KARLSTADS UNIVERSITET

eridob
European researchers in didactics of biology

SMEER, CENTRE OF SCIENCE, MATHEMATICS AND ENGINEERING EDUCATION RESEARCH

ERIDOB 2016

ELEVENTH CONFERENCE OF EUROPEAN RESEARCHERS IN DIDACTICS OF BIOLOGY

5TH – 9TH SEPTEMBER 2016 KARLSTAD

Organised by: Department of Environmental and Life Sciences | The Centre of Science, Mathematics, Engineering Education Research (SMEER) | Karlstad University, Sweden

KAU.SE/ERIDOB-2016

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Dr Niklas Gericke (Chair)

Dr Nina Christenson

Dr Birgitta Mc Ewen

Lic Karin Thörne

Dr Susanne Walan

Maria Kull (Conference Administration)

CONTENTS

FOREWORD

The ERIDOB Academic Committee has invited researchers in Biology Didactics to take part in the XIth Conference of European Researchers in Didactics of Biology. The conference is held at Karlstad University and Karlstad Congress Culture Centre, the 5th – 9th September 2016.

More information about the conference can be found at the conference website: www5.kau.se/eridob-2016

The aim of the conference is to give researchers in Biology Didactics the opportunity to present and discuss their research and results. Contributions should fit into one of the following strands within biology education:

- Students' conceptions and conceptual change
- Students' interest and motivation
- Students' values, attitudes and decision-making
- Scientific thinking, nature of science and argumentation
- Teaching strategies and teaching environments
- Teaching and learning with educational technology
- Environmental education
- Health education
- Social, cultural, and gender issues
- Practical work and field work
- Research methods and theoretical issues

PREVIOUS ERIDOB CONFERENCES

Haifa, Israel 2014

Berlin, Germany 2012

Braga, Portugal 2010

Utrecht, Netherlands 2008

London, UK 2006

Patras, Greece 2004

Tolouse, France 2002

Santiago de Compostela, Spain 2000

Göteborg, Sweden 1998

Kiel, Germany 1996

FUNDING AND SPONSORS

The XI[th] ERIDOB Conference at Karlstad has been funded and sponsored by:

Karlstad Municipality
karlstad.se

Springer Education & Language
www.springer.com/gp/education-language

The Centre of Science, Mathematics and Engineering Education Research (SMEER) at Karlstad University
www5.kau.se/en/smeer

The Teacher Faculty Board at Karlstad University
www.kau.se/en/teacher-education

The Swedish Research Council
www.vr.se

Taylor & Francis through the 50th anniversary of the Journal of Biological Education
explore.tandfonline.com/page/ed/rjbe-50-anniversary-vsi

WELCOME TO ERIDOB 2016 IN KARLSTAD!

Dear colleagues,
it is a real pleasure for us to welcome you to the XI[th] conference of European Researchers in Didactics of Biology (ERIDOB) – Welcome to Karlstad!

ERIDOB has met every two years from 1996 to 2016 enabling researchers to present and discuss research findings related to teaching and learning biology. As the research community has expanded so have the conferences, and we now also have participants from Asia, Africa, and North and South America. Still the conference remains small-scale and friendly with 165 participants. In that way we hope that we can retain the famous ERIDOB spirit with talks about research of excellent quality in a supportive atmosphere filled with joy and generosity, which facilitates productive interaction between new and experienced researchers alike.

The range of research topics addressed during the conference will surely offer plenty opportunities for interesting discussions, collaborative learning and inspiration for future research projects. There are many interesting oral and poster presentations to look forward to. We are also very happy to host two interesting keynote talks by Ross Nehm from Stony Brook University in New York, US and Charbel El-Hani from the Federal University of Bahia in Salvador, Brazil. They will talk about two fundamental topics of biology and biology education: evolution and genetics. The current interest in these topics has led us to include a special theme at this conference: *Teaching and learning of evolution.* The conference also includes four symposia: *Learning biology in informal settings; Socio-scientific based inquiry in the context of biology teaching; Environmental literacy – Grounded in theory and approved in environmental/sustainability education practice;* and *Fostering a philosophical stance toward science: Thoughtfulness and creativity in the biology classroom.* As a continuation of the discussions at the last conference in Haifa, this conference also includes a panel discussion about the future directions of biology education research, chaired by Bill McComas from the University of Arkansas, US.

To stimulate all senses and provide opportunities for informal meetings and discussions the conference also includes a social programme with possibilities to visit some interesting natural and/or cultural sites in the area surrounding Karlstad as well as a mingle reception at Värmlands museum and the conference dinner.

We would like to acknowledge the substantial work of the Academic Committee for reviewing and planning the conference. Additionally, the Academic Committee would like to thank all the reviewers for their contribution in considering the large number of proposals submitted to the conference this year. We would also like to thank the funders and sponsors (see separate list). Last but certainly not least, our sincere thanks and gratitude go to the local organizing committee for their hard work and commitment for the many months leading up to the conference itself!

The XI[th] of ERIDOB 2016 conference 2016 is hosted by the Centre of Science, Mathematics, Engineering Education Research (SMEER) and the Department of Environmental and Life Sciences at Karlstad University, Sweden.

We hope that you will enjoy the conference and your stay in Karlstad.

Niklas Gericke
Chair of the Local Organizing Committee

Marcus Grace
Chair of the Academic Committee of ERIDOB

KEYNOTES

KEYNOTE 1

ROSS H. NEHM
Stony Brook University-SUNY, New York, US

Ross Nehm is Associate Professor of Ecology and Evolution, and Associate Director of the Ph.D. Program in Science Education, at Stony Brook University (SUNY) in New York. He received a Ph.D. at the University of California-Berkeley, a M.Ed. from Columbia University, and a B.S. at the University of Wisconsin. His recent work has focused on science learning, with attention directed at biological concepts such as natural selection and evolution. Dr. Nehm serves as Associate Editor of the journal Evolution Education and Outreach, Associate Editor of the journal Science & Education, and Monitoring Editor of the journal CBE-Life Sciences Education. His major awards include a CAREER award from the U.S. National Science Foundation, a teaching award from UC-Berkeley, and a mentoring award from CUNY. In 2013-14 Dr. Nehm was named an Education Mentor in the Life Sciences by the U.S. National Academies.

THINKING ABOUT EVOLUTIONARY CHANGE: CONCEPTS, CONTEXTS, AND COGNITIVE COHERENCE

Evolutionary change is a core feature of the biological world, although decades of educational research have revealed persistent challenges to the development of normative scientific understanding in students, teachers, and the general public. This talk will review new studies of evolutionary reasoning across age groups (e.g., elementary, secondary school students), nations (e.g., China, Germany, Indonesia, and the USA), and expertise levels (e.g., undergraduates, practicing scientists) using constructed-response assessments. These studies reveal predictable and potentially generalizable insights into how biological concepts are elicited in particular contexts, and suggest that learner sensitivity to such contexts is associated with expertise. These findings have practical implications for biology teaching, learning, and assessment, and could provide a model for how biology education research might build more causal, predictive, and explanatory models of biology reasoning.

KEYNOTE 2

CHARBEL N. EL-HANI
Institute of Biology, Federal University of Bahia, Brazil

Charbel N. El-Hani is Professor of History, Philosophy, and Biology Teaching at the Institute of Biology, Federal University of Bahia, Brazil, and Productivity in Research Grantee level 1-B from the Brazilian National Council for Scientific and Technological Development (CNPq). He is affiliated with the Graduate Studies Programs in History, Philosophy, and Science Teaching (Federal University of Bahia and State University of Feira de Santana), in Ecology and Biomonitoring (Federal University of Bahia), and in Genetics and Biodiversity (Federal University of Bahia). He coordinates the History, Philosophy, and Biology Teaching Lab at UFBA. His research interests are in science education research, philosophy of biology, biosemiotics, ecology, and animal behavior. He is a member of editorial boards of Brazilian and international journals in science education and philosophy of biology, and the Book Review Editor of Science & Education. His research has been published in several leading journals like Science & Education, Cultural Studies of Science Education, Biology and Philosophy, PLOS One.

GENE: THE EVASIVE CONCEPT

The gene concept has been one of the landmarks in the history of science in the 20th century. Since its introduction by Wilhelm Johannsen in 1909, in the wake of his proposal of a distinction between genotype and phenotype, the history of the gene has been a winding road, departing from relatively humble beginnings as an instrumental concept that allowed handy calculations in classical genetics experiments. From these beginnings, it reached through a difficult struggle to understand the inner works of the cell the acme of an all-encompassing molecular concept that allowed one to understand at a single stroke the structure and function of the cell, or the inheritance and development of phenotypes. From those heydays, however, it slowly fell into a gorge of complexities concerning how genomes operate and uncertainties about what after all a gene is. At the end of the 20th century, there were persistent doubts about the prospects that this concept might remain as powerful and fruitful as it had been throughout the century. This raises a number of issues about the role of the gene concept in genetics education. How should we teach about a concept under siege by so many problems? In school science the so-called “classical molecular gene concept” has dominated for many years. According to it, a gene is a stretch of DNA that encodes a functional product, which can be either a single polypeptide chain or RNA molecule, and the gene is treated as an uninterrupted unit in the genome, with clear beginning and ending, performing – through the protein or RNA it codes – one single function. In this talk, we will first consider the history of the gene focusing on different models constructed along the past century to understand what genes are and how they function. We will discuss then the current situation, examining the phenomena challenging the way we understand genes (more specifically, the classical molecular concept) and appraising whether there is really a “crisis” of the gene concept. This will lead us to an analysis of different reactions to the difficulties faced by this concept and a discussion on what should we didactically transpose to school knowledge if we take these difficulties in due account. After reaching a conclusion on this didactical transposition issue, we will consider results of previous studies on how textbooks address genes, at the high school and higher education level, in order to see how close or far are we from what we might be discussing in school science in relation to this currently contested concept.

REVIEWERS

All the submitted proposals for the conference have been anonymously reviewed by at least two senior researchers. Here follow the list of the reviewers of the conference.

Indira Banner	UK
Orit Ben-Zvi Assaraf	Israel
Jelle Boeve de-Pauw	Belgium
Dirk Jan Boerwinkel	Netherlands
Franz Bogner	Germany
Jenny Byrne	UK
Graça Carvahlo	Portugal
Andrew Chandler-Grevatt	UK
Nina Christenson	Sweden
Pierre Clément	France
Laura Colucci-Gray	UK
Michael Dam	UK
Paul Davies	UK
Charbel El-Hani	Brazil
Marida Ergazaki	Greece
Niklas Gericke	Sweden
Maria José Gil Quilez	Spain
Marcus Grace	UK
Angela Hall	UK
Marcus Hammann	Germany
Pam Hanley	UK
Ute Harms	Germany
Chris Harrison	UK
Sue Howarth	UK
Neil Ingram	UK
Bruce Johnson	US
Marie-Christine Knippels	Netherlands
Konstantinos Korfiatis	Cyprus
Moritz Krell	Germany
Dirk Krüger	Germany
Ralph Levinson	UK
Mats Lundström	Sweden
Jürgen Mayer	Germany
Birgitta Mc Ewen	Sweden
Grégoire Molinatti	France
Marcelo Tadeu Motokane	Brazil
Ross Nehm	US
Claes Olander	Sweden
Mary Oliver	UK
Denise Orange	France
Penelope Papadopoulou	Greece
Blanca Puig Mauriz	Spain
Miia Rannikmäe	Estonia
Michael Reiss	UK
Ros Roberts	UK

Eliza Rybska	Poland
Graham Scott	UK
Nigel Skinner	UK
Andrej Šorgo	Slovenia
Karin Stolpe	Sweden
Tali Tal	Israel
Sue Dale Tunnicliffe	UK
Anna Uitto	Finland
Micha Ummels	Netherlands
Linda la Velle	UK
Roald Verhoeff	Netherlands
Susanne Walan	Sweden
Mark Winterbottom	UK
Anat Yarden	Israel
Jörg Zabel	Germany
Michal Zion	Israel
Vassiliki Zogza	Greece

INSTRUCTIONS FOR PRESENTATIONS

Posters and poster presentations
The conference poster boards are 180cm high x 70cm wide, so a portrait layout would be preferable. A1 posters will fit better; A0 posters are acceptable but will slightly exceed the size of the boards. They are pin boards (pins will be provided).

Before the traditional walkaround poster presentation you will be asked to present your poster in two minutes (maximum) for the audience as a whole. There is the opportunity to present the poster with the aid of Power-point slides (a maximum of two slides). The slides are optional.

The audience presentation will first take place in the lecture room as shown in the programme, while the posters will be put up on the boards at the open space outside the lecture room. Hence, the walkaround will take place in the open space outside the lecture room.

Make sure to hang up your poster well in time before the session starts.

Oral presentations (paper presentations)
The oral presentations should be maximum 15 minutes long. In addition there will be time for 5 minutes of questions and/or discussions after each presentation. Computers and projectors are available in all rooms. The easiest way is to bring your presentation on a memory stick and upload your presentation before the session starts.

Symposia
Symposia follow the same procedure as the oral presentations. Note that the number of participants might differ between symposia and there might be more time available for discussions at some symposia. The chair of the symposia is responsible for the timing of the symposia, and if there should be a longer summarizing discussion after all presentations are completed or short discussions after each paper.

Chair
The chair is responsible for ensuring that the session starts on time and that all presentations are given equal time frames. A few sessions include fewer or more contributions and in that case the time for discussion is extended or shortened accordingly, not the presentations. The chair takes responsibility for these possible accommodations.

INFORMATION ABOUT SUBMISSION OF PAPERS FOR THE ERIDOB 2016 PROCEEDINGS

All papers that were accepted for the ERIDOB 2016 conference, for a symposium, an oral or for a poster presentation, are welcomed to be considered for publication in the proceedings.

Submissions: Please submit your paper as a Microsoft WORD for Windows file to the EasyChair system. You will find the link at the conference website: https://www.kau.se/eridob-2016

The deadline: The final deadline for submission of papers is **November 30th 2016, 23:00 (CET).**

Special issue: Note that high quality papers will be selected for a special issue of *The Journal of Biological Education.*

The format: for instructions see the conference website: https://www5.kau.se/eridob-2016/proceedings

PROGRAMME

PROGRAMME AT A GLANCE

Time	Monday September 5th		
	Location: Värmlands museum		
09:00 - 17:00	Arriving at Karlstad		
17:00 - 20:00	Registration		
19:00 - 21:30	Welcome Reception		

Time	Tuesday September 6th		
	Location: Karlstad University		
09:00 - 09:30	Opening Session		
09:30 - 10:30	Keynote 1 – Ross Nehm		
10:30 - 11:00	Coffee Break		
11:00 - 12:30	Paper Session 1a - symposia 1	Paper Session 1b - symposia 2	Paper Session 1c
12:30 - 13:45	Lunch		
13:45 - 15:15	Poster Session 1a	Poster Session 1b	
15:30 - 17:00	Paper Session 2a	Paper Session 2b	Paper Session 2c
17:00 - 17:30	Coffee Break		
17:30 - 18:30	Meetings for Special Interest Groups (SIG)		

Time	Wednesday September 7th		
	Location: Karlstad Congress Culture Centre		
09:00 - 10:30	Paper Session 3a – symposia 3, part 1	Paper Session 3b	Paper Session 3c
10:30 - 11:00	Coffee Break		
11:00 - 12:45	Paper Session 4a – symposia 3, part 2	Paper Session 4b – symposia 4	Paper Session 4c
12:45 - 13:30	Lunch		
14:00 - 18:00	Tour – social event		

Time	Thursday September 8th		
	Location: Karlstad University		
09:00 - 10:30	Paper Session 5a	Paper Session 5b	Paper Session 5c
10:30 - 11:00	Coffee Break		
11:00 - 12:00	Paper Session 6a	Paper Session 6b	Paper Session 6c
12:15 - 13.15	Business meeting (all participants are invited)		
13:15 - 14:30	Lunch		
14:30 - 16:00	Poster Session 2a	Poster Session 2b	
16:00 - 16:30	Coffee Break		
16:30 - 18:10	Panel debate – The future of Biology Education Research		
19:30 - 23:00…	Conference Dinner (Location: KCCC)		

Time	Friday September 9th		
	Location: Karlstad Congress Culture Centre		
09:00 - 10:00	Keynote 2 – Charbel El-Hani		
10:00 - 10:30	Coffee Break		
10:30 - 12:00	Paper Session 7a	Paper Session 7b	Paper Session 7c
12.10 - 12.30	Closing session		
12:30 - 13:45	Lunch		

DETAILED PROGRAMME

	Monday
17:00 – 20:00	**Registration**
Location:	*Värmlands museum*
19:00 – 21:30	**Welcome Reception**
Location:	*Värmlands museum*

	Tuesday
08:00 – 16:00	**Registration**
Location:	*Building 12, Floor 2 (Karlstad University)*
09:00 – 09:30	**Opening Session**
Speaker:	Niklas Gericke and Åsa Bergenheim
Location:	*12A 138 (Karlstad University)*
09:30 – 10:30	**Keynote 1**
Title:	Thinking about evolutionary change: Concepts, contexts, and cognitive coherence
Speaker:	Ross Nehm
Location:	*12A 138 (Karlstad University)*
Chair:	*Niklas Gericke*
10:30 – 11:00	**Coffee Break**
Location:	*Building 12, Floor 2 (Karlstad University)*
11:00 – 12:30	**Parallel paper session 1**
	Paper session 1a – symposia 1: Learning biology in informal settings
Location:	*12B 150 (Karlstad University)*
Chair	*Sue Dale Tunnicliffe*
Title:	The unexpected: Provoking questions at natural history dioramas
Author:	Annette Scheersoi and Sue Dale Tunnicliffe
Title:	Why do Parrots Talk?: Co-investigation as a model for promoting family learning in natural history galleries
Author:	Emily Harris and Mark Winterbottom
Title:	Learning about the human body with medical simulators
Author:	Tali Tal and Sameer Dallashe
Title:	Budding biology teachers: What have botanical gardens got to offer inquiry learning
Author:	Melissa Glackin and Christine Harrison

	Paper session 1b – symposia 2: **Socio-scientific based inquiry in the context of biology teaching**
Location:	*12A 138 (Karlstad University)*
Chair:	*Ralph Levinson*
Title:	Toward socio-scientific inquiry-based learning
Author:	Ralph Levinson
Title:	Socio-scientific inquiry in pre-service education: Challenges and opportunities
Author:	Andri Christodoulou, Ruth Amos and Marcus Grace
Title:	Pre-service teachers' experiences of learning to teach biology through a Socio-Scientific Inquiry-Based Learning (SSIBL) approach
Author:	Marie-Christine Knippels, Roald Verhoeff and Paulien Postma
Title:	The devices of the "démarche d'enquête": The example of the cartography of controversy
Author:	Lucas Nedelec, Gregoire Molinatti, Jean Simonneaux, Laurence Simonneaux, Nicolas Herve and Amelie Lipp
	Paper session 1c – Scientific thinking, nature of science and argumentation
Location:	*12B 257 (Karlstad University)*
Chair:	*María José Gil-Quílez*
Title:	How, when and why? An analysis of primary students' science questions
Author:	Beatriz Bravo-Torija, María José Gil-Quílez, Begoña Martínez-Peña and Belén Embid
Title:	Argumentation, ecology and novels
Author:	Isabel Pau Custodio, Conxita Márquez Bargalló and Anna Marbà-Tallada
Title:	Young children's reasoning when sorting pictures and objects
Author:	Marida Ergazaki, Renia Gasparatou and Eftychia Valanidou
12:30 – 13:45	**Lunch**
Location:	*Building 21 A, Floor 1 (Karlstad University)*
13:45 – 15:15	**Parallel poster session 1**
	Poster session 1a – Teaching strategies and teaching environments
Location:	*12B 150 (Karlstad University)*
Chair:	*Karin Thörne*
	Papers in alphabetical order based on first author surname
Title:	Poster-making knowledge organization activities as a significant component in developing an evolutionary perception in an informal learning environment
Author:	Dina Agadi, Orit Ben-Zvi Assaraf, Yael Gavrieli and Ilil Pratt

Title:	Design of a one day course to improve mathematical confidence of A-level biology teachers in England
Author:	Christian Bokhove, Carys Hughes and Janice Griffiths
Title:	'Playing Darwin': Using drama to teach about evolution
Author:	Martin Braund
Title:	Pre-service teachers' awareness on the teaching strategies involving socioscientific issues, inquiry-based science education to enhance socioscientific inquiry-based learning
Author:	Shu-Nu Chang Rundgren and Carl-Johan Rundgren
Title:	Retrieval practice: A strategy to enhance inquiry learning?
Author:	Anne Erichsen and Jürgen Mayer
Title:	Should we care about the bees? Argumentation and modeling to understand an SSI with pre-service teachers
Author:	Maria Evagorou and Blanca Puig Mauriz
Title:	Blended learning in school to increase learning success during dissections in biology class: A pig heart dissection as an example
Author:	Marc Gerhard
Title:	Bugs Everywhere! An inquiry-based teaching strategy using arthropods for biology learning in primary school
Author:	Marti Hendrichs, Janet Gruber, Martin Scheuch and Günther Pass
Title:	Does generation of prior knowledge enhance efficacy in inquiry learning?
Author:	Irina Kaiser and Jürgen Mayer
Title:	The contribution of natural history museums to science education
Author:	Michael Reiss
Title:	Understanding immunobiological processes – The development and evaluation of a teaching unit based on learning potentials
Author:	Sonja Tinapp and Jörg Zabel
Title:	Guiding to guide: Teaching pre-service teachers to guide inquiry-based learning
Author:	Masha Tsaushu and Irit Sadeh
Title:	Seeking teacher and students opinions about the use of a motivational context-based biology teaching-learning module – A case study
Author:	Ana Valdmann and Miia Rannikmäe
Title:	Stress responses of high school students towards tasks accompanied by molecular or symbolic representations
Author:	Friederike Westermann, Wolfgang H. Kirchner and Nina Minkley

