understand what changes are required in the cognitive environment of learners to motivate and enable them to acquire scientific concepts. The shared interactions of human cognition with its changing environment make possible the integration of the history of science and science education. We argue that an epidemiological approach is the best way to map and understand these interactions.

Name: Pierre Boulos

Title: Ontology and Diagrams: the mathematical reasoning in Newton's Principia

Abstract text: Explicitly when Newton shows us what he means by the mathematical principles of natural philosophy, he does so with diagrams. How essential was it for him to do so? Newton scholarship tends to think not essentially at all. The historical record shows that he had his wonderful tool, the calculus, around 1666 - two decades before the publication of the Principia. Historians have claimed that if Newton had made direct use of the calculus, then this would have simplified the mathematics in the Principia, and reduced the function of diagrams to mere pedagogy. But how would Newton's contempories have thought about the use of diagrams in this seminal work? It turns out the modern reading of the role of diagrams in the Principia is not consistent with how Newton's own contemporaries would have perceived the use of diagrams. Furthermore, it was also rumoured that Newton was "showing off" his genius - who single handedly seems to be the reason cited explaining why the calculus does not appear at all in the work. This paper seeks to explore and correct how the assumption underlying the rumour – namely that the view that Newton could have used to the calculus in the Principia and relegated diagrams to pedagogical tools is a misreading of the Principia. This paper extends recent work (presented at IHPST2015 in Rio) with more reconstruction of some of Newton's more pivotal deductions in his argument for universal gravitation.

Name: Marina Castells

Title: History of Science in nowadays Teaching Science. Levels of Context, Illustrations and Framework

Abstract text: The History of Science has been present in the Teaching Science Sequences in various ways since the beginning of the Teaching of Science. Nowadays experts on Science Education recommend the contextualization of the teaching sequences and/or activities in order they have meaning and interest for the students. We will think about the possible uses of History of Science as context in Secondary Education or Pre-service Science Teacher Training in our XXI century times. We will comment about the levels of context that may be introduced in science teaching. These levels of context will be illustrated and justified through a theoretical framework related to the teaching-in-context that takes for granted the importance of the introduction of the History of Science in the science teaching. Among other, the illustrations will be related to the following science topics: relativity of movement, forces, electricity and magnetism and light. Understanding context in a wide meaning implies that working in context means also learning about a culture of a country or community, and according to this perspective, we propose the use of the history of science in our country as a very relevant context in the nowadays teaching-learning science and about science.

Name: Elizabeth Cavicchi

Title: Making Environments for Learning: Recreating in the Space and Vision of a Century ago

Abstract text: The make-up of environments for learning spans physical-spatial and human-social domains, with potential for interrelating among these. Whereas environments of learning often remain unacknowledged, this study relates from learning that emerged as a student and I increasingly attended to our environment. Doing activities that engaged us with surroundings of space and sky, we noticed spatial, human and interrelating forms. Alongside discussing Euclid's geometry in class, our awareness opened to classical features in the very buildings where we meet: the century-old architecture of William Bosworth. By encountering these buildings while accompanied by their current restorer, we came to see means by which their structure and design promote human interaction and environmental sustainability as intrinsic to education. That character of learning interactively with others and the world supported by Bosworth's campus was articulated by philosopher John Dewey in Democracy and Education, 1916. Arguing that democracy entails healing from divides and dualisms endemic in academic culture since the Greek classical era, Dewey saw experimental science, where learners are investigators, as means to heal those divides. Realizing ourselves within heritage of both Greek classical and 1916 educational vision, my student and I extend it in understanding our environment with its history, while recreating its vision through our evolving experience.

Name: Alberto Cordero

Title: Selective Realism in the History of Modern Science

Abstract text: Selective realists agree that successful empirical theories do not get everything right but they reject pessimistic inductions from the history of science like the one advocated Larry Laudan and others in the 1980s and 1990s. According to selectivists, a theory can be false as a monolithic whole yet still be true at less comprehensive levels, e.g. those corresponding to abstract and/or restricted theoretical applications. Empirically successful theories, they argue, are truthful in this way. The realist task, in their view, is to identify truthful theory-parts and do so convincingly, hence the labels "Selectivism" and "Selective Realism". Virtually all scientific realist projects today are of this variety. Current selectivist projects derive, most recently, from responses to Laudan's the pessimistic induction, but the approach they share is much older, or so I argue in this paper, in which I present and discuss explicit selectivist moves found in key scientific works and period analyses by Galileo, Kepler, Newton, Boyle, Hook, Lavoisier, Whewell, Maxwell, and Einstein. Selectivism, it seems, has been the default realist position during most of the history of modern science.

Name: Jelle De Schrijver

Title: Science dynamics at the university museum. Teaching the nature of science at the crossroads of the history of science and the classroom

Abstract text: Science can be considered as a process of exploration and investigation, continuously developing new tools, theories and concepts reshaping our understanding of the world. In contrast, secondary school students and pre-service teachers often stick to a disembodied view of science, picturing it as a static, unchanging body of knowledge. To tackle this and similar misconceptions about the nature of science, university museums can play a pivotal role as the academic collections bear witness of the dynamics of science and scientific history.
We will report on an ongoing study aimed at developing thinking skills of pre-service teachers and secondary school students with regard to the NoS in the context of a science museum. We distinguish three complementary approaches: (1) thinking by doing, e.g. challenging students to think about science while

doing experiments; (2) thinking by stepping into the shoes of (historic) scientists, e.g. by using historic scientific instruments; and (3) thinking about science by participating in philosophical dialogues.
We will discuss our preliminary findings with regard to the implementation of these approaches in the educational program of the Ghent University Museum. We will focus on the role of the facilitator guiding the dialogue and on the experience of participating students and pre-service teachers.

Name: Jens Jakob Ellebæk

Title: H.C. Ørsted, Science and "Dannelse" in the early 19th century. - Relevant for educational thinking today?

Abstract text: A research into the introduction of the concept "Almendannelse" (Litteracy/Education/Culture) in the Danish discourse about reforming the educational system in the early 19th Century, reveals a time in Danish history where the world famous scientist H.C. Ørsted was working together with central philosophers/professors in humanities in creating a new idea about school curriculum and content. An idea based on the Humboldtian movement with the concept "Algemeine bildung" in the center of reforming the educational system, but in contrast to this movement with a focus on "naturvidenskabelig almendannelse" (scientific literacy) and understanding as a central part of the education of people and individuals. Still today, Ørsteds main points and thoughts are surprisingly relevant to the actual pedagogical discourse and discussion about the balance between knowledge, skills and competencies and other educational outcomes.

Name: Ami Friedman

Title: Collaboration and Communication - forgotten aspects when using HOS in biology classrooms?

Abstract text: Collaboration and communication gained prominence in scientific endeavors during the Age of Enlightenment (ie: The Royal Society of London, the Paris Académie Royale des Sciences, and the Berlin Akademie der Wissenschaften) and are still critical components of doing science today. However, when history of science is used k-12 science classes, it is typically done so by focusing on the contributions of one scientist. For example, biology students will often learn about Mendel and pea plant crosses, Hooke´s coining the term ¨cell¨, van Leeuwenhoek´s refinement of the microscope, Darwin´s concept of natural selection. What is missing from these episodes is the rest of the story. How did Mendel´s work get rediscovered? To what extent did Hooke and van Leeuwenhoek communicate with one another? What was the interplay between Wallace and Darwin in the development of the theory of evolution by means of natural selection? Too often these truncated episodes misrepresent the critical role that collaboration and communication have in science. This paper proposes an approach for teaching biology with history of science that places collaboration and communication at the forefront of these historical cases and then links them to the role collaboration and communication have in today´s scientific endeavors.