Poster session 1b – Environmental education; Practical work and field work

Location: *12B 257 (Karlstad University)*

Chair: *Susanne Walan*

Papers in alphabetical order based on first author surname

Title:	Learning about climate change: The use of metaphor
Author:	Indira Banner, Alice Deignan and Shirley-Ann Paul
Title:	Environmental Literacy in practice: Education on tropical rainforest and climate change
Author:	Kerstin Bissinger and Franz X. Bogner
Title:	Affective factors influencing the intentions of teachers to promote the return of the wolves in educational contexts
Author:	Alexander Buessing, Maike Schleper and Susanne Menzel
Title:	Students´ perspectives on developing an urban school garden
Author:	Ingela Bursjöö
Title:	Effective field trips in nature: The interplay between novelty, preparation and learning outcomes
Author:	Jan van Hoof, Jelle Boeve-de Pauw and Peter van Petegem
Title:	The effect of school garden activities on pre service student teachers' attitudes to teaching biology outside the classroom
Author:	Lissy Jäkel, Ulrike Kiehne and Sabrina Friess
Title:	The development of ecological attitudes of children over five years as they participated in three eartheducation programs
Author:	Bruce Johnson and Jan Činčera
Title:	Teachers thoughts about biodiversity education, plant species recognition and outdoor education
Author:	Arja Kaasinen
Title:	The role of school internships for future biology teachers: A comparison between short- and long-term internships concerning stress load and professional competencies
Author:	Miriam Rest and Wolfgang H. Kirchner
Title:	Promoting children's understanding of forest ecosystem composition: field studies vs conventional classroom teaching
Author:	Eliza Rybska, Katarzyna Białas and Costas P. Constantinou
Title:	Teachers learning in a citizen science project: PCK for nature in the backyard
Author:	Martin Scheuch, Tanja Panhuber and Suzanne Kapelari

Title:	Geographical and mobile information technologies and phenology in European schools: State of the art
Author:	Linda La Velle, Jan Georgeson and Egidijus Čeponis
Title:	Biodiversity in the digital world – Creating experience with local biodiversity by using digital media
Author:	*Judith Wiegelmann, Alexander Finger and Jörg Zabel*
15:30 – 17:00	**Parallel paper session 2**
	Paper session 2a – Scientific thinking, nature of science and argumentation
Location:	*12A 138 (Karlstad University)*
Chair:	*Anat Yarden*
Title:	Systemic Functional Linguistics (SFL) as a means to reveal possible differences between scientific Text genres in the promotion of scientific literacy
Author:	Moriah Ariely, Zohar Livnat and Anat Yarden
Title:	Biology: The ultimate science for teaching an understanding of scientific evidence
Author:	Ros Roberts
Title:	What makes biological experiments difficult? Analysis of difficulty generating characteristics of multiple choice-tasks
Author:	Moritz Krell
Title:	A didaktik analysis of an integrative research project in biology: Meetings between the different forms of knowledge
Author:	Veronica Flodin
	Paper session 2b – Health education
Location:	*12B 257 (Karlstad University)*
Chair:	*Jenny Byrne*
Title:	A longitudinal study of the impact of pre-service teacher training in health education and the implications for biology teaching
Author:	Jenny Byrne, Willeke Rietdijk and Karen Pickett
Title:	The influence of meta-cognitive guidance on drink-related nutritional literacy
Author:	Hagit Cohen and Michal Zion
Title:	The contribution of epistemological beliefs to informal reasoning regarding health socio-scientific issues
Author:	Andreani Baytelman, Kalypso Iordanou and Costas Constantinou

	Paper session 2c – Environmental education
Location:	*12B 150 (Karlstad University)*
Chair:	*Orit Ben-Zvi Assaraf*
Title:	Using ecological networks in teaching the badger-cattle controversy in U.K. schools
Author:	Joanne Nicholl, Ralph Levinson and Paul Davies
Title:	Do students who are exposed to a contaminated environment develop a sense of connectedness to nature?
Author:	Wisam Sedawi, Orit Ben-Zvi Assaraf and Michael Reiss
Title:	Smartphone Games in the context of ESD - Fostering Connectedness to nature with Geogames
Author:	Joachim Schneider and Steffen Schaal
Title:	BioDiv2Go – does the location-based Geogame „FindeVielfalt Simulation“ increase the valuing of local biodiversity among adolecent players?
Author:	Sonja Schaal, Steffen Schaal and Armin Lude
17:00 – 17:30	**Coffee Break**
Location:	*Building 12, Floor 2 (Karlstad University)*
17:30 – 18:30	**Meetings for Special Interest Groups (SIG)**
	The SIG-groups that formed at last ERIDOB-conference will be given a room for further discussion. All SIG-meetings are open for any conference participant that might want to join.
Location:	Building 12, definite rooms will be announced at the conference (Karlstad University)
	Wednesday
09:00 – 10:30	**Parallel paper session 3**
	Paper session 3a – symposia 3, Environmental literacy – Grounded in theory and approved in environmental/sustainability education practice – Part 1
Location:	*Room Zarah, floor 4 (Karlstad Congress Culture Centre)*
Chair:	*Franz X. Bogner*
Title:	Quantifying environmental citizenship: Sound integration of established psychometric models
Author:	Franz X. Bogner
Title:	Ecological values & connectedness to nature: Are we measuring different constructs?
Author:	Bruce Johnson, Constantinos Manoli and Buxner Sanlyn
Title:	The effectiveness of education for sustainable development: Pluralism and holism in the classroom
Author:	Jelle Boeve-de Pauw, Niklas Gericke, Daniel Olsson and Teresa Berglund

	Paper session 3b – Students' values, attitudes and decision-making
Location:	*Room Leander, floor 4 (Karlstad Congress Culture Centre)*
Chair:	*Carl-Johan Rundgren*
Title:	The interrelationship of value and knowledge in students' socio-scientific inquiry-based learning
Author:	Carl-Johan Rundgren, Martin Eriksson and Shu-Nu Chang Rundgren
Title:	Views of students in agriculture about the issue of "pest animals" – Wolves in France
Author:	Laurence Simonneaux and Jean Simonneaux
Title:	Students' motivation when mediating a socio-scientific dilemma
Author:	Melanie Basten and Matthias Wilde
Title:	Students' environmental concerns and perceptions of forest ecosystem services
Author:	Gregor Torkar
	Paper session 3c – Special theme: Teaching and learning evolution
Location:	*Room Sola, floor 4 (Karlstad Congress Culture Centre)*
Chair:	*Ute Harms*
Title:	How to measure students' understanding of randomness and probability in the context of evolution?
Author:	Daniela Fiedler and Ute Harms
Title:	Prevalence and characterization of threshold concepts in dynamic visualizations of evolution
Author:	Lena Tibell, Andreas Göransson, Gustav Bohlin, Konrad Schönborn, Gunnar Höst, Daniel Orraryd, Nalle Jonsson, Jörgen Stenlund, Jan Anward, Daniela Fiedler and Ute Harms
Title:	The natural history perspective on bio-communities – A stepping-stone to evolutionary thinking in lower secondary school
Author:	Martin Jurgowiak and Jörg Zabel
Title:	Analysing evolution learning outcomes in a natural history museum
Author:	Kerstin Kremer and Julia Arnold
10:30 – 11:00	**Coffee Break**
Location:	*Floor 4 (Karlstad Congress Culture Centre)*

11:00 – 12:45	**Parallel paper session 4 and symposia**
	Paper session 4a – symposia 3: Environmental literacy – Grounded in theory and approved in environmental/sustainability education practice – Part 2
Location:	*Room Zarah, floor 4 (Karlstad Congress Culture Centre)*
Chair:	*Franz X. Bogner*
Title:	As personality predicts individual willingness for conservation
Author:	Christine Thorn and Franz X. Bogner
Title:	Individual willingness to protect honeybees: Perception conflict of hazards and conservation
Author:	Mona Schönfelder and Franz X. Bogner
Title:	An explorative study of student understandings of the relationships between the environment and the economy
Author:	Teresa Berglund and Niklas Gericke
Title:	The gender gap in environmental and sustainability education - A cross sectional study of Swedish students from grade six, nine and twelve
Author:	Daniel Olsson and Niklas Gericke
	Paper session 4b – symposia 4: Fostering a philosophical stance toward science: Thoughtfulness and creativity in the biology classroom
Location:	*Room Leander, floor 4 (Karlstad Congress Culture Centre)*
Chair:	*Jörg Zabel*
Title:	The role of moral intuitions in students' decision-making on neuroethical issues
Author:	Alexander Bergmann and Jörg Zabel
Title:	Everyday myths about genetic fingerprinting: Philosophizing with students in the experimental Lab
Author:	Arne Dittmer
Title:	Techno-moral-vignettes in socio-scientific issues-based education on synthetic biology
Author:	Marie-Christine Knippels, Alexandra Slegers and Arend Jan Waarlo
Title:	Towards an ethics of nature: A pedagogy of openness
Author:	Ralph Levinson and Shone Surendran
Title:	Does thoughtfulness need irritation? Case studies about decision-making in biology class
Author:	Britta Lübke and Ulrich Gebhard

	Paper session 4c – Special theme: Teaching and learning evolution
Location:	*Room Sola, floor 4 (Karlstad Congress Culture Centre)*
Chair:	*Marcus Hammann*
Title:	Re-examining the Relationship between acceptance and understanding of evolutionary theory
Author:	Christiane Konnemann, Roman Asshoff and Marcus Hammann
Title:	Thinking across levels of biological organizations: Does knowledge of genetics help students avoid teleological explanations of evolutionary phenomena?
Authors:	Janina Jördens and Marcus Hammann
Title:	Teleological explanations in evolution classes
Author:	Helge Gresch
Title:	Teleological and causal explanations: Students' preference and acceptance judgments as well as the reasons they give for their choice
Author:	Friederike Trommler, Helge Gresch and Marcus Hammann
12:45 – 13:30	**Lunch**
Location:	*Floor 5 (Karlstad Congress Culture Centre)*
14:00 – 18:00	**Social events**
Location:	*Information about attending and transportation to the social events is available in the Conference book and the Conference website: https://www5.kau.se/eridob-2016/social-activities-and-tours*

	Thursday
09:00 – 10:30	**Parallel paper session 5**
	Paper session 5a – Teaching strategies and teaching environments
Location:	*12B 150 (Karlstad University)*
Chair:	*Clas Olander*
Title:	Change in high-school biology teachers' pedagogical content knowledge
Author:	Inbal Flash Gvili and Anat Yarden
Title:	Representations as meditation when learning about the human body in lower secondary
Author:	Clas Olander, Per-Olof Wickman, Russell Tytler and Åke Ingerman
Title:	Teaching biology using role-play simulations: Impacts of student teachers' lessons
Author:	Martin Braund, Christelle Ekron and Zaiboenisha Ahmed
Title:	Teacher-students' lesson plans about scientific inquiry in experimental biology pertaining to professional knowledge
Author:	Robert Blank, Josiane Tardent and Holger Weitzel

Paper session 5b – Students' conceptions and conceptual change

Location: *12A 138 (Karlstad University)*

Chair: *Dirk Jan Boerwinkel*

Title: Revealing conceptual progression during learning identifies difficulties, anchors discussion of design weaknesses, cognitive construals, epistemic obstacles

Author: Francois Lombard, Marie Merminod, Widmer Vincent and Daniel K. Schneider

Title: Problems in defining phenotype and hereditary trait

Author: Dirk Jan Boerwinkel, Daniel van Draanen, Birgit Duijts and Amarja Koers

Title: Between freedom and rule – How can we understand students' moral conceptions about livestock farming and meat consumption?

Author: Nadine Alexandra Tramowsky and Jorge Groß

Title: Nutrition from the soil – The unexpected outcome of teaching experiments about photosynthesis

Author: Denis Messig and Jorge Groß

Paper session 5c – Students' interest and motivation

Location: *12B 257 (Karlstad University)*

Chair: *Matthias Wilde*

Title: Working approaches contributing grade nine students' attitudes and performance in biology

Author: Anna Uitto

Title: Why structure needs to be provided autonomy-supportive – The effects of structure and autonomy support on motivation

Author: Alexander Eckes, Detlef Urhahne and Matthias Wilde

Title: Do interest and motivation influence students´ test performance while working on context-based tasks?

Author: Mariella Roesler, Nicole Wellnitz and Jürgen Mayer

Title: CLIL Biology – Teaching Biology in a foreign language. The influence of classroom language on student motivation and acquisition of knowledge

Author: Petra Duske and Michael Ewig

10:30 – 11:00 **Coffee Break**

Location: *Building 12, Floor 2 (Karlstad University)*

11:00 – 12:00	**Parallel paper session 6**
	Paper session 6a – Research methods and theoretical issues
Location:	*12A 138 (Karlstad University)*
Chair:	*Amelia Abrie*
Title:	Cultural historical activity theory: A lens to explore the teaching of biology as antidote to plant blindness
Author:	Amelia Abrie
Title:	Development and use of test instruments to study the diagnostic-based practical knowledge of prospective teachers
Author:	Julia Warnstedt and Corinna Hößle
Title:	Acquiring diagnostic skills in the "Wadden Sea´s Teaching and Learning Laboratory"
Author:	Lea Brauer and Corinna Hößle
	Paper session 6b – Environmental education
Location:	*12B 150 (Karlstad University)*
Chair:	*Konstantinos Korfiatis*
Title:	Informal nature experiences on green schoolyards
Author:	Andreas Raith and Armin Lude
Title:	Garden-based Learning: Short- and medium-term influence of a school kitchen garden project on elementary school students' environmental literacy
Author:	Stella Petrou and Konstantinos Korfiatis
Title:	Pupils' views of their outdoor learning
Author:	Pia Sjöblom and Maria Svens
	Paper session 6c – Teaching and learning with educational technology
Location:	*12B 257 (Karlstad University)*
Chair:	*Anna Uitto*
Title:	A case study of augmented reality location-based game for learning conceptual biological models
Author:	Tuomas Aivelo and Anna Uitto
Title:	Cognitive activities related to the understanding of visual representations in biology
Author:	Miriam Brandstetter, Christine Florian and Angela Sandmann
Title:	Biology teacher students' use of technical language in video journals
Author:	Till Bruckermann, Büsra Aydemir, Melina Neumann, Ayse Özcan, Vincent Söbbing and Kirsten Schlueter

12:15 – 13:15	**Business meeting,** All conference participants are invited Location
Location:	*12A 138 (Karlstad University)*
Chair:	*Marcus Grace*
13:15 – 14:30	**Lunch**
Location:	*Building 21 A, Floor 1 (Karlstad University)*
14:30 – 16:00	**Parallel poster session 2**
	Poster session 2a - Students' conceptions and conceptual change; Health education
Location:	*12B 150 (Karlstad University)*
Chair:	*Nina Christenson*
	Papers in alphabetical order based on first author surname
Title:	Promoting school learners' understanding of genomics: Determining the basis for further research and curriculum development
Author:	Jeremy Airey, Julia Willingale-Theune, Alistair Moore and Francesca Gale
Title:	A new model for health behaviour
Author:	Julia Arnold and Kerstin Kremer
Title:	Can high school students develop a structural mental system model that presents the human body as a coherent whole?
Author:	Orit Ben-Zvi Assaraf, Jaklin Tripto and Miriam Amit
Title:	What´s Brazilian children think is inside a crab?
Author:	Amauri Bartoszeck and Sue Dale Tunnicliffe
Title:	Assessing knowledge and academic success in biology and physics
Author:	Torsten Binder, Heike Theyßen, Angela Sandmann and Philipp Schmiemann
Title:	Using video vignettes as cases to foster pre-service teachers' diagnostic and design abilities
Author:	Sarah Dannemann and Harald Gropengießer
Title:	Pointing in the right direction: The effect on student reading comprehension of including directional arrows in images of the energy pyramid
Author:	Yun-Ping Ge, Len Unsworth, Kuo-Hua Wang and Huey-Por Chang
Title:	Students' conceptions about pollination and its role in the life cycle of flowering plants
Author:	Peter Lampert, Suzanne Kapelari, Peter Pany, Michael Kiehn and Martin Scheuch

Title:	Once again? - How an upcoming vaccination debate is portrayed in (Swedish) media
Author:	Mats Lundström, Karin Stolpe and Nina Christenson
Title:	Stress and emotions during experimental work in biology education: What role does the work setting play?
Author:	Nina Minkley, Tobias Ringeisen, Lukas Josek and Tobias Kärner
Title:	Understanding of evolution through natural selection among students in university education
Author:	Rianne Pinxten, Mathieu Desclée and Sven De Maeyer
Title:	Health and wellbeing – The school garden, a place to feel good
Author:	Susan Pollin and Carolin Retzlaff-Fürst
Title:	Conceptions of the students about amphibians and reptiles
Author:	Zofia Sajkowska and Eliza Rybska

Poster session 2b, Scientific thinking, nature of science and argumentation; Teaching and learning with educational technology

Location: *12B 257 (Karlstad University)*

Chair: *Birgitta Mc Ewen*

Papers in alphabetical order based on first author surname

Title:	Representational competence in integrating multiple external representations (MERs) in biology education
Author:	Christina Beck and Claudia Nerdel
Title:	Factors influencing future biology teachers' motivation to teach in inclusive classrooms
Author:	Valerie Beckmann and Susanne Menzel
Title:	Instructional support for learning concepts in evolutionary theory with visualizations
Author:	Devasmita Chakraverty, Daniela Fiedler and Ute Harms
Title:	The gene concept in higher education cell and molecular biology textbooks
Author:	Neima Alice Menezes Evangelista and Charbel El-Hani
Title:	Analysis of the presentation of age in school books at primary school and lower secondary school level
Author:	Franziska Ginschel and Kirsten Schlueter
Title:	The meaning of biology teachers' content knowledge, pedagogical content knowledge, and enthusiasm for students' system thinking
Author:	Jörg Großschedl, Daniela Mahler and Ute Harms

Title:	Students' task-solving regarding ecosystem services – A comparison between students with and without Autism Spectrum Disorders
Author:	Mona Holmqvist
Title:	Developing inquiry-based and multidiciplinary approach in a teacher professional development project
Author:	Anttoni Kervinen, Anna Uitto, Arja Kaasinen, Päivi Portaankorva-Koivisto, Merike Kesler and Kalle Juuti
Title:	Assessing biological literacy skills of gymnasium students following implementation of a new competence-based biology curriculum
Author:	Anne Laius, Aveliis Post and Miia Rannikmäe
Title:	Integrating mobile learning in an inquiry based unit concerning the functions of flower
Author:	Charalambia Lazaridou and Zacharias Zacharia
Title:	A historical approach in teaching biological concepts and the nature of science and technology using an ancient technology
Author:	Yeung Chung Lee
Title:	The need of teacher professional development in rapidly expanding fields of biology
Author:	Birgitta Mc Ewen
Title:	Intrinsic motivation in bilingual courses in an out-of-school Lab
Author:	Annika Rodenhauser and Angelika Preisfeld
Title:	Development and evaluation of a project class "human evolution" on the basis of authentic teaching materials
Author:	Ira Synoracki, Miriam Rest and Wolfgang Kirchner
Title:	Descriptions of the protein synthesis in upper secondary biology and chemistry textbooks – An educational data mining approach
Author:	Sara J. Wahlberg and Niklas M. Gericke
Title:	Exploring aspects of scientific media literacy in relation to upper secondary school biology curriculum
Author:	Jonna Wiblom, Carl-Johan Rundgren and Maria Andrée

16:00 – 16:30 **Coffee Break**

Location: *Building 12, Floor 2 (Karlstad University)*

16:30 – 18:10	**Panel debate**
Title:	The future of Biology Education Research
Location:	*12A 138 (Karlstad University)*
Chair:	*Bill McComas*
Panel participants:	Bill McComas, Dirk Jan Boerwinkel, Pierre Clément, Edith Dempster, Yeung Chung Lee, Clas Olander, Michael Reiss, Anat Yarden
Title:	The science of science education: Knowing what we do not know about biology instruction
Author:	Bill McComas
Title:	Developing a conceptual framework for research in biology didactics
Author:	Michael Reiss
Title:	Educational experiences to produce informed and effective biology teachers
Author:	Edith Dempster
Title:	Challenges of teaching biology in different sociocultural contexts
Author:	Pierre Clément
Title:	Developing teachers' professional and pedagogical content knowledge
Author:	Clas Olander
Title:	Theoretical and practical approaches: Making biology accessible to all learners
Author:	Yeung Chung Lee
Title:	Beyond memorization: Making biology an authentic science in the classroom
Author:	Anat Yarden
Title:	Lessons learned: Effective outreach to biology teachers
Author:	Dirk Jan Boerwinkel and Arend Jan Waarlo
19:30 – 23.00…..	**Conference Dinner**
Location:	*Karlstad Congress Culture Centre*

	Friday
09:00 – 10:00	**Keynote 2**
Title:	Gene: The evasive concept
Speaker:	Charbel N. El-Hani
Location:	*Room Sola, floor 4 (Karlstad Congress Culture Centre)*
Chair:	*Niklas Gericke*

10:00 – 10:30	**Coffee Break**
Location:	Floor 4 (Karlstad Congress Culture Centre)
10:30 – 12:00	**Parallel paper session 7**
	Paper session 7a – Teaching strategies and teaching environments
Location:	*Room Sola, floor 4 (Karlstad Congress Culture Centre)*
Chair:	*Iris Schiffl*
Title:	Inter-rater reliability in evaluating cognitive demand and level of difficulty of high-stakes Biology examination papers
Author:	Edith Dempster and Nicola Kirby
Title:	Effects of teachers' professional knowledge on the use of high-complexity instructional tasks and students' achievement
Author:	Christian Förtsch, Sonja Werner, Lena von Kotzebue and Birgit Neuhaus
Title:	Diagnosis of inquiry competencies using hands-on experiments with Mongolian gerbils
Author:	Iris Schiffl and Carina Wurdinger
Title:	A role-play based tutor training in biology-teacher education: Optimizing tutor-student interactions in the context of an outreach lab
Author:	Franz-Josef Scharfenberg and Franz X. Bogner
	Paper session 7b – Students' conceptions and conceptual change
Location:	*Room Zarah, floor 4 (Karlstad Congress Culture Centre)*
Chair:	*Marida Ergazaki*
Title:	Can the idea of the 'balanced nature' be challenged? Students' reasoning about disturbed and protected ecosystems after a teaching intervention and one year later
Author:	Georgios Ampatzidis and Marida Ergazaki
Title:	Learning at natural history dioramas: A model for interpreting museum biological settings
Author:	Edward Mifsud and Sue Dale Tunnicliffe
Title:	Item context effects in evolution assessment
Author:	Ulrike Betzitza and Holger Weitzel
Title:	Teachers' conceptions of environment in West Africa
Author:	Pierre Clement, Jérémy Castera, Lawrence Ntam Nchia, Laurence Ndong, Ivette Bere-Yoda, Mame Seyni Thiaw and Mensan Azadzi Dzamayovo
	Paper session 7c – Scientific thinking, nature of science and argumentation

Location:	*Room Leander, floor 4 (Karlstad Congress Culture Centre)*
Chair:	*Blanca Puig*
Title:	Students' arguments and argumentation to explain the evolutionary links between two human diseases
Author:	Noa Ageitos Prego and Blanca Puig
Title:	The impact of peer discussions on students' arguments when addressing socio-scientific issues in biotechnology
Author:	Birgitta Berne
Title:	Analysis of justifications in pre-service teachers' socioscientific arguments about diets
Author:	Pablo Brocos and María Pilar Jiménez-Aleixandre
Title:	Teachers' beliefs about argumentation - A comparison in the context of the disciplinary cultures of biology and language education
Author:	Julia Schwanewedel, Finja Grospietsch and Patricia Heitmann

12:10 – 12:30	**Closing session**
Location:	*Room Sola, floor 4 (Karlstad Congress Culture Centre)*
Chair:	*Niklas Gericke and Marcus Grace*

12:30 – 13:45	**Lunch**
Location:	*Floor 5 (Karlstad Congress Culture Centre)*

ABSTRACTS

FOR PAPER AND POSTER PRESENTATIONS

Here follows the abstracts for the paper and poster presentations in alphabetic order by the first author's surname

Cultural historical activity theory: A lens to explore the teaching of biology as antidote to plant blindness

Amelia Abrie

Keywords: Activity theory, Botany teaching, Biology teaching, Cultural historical activity theory, Plant blindness

Type of presentation: Oral

Plant blindness' has been coined by Wandersee and Schussler (1999) to describe the lack of appreciation for the importance of plants. Studies have shown that botanical content is in decline in biological curricula, with a corresponding lack of plant related knowledge and interest in students. Botanical education is a powerful way to combat plant blindness. Teaching botany is a complex phenomenon and numerous factors contribute to the complexity of the teaching activity, often leading research to appear fragmented and unconnected.

This study posed the question whether the Cultural Historical Activity Theory (CHAT) (Engeström,1993) is a suitable framework for the analysis, interpretation and modelling of teaching activities. It also questioned whether CHAT can be applied to exploring the object oriented activity of teaching botany to combat plant blindness.

This presentation focuses on qualitative data collected from 13 secondary school teachers (the subject in the activity system) using semi-structured interviews. Using this data, it was possible to establish a preliminary account of the activity system, demonstrating the usefulness and complexity of CHAT for teaching activities.

Components that had the greatest influence on the activity system were characteristics of the teachers themselves, tools, the community and rules, although links were found between all the components of the system. The teachers were experienced and devoted to teaching, but some disliked teaching botany. Their teaching was greatly influenced by their undergraduate training. The community factors that had the greatest influence on the teaching of botany were the teachers' undergraduate lecturers, the socio-economic backgrounds of schools and parents that limited resource availability and learners' negative attitudes towards botany. Tools, including the absence, availability and quality of resources such as classrooms, textbooks, laboratories and funding for specialised teaching activities such as field trips, profoundly constrained or promoted teaching activities. The most prominent rules in the activity system were the recontextualisation (Bernstein, 1990) of botanical content in the curriculum, rapid recurriculation and time and resource constraints imposed by the curriculum and the school. The rules reflect the division of labour of various members of the community.

This study demonstrated that CHAT is a useful tool to explore teaching as an activity system. Teaching botany for combatting plant blindness was shown to be influenced by a complex system of interconnected, interactive factors that may guide future interventions.

Poster-making knowledge organization activities as a significant component in developing an evolutionary perception in an informal learning environment

Dina Agadi, Orit Ben Zvi Assaraf, Yael Gavrieli and Ilil Pratt

Keywords: Evolution, Informal learning, Outdoor learning

Type of presentation: Poster

Today, despite its importance as one of the central ideas in biology, evolution is largely absent from formal 5th-6th grade science education curricula. This lack of support from the formal curriculum has led to the formation of out-of-classroom, informal learning environments for teaching evolution. Our study examines such an environment – "Nature Campus" at Tel Aviv University - seeking to characterize its effect on students' perceptions of evolutionary ideas and principles.

Nature Campus includes national collections that gather, document and study local biodiversity, a zoological research garden that houses the largest collection of animals in Israel, botanical gardens that exemplify life in various habitats. This study examines a program for 6th graders (58 in all), which combines laboratory hours with guided tours in the gardens. It includes four "science days", in which students interact directly with the skulls and stuffed bodies of animals, conduct structured observations in the zoological and botanical gardens, hear lectures and participate in knowledge organization activities. One such activity is making posters, for presentation to the class, which tell the story of the students' experience on the science day.

After each meeting, the children split into groups of 4-5 to make posters for presentation during class discussion. The students received pictures of objects they encountered during the science day and asked to use these in a poster that reflects their perception of what they learned. The poster making processes were analyzed to identify how the students used their science day experiences to present core ideas about evolution and the nature of science.

Analysis of the group poster-making discussions showed that working on the poster encouraged discussion and interaction between the students, resulting in meaningful learning outcomes. These outcomes were influenced by the social interactions in each group, and by the relative dominance of individual members in them.

Students' arguments and argumentation to explain the evolutionary links between two human diseases

Noa Ageitos Prego and Blanca Puig

Keywords: Arguments, Argumentation, Genetics, Human diseases, Secondary students

Type of presentation: Oral

This paper focuses on students' arguments and argumentation about the evolutionary links between two human diseases. Even thought there is a big body of research on argumentation, little is known about students' enactment of this practice in the context of explaining and decision-making on human diseases.

We design a unit that requires modeling gene expression to explain different human diseases. This study focuses on students' argumentation in five small groups in a 10th grade classroom (N=20), while working on a task that requires developing explanatory links between sickle cell disease and malaria. The design of the task includes four sets of data that are provided to students progressively in order to construct arguments that enable them to reach a final conclusion about the links between both diseases. The structure of the task seeks to make the students to evaluate and revise their own arguments in the light of the new evidence provided. We aim to explore:

1) Students' arguments to explain the evolutionary links between sickle cell disease and malaria.
2) Students' argumentation, particularly how are their discursive narratives in terms of the background knowledge behind them.

The methodological approach is qualitative and draws from discourse analysis (Gee, 2005). Data collection includes audio and video recordings, students' written reports and the researcher field notes. For the analysis of objective 1, we apply Toulmin's model (1958) of argumentation for the identification of the elements of students' written arguments. Then, for analyzing the quality of the arguments, we focus on four criteria adapted from Ruy's and Sandoval's rubric (2011): 1) argument structure, 2) argument coherence, 3) data mentioned, 4) justifications. We found that most of the groups focus on describing the information provided rather than in using and explaining them for justifying their claims.

The analysis of objective 2 reveals that some groups build their explanations on historic ideas about black slaves and identify the origin of sickle cell disease on blacks. This result has social implications related to biological determinism.

Promoting school learners' understanding of genomics: Determining the basis for further research and curriculum development

Jeremy Airey, Julia Willingale-Theune, Alistair Moore and Francesca Gale

Keywords: Curriculum development, Genetics education, Genomics education, Pedagogy

Type of presentation: Poster

Ten years after the completion of the Human Genome Project, school science faces a challenge: how to move beyond the traditional focus on the functions and inheritance of single genes to promote children's understanding of the science and importance of genomics. At the onset of this study there was no clear understanding in the UK curriculum development and informal science communities of pedagogical approaches to helping children understand genomics, of the availability of related teaching and learning resources, or of factors influencing their design and use. This collaborative study, conducted by the Public Engagement team at the Wellcome Genome Campus (WGC) and the University of York Science Education Group (UYSEG), comprised three main objectives: 1) to conduct and analyse a discussion amongst the UK biology education research community to gain their perspectives on key issues in genomics education; 2) to complete a landscape review of research regarding the teaching and learning of ideas related to genomics; and 3) to survey resources available to support teaching and learning of genomics-related biology. Members of the Biology Education Research Group (BERG) of the Royal Society of Biology (RSB) were invited to contribute to a discussion, using methodology derived from the Delphi Technique. Four major issues emerged from the discussion: practice in schools, professional development for teachers, curriculum development and the place of Mendelian genetics. The landscape review of the literature on genomics education employed a simplified version of the systematic review methods developed by the Evidence, Policy and Practice Initiative (EPPI) Centre. 112 papers passed through the inclusion criteria, of which 29 have been identified for in-depth analysis (including cross-matching to the themes from the Delphi exercise). Data collection and analysis for the web survey of teaching and learning resources is underway, to develop a typology of resources and identify archetypes. The outputs of this study can be used to inform further research as well as curriculum development. It is envisaged that genomics curriculum development would espouse the design and recommendations for use of pedagogically sound learning progressions, teaching and learning resources, and teacher professional development elements.

A case study of augmented reality location-based game for learning conceptual biological models

Tuomas Aivelo and Anna Uitto

Keywords: Augmented reality, Conceptual model, Digital gaming strategies, Teacher education, Volutionary biology learning

Type of presentation: Oral

Increasing use of mobile phones makes it possible to connect learning outside the classroom with interactive computer games. We designed an augmented reality location-based game, Parasite Race, to make evolutionary biology concepts more tangible. The players can choose between three different parasite species with differing life cycles and two evolutionary strategies. The idea of the game is to model explicitly both evolutionary and ecological processes linked to parasitic lifestyle. We tested the game with in-service teacher-training workshop participants, recorded their gameplay and had group interviews after testing the games. The players had a wide range of different approaches to the game. While some players were able to reflect their gameplay and actions, other players did not collect points as quickly and they lost their motivation quickly. While there were no difference between these groups in how big proportions of their gameplay choices were beneficial, the more successful players performed more actions. The successful players were, though, quick to increase their success rate while the game progressed. Nevertheless, most of the players did not understand the game as a model before group interviews meaning their learning during the game was based on simple heuristics. Thus our results suggest it is important to reflect the meaning of models and simulations in the game not only during the gameplay, but also before and after the actual playing. One possible solution would be to ask players to further develop the game to make it more realistic or even use game programming as a way to make scientific models more tangible.

Can the idea of the 'balanced nature' be challenged? Students' reasoning about disturbed and protected ecosystems after a teaching intervention and one year later

Georgios Ampatzidis and Marida Ergazaki

Keywords: Delayed post-test, Ecological reasoning, Collaborative learning, Model-based learning, Resilient nature

Type of presentation: Oral

This paper reports on insights from the 3rd cycle of a developmental research aiming at the design of a learning environment that could effectively support non biology-major students (a) in challenging the widespread view of the 'balanced nature' and constructing an up-to-date understanding about how ecosystems may function, and (b) in using this understanding to advance their systems thinking skills. Our focus is set on whether and how students' reasoning about the ways ecosystems may respond to human-driven disturbance or protection has been altered after their engagement with the 3rd version of our learning environment and one year later. Informed by constructivism and problem-posing approach, we developed a computer-supported collaborative learning environment for highlighting ecosystems' contingent behaviour through the currently valid idea of the 'resilient nature'. Forty-four, 1st-year educational sciences students were actively introduced to the basic assumptions of this idea in five, 2-hour sessions within an optional course of ecology. In each session students collaborated in triads to explore a 'NetLogo' model. The four models we developed simulated terrestrial or aquatic ecosystems dealing with internally or externally triggered changes. Each model had two versions showing two different trajectories of an ecosystem, which were linked to differences in initial conditions or human actions for its recovery. The two different trajectories shown in the two versions of each model were discussed in whole class discussions at the end of the sessions. In the 5th session, students were mostly engaged in hands-on activities concerning systems thinking. Twenty-three of the participating students filled in a pre-, post-, and delayed post-test questionnaire; the post-test was administered one week after the last session, while the delayed post-test one year later. The 1st part of each questionnaire included four, open-ended items about the behaviour of protected or disturbed ecosystems. These aimed at probing the target assumptions of the 'resilient nature' and their use as warrants for nature's contingent behaviour. The analysis of students' responses to certain items of the pre-test, post-test and delayed post-test showed that the learning environment was rather effective. The ideas of the stability of a protected ecosystem or full recovery of a disturbed retreated in the post-test and maintained their decreased frequencies one year later. Moreover, the idea of contingency as a substantial feature of a protected/disturbed ecosystem which was absent from the pre-test, reached its highest frequencies in the post-test and appeared in lower but still remarkable frequencies one year later.

Systemic Functional Linguistics (SFL) as a means to reveal possible differences between scientific text genres in the promotion of scientific literacy

Moriah Ariely, Zohar Livnat and Anat Yarden

Keywords: Adapted primary literature, Language of science, Scientific literacy, Systemic functional linguistics, Text genre

Type of presentation: Oral

Reading is a neglected activity in the science class, even though reading and writing in science are constitutive parts of ”doing science”. When students do read in class, they read mostly texts obtained from textbooks, popular research articles from the media, or review articles from popular journals. Thus, students usually do not hear the language of science as it is used by scientists in its normal social functions. Indeed, Primary Scientific Literature (PSL), which is the main text genre used by scientists, is highly professional making it extremely difficult for novices to read. In order to overcome the difficulties and to familiarize students with this kind of text genre, PSL articles are adapted to match students' knowledge, reading ability and cognitive skills, while keeping its authentic characteristics. This novel text genre is termed Adapted Primary Literature (APL). The selection of language for the APL articles is implicit and till now it was done intuitively by the APL writers. Here we used Systemic Functional Linguistics (SFL) analysis with an attempt to answer the question how is APL linguistically different from PSL and from popular articles. Three articles, PSL, APL and a popular article about edible vaccines against cholera and malaria, were subjected to SFL analysis. The texts were systematically scanned for specific grammatical features which reflect four features that characterize scientific writing: Informational density, Abstraction, Technicality and Authoritativeness. We found a decrease in Informational density, Technicality, Abstraction and Authoritativeness values going from the PSL to the APL and to the popular article in all parameters, except for ”human participants” that were found to have very low values in the PSL and APL articles and a significantly high value in the popular article. Our findings suggest that the APL article is adapted not only in content and length, but also in grammatical features which lower the lexical complexity and increase the readability of the text, while keeping the main grammatical features of the research articles and the language of science. The SFL analysis suggest that the APL genre is more closely related to the PSL genre than to the popular articles genre in the grammatical features that were examined here. Thus, using APL articles for the learning and teaching of biology may enable to engage students with epistemologically authentic text and may help improve students' understanding of the epistemology and reasoning of authentic science.

A new model for health behaviour

Julia Arnold and Kerstin Kremer

Keywords: Expectancy, Health behaviour, Health literacy, Knowledge, Value
Type of presentation: Poster

There are several models to explain health behaviour. Most of these models are prediction models, which include several factors that can be used to predict healthy actions. Such models for example are: the Social Cognitive Theory (SCT; e.g. Bandura 1977), the Health Action Process Approach (HAPA; e.g. Schwarzer, 1992), the Health Belief Model (HBM; e.g. Rosenstock, 1974), the Theory of Planned Behavior (TPB; e.g. Ajzen, 1991) or the Protection Motivation Theory (PMT; e.g. Rogers, 1983). These models have several important factors in common, but none of these models includes all the aspects. Hence we propose a new model (figure 1), which allows for investigations about the recognition of threat and the assessment of severity and vulnerability, as well as the consideration of controllability. Furthermore, the proposed model includes expectancies about self-efficacy and outcome, besides evaluation processes of the outcomes (values, cost/benefit) in the formation of an intention to act or change action. Additionally, we argue that knowledge (system-, action- and impact-knowledge) can be another factor influencing behavioural change and that this influence should be investigated systematically. In addition, we argue that there are factors that act as cut-offs in the process of forming intentions. We expect the new model to be more powerful in explaining intentions for healthy behaviour, because of the combination of the different models, the inclusion of knowledge and specific knowledge types, as well as the consideration of cut-off-points.

Learning about climate change: The use of metaphor

Indira Banner, Alice Deignan and Shirley-Ann Paul

Keywords: Climate change, Greenhouse, Metaphor
Type of presentation: Poster

The issue of climate change is an important and on-going concern which arguably should form a key part of the science curriculum so that students have a good understanding of causes, processes and potential effects of climate change across the world. It appears from a recent study that students are, for example, confused about differences between the ozone layer and the greenhouse effect, and therefore may not be in the best position to make decisions about climate change in their lives.

In science research metaphor is used by scientists to help them develop ways of thinking about and explanations for phenomena they encounter. This use of metaphor is helpful in supporting new concepts and creative thought. As in professional science environments, teaching and learning about science in school can also be supported by the use of metaphor (as well as closely related analogy and models). However, the translation of the metaphors from scientists or teachers to school students may result in a confused understanding of the concept.

This research looks at the use of metaphor by school students and professional scientists in explaining climate change. By interviewing students (aged 11-16 years) and analysing this data by qualitative coding methods as well as by linguistic metaphor analysis, it can show the metaphors students use and the accuracy of these metaphors in helping students to understand and talk about climate change. A corpus of information by academic scientists is also analysed to compare with school students' use of metaphor.

The data show that students use the term 'greenhouse' as a way of explaining the concepts of climate change. The metaphor is 'alive' in this context and is generally used accurately to explain the basic causes and processes of climate change. This suggests that the idea of the greenhouse is a useful teaching tool. However, as well as misusing this metaphor in some situations, students also used other metaphors (e.g. a band around the world) to erroneously explain climate change. Scientists however use the term greenhouse not as a metaphor but as a noun modifier to form scientific terms, with no explanatory power.

This research suggests that metaphors can be useful in helping teaching and learning of climate change but that this might need to be explained explicitly given the varying nature of the term used in different contexts. Teachers may benefit from guidance in using metaphors in their teaching.

What´s Brazilian children think is inside a crab?

Amauri Bartoszeck and Sue Dale Tunnicliffe

Keywords: Children, Crab, Organ, Organ system, Internal anatomy
Type of presentation: Poster

Invertebrates are a very neglected area in the curriculum of the preschool and first grades of primary school in Brazil. Internal anatomy investigations of what children think is inside invertebrates is very scarce. This study explores the understanding of young Brazilian children through scoring their mental model represented by the drawing of what the children think is inside the crab. We found that children from Southern Brazil have a basic knowledge of the internal anatomy of a crab.

A total of 430 children 194 aged 5, 65 aged 10 (unfortunately only 15.1% of the total sample due to parent´s objections to allow the use their children´s drawings) and 171 aged 12 were asked to draw what they think is inside a type Brazilian crab. A real preserved by the University technician seashore crab (Neohelice granulata, Dana, 1851) was shown in a set-up at the classroom during the class period and children were given 15 minutes to draw a drawing from the set up where was the crab on a A4 sheet of blank paper. These pupils attended 3 public and 1 private schools in an urban area 100 km away from the seashore in Curitiba town. Analysis of the collected drawings by 5 year old pupils revealed that most achieved level 2 according to the rubric used, “one or more internal organs at random”, those at 10 years old achieved level 4 “two or more internal organs in appropriate position, whereas those children 12 years old achieved level 5 mentioning “one organ system” and level 6 “ two or three organs systems’ according to the grade level rubric developed by the authors based on their previous experience on the research area. On the whole only 33,9% of the drawings depicted respiratory system and 23,5% digestive system . This study has shown that children have a poor understanding of the internal organization of organs and organ systems of crabs. Sometimes pupils depicting human or vertebrate organs (e. g. lung instead of gills, “dog” bones) thus using their knowledge of human internal anatomy as a template for explaining their understanding. Heart and brain were the most mentioned organ both genders by all participating ages and respiratory and digestive systems the most mentioned by twelve years old pupils. Educational implications are discussed.

Students' motivation when mediating a socio-scientific dilemma

Melanie Basten and Matthias Wilde

Keywords: Decision-making, Motivation, Socio-scientific issues
Type of presentation: Oral

In German schools, socio-scientific issues are taken into account using the terms bioethical topics and decision-making competence (KMK, 2004). In order to teach bioethical topics and build up students' decision-making competence competence models (e.g. Reitschert & Hößle, 2007) were proposed. Organ donation is a socio-scientific issue that needs consideration beyond schooldays. Especially, since the Decision Rule came into effect every German citizen aged minimum 16 years is asked to take an individual donor decision (BMG, 2012).

Own studies showed that students of grade 11 achieved low competence levels when engaging in decisions concerning organ donation. Basten (2013) postulated in accordance with Reitschert's (2009) theoretical framework that a person's achievement was constrained by their level of epistemic beliefs (Perry, 1970), moral judgment (Kohlberg, 2001) and perspective-taking (Selman, 1984). However, a sufficient level of development in these variables cannot be expected among adolescents (cf. Basten, 2013). Besides theoretical considerations regarding the students' development measurement problems had to be taken into account as the cause for the lack of correlations with motivational variables. Own studies showed that neither students' general epistemic beliefs, need for cognition (Cacioppo & Petty, 1982) or tolerance for ambiguity (Reis, 1997) correlated with their decision-making competence.

The current study aims at correlating the students' performance in a decision-making task with measures for the students' motivation to engage intensively in the task. We increased the stimulative nature of the task by contextualising it. Thereby, we intended to cancel out the restriction of variance and measure the students' competence more validly. Likewise, motivational variables were assessed task-specifically.

As in previous studies, students of grade 11 were asked to take a stand regarding a dilemma situation concerning organ donation. We embedded the task into a cover story and invited 66 students to give advice to a deceased friend's bereaved whether to donate his organs. This led to higher competence levels in the students' written advices (problem awareness, number of arguments, quality of justification) compared to previous studies (Basten, Kraft & Wilde, 2015). Different motivational variables while working on the dilemma were assessed directly after completing the task.

Results reveal that the awareness of the moral problem correlated positively with the students' interest/enjoyment while working on the task ($r=.38^{**}$). The students whose interest/enjoyment was high (mediansplit) also presented more arguments. However, interest/enjoyment did not correlate with the quality of students' justification of their advice (r=n.s.).

The contribution of epistemological beliefs to informal reasoning regarding health socio-scientific issues

Andreani Baytelman, Kalypso Iordanou and Costas Constantinou

Keywords: Epistemological beliefs, Health socio-scientific issues, Informal reasoning, Pre-service primary teachers

Type of presentation: Oral

This study investigated the contribution of epistemological beliefs to pre-service primary teachers' informal reasoning regarding health socio-scientific issues (SSI). The pre-service primary teachers' informal reasoning was investigated and evaluated for spontaneous and analytical thinking according to the dual-process theory, ant it was assessed using open-ended questionnaires, in which arguments had to be constructed, during spontaneous and analytical thinking. Specifically, 243 pre-service primary teachers were asked to construct arguments, counterarguments and rebuttals, as well as different types of arguments ? social, economic, ecological, scientific and ethical? after they had read scenarios on health socio-scientific issues (during spontaneous and analytical thinking). Three different health-SSI were developed and used in the present study: Usage or not usage of vaccines, Consumption of bottled vs tap water, and Usage of underground vs overhead high voltage lines in residential areas. Pre-service primary teachers' epistemological beliefs were assessed through questionnaire, which focus on the multidimensional perspective of epistemological beliefs. The results indicated that sophisticated epistemological beliefs, especially sophisticated simplicity beliefs, contributed significantly to the number, the type, and the quality of the health socio-scientific arguments as well as to the scientific and ethical arguments the pre-service primary teachers constructed (during spontaneous and analytical thinking). This study contributes to the scientific literature on learning and teaching in science and health education in three different ways: The first contribution is related to the enrichment of certain areas of the theoretical framework related to epistemological beliefs and informal reasoning regarding health-SSI. The second contribution is related to pre-service primary teachers' education, indicating the need of sophisticated epistemological beliefs to promote informal reasoning skills for health-SSI. The third contribution concerns improving practices and learning environments in education for science and health education, associated with epistemological beliefs, and informal reasoning skills for health-SSI.