Name: Arthur Galamba

Title: Conflicting Interpretation of Scientific Pedagogy

Abstract text: Historical studies have suggested that there is a distance between concepts of teaching methods, their interpretations and their actual use in the classroom. This issue, however, is not always pitched to the personal level in historical studies. This article provides a case study on this level of

conceptualisation by telling the story of Rómulo de Carvalho, an educator from mid-twentieth century Portugal, who for over forty years engaged with the heuristic and Socratic methods. The overall argument is that concepts of teaching methods are open to different interpretations, and are conceptualised within the melting pot of external social pressures and personal teaching preferences. The article explores Carvalho's conflicting stances: a man able to question the tenets of heurism, but who publicly praised the heurism-like 'discovery learning' method years later. The first part of the article contextualizes the arrival of heurism in Portugal and how Carvalho attacked its philosophical tenets. In the second part, it dwells on his conflicting positions in relation to pupil-centred approaches. The article concludes with an appreciation of the embedded conflicting nature of the appropriation of concepts of teaching methods, and of Carvalho's contribution to the development of the philosophy of practical work in school science.

Name: Haira Gandolfi, Shirley Simon

Title: History, Philosophy and the study of nature of science: reflections for science lessons in multicultural schools

Abstract text: This paper aims to reflect on the contributions that History, Philosophy and Sociology of Science can bring to science teaching in multicultural cities and on their role in teaching about the processes of science (nature of science) in urban and multicultural schools. It is our intention to draw on theoretical perspectives from Cultural Studies of Science, as well as from History and Philosophy of Science, to reflect about how the integration between these fields and the aims of modern science education can foster the construction of different pedagogical approaches to be applied in multicultural settings, such as the current majority of European schools. Some intercultural historical cases (using episodes from the History of Science from different cultures and societies) will be built, analysed and presented in order to illustrate how historical, sociological, philosophical and cultural perspectives can promote science lessons committed to the teaching of nature of science from an intercultural perspective of science. In this scenario, it is our aim to contribute to the current theoretical investigations about multicultural science teaching and theintegration of students with different cultural backgrounds into school science across Europe, which we believe can profit deeply from the study of global historical scenarios.

Name: Liam Guilfoyle, Sibel Erduran, Orla McCormack

Title: Exploring the influence of pre-service science teachers' personal epistemologies on their acceptance or rejection of Education Studies

Abstract text: The need for development of teachers' epistemic beliefs has been highlighted as important for the improvement of science education (Sandoval 2005; Erduran et al. 2007). International literature indicates that many science teachers hold 'unsophisticated' beliefs about the nature of knowledge and the nature of knowing (personal epistemologies - Hofer 2000) in science (Kang 2008; Markic & Eilks 2012). Teacher educators have also been concerned about teachers' rejection of Education Studies (Korthagen and Kessels 1999, Korthagen 2010) but have not yet considered the potential influence of teachers' subject-area epistemic beliefs on the perceptions they hold towards Education Studies. This research explores how science teachers' use epistemic beliefs in science and education studies to justify their acceptance or rejection of Education Studies as a useful part of their professional knowledge base. This paper reports data from a Discipline-Focused Epistemic Belief Questionnaire (Hofer 2000) with 57 pre-service science teachers and subsequent in-depth semi-structured interviews with 12 teachers. The unique finding of this study is that science teachers appear to draw on epistemic beliefs about science in order to justify negative

criticism of knowledge from Education Studies components of their teacher education. The potential implications for science teacher education are discussed.

Name: Burcu G. Guney, Hayati Seker

Title: Teachers' enactment approaches to instructional materials based on history of science

Abstract text: Emphasis on history of science (HOS) in science education brings the need of instructional materials based on HOS. Since enactment of instructional materials involves teacher - material - curriculum interaction, materials based on HOS should be evaluated within this interaction. The aim of this study is to evaluate the teachers' enactment approaches to instructional materials based on HOS within the frame of dynamic interaction between teacher and curriculum. Descriptive case study was employed; data was collected from 4 physics teachers by semi-constructed interviews, and was analyzed by using template analysis. According to the literature on teachers' enactment approaches, teachers offload, adapt or improvise the instructional materials. Findings of this study also showed that teachers mostly adapt materials into their lessons in various levels, and sometimes prefer to offload or to improvise. In the adaptation process six levels were revealed, which were mentioning, using examples, giving as homework, using as introduction, lesson-wide adaptation as students' discovery and discussion. Based on the results, teacher guide books can be suggested which include sample instruction plans on different adaptation levels, tips for using information based on HOS, and teachers' lived experiences of instruction.

Name: Julia Hansen, Helge Gresch, Marcus Hammann

Title: Cultural Theory of Risk and the Psychometrick Paradigm - Perception of risk in the science classroom

Abstract text: Risk is an ever-present constant throughout people's lives. Diseases, new technologies, risk-related socio-scientific issues (SSI) or medical advances all carry specific risks. To be able to navigate risks in everyday life as well as to enter social debate on risk-related SSIs, students need to develop risk competence based on an adequate perception of risk. Risk perception emerges through a complex interaction of affective and cognitive processes, and it is strongly influenced by individual and social characteristics. Two major theoretical frameworks describe the construct of risk perception (see Gardner 2011): Cultural Theory and the Psychometric Paradigm of risk perception. The former internalises risk perception and identifies individual worldviews as well as cultural biases as the precursors of attitudes and perceptions. The latter, in contrast, externalises risk perception by ascribing specific characteristics to the risks themselves. The aim of this study is twofold. It yields a comparison of bothframeworks, the constructionist approach of cultural theory and the psychometric paradigm, as well as their potential impact on science education. Furthermore, this study discusses an empirical approach of assessing risk perception in biology class from theoretical perspectives.

Name: Lena Hansson

Title: The relevance of worldview perspectives in science education

Abstract text: In research focusing science education in western countries, worldview perspectives have been rather neglected (with prominent exceptions such as the research by William Cobern). More specifically this is the case concerning science education in Europe. Often worldview issues are instead raised mostly in relation to indigenous cultures, and to some extent in research focusing religious issues in

relation to science education in western countries. However, also in secular countries such as Sweden, students' worldviews should be of interest for science educators. During the presentation I will, with the starting point in previous research by myself and colleagues, highlight the value of worldview perspectives on science education also in "secular" countries. Such a perspective could contribute to our understanding of what happens in the science classroom, and shed light on questions such as why some students have difficulties understanding science (while others have not), and why some students are uninterested in science (and others view science as very much for them). Implications for science education - research and practice - will be raised. E.g. it will be suggested that worldview presuppositions should be discussed in science class as part of other nature of science perspectives.

Name: Tim Heemann, Marcus Hammann

Title: Towards defining and assessing genetic determinism

Abstract text: Genetic determinism is a challenge when teaching genetics (e.g.Kampourakis et al. 2014). It emerged in qualitative studies with high school students (Schwanewedel 2011; Mills Shaw et al. 2008) and in quantitative studies with teachers (Castéra & Clément 2014). Based on a literature review, we define genetic determinism as the scientifically inappropriate overestimation of the role of one or few genes in the formation of a trait, underestimating other relevant factors. We investigated the psychometric quality of two existing psychological scales for assessing genetic determinism (i.e., the belief-in-genetic-determinism-scale(a)), Keller 2005, and the biological-basis-scale(b)) Bastian & Haslam 2006) in conjunction with two new scales (the one-gene-one-disease-scale(c)) and the genetic-determinism-scale(d)), the latter(d) containing three items from Castéra & Clément (2014). The testing of these scales is pertinent because the two psychological scales have not been tested with high school students. High inter-correlations were expected. A survey of 242 German high school students revealed acceptable reliabilities for three of the scales (a=0.72(a), 0.75(b), 0.80(d)) and a slightly lower a= 0.64 for the OGOD-scale(d). The psychological scales correlate significantly (r=0.61), which is interpreted as evidence for convergent validity. Unexpectedly, the other correlations are fairly weak (r=0.13-0.36). Interviews about the scales are being analyzed to understand student responses and inter-correlation patterns.