Representational copmetence in integrating multiple external represenations (MERs) in biological education

Christina Beck and Claudia Nerdel

Keywords: Item-response-theory, Multiple external representations (MERs), Representational competence, Task-difficulty, Text-picture integration

Type of presentation: Poster

Science education draws on a broad variety of representations, such as verbal-textual, visual-graphical, symbolic and enactive representations. While each of these representations plays a significant role in science communication, there is a common agreement on their combination, called multiple external representations (MERs). Understanding science as a multimodal discourse, dealing with MERs becomes a premise of specialized language competence in learning science at school. It is therefore essential for students to learn to select information and to interpret, construct, translate as well as transform representations to develop a conceptual understanding. In order to create a multimodal representational competence in understanding complex scientific concepts and processes, interacting with MERs is a critical element of science education. Based on a broad range of current literature and empirical work about the role of MERs in communicating science, we created a competence model focusing on the integration of verbal and visual representations in different task contexts to enhance standardization of representational competence. The competence model was created in biological education and consists of the components integration by information selection and interpretation (MERI), integration by construction (MERII), translation and transformation of different scientific representations (MERIII) was operationalized in three different biological task contexts (ecology, metabolic physiology, genetics). The study analyzed the use of different modes of representations (diagrams and schemas), and the relationship between representational competence and different contexts of biological science. First, we will present and describe to what extent the postulated competence model can be confirmed empirically. Second, we will outline which characteristics in biological tasks with MERs generate difficulty. Participants in the study were 548 first-year university students from different fields like different teacher education programs, biology, chemistry, mathematics, physics or mechanical engineering. The data collection was standardized and analyzed via test booklets. Based on item-response-theory, 36 items requiring integration at different components of representational competence (MERI, MERII and MERIII), modes of representations and in biological task contexts were selected. In terms of Rasch-scaling difficulties of all text-picture integration items could be successfully predicted based on the created competence model and on a categorical framework. The findings indicate that there are differences between the item-difficulty in the postulated components of the competence model, i.e. MERI, MERII, MERIII and significant differences across the person parameters.

Factors influencing future biology teachers motivation to teach in inclusive classrooms

Valerie Beckmann and Susanne Menzel

Keywords: Empathy, Inclusive education, Interpersonal reactivity index (IRI), Teacher sentiments attitudes and concerns about inclusive education – Revised scale (SACIE-R), Values

Type of presentation: Poster

The German UNESCO published Policy Guidelines on Inclusion in Education which include “attitudinal changes concerning socio-cultural diversity” and “teachers and teacher education” (Deutsche UNESCO-Kommission, 2014). International research is focusing on e.g. students´ and teachers´ attitudes towards Inclusive Education (e. g. Forlin & Chambers, 2011) as well as on demanding factors of the teaching job that could possibly diminish teachers´ work motivation (e. g. Hakanen, Bakker, & Schaufeli, 2006). Research on the motivations and attitudes of science teachers to teach in inclusive settings is barely represented. Thus this project focuses on the influence attitudes and other factors have on future biology teachers´ motivation to teach in inclusive settings.

In a first partial study interviews with five pre-service biology teachers were conducted. They were asked about their attitude towards Inclusive Education and about the character of demanding job characteristics with and without implementation of Inclusive Education. Results indicate a rather positive attitude towards Inclusive Education. At the same time the job demand “role conflict” (Hakanen et al., 2006) was addressed as the students query their own ability to give each pupil sufficient attention in heterogeneous classrooms.

A second partial study will be conducted in spring 2016. Aim of the study is the investigation of the relationship between the three factors (1) attitudes, (2) values and (3) empathy and the students´ motivation to teach in inclusive classrooms. (1) Attitudes are assessed using the “Sentiments, Attitudes, and Concerns about Inclusive Education – Revised” Scale (SACIE-R) (Forlin, Earle, Loreman, & Sharma, 2011). (2) As values are described to motivate decision making and human behaviors (Bilsky, et al., 2013) they are selected as the second factor. (3) Empathy is described to have a positive effect on helping behavior (Davis, 1983a) and is hence considered to have a positive effect on the motivation to teach in inclusive classrooms. The instrument used is the Interpersonal Reactivity Index (IRI; Davis, 1980).

Can high school students develop a structural mental system model that presents the human body as a coherent whole?

Orit Ben Zvi Assaraf, Jaklin Tripto and Miriam Amit

Keywords: Biology education, Concept maps, Complex systems, System thinking
Type of presentation: Poster

In recent years, the science curriculum has become increasingly focused on the study of complex systems. The “complex systems” approach enables and encourages students to analyze phenomena by describing, constructing and investigating models of systems. This study sought to identify and understand the mental models developed by students as they learn about the human body as a complex system. We tracked the development of the students’ mental system models by means of four concept maps per student, generated over the three years of their high school biology education. The maps were analyzed qualitatively, using each student’s 4 maps to produce a ”story” about the development of their mental system model.

This study is part of a larger study that followed 67 students through their high school biology education, using a variety of tools to learn about the development of their systems thinking. The concept maps generated 67 individual case studies, representing each student’s personal story of development. Our study’s analysis of CMs produced four principal map models, which we translated into models of the systems thinking of the students who wrote them. Overall, our findings indicated a linear progression in each of the four models, showing that these models developed over time from simpler structures, which evolved as they connected with more complex system aspects. One pattern, for example, presented students for whom the expression of the mechanisms of homeostasis improved significantly at the end of the learning process. Their 12th grade map shows the human body with greater complexity, noting hidden dimension aspects in the context of micro level processes. In another pattern, processes at the system level were still absent, but the structural descriptions were more detailed and accurate, with more references to the micro level.

The impact of peer discussions on students' arguments when addressing socio-scientific issues in biotechnology

Birgitta Berne

Keywords: Biotechnology, Learning progression, Socioscientific issues (SSIs)
Type of presentation: Oral

In this study I report on an intervention in science education in which my 14-15 year old students discussed different SSIs in peer groups. Prior to these discussions I provided the students with different perspectives of the issues and gave them time to search for further information themselves. The analysis of students' arguments suggests the students formed their initial arguments during their preparations for the discussions. Furthermore, throughout the peer discussions they elaborated on the initial arguments and supported each other to intertwine ethical considerations or content knowledge to the arguments, or to revise their arguments. Thus, the students seemed to focus on diverse aspects of the different issues. When discussing a general DNA-register they focused on the virtue ethics aspects, when discussing GMO's they focused on longer term consequences and when discussing issues in connection to stem cells they focused on the content knowledge. Moreover, the recurrent peer discussions appeared to support the students to advance in their argumentation process in that they responded to claims by questioning, evaluating and revising each other's claims. As such, the study provides valuable indications concerning the importance of introducing prepared peer-discussions about different socio-scientific issues into the teaching of science in schools.

Item context effects in evolution assessment

Ulrike Betzitza and Holger Weitzel

Keywords: Adaption, Assessment instrument, Evolution, Natural selection, Students' conceptions, Task contexts

Type of presentation: Oral

A number of different instruments exist for the assessment of students' (pre)conceptions about evolution. These assessment instruments differ significantly in task format and task context. Nehm & Ha (2011) found out, that students utter particular conceptions in dependence of a context factor (e.g. gain or loss of a trait). They suggest that there is a need to revise this evolution assessment instruments, because they do not control possible context effects sufficiently (Nehm & Ha 2011). But there is a lack of theoretical models that could explain what students' answers tell about cognitive coherence in evolutionary thinking (e.g. diSessa et. al., 2004). But to create an assessment instrument taking context effects into account, it is necessary to have a better understanding of possible task context effects. With the help of a cognitive linguistic analysis (Lakoff, 1989), idealized cognitive models for the words "adaption" and "selection" in everyday language were employed (Weitzel & Gropengießer, 2009). These models can help to explain the students' alternative conceptions. They were used to make predictions how possible context effects influence students' explanations, which were selected and tested in a previous qualitative study (Betzitza & Weitzel, 2014). For instance, a hint to a "final" state of an evolutionary process should elicit different conceptions than a hint to a supposed initial state. In a next step, a quantitative study was performed to test these predictions and analyse task context effects deeper. For this study appropriate tasks were selected, varied in different contexts and tested with a random sample of 345 students aged between 14 and 17 prior to formal evolution education. For the analysis tasks were coded with a newly developed high-inferent category system. The analysis shows, that the students' conceptions differ clearly between the different tasks and task contexts as predicted by our model. Excluding the initial state of an evolutionary process from a task context has a significant influence on the arising of proximate explanations (?? (1, N=729)=136,89 p<0,001). Giving a hint to any kind of variation in the task context (e.g. "On average cheetahs are able to reach xxx km/h"" instead of "cheetahs are able to run fast") led to a significant higher proportion of evolutionary explanations. Further results and implications for context specific item construction will be discussed at the conference.

Assessing knowledge and academic success in biology and physics

Torsten Binder, Heike Theyßen, Angela Sandmann and Philipp Schmiemann

Keywords: Academic success, Concept maps, Prior knowledge, Problem solving

Type of presentation: Poster

More and more students in Germany drop out of university without earning a degree. Over the last years the dropout rates for biology (20% to 27%) and physics (39% to 41%) at German universities have increased constantly (Heublein et al., 2012, 2014). This trend also becomes apparent in other science-related disciplines at German universities. Finding factors for academic success might help universities to decrease the high drop out rates.

The purpose of our project is to analyse the influence of different types of prior knowledge on students' academic success in biology and physics. On the basis of the model by Hailikari (2009), we differentiate between four types of knowledge: knowledge of facts, knowledge of meaning, integration of knowledge, and application of knowledge. We assume that these types of knowledge predict academic success differently for the two domains biology and physics. For instance, for the introductory biology courses (e.g. taxonomy in zoology), the first three types of knowledge seem to be more important than the application of knowledge. For the introductory physics courses, however, we hypothesize that the application of knowledge is more important to solve physical problems (e.g. using conservation laws in mechanics). In order to analyse the impact of the four types of knowledge, first test drafts were developed for each subject and type of knowledge. Methods and content of those tests were chosen based on the prerequisites of the students and the characteristics of each type of knowledge. Each type of knowledge requires specific tests for accurate measurement (Dochy & Alexander, 1995). Therefore, we use four different methods: knowledge of facts is assessed with a multiple-choice test, knowledge of meaning with a short answers test, integration of knowledge with concept maps and application of knowledge with a problem solving task. In order to assess students` knowledge at three points in time during their freshman year, all in all eight tests were developed. Results of the pilot study will be presented.

Environmental literacy in practice: Education on tropical rainforest and climate change

Kerstin Bissinger and Franz X. Bogner

Keywords: Attitudes (MEV), GLM, Knowledge acquisition, Self-reported ecological behavior, Three-dimensional knowledge

Type of presentation: Poster

Environmental literacy is a key concept in our times to encounter environmental challenges such as global climate change. The anthropocentric influence fosters global warming requesting conscious behavioral changes as a sustainable response. Promoting knowledge, attitudes and behaviors seems to be a reasonable approach in order to prepare adolescents for future challenges. Recently, an environmental literacy model was proposed comprising system-, action- and effectiveness-related knowledge as basis affecting environmental attitudes which induce pro-environmental behavior. In our study, we applied this theoretically derived model in an outreach educational environment. Focusing on tropical rainforests andclimate change, we developed and implemented an educational interventional in a botanical garden which provided an authentic learning environment. We collected data from 283 10th graders based on a pre-, post- and retention test design monitoring knowledge, attitudes and behavior. Our study showcases significant knowledge acquisition and a positive development of the inclusion in nature in one's self concept. Furthermore, we found pro-environmental behavior intentions to increase. In conclusion, we successfully implemented an environmental literacy intervention combining student-centered approaches with self-dependent learning opportunities in an out-of-school context. Our results highlight botanical gardens to be a suitable learning environment to provide direct nature experience which fosters appreciative tendencies and in combination with our educational intervention inducing environmental literacy.

Teacher-students' lesson plans about scientific inquiry in experimental biology pertaining to professional knowledge

Robert Blank, Josiane Tardent and Holger Weitzel

Keywords: Experimentation, Lesson planning, Professional knowledge, Scientific inquiry, Teacher education

Type of presentation: Oral

Learning to create an inquiry based science lesson is a core part of science teacher education. Content knowledge, pedagogical content knowledge and pedagogical knowledge provide therefore an important base (e.g. Shulman 1987, Grossschedl et al 2015). The empirical findings thereto were longtime sparse. Meanwhile results concerning the three knowledge domains and their progress during teacher education exist for science education too. If and to what extend pre-service teachers apply their knowledge they acquired in teacher education programmes into their lesson plans as well as what type of knowledge they use is still insufficiently studied. Analysis of lesson plans and correlations to data of professional knowledge as presented here may help to reduce this existing research gap.

Along a mixed-method design CK, PCK, beliefs and teaching experiences as well as planning abilities of 118 pre-service teachers' from three Swiss universities (n = 52) and one German (n = 66) university, who qualify as biology teachers for lower secondary level, were tested and analyzed. Tests proceeded in a pre-, post- and postpost design. Lesson plans emphasizing scientific inquiry within standardized content and video-recorded peer-discussions about them were analyzed.

Findings of this study show that secondary pre-service teachers' ability to plan lessons focusing on scientific inquiry in experimental biology is limited. The correlation analysis reveals a small, but significant influence of professional knowledge – CK as well as PCK - on the quality of students' lessons plans. The presentation is dedicated to the analysis of lesson plans and tests. Both instruments and correlation results are going to be presented and discussed.

Problems in defining phenotype and hereditary trait

Dirk Jan Boerwinkel, Daniel van Draanen, Birgit Duijts and Amarja Koers

Keywords: Genetics, Hereditary trait, Phenotype, Student ideas, Textbooks
Type of presentation: Oral

Whereas many studies exist on the scientific and educational meaning of the concept gene, few have been done on the concepts phenotype and hereditary trait. Yet these terms are problematic as they are often ill defined in textbooks and many different meanings seem to exist, which hinder student understanding of gene-environment-trait relations. In this study, a framework of different meanings of hereditary trait was developed, which was subsequently used to investigate textbooks, genetic scientists and secondary school students. Traditionally, hereditary traits in biology education concern outward visible variable features which are not influenced by the environment. This limitation of the meaning of hereditary trait can create a false image of what genes do, as most features do not fit in this category.

The developed framework included six categories in which traits can differ from the commonly used examples; a. outer visible versus non visible, b. organism level versus multiple levels, c. environment-independent versus partially environment dependent, d. traits with variance within a population versus traits without variance, e. traits which remain the same versus traits which change, and f. traits on organism level versus traits which influence the risk or susceptibility for other traits.

Although Dutch textbooks still give many traditional examples of hereditary traits, over 20% of the examples concerned non outer visible traits and traits with environmental influence. The other categories were mentioned scarcely or not at all. The concept phenotype was both used for the whole of traits and for a specific trait, in which case phenotype and trait mean the same.

Genetic scientists differed much in their use of the terms genotype and hereditary trait, indicating that the meaning of these terms is strongly linked to a specific field of research, and no general definition for biology education can be derived from their use in scientific contexts. Upper secondary school students which had received genetics education mentioned in 80 % of the examples of hereditary traits visible, variable traits without environmental influence. Traits with partial environmental influence were often considered not to be hereditary traits. When confronted with other types of hereditary traits, more than half of the students had doubts whether partially environmental dependent traits, traits without variance and traits which change during development could be considered as hereditary traits.

Design of a one day course to improve mathematical confidence of A-level biology teachers in England

Christian Bokhove, Carys Hughes and Janice Griffiths

Keywords: Biology teaching, Curriculum, Mathematics, Professional development, Secondary school

Type of presentation: Poster

Recent changes in the A-level (16-18 yr olds) curriculum mean that Biology teachers are confronted with more mathematics to teach (Department for Education, 2014). Building on literature on Communities of Interest (CoI), boundary objects and maths confidence, we report on a study in which three biology teachers, a biology education researcher and a maths education researcher designed a one day course for teachers to address some of the gaps in mathematical content knowledge to build maths confidence. The study consists of two parts. In part A, which is process oriented, the CoI of three Biology teachers, one maths education researcher and one biology education researcher, set out to design the one day course. In part B the one day course was delivered to a group of Biology teachers (N=22). The day was provided for free to teachers and focused on exponentials/logarithms and statistics. These aims, accompanying content and pedagogical design of the day followed from part A, and were designed by the CoI. The preliminary findings of this study suggest that involving different stakeholders (in a CoI) in the design of a one day professional development course can be successful. Part A of the study, the process, showed that the teachers involved found the design process very useful for three reasons. Firstly, in the process of designing the day course they experienced a lot of knowledge acquisition and improved understanding, particularly on exponentials and logarithms. Secondly, they expressed improved confidence in teaching the maths in A level biology. Finally, they also expressed they had a better understanding of the processes involved in the calculations. For part B of the study, the product, the data showed that teachers valued the elaboration of new content on exponentials/logarithms. The statistical content was well-known already but the chosen teaching and learning methods allowed attendees to compare and discuss their own pedagogies in teaching statistics, which built confidence. Finally, the maths confidence questionnaire showed that the teachers thought they could learn maths, and found it important for their work, but that they needed support because it was difficult. Some limitations of the study are discussed.

Cognitive activities related to the understanding of visual representations in biology

Miriam Brandstetter, Christine Florian and Angela Sandmann

Keywords: Biology education, Cognitive activities, Thinking aloud, Visual representations

Type of presentation: Oral

Learning in biology requires the ability to understand visual forms of representation because information about subject specific concepts is communicated through various forms of depictions. In order to understand the depicted phenomenon active cognitive processing of the perceived information is required. Yet it is unclear in which cognitive activities students engage while studying representations of biological processes. In this study 42 students (age 13-14) were asked to think aloud while trying to understand two different representations of blood circulation and patellar reflex. Thinking aloud protocols were transcribed and students' flow of speech was cut into single statements (propositions). Individual understanding of representation was evaluated through a standardized list of expected statements. Through qualitative content analysis of the thinking aloud protocols a category system of 16 different cognitive activities was developed and all of students' single statements (N = 4351) were categorized accordingly. In order to reduce the category system and analyze underlying patterns of activities factor analysis were conducted. Results show 4 underlying patterns of cognitive activities. Factor 1 represents "inferences predominated by elaboration of the depicted information", Factor 2 represents "inferences predominated by the recall of adequate prior content knowledge", Factor 3 represents "criticism" and Factor 4 represents "metacognition". Factorscores for each student were conducted according to their individual statements and relationships between cognitive activities and understanding of representation were analyzed through regression models. The results suggest, that students who predominantly show cognitive activities of factor 1 and 2 reach high understanding of representation. The results give detailed insight in student' cognitive activities while studying biological process diagrams. Based on the results it is possible to infer explicit instructional guidance to students in order to help them to engage in cognitive activities that promote better and deeper understanding of the depicted biological phenomenon.

Acquiring diagnostic skills in the ”Wadden Sea´s Teaching and Learning Laboratory”

Lea Brauer and Corinna Hoessle

Keywords: Diagnostic skills, Vignette tests, Wadden Sea´s Teaching and Learning Laboratory

Type of presentation: Oral

The acquiring of the skills of diagnosing learners´ learning activities is becoming increasingly important in the training of students who want to become a teacher (Hößle, 2014; Hußmann & Selter 2013). Diagnostic skills are an instrument for fine-tuning quality development in the education system (Artelt & Gräsel, 2009). Diagnostic skills also help teachers “appropriately assess their students’ traits and estimate learning and task requirements.” (Artelt & Gräsel, 2009, p.157, translated by Lea Brauer from the German original) Research in this field is still well below satisfactory (Artelt & Gräsel, 2009; Brunner et al., 2011; Schrader, 2009). Based on research in pedagogical content knowledge, the presented study aimed developing test instruments to detect the experiment-related professional knowledge by expectant biology teachers in an objective, reliable and valid manner. The impact of active participation in the Teaching and Learning Laboratory (Lehr-Lern-Labor) on the young teachers’ ability to observe and accurately diagnose of learners´ learning activities was tested. The test instruments consist of two written and one video-based vignette tests which depicting various experimentation skills of pupils. Based on Baer and Buholzer (2005), the teachers were asked, as part of an open evaluation format, to provide written diagnoses of the learning activities shown. A coding manual geared around the experimentation skills model devised by Nawrath, Maysienka and Schecker (2013) was developed to analyse the data. The coding schema was also used to ensure the objectivity of the scoring process. Furthermore, the interrater reliability (Cohen’s kappa 0, 8) was determined for the open questions. The instruments were presented to several experts from the didactics of biology (N=20) and experienced biology teacher (N=20) for validation. The study was outlined in a pre-post design and interrupted by a 14-week seminar in which the students developed learning concepts relating to the Wadden Sea. Initial results show that the diagnostic skills of the students improved. But further action and support is still required. The study outcomes shed light on the impact of participation in the Teaching and Learning Laboratory on the development of aspiring teachers’ diagnostic skills. Furthermore the study is a first step towards an efficient analysis of the role of teaching in a Teaching and Learning Laboratory and in the field of improving diagnostic skills of students.

‘Playing Darwin’: Using drama to teach about evolution

Martin Braund

Keywords: Drama, Evolution
Type of presentation: Poster

Darwin’s life parallels a schism in western intellectual thought, representing a cultural and educational divide between arts and sciences. This world view promotes science as, “tangible, measureable and real” and the arts as, “immaterial, intangible, unquantifiable and imaginary” (Morris, 2006: 152). From this perspective biology is reductionist, reducing the world, as Darwin started to do, to its simplest understandable parts. But, as Darwin realised, grand ideas like his require synthesis and integration to create a believable whole. From this perspective Biology is a creative enterprise, yet few teachers in schools or their pupils seem to recognize this. A writing project involving 26 international Darwin scholars, Darwin-Inspired Learning, was formed to provide students with insightful study of Darwin’s books, letters, ideas and experiments to, “create an atmosphere … in which scientific and creative imagination flourishes” (Boulter, Reiss & Saunders, 2015: ix). In this paper part of that work, using Drama to understand Darwin, is discussed.