Name: Peter Heering

Title: Story Telling with teachers - Experiences and Perspectives

Abstract text: Using stories that are based on historical episodes is an approach in science education that has been advocated for quite a while. Recently, the Flensburg group started a project that also uses stories developed from the history of science; however, a particular emphasis is placed on the way these stories are to be used: we believe that the approach is particularly beneficial when stories are actually told in the classroom by the teachers. In order to enable (and encourage) them to use this approach, we have carried out a number of teacher trainings in collaboration with a professional story-teller. Emphasis was placed on the "art of storytelling", thus teachers were trained in how to develop a story that can be told out of the text that served as a basis.
The participants' expectations, perspectives and reflections were evaluated with questionnaires that use a pre-, post, follow-up design. In the presentation, the approach will be presented together with a discussion of the teacher trainings. Moreover, some results of the evaluation will be presented together with potential consequences for the project.

Name: Susanne Heinicke

Title: The language and underlying culture of Error: in the history of Science and in today´s classrooms

Abstract text: When striving for knowledge, science also always has to cope with limits set by its empirical capacity. It is faced with a discrepancy between the desired or expected on the one and the real found on the other hand. With common terms like "error" we usually connote such a deviation from the consistent - either manifested in terms of an anticipated extern truth or an intern information resulting from expectations due to previous measurements. Yet, the history of science and today's classroom practice knows a larger variety of technical terms as (e.g. for the English language) flawed, faulty or imprecise measurement, mistake or uncertainty to indicate this discrepancy. Now, considering that the way we think influences terminology and terminology again gives way to the development of thinking, it is worth the study what kind of error language and connected error culture prevails in today's teaching of science and how both historically were formed. The paper will present examples e.g. from the works of Kepler, Galilei, Gauss, Joule and others as well as results from the analysis of today's Learning materials and teaching practice.

Name: Andreas Junk

Title: Plenty of room? Approaching the field of nanotechnology in senior science classes in Germany

Abstract text: Nanotechnology is not a compulsory subject in senior science classes in Germany. Yet it is expected of German pupils to acquire knowledge on any field of science, which is not covered by the curriculum but could be linked to the contents of their science classes. Pupils have to write an essay on a field of their choice and they frequently turn to subjects of modern physics which are subject to public discussion. The approach to nanotechnology can be made through Richard Feynman's after-dinner speech "There's Plenty of Room at the Bottom" but the step from Feynman's talk to any of the potential examples for nanotechnological developments which we can encounter in our daily life is a difficult one. In my talk I will focus on the opportunities presented by using Feynman's talk as well as the difficulties in developing an introduction into the new field at senior class level.

Name: Kostas Kampourakis, Kevin McCain

Title: Believe in, believe about: Which question do polls about evolution really ask, and why does it matter?

Abstract text: In this paper we argue that studies on public acceptance of evolution are often misleading because the questions asked and compared to one another do not always give an accurate picture of respondents' views. We point to a potential source of problems with surveys designed to determine acceptance rates of evolution that has not been noted before now: the distinction between belief in and belief about. These phrases are not properly distinguished and as result responses to questions on belief in God are compared to responses to questions on belief about evolution. We suggest that this is a major conceptual issue, and that distinguishing between the two types of questions can help remove an un-recognized confounding element from these sorts of studies. We also point to other components of the questions in these studies that might lead to biased or otherwise distorted responses, such as whether the term "God" is included or not in the questions. We conclude that philosophy of science has an important role to play in order to clarify the constructs in these kinds of surveys and produce valid results.

Name: Ricardo Karam

Title: Different Uses of Complex Numbers in Physics

Abstract text: Complex numbers were primarily conceived in the middle of the sixteenth century as a tool to solve cubic equations. The nature of the imaginary unit has intrigued mathematicians ever since and continues to puzzle school pupils from their first contact with it. Due to their inventive character, it seems unlikely at a first glance that complex numbers could be useful for understanding the physical world. However, approximately 200 years after their invention, physicists gradually began to utilize complex numbers to model different kinds of physical phenomena, a process called "complexification of physics" by Salomon Bochner. In this talk, several historical case studies illustrating different uses of complex numbers in physics will be presented. The variety of uses and interpretations exemplified in these episodes show that there is much more to complex numbers than the bewilderment about the existence of the square root of a negative number. This flexible and opportunistic use provides a counterargument to Wigner's "unreasonable effectiveness of mathematics in the natural sciences". Finally, the study should also shed light on some didactical implications for both physics and mathematics instruction.

Name: Regina Kelly, Sibel Erduran

Title: An Investigation of Preservice Science Teachers' Views of the Epistemic, Cognitive and Social Aims and Values of Science

Abstract text: Aims and values of science are often implicit in science education. There is, however, often insufficient attention dedicated to making explicit the aims and values of science in lessons. Aims and values refer to particular criteria such as 'objectivity' and norms such as 'integrity' that science and scientists must adhere to in engaging in the scientific enterprise. In this paper, we focus on third year science education undergraduate students' views of the epistemic, cognitive and social aims and values of science. The research reported in the paper aims to investigate the views these students hold about the epistemic-cognitive and social aims and values of science. Understanding preservice teachers' perceptions of the aims and values of science are important as they are the future educators who will contribute to the design and implementation of science instruction. A mixed methods research design was employed to collect and analyse data from focus group discussions and questionnaires. The findings offer insight about preservice science teachers' interpretations of the aims and values of science. The study offers a systematic approach to the consideration of aims and values of science in science education, being inclusive of a range of epistemic, cognitive and social aims and values.

Name: Mario Kötter

Title: Pseudoscience as a context for teaching and assessing NOS

Abstract text: Research shows that teaching Nature of Science remains a challenge. We argue that the demarcation problem, i.e. distinguishing science from pseudoscience, may be beneficial for developing students' understanding of science, an approach that has not received much attention in the literature so far. As the demarcation problem requires an answer to the question what science actually is, pseudoscience might be used as a context for discussing about whether or not - and if so how - science can be defined. This context also provides an opportunity for analyzing various and often contrary views held on the meta-level about the issue, e.g. the normative-descriptive-dispute, associated with the different methodical approaches of philosophy and sociology of science, which in turn influenced didactical currents like NOS and Wissenschaftspropädeutik. Whereas experts are aware of the various problems associated

with the demarcation-problem, laypersons often rely on overly simplistic ideas of science. Challenging these ideas in authentic demarcation-tasks may help students to gain a better understanding of science, avoiding both scientism and antiscientific attitudes. We further report on students' responses to a demarcation-task. Homoeopathy proved a fruitful context for assessing college students' formal knowledge and functional understanding of science.

Name: Lea Valentina Lavrik, Meir Vladimir Shunyakov

Title: How can we inspire students emotionally in physics classes by using the history of science?

Abstract text: We have developed a system of tests that precede the study of specific topics in physics lessons and enable teachers to inspire their students emotionally and mobilize their attention. This approach is called the method of selective mobilization of attention, and the reason it has a powerful influence is because certain students tend to spend their time off-task at different moments of time during physics lessons.
The history of science offers suitable material for the creation of these tests being that it is rich in examples of searches and instructive errors. On the basis of these examples, as well as specific intuitive models of pupils according to their prior knowledge of the subject, we have prepared tests that cultivate the attention and emotional involvement of these students. This method has been experimentally applied in a number of academic teaching colleges and in high schools in the study of mechanics (free fall), electricity (Ohm law in direct current circle) and optics (shadows, rainbow geometry) courses. The research results and the application of this method will be presented in our report.

Name: Ana Leci, Fanny Seroglou

Title: The atlas movies channel on YouTube: Non-experts give form, shape and sound to abstract science concepts

Abstract text: In this paper, the design, development and analysis of atlas movies channel is presented. This educational science web-channel aims to become a place that highlights the needs and perspectives of non-experts in teaching and learning science concepts. The atlas movies channel on YouTube contains slowmation movies (slow animation) that are created by: a) children 4-12 years-old, b) pre- and in-service teachers in primary and pre-school education, c) researchers in science education. Creating a slowmation movie offers the opportunity to non-experts to give form, shape, sound and meaning to abstract science concepts and shows how they wish to learn and interact with science concepts and phenomena. To evaluate the channel's impact we analyze using the GNOSIS research model focusing on several aspects of the nature of science: a) the content of the channel (the developed slowmation movies), b) the visitors comments on the up-loaded movies and YouTube analytics, and c) the interviews of children, pre- and in-service teachers who created the slowmation movies. The results of the analysis indicate that this multimodal environment acts as a dynamic educational tool opening new perspectives for creative and interactive learning and teaching science.

Name: Lotta Leden, Lena Hansson, Andreas Redfors

Title: Socio-cultural aspects of science in the science classroom: teachers' perspectives

Abstract text: Students' interest in science is declining. Science teaching often have science as facts as its main focus. In such science teaching there is often little room for socio-cultural aspects of science. It has, however, been shown that students could gain more interest in science if broader perspectives are included. Making socio-cultural aspects a topic in the science classroom is considered hard. In order to gain more knowledge about issues related to the implementation of socio-cultural aspects in the science classroom we have focused on teachers' perspectives. In this presentation we will provide results from a three-year research-project. It is a case study of six teachers, teaching science in grades 1-9. During the project the teachers met in focus groups four times a year and discussed different aspects of science. During the focus-group meetings they also planned and reflected on classroom activities with a focus on socio-cultural issues, which they implemented between meetings. Questionnaires, interviews and classroom observations where used in addition to the data collected from the focus groups. The results provide information on teachers' perspectives on appropriate approaches and activities for different years, as well as information about teachers' perspectives on both challenges and benefits from implementing socio-cultural aspects.

Name: Rene Leubecher, Alexander Bergmann, Alexander Finger

Title: Moral Reasoning in the Science Classroom - Evaluation of a Pre-Service Teacher Training Program

Abstract text: Modern conceptions of science education emphasise on the role of students' decision-making on bioethical and socio-scientific issues for the development of scientific literacy. This requires teachers to deal with subject-specific knowledge and the ethical dimension of biological topics at the same time. Currently, not all biology teachers have learned to cope with this challenge. Moreover, some of them do not even estimate the ethical dimension as a matter of their subject. Implementing bioethics in teacher training is a promising way to face this problem. Therefore, we designed and evaluated an elective pre-service teacher-training course supporting the development of the participants' abilities to prepare, conduct and reflect biology lessons containing ethical aspects. The intervention was accompanied by pre- and post-interviews (N=22). A special focus was kept on the participants' conception of bioethics and moral reasoning, and their anticipated role as a science teacher when dealing with ethical issues in the classroom. We analyzed and compared the interviews based on the grounded theory methodology. At the conference, we will present our results and discuss the implications for teacher training.

Name: Britta Lübke, Urlich Gebhard

Title: Thinking about everyday myths. Case studies in biology class.

Abstract text: This study wants to explore the role of irritation as a trigger for Bildung - according to Hans-Christoph Koller's theory of Bildung as a transformative process - while thinking about genetic engineering in biology class. The analyzed lessons refer to the theory of everyday myths by Ulrich Gebhard. The main issue of this theory is the reflection of everyday myths, which can be defined as cultural embedded views of the world and the self. Learners implicitly refer to everyday myths when thinking about bioethical issues. In this understanding and besides teaching subject matter, the aim of biology classes is to support a general thoughtfulness and the ability of self-reflection as well as to reflect underlying, cultural embedded assumptions about the world in order to enhance high quality decision-making. Two classes of the eleventh grade where accompanied for two months and weekly semi-structured qualitative interviews were conducted with seven learners. Moreover, data of classroom observation and learners' documents are available. The data were analyzed by means of Grounded Theory. The results show that irritation can be

either the starting point of thinking processes or its end. Furthermore, the results indicate that the teacher plays a special role for supporting general and philosophical thoughtfulness.

Name: Terhi Mäntylä, Ismo Koponen

Title: Teaching models of electric current in upper secondary school physics: The role of macroscopic and microscopic models in teaching electric current

Abstract text: A good teaching model is an important factor in instruction. It has to correspond to the scientific view, take into account the abilities of students and function in the reality of school environments. In this study, four experienced upper secondary school physics teachers were interviewed about their teaching of electric current. As a result of qualitative analysis of interviews, the teachers' teaching models were represented in graphical form from conceptual perspective, which allowed the comparison of teaching models. The analysis showed that the conceptual structures of three teaching models were quite similar although the teachers had quite different epistemic emphases. When compared with the scientific view of electric current, the models at macroscopic level were appropriate and in line with Kirchhoff's macroscopic formulation. However, at the microscopic level, the models had more confluences with the outdated historical models than with the current microscopic view.

Name: Paulo Mauricio

Title: Enriching thermodynamic teaching and learning with Holton’s tapestry

Abstract text: Sadi Carnot’s *Réflexions sur la puissance mortice du feu* has had been recognized as a first step in what we now call the second law of thermodynamics. Named after Carnot, the theoretical engine that would attain the utmost efficiency is now thought in all curricula. In Portugal it is introduced at 10th grade following a general trend in European countries.

At this level of schooling, most students are asked to solve problems related to the computation of efficiency and/or heat losses at diverse situations more or less related to real life problems. However, there isn’t done in textbooks any relevant connection between Carnot engine, engineering – from where Carnot obtained his insights - history of Industrial Revolution and, more generally, 1800 European history, physics and art, particularly paintings. This web of connections, akin to Holton’s "tapestry of cross connections" would favour a more inclusive science education for it is directed to all students and not only to the ones interested in follow university. With this work we intend to present a pedagogical approach to introduce the second law of thermodynamics that would surpass the above mentioned limitations.

Name: Barbara A. McMillan

Title: Learning Science as Cultural Activity: Delaying Specialization, Educating Citizens

Abstract text: In an era in which STEM education has replaced science education in many nations it's interesting to consider the consequences of learning science as a cultural activity rather than a body of knowledge or as preparation for employment in the high-tech, knowledge-based global economy. Whether we adopt Snow's anthropological sense of culture or Arnold's "to know the best which has been thought and said in the world," it's necessary to decide upon the historical, sociological, and philosophical aspects of science to include in primary and secondary science education and the contexts in which these cultural aspects will be presented. Stinner (1991) suggested a multifaceted approach that would include contextual

teaching that generates questions involving science and the humanities, history-based thematic teaching, and teaching using literary texts written for the public by scientists. He also acknowledged the real potential of STS courses and Byers recommendation for interdisciplinary courses. Using what has been learned in studies focused on the role of the affective in coming to know and act, this paper looks at how we might organize the contents and pedagogical/instructional approaches of a vertical curriculum focused on science as culture, and place - the location in which one teaches.