Teaching biology using role-play simulations: Impacts of student teachers' lessons

Martin Braund, Christelle Ekron and Zaiboenisha Ahmed

Keywords: Analogous teaching, Drama, Role-play, Socio-cultural learning, Teacher education

Type of presentation: Oral

Drama is used to build knowledge and understanding in biology as part of a socio-linguistic, constructivist approach. Role-plays, where the physical actions of players are analogous to structures, concepts or processes (in this study: cell structure, transmission and reception of sound and human fertilisation) are thought to be particularly powerful teaching strategies. A problem restricting biology teachers using these approaches more widely has been their lack of sufficient pedagogical knowledge of drama. After training in drama's use in teaching, four BEd Life Sciences (biology) student teachers at a university in the Western Cape of South Africa designed and taught lessons to classes of the same age and ability in grade 7. One lesson used role-plays (intervention group) and the other used more conventional methods, such as board, book and practical work (comparison group). Both lessons were observed and video-recorded and learners in each class were post-tested in content directly associated with the lesson. Episodes of teaching, deemed critical to learner success in the lesson with drama, were identified and mapped against differences in test results between the drama (intervention) and non-drama (comparison) classes. Successful critical episodes for lessons using drama included; good management of classroom space, continuous monitoring of group planning and role–play preparation and the ability to link role-played actions to structures, concepts or sequences. Episodes impacting negatively were associated with the suitability of role-plays to clearly portray biological concepts (such as cell components and their functions) and the sequencing of actions (such as stages in human fertilisation and implantation of the blastocyst). For two of the four student teachers, negative episodes revealed particularly poor applications of content knowledge that was not evident in the lessons taught without drama. Post-tests showed a positive effect in favour of drama lessons for two of the students (effect sizes: 0.55 and 0.43). In one of these cases positive test results in favour of the role-play lesson were in spite of an imbalance of negative critical episodes over positive ones, suggesting that in this case drama role-play may have had the capacity to transcend poor teaching. The findings suggest student teachers require more faculty input to use this type of drama successfully, particularly to better secure thorough content knowledge and deploy this in situations involving highly active learning by pupils.

How, when and why? An analysis of primary students' science questions

Beatriz Bravo-Torija, María José Gil-Quílez, Begoña Martínez-Peña and Belén Embid

Keywords: Inquiry, Interactive books, Primary education, Science questions
Type of presentation: Oral

The ability to ask questions is recognised as one of the main scientific practices, and students should be provided with opportunities to pose their own questions about different phenomena. In this work, we seek to analyse the science questions asked by 131 primary students in their science class while working with interactive notebooks. This methodology has been designed to support an inquiry-based approach to science instruction and promote environments in which students have opportunities to be creative and independent thinkers.

The research questions are: What type of questions do students produce at the beginning of the course? After one year of working with interactive notebooks, what are the differences between their questions at the beginning and end of the course?

Two different tests were performed to collect students' data based on the methodology of the interactive notebooks, one at the beginning of the year, and another at the end. The two tests consisted of different pieces of information about earthworms or plants, and four tasks connected with them.. In this work we analyse the third task: formulation of science questions. The categories used were: predictive, causal, descriptive, declarative and anecdotal questions.

Our findings suggest that there is an increment of causal and predictive questions from the initial to the final test, especially in 4th grade. These findings could indicate that the use of interactive notebooks promotes an improvement in the type of questions students ask. Nevertheless, the number of declarative questions is still quite high in 5th and 6th grade. Based on these results, we think that a deeper analysis is needed to understand why these differences exist among the three grades. A broader discussion of these results will be presented at the conference.

Analysis of justifications in pre-service teachers' socioscientific arguments about diets

Pablo Brocos and María Pilar Jiménez-Aleixandre

Keywords: Argumentation, Decision-making, Diets, Sustainability

Type of presentation: Oral

The improvement of the public's ability for decision-making and argumentation has been deemed of high importance in our technologically-based society. The socioscientific issues (SSI) framework has become an important tool for promoting these skills, but much research is still needed for answering key questions about its implementation, and the educative potential of many socioscientific topics remains unexplored as well. This study addresses the topic of diet election, reflecting the challenge of feeding the world population in the future and the recent research outcomes on the impact of diets on sustainability and health. The aim of our analysis is to investigate the use of justifications –in a wide sense– in pre-service teacher's arguments about dietary options, in order to determine the type of supporting reasons held and their relationship with the decision-making outcome. 74 pre-service teachers participated in the study and were asked to work in groups for discussing and writing an argument about an appropriate diet. The written reports were analysed adopting the SEE-SEP model, which was developed by linking 6 subject areas (Sociology, Environment, Economic, Science, Ethics and Policy; hence the name) and 3 different aspects (Knowledge, Values and Experiences) to attain a holistic and multi-disciplinary perspective. The results show that most justifications related to Knowledge, followed by Values and Experiences, which contrasts with previous studies. Science was the more frequent subject area, with the exception of Ethics in the reports proposing vegetarian or vegan diets. The findings points towards an influence of the activity design in the resources of justifications and towards a relationship between different patterns of prioritization of the subject areas and the outcomes of the decision-making process. Educational implications relate to the elucidation of the most effective paths to improve student's ability for argumentation and decision-making in SSI contexts involving multi-disciplinary resources.

Biology teacher students' use of technical language in video journals

Till Bruckermann, Büsra Aydemir, Melina Neumann, Ayse Özcan, Vincent Söbbing and Kirsten Schlüter

Keywords: Experimentation competency, Inquiry learning, Technical language, Video journals

Type of presentation: Oral

Since education of biology teachers stipulates knowledge and skills in hypothesis-led investigations, inquiry-based university courses should promote experimentation competency. Based on a model of experimentation competency, support of inquiry learning provides a framework for the promotion of experimentation competency. Besides scaffolding the inquiry process by step-by-step help cards, communication and reflection on the inquiry process by lab journals is beneficial for learning principles of scientific inquiry. Concerning lab journals, multimedia learning provides different affordances to connect teacher students with the learning goal of preparing, communicating and reflecting on these journals. Technology holds opportunities for representing the inquiry procedure multimodal in order to reflect on it. While the influence of technology on language still needs to be investigated, this may change communication processes (written to spoken language) and therefore may change use of technical language. This study investigates if the use of video journals promotes experimentation competency and affects the use of technical language. To investigate these objectives N=63 teacher students in an experimental and a control group are treated differently concerning the documentation, communication and reflection of the inquiry process in five sessions of a practical course on general biology. Groups of three to four teacher students participated before and after the treatment in a performance assessment of their experimentation competency. Their performance was recorded on video and evaluated by a structuring content analysis and subsequent rating on competency levels. During the treatment all lab journals were collected and afterwards analyzed by a tool for diagnosis of technical language. The performance on experimentation competency differs significantly in favor of those groups who prepared written journals in the treatment. Differences in technical language are considered to interfere with differences in the outcome of experimentation competency and will be presented at the conference.

Affective factors influencing the intentions of teachers to promote the return of the wolves in educational contexts

Alexander Buessing, Maike Schleper and Susanne Menzel

Keywords: Environmental education, Model of goal-directed behavior, Wolf, Teacher emotions

Type of presentation: Poster

Several studies in the last years revealed the growing significance of affective factors and especially of emotions in environmental education. While there is several research about topic emotions of students, teacher topic emotions and their effects are nearly neglected in environmental education. Decision-making in issues of biological conservation behavior is an integral part of an education for sustainable development (ESD). The return of the wolves can function as a specific context for decision-making processes in biology education. Because of the great influences of emotions in human relationship to wildlife, we choose it as an example context. In the present study we examined the effects of topic emotions on the desires and intentions of future teachers to promote the return of the wolves in educational contexts. For this purpose we adopted the model of goal-directed behavior (MGB) of Perugini and Bagozzi (2001) with a focus on desires and intentions. In contrast to the original model emotions were assessed as discrete emotions and different context-specific factors like wildlife value orientations were added. The research questions addressed were (1) which factors influence the desires and intentions of teachers to promote the return of the wolves in educational contexts, (2) what is the relationship between desires and intentions of teachers to promote the return of the wolves and (3) are there more meaningful antecedents for the desires and intentions than the existing ones in the MGB. For the research still being in progress at the moment of proposal the results and findings will be presented on the poster at the conference.

Students´ perspectives on developing an urban school garden

Ingela Bursjöö

Keywords: Educational practice, Plant science, Teenagers, Urban school garden
Type of presentation: Poster

In spite of the fact that substantial research support school gardens, several urban schools in Sweden do not find space or time to grow plants with a purpose to embed the garden in an educational practice. Managing a school garden is time consuming and has not been extensive in the urban school design for several years. In addition, urban gardening has to manage the risks with contaminated soil. However, interest in urban school gardens is growing in popularity and several perspectives from teachers, researchers and society are easily available, while teenagers´ perspectives seem to be somewhat elusive and shallow. The present study therefor aims to understand how students experience an urban school garden. In order to do so research questions are constructed to be able to trace in what ways teenagers engage in the development of an urban school garden.

Empirical data is mainly collected by semi-structured interviews in focus groups. Furthermore, observations when the students are in the school garden are made, taking notes and photographing. Educational material from the students, mainly produced on their biology lessons, is collected and analyzed. The study has a qualitative approach using a phenomenological and hermeneutic framework.

The findings reveal how students engage in a variety of ways in the development of the garden. The answers in the interviews show a high commitment, interpreted as a shared responsibility. Signs of environmental awareness among the teenagers are exemplified in suggestions of how the community can provide more space to grow edible herbs, fruits and berries. The teenagers in the present study also show signs of empowerment when they produce educational material in order to make an impact on politicians and other major stakeholders in city planning.

The findings are of interest for researchers, teachers, school leaders and city planners. Extended knowledge of contemporary urban school gardens has an impact on environmental education, health education, and biology didactics in general, as well as education for sustainable development.

A longitudinal study of the impact of pre-service teacher training in health education and the implications for biology teaching

Jenny Byrne, Willeke Rietdijk and Karen Pickett

Keywords: Biology teachers, Health education, Teacher training

Type of presentation: Oral

Health education is not necessarily the core business of all teachers but there is a growing body of knowledge that positive health and education outcomes are linked. Therefore it seems essential that health education is included as part of training for all teachers, especially biology teachers as they often are expected to deliver specific aspects of the health education curriculum. However the subject is not always prioritized and little is known about the impact of such training on teachers' knowledge and attitudes towards promoting health in school. This paper reports on Phase 1 of an 18 month project that examines the long-term impact of an innovative health education programme during pre-service teacher training in England. Quantitative and some qualitative data were collected via an online questionnaire sent to three consecutive cohorts of trainee teachers to assess their attitudes, confidence and competence to teach and promote health and how this changes over time. In-depth qualitative data were obtained from semi-structured interviews to explore the factors that influence pre-service teachers' role in engaging as health promoters. Questionnaire responses indicate that training increased levels of knowledge, skills and confidence to teach health education. However knowledge, skill and confidence in topics such as sex and relationship education and drug education were lower than other topics such as healthy eating. Pre-service training is only the beginning of these teachers' training in health and it would appear that further training is needed at in-service level especially in some of the more sensitive topics. This will be important for all teachers but as biology teachers in England are likely to be at the forefront in the delivery of these topics they will need more training not only in the scientific content but also how to deal with the social and emotional aspects of these topics in order to manage an effective and holistic approach to such issues as sex and relationships education. Barriers and facilitators to teaching health education were recognised including practical experience and support from senior management is recognized as essential to ensure heath education is given the same status as other curriculum areas. Qualitative data from interviews supported the questionnaire findings.

Instructional support for learning concepts in evolutionary theory with visualizations

Devasmita Chakraverty, Daniela Fiedler and Ute Harms

Keywords: Evolutionary theory, Instructional support, Probability, Randomness, Visualization/simulation

Type of presentation: Poster

Understanding evolution is central to understanding biology, and is a key objective in school curricula. However, student understanding of evolution is not always accurate. Several fundamental threshold concepts (like randomness and probability) are needed to understand how evolution works, and are complicated to teach and learn. This is because they are composed of integrated and linked systems of concepts that are fundamental to understanding evolution.

In this study, we will explore whether teaching and learning randomness and probability can be facilitated using a previously developed web-based interactive visual application ("Line-application") and accompanying instructional support (interpretative and reflective support).

Interpretative support (provided prior to interaction) focuses on the particular content of evolution displayed through visualizations. In contrast, reflective support (provided during/after the interaction) focuses on aspects to scaffold learners' metacognitive knowledge by prompting reflective processes. Our objective is to understand the effectiveness of particular instructional supports in facilitating the understanding of randomness and probability using the "Line-application".

We will use a control-treatment experimental study with a pre/post-test design with students majoring in biology at the Kiel University (N=90). Students will be randomly assigned to a control (C; N=30), or one of the two treatment (T1 and T2; N=30 each) groups. Data for students' understanding of evolutionary theory and specifically, understanding of randomness and probability will be collected before and after intervention using the "Conceptual Inventory of Natural Selection" and a test instrument we are currently developing to measure the understanding of randomness and probability. For the intervention, all three groups will receive instruction about working with the "Line-application". The control group will only work with the application without receiving additional instructional support. T1 will receive interpretative support in the form of questions and worked-out examples for activating pre-knowledge prior to working with the "Line-application". T2 will receive reflective support for reflecting on the work they will do with the "Line-application", using reflective notes. At the end of the task, we will ask all the three groups about how they think using the "Line-application" helped in their understanding of evolutionary theory. We aim to understand how "understanding evolution" is associated with certain forms of support measures like interpretative and reflective support. Our findings will be of interest to researchers and practitioners in the field.

Pre-service teachers' awareness on the teaching strategies involving socioscientific issues, inquiry-based science education to enhance socioscientific inquiry-based learning

Shu-Nu Chang Rundgren and Carl-Johan Rundgren

Keywords: Primary education, Socioscientific inquiry-based learning, Teachers' professional development

Type of presentation: Poster

Together with Inquiry-Based Science Education (IBSE), teaching and learning about SocioScientifis Issues (SSI) and the related argumentation skill (termed informal argumentation or SSI-argumentation) are emerging and hot research topics in science education internationally during the past decades. Embedding the four important concepts regarding Responsible Research and Innovation (RRI), Citizenship Education (CE), SSI and IBSE for the education in modern society, the teaching strategy of SocioScientific Inquiry-Based Learning (SSIBL) is generated and recognized by the European Commission to promote in teacher education and apply in school education. The presentation is based on an EU FP7 project, PARRISE (No. 612438), aiming to develop TPD courses to enhance pre- and in-service teachers' competence on teaching students' SSIBL in formal and informal education from primary to upper secondary education levels. The purpose of this presentation is to demonstrate a design of a SSIBL TPD course (with a focus of RRI, SSI, IBSE and CE concepts) for a group of pre-service teachers at primary education level. Further, the pre-service teachers' awareness on teaching strategies involving SSI, IBSE to enhance SSIBL is investigated with the main research questions including:

1. What are the pre-service teachers' awareness of SSI and IBSE teaching?
2. What are the re-service teachers' awareness of SSI, IBSE and SSIBL teaching after the SSIBL TPD course?
3. What are pre-service teachers' general feedback on the SSIBL TPD course?

Through the pre- and post-test with quantitative Likert-Scale questionnaire survey, the results showed that the 26 pre-service teachers' confidence on SSI, IBSE and SSIBL teaching strategies were increased and need for further education was decreased, both with significantly differences ($p < 0.05$) after the SSIBL TPD course. Also, the general feedback on the SSIBL course was positive as well.

Teachers' conceptions of environment in West Africa

Pierre Clément, Jérémy Castera, Lawrence Ntam Nchia, Laurence Ndong, Ivette Bere-Yoda, Mame Seyni Thiaw and Mensan Azadzi Dzamayovo

Keywords: Anthropocentrism, Ecocentrism, Environmental education, Francophone countries, Teachers' conceptions, West Africa

Type of presentation: Oral

This work is the first attempt to identify teachers' conceptions of the Environment in five West African Francophone countries, and to compare them with those of their French colleagues. Are the teachers' conceptions of environment, in these countries, very similar due to the similarity in their Francophone educational systems, or do they differ as a result of the peculiar socio-cultural and environmental contexts of each country?

We used the questionnaire built and validated by the research project Biohead-Citizen. Similar samples of pre- or in-service teachers (in Primary Schools, and in Secondary Schools teaching Biology or Language) filled out the questionnaire, anonymously. Multivariate analyses such as Principal Component Analysis (PCA) and Between-class analysis completed by a randomization test were done using the software "R", to see if they were significant observed differences in the data obtained from 2144 respondents.

The first component of the PCA shows that the teachers' answers mainly oppose anthropomorphic to non-anthropomorphic attitudes (whether a snail, a fly or a frog is able to feel happiness or not). Independently, the second component opposes two sets of conceptions: anthropocentric versus non anthropocentric, as well as non ecocentric versus ecocentric attitudes. The judgements of GMO are partly correlated with this opposition as pro-GMO opinions are correlated with anthropocentric attitudes.

The Between-class analysis shows that the teachers' conceptions of environment clearly differ among the countries. These differences are very significant ($p<0.001$: randomization test). Most of the French teachers are less anthropocentric than their African colleagues, and also less anthropomorphic. The questions related to ecocentric attitudes, except one, do not differentiate the countries. There are also significant differences among the African countries; in Burkina Faso, the teachers' conceptions are more similar to those of French teachers, while in Cameroon they are the most different possibly due to its bicultural and bilingual nature.

These results show that the socio-cultural and environmental context of each of these countries influences teachers' conceptions of environment more than the apparent similitude of their educational systems. Some hypotheses are proposed to explain the observed differences among these Francophone countries.

The influence of meta-cognitive guidance on drink-related nutritional literacy

Hagit Cohen and Michal Zion

Keywords: Meta-cognitive awareness, Nutritional literacy, Sugar-sweetened beverage

Type of presentation: Oral

Food consumption during childhood affects growth and predicts the risk of obesity, diabetes and cardio-vascular disease in adults. Sugar-Sweetened Beverages (SSB) contribute to the obesity epidemic by increasing the amount of sugar consumed daily. There is also evidence of chronic moderate dehydration being a risk factor for various diseases and studies have shown that much of the population is chronically dehydrated. One of the factors that can improve food and drink consumption is the level of nutritional literacy, defined as the ability to achieve, understand and process nutritional information. Increasing the level of drink related nutritional literacy (DNL) results in increased water drinking and reduced sweetened drinks consumption. Improvement in pupils' ability in making drink and food related choices may also be facilitated by meta-cognitive awareness that improves pupils' functions like planning, management and control of learning.

The goal of the research is to evaluate the contribution of meta-cognitive guidance on the development of DNL. The research was conducted on 200 pupils aged 9-10 years. The research included a test group and a control group. In both groups the pupils prepared and held an activity in order to encourage water drinking and reduction of sweetened drinks for younger pupils aged 6-8 years, as part of their science class. In the test group, the pupils received guidance for developing meta-cognitive awareness while preparing the activity. The change in DNL (knowledge, attitudes and behaviour) was tested using quantitative and qualitative methods.

A statistically significant increase was found in the knowledge factor of DNL in all pupils of both research groups as a result of studying the subject. Pupils that received meta-cognitive guidance show a statistically significant increase over the control group on the attitude factor of DNL. The pupils of the test group showed a larger behavioural change than the control group pupils in the context of the quality of their daily drinking and on special occasions. In addition, the test group pupils explained that their drinking behaviour was planned, monitored and controlled.

Increasing nutritional literacy at a young age can significantly benefit children for the rest of their lives. Developing nutritional literacy by increasing meta-cognitive awareness in children may provide them with tools for coping with the modern world. Science teachers that choose to teach according to the suggested model may generate significant changes in children's drink related behaviour.

Using video vignettes as cases to foster pre-service teachers' diagnostic and design abilities

Sarah Dannemann and Harald Gropengießer

Keywords: Case-based learning, Students' conceptions, Teacher professionalism, Video vignettes

Type of presentation: Poster

"She did not understand blood circulation in a correct way. If I would be her biology teacher, I would teach the subject again, maybe with better material, that corrects her false thinking" (Tim, bachelor pre-service teacher). If pre-service teachers are asked to explain how they can support students' learning many of them answer similar to Tim. Compared with educational theories of learning two aspects are crucial: the pre-service teachers assess the scientific perspective as the most important factor when it comes to design learning environments. In contrast, students' conceptions are either neglected or dismissed as ideas that just need correction.

These findings emphasise two main challenges of teacher professionalism. Pre-service teachers have to enhance their model of learning and teaching. They have to recognize that students' conceptions are as important as scientific conceptions to design learning environments. Furthermore, the scientific content has to be critically analysed from the learners' perspective. This procedure corresponds to the model of educational reconstruction that is commonly used as a frame to design learning environments.

Case-based learning is applied in university courses that deal with complex situations, e.g. law, medicine or pedagogy. Empirical studies give clues that it may foster domain-specific abilities and facilitate their application in similar situations.

The first aim of this study is to design cases for biology teacher education that support diagnostic and lesson planning strategies. Furthermore, a tutorial was designed and implemented with four groups that differ concerning their qualification. The pre-service teachers analyse cases in single or group discussions and design learning environments. Then they are asked to reflect on their practice. Both phases are videographed and analysed using qualitative content analysis and metaphor analysis.

The results indicate that cases enhance teachers' knowledge and their abilities to plan student-oriented learning environments. However, they are not able to perform a critical analysis of the scientific content. Three main factors for good practice were identified: the pre-service students' conception of learning and teaching, their biological understanding, and their abilities to use biology specific educational criteria to reflect.

Inter-rater reliability in evaluating cognitive demand and level of difficulty of high-stakes biology examination papers

Edith Dempster and Nicola Kirby

Keywords: Cognitive demand, Examination papers, Inter-rater reliability, Levels of difficulty

Type of presentation: Oral

High-stakes examinations are written at the end of the 12th year of schooling in South Africa. The examination papers are set by a team of examiners, moderated by two teams of moderators, and evaluated by an evaluation team.

The examiners and moderators are supplied with a weighting grid for four types of cognitive demand: Knowing Science (40%), Understanding Science (25%), Applying scientific knowledge (30%) and Evaluating, analyzing and synthesizing scientific knowledge (15%). Key verbs are provided for each type of cognitive demand, but they are not defined. Examiners and moderators must show that they have met the specified weighting by types of cognitive demand.