Name: Duygu Metin, Jale Cakiroglu, Gulsen Leblebicioglu

Title: Methodological differences between science and pseudoscience: the case of crystals from the standpoint of 8th graders

Abstract text: Demarcation problem between science and pseudoscience is important but neglected aspect of science education. Demarcation problem represents philosophical problem dealing with what should be considered scientific and pseudoscientific. It is epistemological, sociological, psychological, and methodological issue as well. Specifically, the present study aimed at discovering and describing reasoning patterns that middle school students used while they reflected their understandings about pseudoscientific issues in terms of methodological differences between science and pseudoscience. For this reason, this study focused on middle school students' comprehensions about process and justification of pseudoscientific applications related to crystals and, reliability and certainty of knowledge that derived from these pseudoscientific applications. This study was qualitative in nature. Basic interpretive qualitative approach was used as a research design. Seven girls and seven boys (8^{th} graders, 14 years-old) participated in the study. Data were collected through repeated individual interviews. The results showed that the students were very gullible in terms of process and justification of pseudoscientific applications, and reliability and certainty of pseudoscientific knowledge related to crystals. When the students reasoned about given pseudoscientific claims and research
designs about crystals in terms of given aspects, they generally used weak reasoning patterns that were closer to that of pseudoscientists.

Name: Claus Michelsen

Title: Ørsted, Humboldt, Gauss, Weber, Schumacher, and magnetism, and narratives in the classroom

Abstract text: In 1820 the Danish scientists Hans Christian Ørsted demonstrated a relationship between electricity and magnetism in his famous wire-compass experiment. Ørsted's discovery inspired numerous scientists by a variety of experimental and theoretical constructs, and his scientific impact extended far beyond Denmark's borders. Between 1801 and 1846 Ørsted made eight grand tours, which gave him the chance to work with great scientists of his time. In the period from 1827 to 1833 he had three meetings in Germany with Humboldt, Gauss, Weber and Schumacher. At the meetings the scientist among other things discussed geomagnetism and measurement of the declination of the Earth's magnetic field. The paper refers to a project in which seventh grade pupils participated in learning activities centered on Ørsted's meetings with the German scientist. The activities were based in an inquiry and narrative approach to teaching science with the aim to portray science as rooted in culture, history, and society, and as a human endeavor. Special emphasis was put on the pupils' products of the activities, such as papers, posters, drama, and experimental equipment. The pupils' products were analyzed to trace their conceptions of nature of science. The paper presents the results of this analysis.
Name: Breno Moura

Title: The changing role of Newton's fits in 18th century: social and cultural factors for the rejection of a theory

Abstract text: In 1704, Newton published his Opticks, his major book about light and colors. In Book II, he presented the theory of fits of easy transmission and easy reflection, which implied that the ray of light had inherent and alternate tendencies to be transmitted or reflected from time to time. For Newton, the existences of the fits were proved by experiments, like the heterogeneity of light. It played a crucial role in the discussion of Book II, since Newton used it to explain the appearance of colored rings in thin and thick films, known nowadays as "Newton's rings". He seemed to believe that this concept would free him from the adoption of hypothesis to account optical phenomena. However, throughout 18th century, the role of the fits changed dramatically. In the works of Newton's followers, it was either treated superficially or completely ignored. Some of them classified it as a mere hypothesis or a doubtful concept. In this communication, I will present an analysis of the changing role of Newton's fits. My purpose is to discuss some aspects of the process of rejection of scientific theories, claiming that it is closely related with social and cultural contexts in which it occurs.

Name: Sabina Muminovic

Title: Historical contextualisation of Hooke's Law in Education

Abstract text: Hooke´s Law of Elasticity is a topic in almost every teaching program in physics in the lower secondary school. It is usually just mentioned in context with some school experiments (measurements), the introduction of measuring devices such as spring balance or everyday situations - but it is not really historically contextualized. A historical review of the development of this law and implementing in teaching would form an important option for lecturing this law. If we are enabled to show students through history and the experiences of the 17th century scientists how to determine a law by researching different areas, they are enabled to understand the connections better.
As a part of my PhD-Thesis I analyze the historical background of Hooke´s Law of elasticity, the ideas and experiments. I examine the historical context of his work, the different influences and motivations as well as Hooke´s relationship to the Royal Society of the 17th century.
Does Hook´s Law have something in common with Boyle´s Law? There is an ambiguity with Hooke´s claim in his work "La Potentia Restitutiva,or, of Spring" in which he wrote that his "Law of Nature" was something that he discovered during his work on "Micrographia". Was the experimental proof of Boyle´s Law actually the first hint for Hooke´s Law of elasticity? If so, what implications would result in an educational perspective?

Name: Lydia Murmann

Title: Husserl and Science Education

Abstract text: Edmund Husserl (1859-1938), mathematician and philosopher, found the natural sciences - physics in particular - guilty of having forgotten about their foundation in the sensual qualities of the lifeworld. He did so in an epistemological sense, not questioning either the value or the respectability of scientific knowledge itself. In Science Education, also, there seems to be a certain kind of amnesia or ignorance with respect to the Nature of Science in terms of epistemology. How else could it be that we speak of scientific knowledge on one hand and students' conceptions (with reference to constructivism) on the other, while science largely depends on idealizations, and students' sense-making is noticeably rooted in experience? And isn't there a deep and practical similarity (on the level of individual cognitive or psychic

effort) between Husserl's concept of epoché (suspension / bracketing / phenomenological reduction) and the learning objective of "being able to differentiate between observation and interpretation" - which can be found in German science curricula for grades 5 to 10 in 2016? The paper presentation will discuss the question, which theoretical and practical enrichment science education and science educators can find in receiving some of Husserl's fundamental ideas.

Name: Edvin Østergaard

Title: "And yet it does not move!" Fostering students' rooting in science education

Abstract text: "And yet it does not move!" Fostering students' rooting in science education. If science teaching does promote students' feeling of alienation and uprootedness, as Roth (2015) argues, how should one teach science in a rooted manner, grounded in students' lifeworld familiarity? Our original Earth, Husserl claims, does not move, ''sie ruht" (Husserl 1940, p. 313). From a phenomenological perspective, Earth is a ''soil body'' (Bodenkörper) as it forms firm ground for our comprehension of the world. The relation between the moving and the stagnant Earth is comparable to Heidegger's (1962) distinction between geometrical and existential space; the first describable by laws of physics, the latter our lifeworld, our space of existence. Geometrical space, Heidegger argues, presupposes lifeworld space, as our very being is a precondition for conceiving dimensions of the geometrical space. Heidegger warns against a too strong emphasis on the physical space, as this could lead to an "Entweltlichung", where ''the wordly character of the ready-to-hand gets specifically deprived of its worldhood'' (ibid., p. 147).
I discuss conditions for rooting in science education by drawing on experiences from our teacher education program. I hereby emphasize (i) aesthetic experiences in science class as a complementary to the heavy weight on conceptual learning, and (ii) historical and ontological aspects incorporated in science teaching.

Name: Martin Panusch

Title: Just another Christmas Lecture?

Abstract text: All physic students of Flensburg have to train their experimental skills in a special lab course in their first semester, where basic proficiencies concerning observations, measurements and lab reports are taught. In the last three years a special lesson was included in December about two weeks before Christmas. This special lesson is based on Faraday's lectures on the chemistry and physics of (burning) candles that were published in 1861 as "The Chemical History of a Candle". The main topic of this lesson is about perception, stabilization of observation moreover it is an example of the Socratic teaching method according to Wagenschein. In the following lesson the students were asked to write an anonymous short self-reflection of their experimental process. They were asked to note what they learned, what they think this lesson is worth in their context of physic teacher training and what flaws they could find in it. Afterward the group discussed openly about these questions and a tentative synopsis was compiled. Evaluating the anonymous and open statements of the students and enriching them with some reflections on the lesson I will answer the question if or how such a seemingly outdated and old fashioned lesson is profitable in our context of teacher training.

Name: Morten Rask Petersen

Title: How to implement 100 year old American thinking in modern European science education?

Abstract text: In European context the Rocard report (European Commission (EC), 2007) there has been a severe focus on inquiry based science education (IBSE) in European projects and in development of new science curricula across Europe. But an inquiry approach towards learning science is not new. 100 years ago the American philosopher John Dewey was among the founders of an inquiry approach to teaching and learning in general and with specific significance for science education (Dewey, 1913). The aim of this proposal is to link the thoughts of Dewey with the experiences from a large scale European project on IBSE - the SAILS project (Strategies for Assessment of Inquiry Learning in Science). Results from case studies and teacher educational workshops will be held against the thoughts of Dewey to illustrate how this old thinking can contribute to recent science teaching.

Name: Oleg Popov

Title: Issues of intercultural competence in Swedish science education

Abstract text: Multiculturalism and intercultural education have been for the long time constitutive components of Swedish teacher training, in particular concerning the teaching of Swedis has second language (Johansson, 2008). However, in the curriculum discourse and practice of other subjects, this concept appears to be poorly explored and instrumentalised (Popov, Sturesson, 2015). Nowadays, when teacher students go to school practice, they face culturally diverse classrooms and challenging educational contexts (Popov, Sturesson, Carlsson, 2012). They need to deal with cultural heterogeneity on pedagogical and curriculum planes (Popov, Sturesson, 2015). The focus of this paper is to highlight important elements of intercultural competence as they perceived by the science teachers. Theoretical lens of the socio-political framing of education (Gutiérrez, 2013), in particular issues of identity construction is used in the study. The concept of identity is related to what a person does and his or her activities. Identity is dynamic and depends on participation in a particular community that position an individual "through and in race, class, ethnicity, sexuality, gender, religion, language, and so forth" (Gutiérrez, 2013, 46). Theoretical constructs of multiculturalism were also important to highlight different dimensions of science teachers' intercultural competence.

Name: Valentina Roberti, Giulio Peruzzi

Title: Exposing Color: Newton´s Theory through Maxwell´s Lens

Abstract text: Even as a child, James Clerk Maxwell always showed his curiosity toward color: "that (sand) is red; this (whin) stone is blue". "But how d'ye know its blue?". Maxwell's curiosity led him to never abandon his studies on colors throughout his life, creating inter alia the foundation for quantitative color measure and for practical color photography. Newton's theory of color represents a fundamental starting point for Maxwell's researches in the field. Trying to point out the influence of Newton's theory on Maxwell's work on colors could be therefore significant to better understand Maxwell's theory of compound colors.
In order to eliminate Newton's arbitrary choice of the number of primary colors and Newton's confusion between optical and pigment mixture of colors, Maxwell adapted Newton's color circle to his triangular representation, with three primary colors as vertices. Furthermore, reading Newton's contributions, Maxwell found a valid indication of the method to predict the outcome of optical mixtures of light in analogy with the calculation of the center of gravity, in line with his conception that "there is no more powerful method of introducing knowledge into the mind than that of presenting it in as many different ways as we can". This is also a useful lesson relevant for educational purposes.

Name: Lydia Schulze Heuling

Title: Performative Dimensions of the Socially Inclusive Science Centre

Abstract text: Science is learned in a variety of settings and for various reasons. Spaces in which humans learn are often conceptualized as formal (e.g. classrooms) or informal settings (e.g. kitchen, garage or science centre). This talk deals with the Science Centre as complex informal learning space. Under the presumption that perceptibility and experiencebility are prerequisites for learning encounters it is important to seek an understanding of how typical relations of things in a Science Centre have a meaning for excluding or including so called minority groups.
How things relate in a Science Centre can be analyzed from several perspectives. Three of these are (1) the arrangement of things in space and their consequence for interaction, the (2) relation between the body and the exhibit and the (3) practical use of the exhibits. It therefore is important to have a closer look on performative aspects taking place in Science Centres, ranging from speech-movement-relationships over movement practices as far as to movement itself as a generative causal power. Nevertheless, the things forming a Science Centre are based on a particular normativity dispositive of the human body. This has an impact on the body techniques we find in these places. Agreeing to this argument we see ourselves confronted with crucial sociological and epistemological implications and questions towards science and science education.
This talk gives insight into the latest research collaboration between the Flensburgian Science Centre Phänomenta and the Physics Education and History research Group at Europa-University Flensburg. We would like to share and discuss with you the different levels of interpretation of our current findings.

Name: Julia Schwnewedel, Finja Grospietsch

Title: Teachers´ Beliefs about argumentation - A comparison in the Context of the disciplinary cultures of science and language education

Abstract text: Argumentation is considered important as a cultural practice but also as a tool fostering learning. Consequently it is promoted in nearly all school subjects. However, it is unclear whether teachers understand and teach argumentation in comparable ways in different subjects. In this context, we investigated science and language teachers' beliefs about argumentation.
The sample consisted of five science teachers and five teachers of German language. For the investigation of their beliefs problem-centered interviews were performed. We conducted qualitative content analysis to identify and categorize the beliefs.
Data analysis led to a categorization with ten major categories describing the beliefs about argumentation. Comparative analysis showed differences in eight of the ten major categories between science and language teachers' beliefs.
Results unveiled differences, e.g. concerning learning goals or the selection of instructional topics, as well as in terms of the assessment of students' argumentations. The results allow us to conclude that biology and language teachers' hold different beliefs about argumentation. At the conference these differences will be explained in the context of different disciplinary cultures resulting in different subject-specific habitus. The findings help to differentiate disciplinary cultures in the context of schools, and prospectively better understand their function in instructional processes.

Name: Hayo Siemsen

Title: The intuitive new thinking in science through Beneke and Mach: Mathematical Intuitionism and "New Physics"

Abstract text: By the start of the 19th century, all seemed settled: Mathematics, especially geometry, had been established since Euclid, physics had been given a new foundation by Newton and even philosophy was seemingly securely founded by Kant's metaphysical system. Many scientists held the opinion that what was now left to do for science was the "filling-in the details". But all these "foundations" proved insufficient by the end of the century. Planck and Einstein developed quantum physics and relativity theory, Riemann, Clifford, the intuitionists and the formalists developed a new geometry (topology), Kant's system was superseded by similar metaphysical systems, one after the other.
Why did this happen? The current dominant narrative assumes that it was new observations made possible by new technologies, which created an empirical necessity for these transformations in science. This was certainly necessary, but was it sufficient? Interestingly, all the keyplayers in this "transformation drama" had been influenced directly or indirectly by one person. Strangely, this person is little known: Friedrich Eduard Beneke. Beneke had developed a new, empirical psychology, from which he transformed philosophy and made it a pragmatic/empirical-genetic "philosophy of nature" (not natural philosophy). It was this new way of thinking, a new perspective, which enabled a re-evaluation of the central concepts and therefore the hidden inconsistencies in many sciences.

Name: Constantina Stefanidou

Title: History and Philosophy of Science for Citizenship: The case of “Life of Galileo” by B.Brecht.

Abstract text: History and Philosophy of Science have been systematically proposed as appropriate for deeper understanding of the Nature of Science and thus developing a more functionally literate citizenship (Allchin 2013, Hodson 2009, Irwin 2000). Science education for citizenship refers to science education aiming at preparing students for active, informed, critical and responsible involvement in situations where insights into different aspects of science might improve the quality of students’ participation (Kolsto 2001), emphasizing the role of science in society. History and Philosophy of Science constitutes a breeding ground for negotiating concepts relating to science and democracy. In this context, this article explores the possibility that the dramatization of a play, namely “Life of Galileo” by B.Brecht, contributes to the active engagement of students with ideas about Nature of Science related to citizenship: science – society and science – religion interaction, scientist’s responsibility towards history and the public ownership of science.