The final evaluation team differentiates between type of cognitive demand and level of difficulty of questions. It recognizes that a question requiring students to synthesize knowledge and create a new product may be easy because the subject matter is simple.

A problem arising with so many levels of setting and moderating is that team members may not agree on their allocation of questions to types of cognitive demand. This paper reports on a concerted attempt to increase inter-rater reliability in a team of four external evaluators. The team constituted one University lecturer in Didactics of Biology, one Biology teacher from the private school system, one Subject Advisor from the public school system, and one Biology teacher from the public school system.

The team discussed the definitions of each of the four types of cognitive demand prescribed by the curriculum and each level of difficulty, rated from 1 (very easy) to 4 (very difficult). They worked through three examination papers together, discussing each question until consensus was achieved. The team then separated and analysed a further nine past papers independently. A second meeting was held after all team members had completed the analysis, and results compared. Where large inter-rater discrepancies occurred, analyses were revised until greater agreement was achieved. A month later, four examination papers were analysed individually, and results submitted to the team leader. This provided an opportunity to measure inter-rater reliability, which was calculated using Gwet's method for more than two raters. Inter-rater reliability of cognitive demand was <0.4 in one paper, and just over 0.4 in three papers. Levels of difficulty were less reliable, with two papers achieving <0.4 and two papers just over 0.4. The conclusion reached was that inter-rater reliability was difficult to achieve, given the different backgrounds of the team members.

CLIL Biology – Teaching Biology in a foreign language. The influence of classroom language on student motivation and acquisition of knowledge

Petra Duske and Michael Ewig

Keywords: CLIL – Content and Language Integrated Learning, Competence-based teaching approach, Gender, Student motivation

Type of presentation: Oral

Content and Language Integrated Learning (CLIL) is a dual-focused educational approach in which an additional language is used for the learning and teaching of both content and language. This competence-based teaching approach has been implemented in most European education systems and has embeded itself in mainstream education. Numerous studies have shown the benefits of CLIL teaching for various aspects of language acquisition. This study deals with the question in how far CLIL Biology (i.e. teaching Science/Biology in English as a foreign language (in Germany)) influences the students' motivation and their acquisition of knowledge in Biology.

To answer these questions, a quantitative study (n=788) with pre-post-follow-up design and control group has been conducted with 29 classes (grade 9) and 13 teachers at 10 schools in Germany. To increase the validity of the results, each teacher taught at least two classes. The multivariate analysis of the quantitative tests shows the following results: There is no significant difference between the students' motivation taught in English and in German. Whereas the CLIL students' motivation correlates with their motivation in the school subjects Biology and English, it does not correlate with the students' performance in these subjects. CLIL students show at least similar results in all knowledge tests as the students taught in German. In contrast to some criticism of bilingual teaching, CLIL therefore does not impair the students' acquisition of knowledge. Furthermore, no correlation has been found between the students' growth of knowledge during the CLIL unit and their motivation or competence in English.

Although CLIL seems to be equally suitable for girls and boys regarding their motivation, girls seem to learn more during a CLIL unit in Biology than boys. In addition to these empirical data, the study provides evaluated material for teaching CLIL Biology, which is still rarely available and urgently demanded by (German) Biology teachers.

Why structure needs to be provided autonomy-supportive – The effects of structure and autonomy support on motivation

Alexander Eckes, Detlef Urhahne and Matthias Wilde

Keywords: Instructional strategies, Motivation, Non-formal learning environments
Type of presentation: Oral

Structured instructions help students to recognize learning opportunities at non-formal settings and keep them in the learners' focus of attention (Falk & Balling, 1982; Gottfried, 1980; Griffin & Symington, 1997). Structure supports students' perception of competence and their perception of control over learning outcomes (Jang, Reeve, & Deci, 2010). Autonomy-supportive instructions help students to be task-persistent when no external support is available (Connell & Wellborn, 1991). Autonomy-supportive teacher behavior nourishes students' motivational resources and satisfies the need for autonomy (Basten et al., 2014; Reeve & Jang, 2006). Thus, the present study aimed to investigate the motivational effects of structure (basic vs. extensive) and teacher behavior (autonomy-supportive vs. controlling).

One-hundred and fourteen high school students of fifth to seventh grade from schools of higher stratification level visited an exhibition centered on the locomotor system of human and animals at a local university. In a 2x2 post-test design, the study tested the effects of basic or extensive structure in combination with autonomy-supportive or controlling teacher behavior on intrinsic motivation. Students' motivation was measured by the Intrinsic Motivation Inventory (IMI; Ryan, 1982). Significant interactions of teacher behavior and structure were found for the IMI subscales interest/enjoyment ($F(1, 107) = 10.46$, $p < 0.01$, ?2 = .029), pressure/tension ($F(1, 105) = 2.91$, $p < 0.05$, ?2 = .027) and perceived competence ($F(1, 105) = 8.13$, $p < 0.01$, ?2 = .072). The subscale perceived choice showed an interaction tendency ($F(1, 107) = 2.86$, $p = 0.09$, ?2 = .026).

Extensive structure offering autonomy support led to significantly higher interest and enjoyment, lower pressure and higher competence. However, offered in a controlling way, extensive structure was associated with lower interest and enjoyment, higher pressure, lower perceived choice and competence. The conclusions of these results are outlined.

Young children's reasoning when sorting pictures and objects

Marida Ergazaki, Renia Gasparatou and Eftychia Valanidou

Keywords: Biology education, Categorization criteria, Preschoolers, Reasoning skills, Stimulus-medium

Type of presentation: Oral

This paper reports on a qualitative case study that explores young children's ability to spontaneously categorize biological and non-biological entities presented to them as pictures or 3-dimensional objects. Our focus is set on the sorting-criteria children activate depending on the stimulus-medium and whether these criteria differ, particularly in terms of whether they concern properties inherent to the entities (intra-entity criteria) or associations emerging in their interactions (inter-entity criteria). The participants of the study were 120 preschoolers (60 girls/60 boys, age 5-5.5), attending public kindergartens in Patras' areas with medium/high socio-economic status and were selected due to their teachers', parents' and own agreement. Tracing children's reasoning was performed through individual, semi-structured 15-20-minute interviews in quiet places of children's schools. We used 24 items: 3-D toy-objects and pictures. Pictures were photographs of the objects in a 'sketch-format'; they looked similar with the objects but without a 3-D effect. The items were divided in two sets with 4 animals, 4 plants and 4 artifacts each. For each child, one set was presented as pictures and the other as objects. Each set appeared as pictures for half the children and as objects for the other half. Half the children were first given pictures and half were first given objects. So, the order of the two free-sorting tasks (pictures-task and objects-task) was counterbalanced. In both tasks, children had to (a) recognize what was represented by each picture/object, (b) create groups with them, and (c) provide a justification for each group. The tape-recorded interviews were transcribed and coded within 'NVivo', which gave rise to four main categories of criteria ('biological', 'ordinary', 'story-making' and 'appearance-related'). These were then characterized as intra- or inter-entity criteria. According to our findings, the frequency of intra- and inter-entity criteria did not differ much in the two sorting-tasks. Children appeared to slightly prefer intra- rather than inter-entity criteria, regardless whether they were sorting pictures or objects. Moreover, intra-entity criteria were slightly more frequent at the pictures-task rather than at the objects-task, while inter-entity criteria were almost equally activated in both. Our findings show that both objects and pictures could be used within introductory learning environments for participants at the age of five. Biology-instruction could build - without medium-restrictions - on children's emerging potential to activate intra-entity conceptual relations, in order to help them enhance their ability to categorize taxonomically.

Retrieval practice: A strategy to enhance inquiry learning?

Anne Erichsen and Jürgen Mayer

Keywords: Inquiry learning, Learning strategy, Memory, Retrieval practice
Type of presentation: Poster

In the field of science education inquiry learning seems to be a promising method for achieving the goals of education: durable and flexible learning (Furtak, Seidel, Iverson & Briggs, 2012). Even though the benefit of this method has been confirmed in numerous experiments there still exist criticism concerning the durability and effectiveness for biological concepts (Kirschner, Sweller & Clark, 2006). Educational approaches are trying to face that problem by implementing scaffolds that ease the acquisition (Arnold, Kremer & Mayer, 2014). According to research from cognitive psychology this attempt seems to be dramatically wrong: Manipulations that have an advantage during instruction can fail to support learning (Bjork, 2013). For this very purpose retrieval practice seems to be appropriate (Roediger & Karpicke, 2006). Although the powerful mnemonic effect of retrieval practice has been shown the benefit for enhancing inquiry learning has yet to be proofed. To close this research gap an experimental study (funded by LOEWE excellence programme) involving 6th graders (N = 120) is planned. In a controlled experiment an inquiry activity which includes retrieval processes is going to be compared with inquiry tasks that incorporate reading or no extra guidance to build up sustainable knowledge. The learning outcome will be measured immediately after the inquiry task and one week later. The purpose of the project is to identify strategies, that enhance the instruction during inquiry learning. On the poster first findings are going to be presented.

Should we care about the bees? Argumentation and modeling to understand an SSI with pre-service teachers

Maria Evagorou and Blanca Puig Mauriz

Keywords: Argumentation, Controversial, Modeling, Pre-service teacher education
Type of presentation: Poster

The purpose of this study is to explore how pre-service teachers model a controversial issue, and then how they use and change their model to argue about possible solutions and causes to the issue. The participants of this study were 24 pre-service elementary school teachers who were engaged in a specially designed teaching sequence for 6 weeks. Preliminary findings reveal that the students were excited with the modeling process and during the modeling process they had to look for more information on how the bee community is organized in order to improve their models, and that the models were very helpful in supporting the pre-service teachers to make decisions for the scenarios provided.

How to measure students' understanding of randomness and probability in the context of evolution?

Daniela Fiedler and Ute Harms

Keywords: Evolution, Probability, Randomness, Students' understanding
Type of presentation: Oral

Evolution is the central, unifying and overarching theme in biology. Nevertheless, researchers have consistently reported students facing conceptual difficulties with its understanding. In particular, those aspects of evolution are misunderstood that are strongly related to abstract concepts like randomness and probability, so called threshold concepts. Despite the wide variety of instruments measuring students' knowledge of evolution, tools that assess students' understanding of randomness and probability – especially in the context of evolution - are lacking. To test our hypothesis that the understanding of randomness and probability mediates the understanding of evolution, we designed the "Randomness and Probability in Evolutionary Theory Assessment" (RaProEvo). The RaProEvo measures students' understanding of randomness and probability in the context of evolutionary theory using multiple-choice and open-ended questions. We are designing the instrument in two steps. In the first step we search for appropriate items for the context of evolution and mathematics. We divide the items into two contexts because in biology mathematical explanations of randomness and probability also serve as explanations for random processes. Therefore, a connection between the contexts of evolution and mathematics is suspected. The pilot study has a proportion of three open-response items in the context of evolution, and 26 open-response and multiple-choice items in the context of randomness and probability. We administered the pilot paper-based test to a group of German university students (N = 48). Students' answers to the open-response items in context of evolution show a low usage of concepts of randomness and probability and an intermediate usage of concepts of evolutionary theory. Initial findings also indicate correlations of understanding randomness and probability in evolution and mathematics with understanding evolutionary theory. Nevertheless, the instrument needed improvement especially in respect to measuring students' understanding of randomness and probability in context of evolution. In a second step we therefore revised the items and developed additional ones. Now the main study has a proportion of 26 open-response and multiple-choice items in

Change in high-school biology teachers' pedagogical content knowledge

Inbal Flash Gvili and Anat Yarden

Keywords: Action Research, Pedagogical content knowledge, Reflective writing
Type of presentation: Oral

Reflective thinking is a central tenant of teachers' education. Within science education teachers' reflection is seen as a mechanism that promotes development in teachers' pedagogical content knowledge (PCK) - knowledge of how to teach specific content. Still, it is not clear how reflection facilitates this goal. Transformative learning theory asserts that there are three main types of reflections: reflections on the process or the content of an experience, and critical reflections on the very assumptions used to frame the experience. The theory predicts that the use of critical reflection facilitates transformation in meaning perspectives (e.g. theories, beliefs) people use to interpret their experience. Individual teacher PCK's can be seen as a meaning perspective teachers hold when they come to teach specific content. If we accept this than critical reflection should facilitate transformation in teachers' PCK. To test this theory we examined changes in two high-school Biology teachers' PCK as they were engaged in a yearlong action research workshop. The goals of this study included: distinguishing between different types of teachers' reflections about their action research and associating types of reflection with types of changes in teachers' PCK. Within the workshop the biology teachers are asked to design an action research that focuses on the relationship between their teaching and students' learning outcomes within a single curricular unit (of their choice). They are periodically asked to reflect on their research. For the purpose of this study we chose to analyze the reflections of two out of six Biology teachers that participated in the workshop. These two teachers were chosen since both focused their research on the same curricular topic: genetics, and identified the same challenge related to students' understanding: organizing concepts taught separately into a coherent and systematic model of information transfer- from gene to trait. Analysis of the teachers' reports showed that the first teacher utilized critical reflection towards her assessment tool and this resulted in transformation in the way she teaches genetics. At the same time the second teacher used process reflection towards the teaching strategy and this resulted in elaboration of his instructional knowledge without significantly changing the way he teaches the topic. These results suggest that critical reflection facilitates significant changes in teachers'' PCK. The generalizability of our conclusion is limited due to the research case study design. Still, we hope that the knowledge gained in this study will help support teachers' development in action research workshops.

A didaktik analysis of an integrative research project in biology: meetings between the different forms of knowledge

Veronica Flodin

Keywords: Didaktik, Gene concept, Knowledge content, Knowledge forms
Type of presentation: Oral

The study of biology as a discipline gives reasons to expect differences between different sub-disciplines. This study is aimed at content knowledge in the form of the use of gene concept. By studying an integrative research project in biology, where various sub disciplines have come together on common problems to solve, the gene concept in use is illustrated. Is it possible to distinguish different uses? The researchers' meetings, where they try to integrate research results, are regarded as didactical practices where they teach and learn from each other. The study involves a characterization of the use of gene concept during these meetings. The results point to uses of concepts that are strongly context bound, even within a subject such as biology. The biological research questions are dependent on a specific context that consists of specific research system that evolved historically; organisms with their conditions and different methods and tools. The gene concept has different meanings depending on the research context it is used within. It raises questions about the concepts function as tools of research compared to teaching's focus on definitions. A didaktik analysis of the integrative research project provides the opportunity to develop a reference on how knowledge can be shaped in the face of new contexts and require adaptation to become useful again.

Effects of teachers' professional knowledge on the use of high-complexity instructional tasks and students' achievement

Christian Förtsch, Sonja Werner, Lena von Kotzebue and Birgit Neuhaus

Keywords: Instructional quality, Multilevel analysis, Professional knowledge, Video analysis

Type of presentation: Oral

Instructional tasks can be categorized according to complexity. Within the German project ESNaS a competency model was developed describing the complexity of tasks using three levels: fact, relation, and concept (Kremer et al., 2012). Empirical studies in the field of biology already indicate that a high-linking instruction and teaching based on core ideas (or concepts) fosters students' achievement (Förtsch et al., submitted; Wadouh et al., 2014). Additionally, in theoretical models of teaching and learning, teachers' professional knowledge is described as important prerequisite for instructional quality. Until now, there are mainly studies in the field of mathematics, which examine the effect of teachers' CK and PCK on instructional tasks (Kunter et al., 2013). This study aimed to analyse the effects of teachers' CK and PCK on the use of high-complexity instructional tasks and students' achievement. Within the project ProwiN, 43 biology teachers from German secondary schools were videotaped for two lessons on the topic neurobiology (N=85 lessons). Before videotaping, teachers' CK and PCK was measured using two separate paper-pencil-tests. Students' achievement was measured using a pre- and post-achievement test. All tests were analysed using the Rasch partial credit model and showed good fit-values (all Infit/Outfit-MNSQ≤1.3), person (all ≥.53) and item reliabilities (all ≥.96). Instructional tasks were defined as teachers' content-related request for students to act or to think and were identified in all videos. Afterwards all tasks were coded according to complexity (fact, relation, concept). A second independent coder coded 10% of the tasks. Cohen's ? of .94 indicated a high agreement. Next, the percentage of high-complexity tasks (relation and concept) for each lesson was calculated. Descriptive results showed a mean of 31.3 instructional tasks (SD=13.3) per lesson, which included 6.4 high-complexity tasks (SD=4.5). ICC showed that 19% of variance in students' achievement was located on the class level. Results from multilevel path models showed no significant effect of teachers' CK (?= .20, p=.169) and a significant positive effect of teachers' PCK (?=.39, p=.005) on the use of high-complexity tasks, which explained 17% of its variance. Additionally, high-complexity tasks positively significant effected students' achievement on the class level (?=.45, p=.001, R?=.21). On the student level, we controlled for students' pre-test and willingness to make an effort. Consequently, the use of high-complexity tasks is an effective teaching strategy fostering students' achievement. Additionally, higher PCK leads to the use of high-complexity tasks, which justifies the integration in teacher university education and development programs.

Pointing in the right direction: The effect on student reading comprehension of including directional arrows in images of the energy pyramid

Yun-Ping Ge, Len Unsworth, Kuo-Hua Wang and Huey-Por Chang

Keywords: Energy pyramid, Functional descriptions, Image design

Type of presentation: Poster

Cognitive theories indicate the use of images is a powerful tool in facilitating science learning, particularly when images including explicit visual cues to key concepts. Arrows have been shown to be highly beneficial in cueing functional descriptions in learning about the car brake system. However, in images dealing with other topics such as the energy pyramid some include arrows whereas others do not. Learning to understand the energy pyramid has been identified as difficult due to their inadequate understanding of dynamic processes in the ecosystem. The study sought to examine the effects of the inclusion of arrows in comprehending the diagram of the energy pyramid. An experiment was conducted to determine whether an image design including arrows cued greater understanding than images without arrows. A 5-phase interview was developed to investigate reading comprehension in different conditions of verbal affordance. 12 Taiwanese students from year 7 were homogenously assigned as the participants either in a control group to read the text and diagram without arrows or in a treatment group to read the same texts but with the diagram with arrows. The participants were further identified as having low, medium, or high levels of prior knowledge on the topic according to a pre-test. At Phase 1, when only the image was provided, all the participants in the treatment group could communicate some descriptions of the functioning of the ecosystem, while in control group only one could do so. Little change occurred when the caption was revealed in Phase 2. Phase 3 provided the image, caption, and verbal text. Both groups generated more interpretations about causal relationships in the ecosystem. However, the control group seldom mentioned energy source and energy loss. The climax of meaning construction for control group was at Phase 4 when the diagram with arrows was represented. In contrast, in contrast this occurred in Phase 3 for treatment group. When the participants were asked to judge the most useful image in Phase 5, eleven out of twelve judged the diagram with arrows as superior in helping them comprehend the concept. Functional descriptions are important in understanding the energy pyramid. Without these descriptions, student conceptualizations based on a static view of the system are completely inadequate. The effect of arrows in cuing more functional concepts is clearly demonstrable even under the condition where the verbal text is not represented. Implications for textbook publishers and teachers are briefly outlined.

Blended learning in school to increase learning success during dissections in biology class: A pig heart dissection as an example

Marc Gerhard

Keywords: Blended-Learning, Flipped classroom, Pig heart dissection, Learning success, E-learning, Peer feedback

Type of presentation: Poster

An E-Learning phase in the form of an online course before and after an actual dissection increases students' learning success for three reasons:

- The problem can be fully assessed und it can be made clear what students should be looking for. This can be formalised through clearly stated hypotheses, which can be reviewed in advance by the peer group.
- A short video demonstrating the steps of the dissection reflects the exact situation in the class room (the same dissection tray, preparation utensils and object to be dissected). By helping the students conduct a more professional dissection they learn more, since less false cuts are made and they work faster (45 min).
- By representing the real situation in the video, students know what to expect. This decreases feelings of disgust and thus failures.

Based on our results of the investigation the use of a blended learning scenario at schools makes sense. Slower learners and visual learners in particular benefit from the clearer structure and the use of realistic video clips for preparation.

Analysis of the presentation of age in school books at primary school and lower secondary school level

Franziska Ginschel and Kirsten Schlueter

Keywords: Portrayals of old age, Textbook analysis

Type of presentation: Poster

The article presents an analysis of how old age is portrayed in schoolbooks used in teaching (i) basic science at primary school level and (ii) biology and politics in the lower classes of secondary schools. An accompanying feature of demographic change is that the older generation plays an increasingly important role in society. Consideration of how age is portrayed is a possible step in order to establish how schoolchildren are prepared for demographic changes. A total of 66 teaching materials used in the German state of North-Rhine-Westphalia were included in the investigation. The texts and illustrations of older people in these textbooks were examined with regard to physical appearance, mental condition and social behaviour in order to provide a more detailed description of the portrayal of age conveyed in the literature used in schools. The results of the analysis show that issues dealing with age and growing old are inadequately addressed, both as regards the quantity and the quality of the material. As a rule, portrayals of age that differentiate between the various situations experienced by older people are not represented. Schoolchildren are therefore inadequately prepared for dealing with old people. This is however important in developing closeness between the generations and in promoting the exchange of opinions and experiences.

Teleological explanations in evolution classes

Helge Gresch

Keywords: Classroom discourse, Documentary method, Evolution, Lamarck, Students' conceptions, Teleology

Type of presentation: Oral

A teleological cognitive bias is a central obstacle in understanding and explaining evolutionary processes, in particular natural selection and adaptation. Rather than offering ultimate causal reasons, students often explain evolutionary change by referring to the function of a specific trait and the need of the organism to adapt. These explanations imply goal-directedness and purpose. Although many studies have investigated students' use and acceptance of teleological explanations in questionnaires and interviews, it has not yet been examined, which role teleological explanations play in the classroom and how teachers deal with them. Therefore, it was investigated in this study in which ways teleological explanations are addressed in student-student and student-teacher interactions in secondary school evolutionary classes. The analysis of classroom discourse should aim at integrating both the semantics of the language as part of the thematic pattern (what is said) and the organizational structure of social interactions (how it is said). Six evolution units about adaptation were videotaped for this purpose (grades 7-13, 32 videotaped 90min-periods). The videos were analyzed using the documentary method, which allows to examine both, the immanent or literal meaning (what is said) and the documentary meaning (how it is said) by reconstructing the organization of classroom discourse, e.g. propositions, elaborations, antithetical or oppositional interactions. Different types of dealing with teleological explanations were reconstructed through comparative analyses. In all evolution units, teleological explanations of the students were observed and addressed in the classroom. In one type of interactions, the role of intentionality and consciousness in the process of adaption was discussed explicitly as a misconception of the students. In this type, some of the students considered intentional and goal-driven adaptation to be more plausible than causal explanations. In other interactions, explanations that included goal-directed adaptation were framed as a problem of scientific formulations rather than problems in the conceptual understanding of the students. Contrastingly, in a different type of interactions, the teacher provoked teleological explanations. A cheerful interaction could be reconstructed. Several interactions of a different type showed that an intentional, purposeful evolution was regarded as absurd by the students. Lamarck's theory was framed as outworn and stupid, while causal explanations were considered to be plausible. We suggest for biology education practice to address the difference between causal and teleological explanations on a metacognitive level and to sensitize students for scientific and teleological language.