Name: Ekaterina Teteleva, Sergey Bogdanov

Title: Students' contest with Eratosthenes: boreal lake vs Egyptian desert

Abstract text: The brief overview as well as thorough insight into the history of Science reveals the "golden series" of experiments and discoveries. In due times these ones not only overturned Science paradigms, but followed by tectonic shifts in cultural environment and world viewing. Moreover this series mostly remains actual and challenging for each next generation of researches. Thus Earth's sphericity studies started by Eratosthenes were developed during centuries and nowadays are supported by satellite altimetry technique. As for students it's hard to overestimate the role of cornerstones studies in achieving their best vision of science in a wide context. As for teachers the challenge is to design the "revisiting" of these experiments in a way suitable for concrete learning environment. In the paper the experiment on estimation of Earth radius appropriate for Russian North soft landscapes is presented. With the lack of mountains we gained from the lake coast measurements. The first year students studying "Introductory

Physics" were the target group. The accuracy of estimations was less than 10% with the true value within the confidence interval. During experimental session the students were really inspired by the "reopening of Earth sphericity" processes. This proves that such experiments contribute to students' motivation.

Name: Friederike Trommler, Helge Gresch, Marcus Hammann

Title: Students' Reasons for Preferring Teleological or Causal Explanations

Abstract text: Teleological conceptions are considered a major source of difficulties in learning biology (Lennox & Kampourakis 2013). Whereas biology educators intend to promote the ability to explain biological processes causally (Abrams & Southerland 2001; Osborne & Patterson 2011; Tamir & Zohar 1991), students often prefer teleological explanations over causal explanations (Richardson 1990). This study examined the reasons secondary students (10-17 years old) give when asked to explain their preference of teleological or causal explanations. In a questionnaire with ten forced-choice items, the participants (n=315) preferred teleological (M 6.44, SD 1.89) over causal explanations (M 3.56, SD=1.89). Interviews with a subsample (n = 26) revealed that students reasoned etiologically, i.e. teleologically and causally, to explain their preferences, but that they also referred to a number of non-etiological reasons (i.e. familiarity, complexity, and five more). The given reasons varied within an individual student and also for a particular phenomenon across different students. A close look at students' responses to the teleological explanations showed that the students did not recognize them as such, but rather focused on functions, which appeared attractive to them. Consequently, biology education should explicitly address the differences between causal explanations, teleological explanations, and functional analyses. An empirical design for investigating the effects of implementing this approach will be presented for discussion at the conference. Abrams, E. & Southerland, S. (2001). The how's and why's of biological change: How learners neglect physical mechanisms in their search for meaning. International Journal of Science Education, 23(12), 1271-1281.

Name: Anna Tzampazi

Title: Teaching science in second chance schools: Two case studies inspired by philosophy of science

Abstract text: Second Chance Schools are part of adult education and in Greece provide a degree equivalent to the ones given by state high schools. Science curricula are based on the students' needs and focus on encouraging a positive attitude towards science learning and developing metacognitive and social skills and attitudes. In this paper, two case studies inspired by philosophy of science are presented. In the first case study, comics introduce students to science concepts such as gravity and help them elaborate on the image of the scientist. In the second case study, historical narratives provide the context to appreciate scientific shifts: a) from the geocentric to the heliocentric system, b) from creationism to the theory of evolution, c) from the conscious to the subconscious self and the dominant image of reality in science. Mafalda, Mickey Mouse, Copernicus, Darwin and Freud meet in the classroom of second chance high to open a window for science learning to non-expert adults re-defining the importance of teaching science.

Name: Gudrun Wolfschmidt

Title: Astronomy and History of Science in European Context - a Network for Edutainment

Abstract text: Bremen is a center of technology, well-known for the air and space industry. But it has a long tradition in science, especially astronomy, which was introduced as ``Astro Walk Bremen" by Lieselotte Pézsa in 2005. It starts in the Kunsthalle (art museum), and a guided tour is offered like ``science on stage" by a theatre actor dressed as Wilhelm Olbers. Places of interest and art in public spaces referring to famous astronomers like Wilhelm Olbers, Friedrich Wilhelm Bessel, Carl Friedrich Gauß are presented. Under the motto ``The future lies in the past" this guided tour is developed connecting astronomy, art and culture in European context. Possible network partners for Astro Walks in the footsteps of prominent European astronomers are in German and European cities (e.g. Göttingen, Hamburg, but also Prague, Tartu/Estonia and Frauenburg/Poland). In addition a project of junior guides for school children (Schüler führen Schüler) is developed. In Lilienthal the famous reflecting telescope of Johann Hieronymus Schroeter, the largest on the continent (1785), reconstructed in 2015, is now used for astronomical observations for the public and for school education by the ``Astronomische Vereinigung Lilienthal "(AVL). Further activities in Bremen are offered by the ``Olbers-Gesellschaft" (*1920) with a planetarium in the navigation school (1952) and an observatory (1957), e.g. a practical physics course for Bremen University, student laboratories (part of IPN Kiel), and in addition by the industry and research organisations like DLR and ZARM with hands-on experiments and training. All these educational activities for school children as well as for students raise interest in astronomy, physics and space technology.

Name: Hagop Yacoubian, Taline Madirossian, Layan Al-Khatib

Title: A Framework for Analyzing the Image of the Scientist Portrayed through Educational Resources

Abstract text: This paper reports on (1) the process of constructing a comprehensive framework that can serve as a tool to analyze the image of the scientist portrayed through text in educational resources and on (2) the results of a pilot study that involved analyzing the image of scientist portrayed through the Lebanese National textbooks of Life and Earth Sciences at the Intermediate level. The process of constructing the framework involved four phases, namely (1) an extensive review of the relevant literature in science education; (2) synthesis work that involved drawing from recurring themes, creating categories and subcategories, and developing an illustrative model; (3) pilot testing the framework using the three textbooks mentioned above; and (4) revising the framework based on feedback from the pilot study. Our analysis of the textbooks revealed that most scientists mentioned are white males of middle-upper class, European or North American, rational, objective and unemotional individuals. They are portrayed as discoverers of truth, engaged in one-man-show, mostly occupied with experimental work in their labs aiming for producing detached theories. The stereotypical image of scientists portrayed through these textbooks carries misinformed views of the nature of science and is quite aligned with ones reported in other contexts.

Name: Jörg Zabel

Title: The Nature of Biological Science: What can Biology Lessons contribute to Science as Culture?

Abstract text: Mayr (2004) argued that the nature of biology differs fundamentally from the classical physical sciences. With respect to this 'autonomy' (Mayr 2004), biology is predestined to develop a modern view on the nature of science in the students' minds (Langlet 2002). E.g., this includes a variation concept

instead of typological thinking, and stochastic events instead of simple determinism. In order to investigate how students explain biological phenomena, we reanalysed data from two different studies: (1) an interview study (Germany, n=3, age 15 ys.) on the role of chance in biology, and (2) a study on the students' explanations for evolutionary phenomena, based on a writing assignment (Sweden, n=64, age 16-17 ys.). Our reanalysis focussed on the categories vitalism, teleology, essentialism, determinism, dual causation, and chance. Most students considered the genuine character of the living world in their explanations and did not reduce living beings to physical laws and mechanisms. They implicitly acknowledged the autonomy of biology, but often used essentialist and teleological explanations. We conclude that biology education can indeed contribute to a modern view on the nature of science, but only if we teach our students how to explain the living world in a scientifically appropriate way.