The meaning of biology teachers' content knowledge, pedagogical content knowledge, and enthusiasm for students' system thinking

Jörg Großschedl, Daniela Mahler and Ute Harms

Keywords: Content knowledge, Doubly latent model, Enthusiasm for teaching, Enthusiasm for biology, Pedagogical content knowledge, System thinking

Type of presentation: Poster

Biology is the science of living systems. Consequently, fostering system thinking is an important purpose of biology education. Accordingly, the question arises how system thinking can be improved. An important factor to consider in this context is the biology teacher. Characterizing a successful biology teacher requires both the consideration of cognitive aspects (here: content knowledge - CK and pedagogical content knowledge - PCK) and motivational aspects (here: enthusiasm for teaching and enthusiasm for biology). Empirical results concerning the relation between these aspects of biology teachers' professional competence and students' system thinking are lacking so far. Biology teachers' (N=41) CK, PCK, enthusiasm for teaching, and enthusiasm for biology were measured using paper-pencil tests. Beyond that, the teachers were asked to develop a short teaching unit (4 h). System thinking of 1036 students (7th and 8th graders) was measured before and after the teaching unit with paper-pencil tests and concept maps. All measures, except the questionnaire related to enthusiasm for teaching and enthusiasm for biology, as well as the teaching unit are related to the specific biological content 'Mytilus edulis in the ecosystem Wadden Sea'. A doubly latent model was specified to investigate the relationship between biology teachers' (1) CK, (2) PCK, (3) enthusiasm for teaching, as well as (4) enthusiasm for biology and students' system thinking. The analysis shows a significant positive relationship between biology teachers' PCK as well as enthusiasm for biology and students' system thinking.

Our results offer first insight into the relationship between cognitive and motivational aspects of biology teachers' professional competence and students' system thinking abilities. Furthermore, they document the necessity to foster both the development of cognitive and motivational aspects in biology teacher education to improve teaching and learning.

Bugs everywhere! An inquiry-based teaching strategy using arthropods for biology learning in primary school

Marti Hendrichs, Janet Gruber, Martin Scheuch and Günther Pass

Keywords: Active learning, Arthropods as model organisms, Early years' science, Hands-on activities, Inquiry-based learning, PYP science curriculum

Type of presentation: Poster

Teaching scientific concepts to students by using arthropods as model organisms has gained popularity in recent years. The children's natural curiosity and their special interest in insects and spiders provides the opportunity to explore biological concepts at an early age. The Primary Year Programme (PYP) at the Vienna International School (VIS) in Vienna, Austria, where this research has been conducted over the past eight years, is a trans-disciplinary and inquiry-based curriculum that promotes active learning through Units of Inquiry (UOI). The main objective of this study was to develop and validate an effective and inquiry-learning teaching strategy that promotes the scaffolding and integration of selected concepts of biology through hands-on activities with arthropods. The UOI about small animals on Grade Primary (5-6 year old students) enables the implementation of this strategy at the beginning of Primary School at the VIS. For this purpose, terrariums with arthropods are placed in the classes at the beginning of the UOI, together with arthropods' models, books and educational guides. During a period of six weeks, the children are allowed to explore freely anytime, creating an active learning environment facilitated by the classroom teacher. Furthermore, every week the school's science coach provides guidance during a 1-hour to each class, in which selected biological concepts are jointly investigated following the scientific inquiry process. Other activities include outdoor explorations and field trips. To evaluate the children's acquired knowledge under this strategy, a survey based on sketches was conducted six months after the end of the UOI. The children were requested to draw the arthropods they remembered. Results demonstrate the children's understanding of biodiversity (28 different arthropod taxa); the most popular arthropods were spiders, butterflies and ladybirds. Even though characteristics of arthropods were not always accurately reflected, the sketches reflect the children's understanding and acquired knowledge on biological concepts and observation skills. In addition, 68% of the children included a variety of connected concept-related comments. This inquiry-based learning strategy using arthropods was confirmed to be an effective teaching strategy, where children gained ownership of their learning by constructing biological content knowledge at an early age.

Students' task-solving regarding ecosystem services – A comparison between students with and without Autism Spectrum Disorders

Mona Holmqvist

Keywords: Austism spectrum disorders, Ecosystem services, Secondary school, Task-solving

Type of presentation: Poster

There has been an increasing interest for ecosystem services in society recently, and this interest has also influenced education. In this study, the aim is to develop knowledge about how this new school-phenomenon can be understood by students in grades 7 to 9, with and without Autism Spectrum Disorder (ASD). Ecosystem services literacy aims to help inform decision-makers for a sustainable environment in the future, and by that developing students' knowledge in the field becomes crucial as the students are tomorrow's decision makers. Participants were students with ASD in grades 7 to 9 (N=11) and controls (25 in grade 7 and 25 in grade 9). The 11 adolescents with ASD (4 female and 7 male) were aged 13-16 years (M=15, 18 years) who met DSM-IV (American Psychiatric Association, 2000) criteria for ASD. The school is an ordinary compulsory secondary school (grades 7 to 9). The data consisted answers of 4 tasks in both groups (ASD N=44 and controls N=200).

The data material consists of answers form four questions, related to two core contents in the Swedish Biology syllabus, namely: (A) Animals, plants and other organisms' life. Photosynthesis, combustion and ecological relationships and the importance of knowledge of this has, for example, Agriculture and Fisheries, and (B) Ecosystems in the environment, relationships between different organisms and names of common occurring species. Relationships between organisms and the inanimate million.Task (1) four sentences including needed information in to solve the task; (2) cartoon with one person asking a question and four alternative answers, (3) 8 sentences describing the foods way from to the kitchen and the difference between animal and vegetable food-production. A statement was made before the question was given: 'school serves vegetarian food twice a week. How will this affect our environment?'

The qualitative analysis of the data shows different difficulties students in the two groups have in understanding the meaning of the tasks. The students with ASD had difficulties in finding the global overview of the content of the task to create an overall understanding of the intention of the task and how to answer the given question. On the other hand, the students without ASD make assumptions grounded in their own everyday ideas which made them end up with an incorrect answer as they did not relay on the information given in the tasks.

Effective field trips in nature: The interplay between novelty, preparation and learning outcomes

Jan van Hoof, Jelle Boeve-de Pauw and Peter van Petegem

Keywords: Excursions, Learning, Novelty, Preparation
Type of presentation: Poster

Nature excursions are a common practice in primary education. Typically, these excursions take children outside the classroom to learn about nature. Goals of such learning are both cognitive and affective. Such excursion are, however, not always effective in achieving these goals. One of the causes of their ineffectiveness can be that the learning environment is experienced as “too new” or novel by the articipating children. Literature describes three different dimensions of newness which, together, form the novelty space within which learning takes place during the excursion: a cognitive (“what will we learn”), a physical or practical (“where will we learn”), and a psychological dimension (“how will we learn”). If novelty is high, learning can be hindered through distraction, confusion or experiencing newness. Novelty can, however, also be too low, which might result in disinterest. There thus seems to be an optimal amount of novelty, which could be achieved through offering customized preparation to the children taking part in an excursion.

The current paper reports on a quantitative study about the novelty of De Kesselse Heide (a moorland area in Belgium) as a learning environment for nature excursions for primary school children, the preparation offered by their teachers and the children’s learning outcomes. Included outcomes are ecosystem knowledge, preservation and utilization values (2-MEV) and inclusion of nature in the self (INS). In total 484 children and 24 teachers participated in the study. Results of multilevel regression models show that the effects of the excursion, though intended to be both cognitive and affective, are mainly to be found on the cognitive side. Teachers furthermore seem to spend little effort in preparing their students for the excursion. The results furthermore confirm the curvilinear effect of novelty on learning. Implications for theory and practice are discussed.

The effect of school garden activities on pre service student teachers' attitudes to teaching biology outside the classroom

Lissy Jäkel, Ulrike Kiehne and Sabrina Friess

Keywords: Attitudes, Ecologically oriented gardening, Outdoor teaching, PCK, Nature Awareness

Type of presentation: Poster

The meaning of outdoor teaching and ecologically oriented gardening is connected with expectations regarding the demands of sustainable development of nature and society. At present, knowledge and willingness toward conservation of biodiversity (National Nature Awareness Study) are sufficiently present only in a quarter of the population of Germany. Teachers should have PCK for designing effective outdoor learning processes with students as well as teaching in classroom.

The purpose of this research was to determine whether the integration of ecologically oriented school garden projects into the university curriculum positively influenced pre service student teachers' attitudes toward nature and teaching outside. How does one qualify trainee teachers to make best use of school gardens for didactic purposes?

Pre service student teachers during their first semester in biology were included in the study, compared in a control and an experimental group. The experimental group had to develop learning material for teaching children outside. The freshmen developed and tested learning materials toward botany to integrate into the school curriculum, and got feedback by the university teachers during the process of development and teaching. This research was in collaboration with schools. The learning situations were oriented towards interesting contexts, to direct experiences with living organisms.

The questionnaire (pretest/ posttest) was in three parts. Part one concerned attitudes toward nature and nature conservancy. The second part dealt with attitudes to the didactic potentials and possibilities of outdoor teaching and personality development. The third part dealt with self-assessment regarding one's gardening capabilities and ability to teach outdoors.

Additionally, a questionnaire on interests in different domains of biology was used. Self-estimations of learning success of all participants of the experimental group were collected with short written texts in an open format, and analyzed qualitative (n=65).

Positive attitudes towards nature were measurable in pretest and posttest. They remain high throughout the first semester. Pre service student teachers in general make a realistic assessment of own horticultural capabilities. The didactic skills for field work with children and horticultural skills still need to be improved. In the course of their learning, the student teachers display increasing expectations about their own effectiveness with regard to the possibility of strategies for learning outside and in school gardens.

The development of ecological attitudes of children over five years as they participated in three earth education programs

Bruce Johnson and Jan Činčera

Keywords: Attitudes intervening, Earth education

Type of presentation: Poster

This was a longitudinal study of the development of environmental attitudes in children who participated in three sequential earth education programs over four years with follow-up data also gathered in the fifth year. During each of the five years, the children completed the Model of Ecological Values Scale (2-MEV) as well as knowledge and behavior instruments. In addition, they were interviewed individually each year and were observed during each of the three programs. Analysis showed that all participants began the study with pro-environmental values. Those generally remained high and mostly increased during the first year or two. For some of the participants, though, those attitudes in some cases became less pro-environmental as they entered early adolescence. Six participants representative of different development trajectories were selected and profiles of each were created, based not only on the written scales but also on the interviews and observations. The profiles reveal that participation in the programs positively influenced environmental attitudes but so did outside factors such as peer pressure, family concerns, and changing interests as they entered early adolescence. For some of the participants, these factors outweighed the influence of the programs while for others they did not or actually supported the positive development of environmental attitudes.

Thinking across levels of biological organizations: Does knowledge of genetics help students avoid teleological explanations of evolutionary phenomena?

Janina Jördens and Marcus Hammann

Keywords: Evolution, Genetics, Students' understanding, Teleological explanations
Type of presentation: Oral

Several studies focused on the effects of teaching genetics knowledge in an evolutionary context. As selected chief findings, students' teleological explanations and their tendency to explain evolutionary change at the phenotypic level alone were found to decrease because of making knowledge of genetics available to the students. However, inert knowledge of genetics has also been reported and often, genetics knowledge also surfaces in teleological explanations. As a consequence, we investigated, to what extent students who explain evolutionary change teleologically differ in their use of genetics knowledge from students who do not explain evolutionary change telologically. The sample consists of 206 high school students who participated in a randomized teaching experiment with a pre-post-test design involving a comparison group. One group experienced how selection impacts allele frequencies, whereas the other did not. The study builds on the categories used for coding student explanations in Kampourakis & Zogza (2009) and Jördens et al. (submitted). One of the major implications of this study is that genetics knowledge may be helpful for the students, but may not be an all-encompassing guarantee for avoiding teleological thinking.

The natural history perspective on bio-communities – A stepping-stone to evolutionary thinking in lower secondary school

Martin Jurgowiak and Jörg Zabel

Keywords: Evolutionary thinking, Natural history perspective, Secondary school
Type of presentation: Oral

Most students believe ecosystems to be in perfect equilibrium and static throughout time as long as they remain untouched (Jelemenská 2006). Biology education may have contributed to this problem, as it often limits itself to describing biological entities and functional biology Kattmann (1995). Meanwhile, many curricula emphasize evolution as a unifying theme (e.g. Olson Et Al. 2012). Kattmann and Van Dijk (2009) make a case for a natural history perspective in biology education as a first step towards this objective. When initially establishing a natural history perspective, it seems reasonable to choose students from the beginning of secondary biology education and bio-communities as a smaller grain size of ecological phenomena. The main objectives of this study are to identify students' conceptions about (1) the interdependencies between living beings and their environment, as well as (2) the historical and prospective development of a biocommunity. Furthermore (3), we evaluate particular teaching interventions designed to procure a natural history perspective.

We conducted problem-centred individual interviews with students in grade 6 (N=6, age 12). Based on photographs, the students were asked to explain past and prospective changes in different ecological contexts (plant with special growth form, clearing with fallen trees, timberland, natural forest). All data were analysed for nomological and historical explanations, using Qualitative Content Analysis (Mayring 2008).

Those students who noticed an obvious phenomenon on the picture, such as a fallen-down tree, regularly used retrospective propositions in their oral explanations and predictions. They tried to explain how things happened, thereby using nomological propositions ('all trees must die'), but also descriptions of contingent events such as lightning or plant disease. Those students uttering nomological statements used attributes such as 'certainly' or 'always', using their knowledge on laws and regular processes in nature. In contrast, those students that also integrated contingency into their explanations would use the concept of probability and depict multiple alternative scenarios in their predictions.

Our findings indicate that in this young age group already, students are intuitively able to combine nomological and contingent aspects in their explanations. This encourages the introduction of a natural history perspective in early secondary school, thereby teaching a more adequate way of explaining phenomena of the living world than by using the idea of 'natural laws' only. Currently, we are developing a teaching unit according to our findings.

Teachers thoughts about biodiversity education, plant species recognition and outdoor education

Arja Kaasinen

Keywords: Biodiversity education, Outdoor education, Plant species recognition
Type of presentation: Poster

We are facing many global environmental problems, like climate change, invasive species and forests fragmentation. We are talking a lot about biodiversity, but do people really understand, recognize or notice it? Biodiversity is one of the most important things when we think our life and the future of the planet Earth. That is the reason why biodiversity education is important. Detection of environment starts with species recognition. We have to teach children all over the world how to live in a sustainable way.

The purpose of the research was to determine how well Finnish pupils and students of different ages recognize plant species, which variables explain recognition of plant species, what plants and nature mean to the subjects and how plant species identification should be taught in general education in Finland. One of the question was to find out what teachers think about biodiversity education, plant species recognition and outdoor education. The subjects were pupils from: every class level of the primary schools (grades 1–6); lower- secondary school (grades 7–9); high school (grades I–II); university departments of teacher education and classroom teachers and teachers from university involved with environmental teaching and also experts from education and botany. A total of 883 people took part in the research. Result showed that Finnish pupils do not recognize plant species very well. Teachers understood the importance of plant species recognition and outdoor education.

Does generation of prior knowledge enhance efficacy in inquiry learning?

Irina Kaiser and Jürgen Mayer

Keywords: Generation effect, Inquiry learning, Long-term memory

Type of presentation: Poster

In the concept of inquiry-based learning, students are involved in the active process of knowledge construction – not only for the acquisition of content knowledge but also for the procedural understanding of an investigation. Despite rather extensive analysis of the learning effectiveness of inquiry learning, the fundamental theory and underlying explanation is not yet clear. Besides the constructivist theory of learning, theories and models of cognitive psychology can be used for this purpose. One common underlying aspect of each of the foregoing learning strategies is the generation effect, an encoding phenomenon in which actively generated information is retrieved more successfully than passively learned information. But while the generation effect has been demonstrated in many different studies with short verbal or simple arithmetic problems, complex generating tasks in realistic teaching situations have not been investigated yet. This project (funded by LOEWE Excellence Programme) focuses on the benefit of the generation effect in the context of an authentic inquiry learning environment for the purpose of identifying learning strategies which increase retention.

In the first out of three experimental studies, the students are randomly assigned to three experimental groups that differ in the type of encoding task for content knowledge (generate with feedback vs. generate vs. read). The short- and long-term outcomes (dependent variables) will be compared via two paper-pencil-tests (with open-ended and closed items) at two different times.

Developing inquiry-based and multidiciplinary approach in a teacher professional development project

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

Keywords: Biology education, Inquiry-based approach, Multidisciplinary science education, Teacher professional development, Team teaching

Type of presentation: Poster

The research and development project carried out in the Department of Teacher Education in Helsinki University aims to promote primary and secondary teacher students' and in-service teachers' abilities to work collaboratively sharing their expertise to develop multidisciplinary science and mathematics teaching in primary or lower secondary schools. The third aim of the project is to produce new instructional materials and approaches for inquiry-based and integrative science teaching, put it into practice and investigate the implementation. Research and development of inquiry-based and multidisciplinary approaches in science education are important, because these approaches are emphasized in the new Finnish core curriculum for basic education. In the designed model of this study teacher students, in-service teachers and teacher educators formed teams, and with help shared expertise apply the chosen science theme for the specific schools and plan the instruction. The phases of the project round are planning of the instruction, implementation at schools, evaluation, and reflection in the end of the project. The pilot project started in 2014 and by the end of 2015 the project has been carried out in seven primary schools and in one secondary school. The themes were built mostly around biological phenomena. Interviews, questionnaires and videos were used as research data and analysed both qualitatively and quantitatively. The preliminary analysis of the data indicated that both teachers and teacher students regarded collaboration in planning and teaching important so that the collaboration in mixed groups were emphasised. Despite the teachers and teacher students found that their skills in using student-centred and hands-on activities increased, the actual inquiry practices were often more teacher than student-centred. The participants also felt that there was not enough time for proper introduction, engagement and collective evaluation with the pupils. When multidisciplinary approach was used in teaching, the participants still had difficulties to specify the level of integration. Thus, parsing of theoretical concepts may help teachers to focus on key issues of inquiry-based and multidisciplinary approach. The results indicate that inquiry-based approach, multidisciplinary integration and team teaching, competencies largely required by the renewed curriculum, are challenging for the teachers. In order to promote the project's goals, it is important to acknowledge different levels of inquiry-based instruction and different levels of integrative science teaching during the whole planning process. It is also important to promote co-operation and shared expertise within the team.

Re-examining the relationship between acceptance and understanding of evolutionary theory

Christiane Konnemann, Roman Asshoff and Marcus Hammann

Keywords: Evolution acceptance, Evolution understanding

Type of presentation: Oral

The relationship between acceptance and understanding of evolutionary theory – though not new - is still under debate. Whereas some studies found weak positive inter-correlations between acceptance and understanding (e.g., for US high school students), others found no significant correlations in other samples (e.g., in Turkish university students), strong correlations (for US high school teachers) and medium correlations (for US college and university students). Findings seem to depend on the sample and also, importantly, on the way acceptance is defined and measured (Konnemann et al., 2012). Therefore, we re-examined the relationship between acceptance and understanding of evolutionary theory with a newly developed measure of acceptance based on the ABC-model of attitudes (Eagly & Chaiken, 1993). In a sample of 1637 high school students, we used, among other instruments, the cheetah probe (Bishop & Anderson, 1990), the MATE (Rutledge & Warden, 1999) and the newly developed attitude measure. Results show highercorrelation coefficients for MATE and understanding than for the attitude measure and understanding. This is interpretable in terms of the problem in MATE of confounding acceptance and knowledge. The findings will be discussed in terms of their implications for research and teaching.

What makes biological experiments difficult? Analysis of difficulty generating characteristics of multiple choice-tasks

Moritz Krell

Keywords: Biological experiments, Difficulty generating task characteristics, Experimental competencies

Type of presentation: Oral

Experimental approaches are central for investigating causal relationships in biology. Thus, students' experimental competencies are one focus of biology education research. In this study, multiple choice (mc)-tasks were developed to assess students' competencies in forming hypotheses (HYPO), testing hypotheses (TEST), and analysing evidence (EVID).

It is argued that the analysis of difficulty generating task characteristics may contribute to construct validation, guide task development, and inform practitioners about possible affordances and constraints in learning a construct. In a previous study, the experimental competencies, task complexity, and experimental contexts were shown to be significant difficulty generating task characteristics of a mc-test. The objectives of this study are to replicate the previous study and to provide an explanation for the context-effects by assessing the contexts' interestingness, familiarity, and relevance ('context-person-valences'). For these purposes, a mc-test assessing students' experimental competencies was developed based on a faceted test design with the three dimensions experimental competencies (HYPO, TEST, EVID), task complexity (low, high), and experimental contexts (photosynthesis, seed germination, respiration, prey catching, yeast dough, and mould formation). 36 mc-tasks were developed by systematically crossing the three dimensions. Context-person-valences were assessed using 4-point rating-scale items. N=126 secondary school students participated in this study so far.

The findings generally provide evidence supporting the findings of the previous study. EVID turned out be more difficult for students than HYPO and TEST, which may be explained with the need to relate data to hypothesis. As expected, more complex mc-tasks were more difficult for the students than less complex mc-tasks, which may be explained with a higher amount of cognitive load. Finally, significant differences in task difficulty occurred between the experimental contexts. However, based on the data available so far, no significant and systematic relations between task difficulty and context-person-valences were found.

Currently, the sample is enlarged to allow for a more profound data analysis. As it was done in the previous study, the Linear Logistic Test Model will be applied to assess the experimental competencies, task complexity, and experimental contexts as difficulty generating task characteristics within one analysis, additionally considering the context-person-valences.