Sessions

First session

Name: Arne Dittmer (Session organizer)

Session Title: The Challenge of Teaching Science as a Cultural Activity: New Directions for NOS

Session abstract: Which theoretical and practical knowledge about the philosophy and history of science and which teaching skills are needed to teach about the nature of science in science classes? This is the issue of this session about the challenge of teaching science as a cultural activity. The papers of the session discuss the relation between knowledge and skills regarding the requirement that science teachers should foster an adequate understanding about the nature of science.
Despite of the "consensus view" on the essential characteristics of science, it seems to be necessary to teach students also about the complexity and heterogeneity of natural sciences. But there is a contradictory tension between reducing complexity on a few features and promoting an appropriate understanding of science, regarding e.g. the cultural and social embeddedness or the dynamic of scientific developments and its cultural impacts. The session addresses the question of what counts as "useful" or "functional" knowledge about the nature of science in science classes and what are the requirements for an appropriate way of teaching. Regarding the complexity and heterogeneity of science, teaching about the nature of science is also a question of a reflective and open-minded stance and a question of a discourse-oriented teaching style.

Name: Arne Dittmer, Agustin Aduriz-Bravo

Title: The Challenge of Teaching Science as a Cultural Activity: New Directions for NOS

Abstract text: Since the stabilisation of the "nature of science" (NOS) as a line of research and innovation within science education two decades ago, there has been on-going debate around the issue of how to select NOS content to be taught (cf., first discussions by Rosalind Driver and seminal work by Norman Lederman and his colleagues). Debate can be pinned down to the "big" question of how to identify ideas, questions, models, constructs, authors, materials, activities, etc., adequately representing what science is and at the same time having educational value. Attacking such issue with theoretical, methodological, and practical derivations entangles a series of difficulties; among these, the necessity to prepare science teachers to effectively teach the nature of science.
This position paper is followed by two empirical and practical papers on new direction and new pedagogies; its purpose is to set the backdrop of international discussion on the new directions towards which research

and innovation in the nature of science is heading. We argue around contended topics that we have identified in the literature; particularly, on the need of a "renewed" conception of NOS as a curriculum component that attends to setting science in its broader cultural context.

Name: Agustin Aduriz-Bravo, Nelson Bejarano

Title: The Challenge of Teaching Science as a Cultural Activity: Which Directions for NOS?

Abstract text: Knowledge about science, known as "nature of science" (NOS), is nowadays a targeted outcome for science education. Highlighting its educational importance brings about the need to prepare teachers to tackle this new curriculum component. Thus, in the field of didactics of science (i.e., science education as a discipline), there is increasing discussion on what we may call "NOS education of teachers". The dominant position when selecting what counts as NOS in science education is usually characterised as the "consensus view"; such view is based on "tenets" that purportedly depict the main features of science, and that should be the object of teaching. Derivatively, it is supposed that science teachers should be acquainted with these tenets and their use. The aim of this paper is to review current literature on NOS and find some theoretical and empirical studies providing criteria thatsupport other Which "nature of science" could be most useful for science teachers? Some hints from a literature review perspectives -different from the consensus view- that can be considered powerful for science teacher education in light of the imperative that they teach NOS in their classes. We address the question of what counts as a "functional" NOS for teachers, i.e., not only meta-scientific knowledge that is ready-to-be-taught in the classroom, but also that can transform teachers' pedagogies.

Name: Florian Kolbinger, Arne Dittmer

Title: Dialogue and Debate in Biological Education

Abstract text: Argumentation is a fundamental technique in science, but it is hard to implement in scientific classrooms (Osborne, 2010). It is usually connected with the logic of concluding, reasoning or rhetorical competencies, whereas aspects of dialogue and participative interactions seem to receive less attention (Erduran, Ozdem & Park 2015). But, exactly latter aspect of argumentation might lead pupils to a discourse-oriented attitude and might procure a deeper understanding of the epistemological, ethical and political interconnections of science and its boundaries. Science teachers, however, might need to scrutinize their own beliefs and values. Besides content- and pedagogical-content knowledge, they especially need to be motivated (Kunter et al., 2013) to accept and deal with open, discursive or struggling themes of biological science. Within academic trainings pre-service teachers were encouraged to prepare, implement and reflect on biology lessons with a special focus on the History and Philosophy of Biology. Video-self-reflective practices and feedback meetings aimed to assist teacher-students in their explicit reflection on their teaching objectives and communicative approaches and invited to investigate, e.g. on self-concepts, epistemological beliefs or views on the "Nature of Bioscience". Focus of the study is to illuminate socialization and attitudinal issues inhibiting dialogue and participation in science classes.

Second Session

Name: Prof. Dr. Reiners (Session organizer)

Session Title: The Nature of Science in Chemistry Teacher Education - Reflections and Empirical studies

Session Abstract: Based on C.P. Snows' distinction the session tries to pave the way towards bridging the gap between the two cultures in chemistry teacher education by promoting an adequate understanding of Nature of Science. The way will start with an empirical study on the notion of creativity which is suitable to point out similarities between the cultures. Another study will focus on the notion of theories and laws as domain-specific concepts in chemistry. A reflection on the cultural argument of promoting Nature of Science is based on technical language and the concepts behind them, which are supposed to help appreciating a chemistry-specific view on the world as a cultural achievement.

Name: Prof. Dr. Reiners

Title: The Cultural Argument for Understanding Nature of Science - What is behind it?

Abstract text: Understanding Nature of Science is a central component of scientific literacy, which is agreed upon internationally, and consequently has been a major educational goal for many years all over the globe. In order to justify the promotion of an adequate understanding of Nature of Science several arguments have been developed, among them the cultural argument that "an understanding of the nature of science is necessary in order to appreciate science as a major element of contemporary culture." (Driver, et. al. 1996). But what is behind this argument? Based on C.P. Snows' vision of two cultures this question will be addressed and answered from an educational point of view.

Name: Karl Marniok

Title: Using the History of Chemistry to Teach the Nature of Scientific Laws and Theories

Abstract text: The nature of scientific laws and theories is an integral part of the nature of science (NOS). There are three prevalent misconceptions about laws and theories among both students and the common population: The idea that scientific laws are an absolute kind of knowledge, the belief that scientific theories are mere guesses or particularly uncertain knowledge lacking sufficient "proof", and the misconception that laws and theories are hierarchically related with theories "maturing" into laws. Some German educational directives specifically require to learn about the nature of laws and theories, although the term nature of science is never used. A research project investigates these misconceptions among pre-service teachers. As a part of introductory courses for students, two different approaches with varying degrees of contextualization were tried. The highly contextualized approach encompassed historical case studies in chemistry in order to achieve a better understanding of laws and theories. The results were assessed using questionnaires and portfolios in which the students document their learning progress accompanying the courses.

Name: Markus Bliersbach

Title: "Creating Creativity": Improving Pre-service Teachers´Conceptions about Creativity in Chemistry

Abstract text: Although creativity is considered as one of the key competencies in modern society and as a central aspect of nature of science, it has been neither established as a main topic in chemistry education research nor in today's chemistry education practice. As a result, students mostly characterise chemistry as a solely logical and analytical discipline and do not appreciate the importance of creativity in the development of chemical knowledge. The research project tries to address this deficiency. Based on the assumption, that adequate conceptions of chemistry teachers represent a necessary condition on the way to implement creativity into education practice, we focus on pre-service chemistry teachers. The principle

aim is to find out, how they can be supported in developing appropriate conceptions about the role of creativity in scientific research processes and about possibilities to implement creativity into chemistry lessons. For this purpose, different approaches are evaluated in several qualitative studies in pre-service chemistry teacher courses at the University of Cologne. Some approaches include historical or contemporary examples of creative research processes, others enable the teacher students to become creative themselves. Results and implications will be discussed in the presentation.