Analysing evolution learning outcomes in a natural history museum

Kerstin Kremer and Julia Arnold

Keywords: Evolution, Instruction, Natural history museum

Type of presentation: Oral

The study aims at analysing the impact of evolution instruction in a natural history museum on 5th grade students' creationism beliefs. Therefore, we tracked evolution knowledge gain and belief development with special focus on biblical literalism of the novice learners over three test times before and after a one-day education program in a natural history museum. The study was carried out with 42 5th grade students (24 girls, 18 boys). Students visited the museum together with their biology teachers and participated in a program consisting of a guided tour and a fossil imprint activity. Data analyses were conducted using the item response theory (Rasch partial credit model) and classical test theory. The mean values of the person measures of evolution knowledge and creationism beliefs were compared over time via ANOVA followed by Wilcoxon signed-rank tests. Furthermore, a simple linear regression analysis was conducted to determine if creationism beliefs could be predicted from evolution knowledge. The results show that evolution knowledge significantly predicted creationism beliefs. From the results we conclude that a knowledge gain initiated by evolution instruction in a natural history museum can help novice learners to overcome non-rational creationism beliefs. The belief change and knowledge gain are stable over time.

Assessing biological literacy skills of gymnasium students following implementation of a new competence-based biology curriculum

Anne Laius, Aveliis Post and Miia Rannikmäe.

Keywords: Competence-based biology curriculum, Lactose intolerance, Scientific creativity, Socioscientific reasoning

Type of presentation: Poster

Sustainable societies need a workforce with a very creative and reasoning nature to be able to cope with rapidly changing everyday issues and problems. This is in line with the goals of a new competence-based biology curriculum gymnasium students' scientific creativity and socio-scientific reasoning skills. This study examines such competences in the context of lactose intolerance. The study involves over 2000 students from 10th grade (N=1116) and 12th grade (N=802) from 44 representative secondary schools who were tested against biological literacy components. Data were gathered using an 8-item competence related complex test. The results reveal that the implementation of the new biology curriculum has not affected significantly the students' learning outcomes in enhancing such competences and biology studies at the gymnasium level have not supported effectively the students' ability to transfer biological and chemical knowledge into handling everyday situation over 3 years period. This suggested that the implementation of a new competence-based biology curriculum did not meaningful affect students' scientific creativity skills (mean increase 0,29) and socio-scientific reasoning skills (mean increase 0,06). These outcomes were discussed.

Students' conceptions about pollination and its role in the life cycle of flowering plants

Peter Lampert, Suzanne Kapelari, Peter Pany, Michael Kiehn and Martin Scheuch

Keywords: Botanics, Life cycle of plants, Pollination, Students' conceptions
Type of presentation: Poster

The concept of "life cycles" and how they vary amongst different organisms is fundamental in Biology. Thus understanding the life cycle of angiosperms as sequential order of distinct stages in plant life is a basic learning goal in secondary school. Several studies have already shown that students have difficulties in understanding the life cycle of plants. Within the life cycle of angiosperms, the process of pollination plays a major role. Surprisingly, previous studies barely investigated the students' ideas about pollination. Therefore, the aim was to examine students' conceptions of the process of pollination and its role within the life cycle of flowering plants.

In a qualitative pilot study, conceptions of lower secondary grade students about pollination were investigated using guided interviews. Results imply that there are considerable differences between students' understanding and scientific concepts regarding various aspects of pollination. First of all, students often described insect-pollination as an act insects carry out deliberately. Furthermore, ideas about interdependencies amongst flowers and their pollinators revealed misconceptions of evolutionary processes in general. Most importantly, students showed severe difficulties to differentiate between pollination and seed dispersal. The confusion of these two processes indicates that students not only have serious problems to comprehend the chronicle order of pollination, fertilization, seed development and seed dispersal, but also struggle to connect these processes.

In order to improve the students' understanding of the life cycle of plants, various methods and learning materials are developed and assessed through Teaching Experiments. The aim of this research is to find ways to bring students closer to the topic of pollination and to gain a deeper understanding of the students' concepts about the life cycle of flowering plants.

Integrating mobile learning in an inquiry based unit concerning the functions of flower

Charalambia Lazaridou and Zacharias Zacharia

Keywords: Conceptual understanding, Mobile learning, Plant biology, Primary school
Type of presentation: Poster

The purpose of this research was to examine the contribution to an inquiry based learning of an alternative design unit in plant biology, that implemented the possibilities offered by mobile technology. Specifically, we investigated whether the use of mobile devices during field trips could enhance fourth graders learning about flowers, their parts and their functions more than the use of traditional means. For this purpose, we designed a pre-post experimental design study, which involved two conditions; one using a mobile device and another using traditional means (e.g., textbook pictures). The two conditions did not differ in any other way throughout the intervention. The sample comprised of 48 fourth graders (24 in each condition), who studied the flower, its parts and their function. A conceptual test was administered to assess students' understanding before and after instruction. Moreover, the students' science notebooks and accompanying artefacts were collected and used as a data source for examining students' progress during the study's intervention. The data analysis involved quantitative approaches. Findings revealed that using mobile devices enhanced students' conceptual understanding more than using traditional means.

A historical approach in teaching biological concepts and the nature of science and technology using an ancient technology

Yeung Chung Lee

Keywords: Ancient technology, Fermented food technology, Nature of science and technology, Science technology and society

Type of presentation: Poster

This paper reports on a series of classroom activities which employed a historical approach in teaching microorganisms and fermentation through re-visiting an ancient Chinese technology – the technology of 'qu' (mould ferment). This technology has been practiced by the Chinese from ancient times until now in the making of wines and other fermented food products, and had precipitated the development of modern enzyme technology. A series of activities were designed and trialed in a secondary biology class in Hong Kong. These activities were based on a Technology-Society-Science (TSS) approach, a manifestation of the STS approach, which situates the discussion of the relationship among T, S, and S in the context of technological development over a historical time span. The activities were intended to elucidate the scientific principles behind fermented food technologies as well as to lead students to understand and appreciate the differences between the nature of science and the nature of technology, and how the two disciplines interacted with each other in a nuanced manner. A cultural perspective was also incorporated in discussing cultural impacts on the transfer of this technology from China to the West through Japan. Students were asked to record their reflection on their learning experiences on a proforma with six questions guiding them to think further as to how technology differs from, yet related to, science. Preliminary findings show that students found these activities interesting and capable of extending their understanding of ancient technology. Students were also able to generate some insightful thoughts about the relationships between science and technology. These findings have implications for the teaching of biology through an STS approach situated in traditional and indigenous technology, a much neglected area in contemporary biology curricula.

Revealing conceptual progression during learning identifies difficulties, anchors discussion of design weaknesses, cognitive construals, epistemic obstacles

Francois Lombard, Marie Merminod, Widmer Vincent and Daniel K. Schneider

Keywords: Assessing students progression, Conceptual change, Conceptual obstacles, Inquiry, Immunology, Models

Type of presentation: Oral

This contribution introduces a method to follow student progress during the process of learning and its use for identifying conceptual difficulties in student progression and anchors discussion of possible causes. We have shown that student progression in a long-term inquiry designs is neither a ladder nor a roaming trail: knowledge appears in some mosaic pattern where “causal islands” are created, filled and connected through small steps.

The method for monitoring student progression is based on extracting concepts and causal links expressed in student’s successive written productions, then mapping them onto concept maps of the knowledge students should learn. Using this instrument, we will analyze 7 year of student productions in a shared wiki writing space during inquiry. Time sequence in which concepts / links appear (early or late in the wiki history) was measured with a prevalence indexes counting occurrences of each item across all revisions. Patterns across all revisions of all years were computed. This consolidated prevalence index offers systematic data to discuss causes for late-appearing model items as difficulties in learning, weaknesses of designs or epistemic specificities of the knowledge structure in resources. Research questions for this contribution are: Can time patterns that this method reveal i) identify conceptual difficulties ii) reveal conceptual obstacles, cognitive construals or threshold concepts?

We will present data in immunology and molecular genetics. Low consolidated prevalence indexes clearly revealed conceptual difficulties: model items that appeared repeatedly late in the learning process. An example is negative clonal selection of lymphocytes in the maturation of immune system. We will discuss evidence leading to interpret them as possible threshold concepts, cognitive construals, or epistemic structure of the knowledge field. Implications for designing curriculum, organizing instruction, guiding learning processes in various pedagogies are considerable, and we will discuss limits and possible generalizability.

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

Mats Lundström, Karin Stolpe and Nina Christenson

Keywords: Content analysis, HPV, Media report, Risk, Side effect, Vaccination
Type of presentation: Poster

Different kinds of vaccinations are lively discussed in media. This is not a new situation, but has been intensified with break-outs of pandemics or unexpected side effects of a vaccination, such as the swine flu vaccination. The starting point in this project is the vaccination against human papillomavirus (HPV). The virus can cause cervical cancer and the vaccination is nowadays a part of the vaccination programme in Sweden and is offered all Swedish girls. During the last year some side effects of the HPV-vaccination have been reported. The decision about the vaccination can in science education be regarded as a socio-scientific issue (SSI). A socio-scientific issue can be described ‘‘to be one which has basis in science and has a potentially large impact on society’’. These SSI’s are often reported in media. The capacity to follow and evaluate discussions about science in media is often emphasized and reported as a deficit in the scientific literacy among students. This study focus media reports in the risk society, since side effects are risks both for the society and the individual. The purpose with this study is to investigate how media reports about the vaccination against HPV. This is the first step in a larger study where the purpose is to investigate how young people deal with the vaccination discourse. A qualitative content analysis was conducted on the six largest daily newspapers in Sweden. The content analysis resulted in eight categories. The categories were facts, scientific knowledge, medical knowledge, risks, worry and alarm, emotional arguments, economy, individual versus society. Even if medical or scientific knowledge are common the media reports demonstrate a wider repertoire of arguments. For instance is emotional arguments a part of how media presents a problem. In this way the use of media reports can broaden the arguments when discussing the subject. In addition, the worries and alarms are interesting from an educational perspective, since these can be critically analysed and discussed in science education. In our presentation we will describe the categories more thoroughly to illustrate the different categories. We will also compare the categories to those texts students meet in their biology textbooks.

The need of teacher professional development in rapidly expanding fields of biology

Birgitta Mc Ewen

Keywords: Bioinformatics, Epigenetics, Teacher professional development, The new biology

Type of presentation: Poster

Development goes fast within biology, especially within the fields of bioinformatics and epigenetics. During the last ten years next generation sequencing technologies dramatically have increased the amount of available DNA data from different organisms. The DNA data can be used in different ways, for example to understand phylogeny relationships, to perform human gene tests and to better understand the fast evolution by pathogen microorganisms, such as the human immunodeficiency virus (HIV). Access to vast amounts of DNA data has big significance and discussions about its consequences ought to be high-lighted. The new field of epigenetics will have big consequences in a great variety of fields, not only in science, but also in for example pedagogy, sociology and psychology. The aim of this study is to investigate how the fast developing fields of bioinformatics and epigenetics are presented and offered as teacher professional development (TPD) initiatives for teachers at senior high school, upper secondary school, college and university level. The initiatives had to be properly described with aims, methods and results, so it could be assessed how effective the TPD had been. Literature was searched in well-known databases, publishing houses and journals. Moreover, the content indexes of a number of science education journals and general educational journals were scanned for important articles. Search time was 2007 until the present. The intention of this review was strictly focussed on TPD, not to catch teachers' ethical views of, conceptions of or attitudes to these new fields. Nor were issues about curricula or assessment studied. The following search criteria were used. It was required that the teachers participated in an in-service professional development intervention within the area of bioinformatics and epigenetics. Pre-service teachers in teacher-training were not included, nor were teachers participating in informal initiatives. The method of the professional development intervention had to be properly described so drawn conclusions could be evaluated. There was a need of report of outcomes, either with respect to teacher and/or student learning. The chosen studies needed to be published in peer review journals. The result of the search shows that only one study has been found which fulfil these requirements. This shows the necessity to develop new teacher professional development initiatives within the rapidly developing fields of bioinformatics and epigenetics.

The gene concept in higher education cell and molecular biology textbooks

Neima Alice Menezes Evangelista and Charbel El-Hani

Keywords: Gene, Cell and molecular biology teaching, Textbooks

Type of presentation: Poster

Recently, there have been increasing doubts about the classical molecular gene concept, according to which a gene is a nucleotide sequence in DNA codifying a single functional product. In a previous study, we found that this concept prevailed in cell and molecular biology textbooks, despite its problems, and rarely found any questioning about what we mean by gene. Here, our goal is to investigate whether such questioning appears in recent editions of widely used cell and molecular biology textbooks. We performed a categorical analysis, decomposing the texts into recording units that were recomposed in analytical categories based on the meaning ascribed to genes and their functions. Our results show that the classical molecular concept still prevails in the textbooks and there is still no sign of consequential didactic transposition of the doubts about the meaning of genes. A worrisome finding is an extensive overlapping of an instrumental deterministic understanding of genes (gene-P) and the classical molecular concept, favoring genetic deterministic views, with important sociopolitical and educational consequences. Another problem is the lack of an epistemological treatment of models, resulting in indiscriminate mixture of ideas about genes from different models. Although the textbooks address phenomena that are hard to accommodate in the classical molecular concept, they typically do not discuss consequences to our understandings about the genes.

Nutrition from the soil – The unexpected outcome of teaching experiments about photosynthesis

Denis Messig and Jorge Groß

Keywords: Cognitive metaphor theory, Conceptual change, Photosynthesis, Students' conceptions

Type of presentation: Oral

Photosynthesis is a major topic when it comes to biological key issues like biomass production, food webs and fossil energy. In spite of its biological importance, research has shown that students understand this assimilation process with everyday conceptions often opposing scientific conceptions. Anderson et al. (1990) found that 98 percent of all participants assumed that plants absorb their nutrition exclusively from the environment. Why is it so difficult to understand the nature of plant nutrition? According to the cognitive metaphor theory, learning processes are based on personally acquired experiences (Lakoff & Johnson, 2008). These basic experiences, like human nutrition, are used to explain concepts that cannot be experiences directly, like plant nutrition. As a consequence, everyday conceptions about photosynthesis evolve. In order to successfully convey scientific conceptions about plant nutrition, it is, therefore, inevitable (1) to prove existing teaching material whether it is suitable for conceptual changes or even foster students' everyday conceptions and (2) to develop interventions that trigger conceptual changes towards a scientific understanding.
In our research we focused on experiments designed by van-Helmont and Priestley about photosynthesis and plant nutrition. To identify students' conceptions and the interventions' impact on learning processes, we videotaped high-school students (grade 10, n=12) in teaching experiments and analyzed the gained data by qualitative content analysis (Mayring, 2000). By that, we were able to categorize different concepts about plant nutrition before and after the intervention. The results show that the chosen teaching material (van-Helmont and Priestley) strengthen non-scientific conceptions. Almost all participants were able to explain the experiments' outcome using non-scientific conceptions and, thus, reinforcing them. Consequently, none of the interviewed students were able to overcome crucial learning barriers such as the absorption of carbon dioxide for biomass production. Instead, their non-scientific conceptions were proven plausible and applicable. Due to these results, we developed an evidence-based experiment to consider students' conceptions, to question them and to change them towards scientifically more adequate ones. We focused on the understanding of respiration and photosynthesis. Using the indicator bromine-thymol-blue it is possible to visualize the carbon dioxide absorption due to photosynthesis at daylight and the release of carbon dioxide caused by respiration at night. If conceptions are changed by means of our intervention remains a question still to be discussed.

Learning at natural history dioramas: A model for interpreting museum biological settings

Edward Mifsud and Sue Dale Tunnicliffe

Author keywords: Dioramas, Informal learning, Interpretative model, Mental model, Visualisation

Type of presentation: Oral

This research investigates how elementary school children visualise and interpret natural history dioramas at the Museum of Natural History in Malta. Such dioramas have great potential for biological learning at all levels. Students (9-10 year olds) from a Maltese elementary school were asked to produce drawings about local animals and plants and after visiting the dioramas they were asked to draw their favourite (out of five) with all the biota it presents. Drawings were qualitatively and quantitatively analysed using Altas.ti. Results show that pupils notice birds, mammals and arthropods mostly, while there seems to be a general disregard for plants. Most pupils also show preference for one particular diorama. There is a general progression to improved biological representation from class drawing to diorama drawing. This indicates the potential of natural history dioramas as a tool for biological learning. How these museum settings are interpreted thus becomes important. We thus propose an interpretation model for making sense of museum settings, in this case the natural history diorama.

Stress and emotions during experimental work in biology education: What role does the work setting play?

Nina Minkley, Tobias Ringeisen, Lukas Josek and Tobias Kärner

Keywords: Achievement emotions, Cortisol concentration, Heart rate variability, Students' experiments, Subjective stress perception

Type of presentation: Poster

Experiments are an essential, but complex teaching method in science education. They carry a high cognitive load and the risk of failure, which may induce stress among students. However, it remains unclear if the work setting may modulate physiological and subjective stress reactions as well as emotions during experiments. Based on Chi's taxonomy (2009) of work settings, we designed a randomized experimental field study in which high school students (N = 104) either watched an experiment on video (control condition), conducted the experiment on their own (individual condition), or in groups of four (group condition). During the experiment, perceived stress, heart rate variability (LF/HF ratio), and salivary cortisol concentration were measured. Students' emotions were assessed before and after the experiment.

Individually working students showed the strongest subjective stress response and response of LF/HF ratio, followed by those in the group condition. Students of both conditions showed also a weakened diurnal cortisol decrease, indicating more stress. Controls displayed the weakest stress reactions. Across conditions, enjoyment dropped and boredom increased, with the strongest changes in the control condition. In terms of associations, the two achievement emotions were negatively related with each other in all three conditions. Moreover, the LF/HF ratio was positively related to subjective stress in the control condition and negatively related to boredom in the control and group condition.

The findings suggest that conducting experiments alone carries the risk of self-attributed failure, which is accompanied by elevated stress levels. Conducting an experiment in a group is less stressful, as others constitute a source of support, which may balance out knowledge gaps and reduce the risk of failure. Watching others conduct an experiment carries no risk of failure and, thus, the lowest stress responses, but comes with the cost of minimized enjoyment and maximized boredom.

Using ecological networks in teaching the badger-cattle controversy in U.K. schools

Joanne Nicholl, Ralph Levinson and Paul Davies

Keywords: Badger-cattle controversy, Disease transmission, Ecological networks, Pedagogy, Tubeculosis

Type of presentation: Oral

Mapping of ecological networks as social spaces serve as a means of overviewing ontological relationships that different groups – for example groups of school students, media, scientists, teachers – make of the transmission of tuberculosis in cattle in the U.K. The U.K. has a recent history of disease in cattle and this latest episode has resulted in the controversial culling of badgers. The culling is controversial for many different reasons: uncertainty both in the mechanism of disease transmission and whether the culls work; conservationist pressure groups in protecting the badger – a mammal that has a considerable cultural resonance – and the political and economic implications associated with diseased cattle. Ecological networks is a methodology that allows participants to link actors in a controversy to other actors through actions called 'tasks'. Tasks always reflect elements of uncertainty, tension and other possible actions. Participants can ask questions related to each task. As a result a map of participants' knowledge of the controversy can be built up. Maps from different participants can be composited through CMAP technology to give an overview of knowledge and perceptions of the controversy, identify the main questions, compare knowledge and perceptions of diverse interest groups and act as teaching tools to help teachers build on questions. Initial findings have demonstrated the efficacy of this methodology in identifying different dimensions of knowledge participants can bring to a controversy and what is not known.

Representations as meditation when learning about the human body in lower secondary

Clas Olander, Per-Olof Wickman, Russell Tytler and Åke Ingerman

Keywords: Classroom, Human body, Lower secondary school, Pragmatism, Representations

Type of presentation: Oral

The rationale in this paper is that in order to make meaning of science in school, students are dependent on representations as mediating means. Besides that, learning concerns establishment of continuity between purposes, e.g. Johansson & Wickman (2011) suggested that learning progressions could be analysed from proximate purposes (close to students´ prior experiences) and ultimate purposes (more scientific ones).

The aim is to investigate ways that secondary students, 14 years old, learn about the human body by focusing meaning-making of representations. The ultimate teaching purpose was articulated as "transportation and transformation of substances which will eventually reach the cells". The research questions concern in what ways representations afford and hinder the students' ways of making sense of the content

The issue of exchange of substances came up early in the production of the representation because the students found it necessary to explain how material exchange across surfaces between organs was possible. The students decided that substances "jump" thus avoiding articulation of the specific mechanism and later the jump was visualized with arrows and text. The metaphor 'jump' offers an agreed term that 'stands fast' (Wickman, 2014) and allows students to move forward even though the material processes associated with jumping are not clear. It acts as a place holder metaphor that sequentially becomes more articulated and refined as students views of what is being exchanged, and where, are developed as part of the ultimate purposes of the sequence.

The students started their conversations with naming the substances that enter the body using everyday terms like food and air however these words are replaced by nutrition/oxygen (intermediate wording) to nutrients/glucose and oxygen molecule. The gradual transformation of wording towards a more scientific language could be explained by the teacher´s re-phrasing when talking with students. Another reason might be that the affordance of visual diagrams lies in the way it productively constrains attention (Prain & Tytler, 2012) and thus creates a need for inclusion of other semiotic resources like arrows and formulas.

The scientific language progression towards more discriminating and technical terms, as described above, is one of the key factors that scaffold the progression. Another factor is that the ambition of establishing continuity between proximate and ultimate purposes (Johansson & Wickman, 2011) seems to work for these activities. The students often ask each other "where does this substance go now?" or "how does it reach the cell?".

Argumentation, ecology and novels

Isabel Pau Custodio, Conxita Márquez Bargalló and Anna Marbà-Tallada

Keywords: Argumentation, Ecology, Informal learning, Novels, Secondary school
Type of presentation: Oral

Ecology is one of the main topics in biological education. Despite its importance, students have been shown to perform poorly in ecology. In this communication we analyse the arguments used by a group of participants in a book club when they had to guess what animal describes a young-adult novel. The aim of the activity is that participants activate their knowledge about animals and the relationship with their environment. Our framework is based in the idea that science education should promote scientific literacy in a fundamental sense, this means that students should learn to make sense of a large variety of texts. In particular we use novels because narratives can be used to communicate science in a more comprehensible, relevant and accessible way. But being scientifically literate also means to be able to "explain phenomena scientifically, evaluate and design scientific enquiry and interpret data and evidence scientifically". In this framework, argumentation should also be integrated into science education. The key objective of this communication is analysing what kinds of arguments are used by the participants in a book club, aged 12-16, when guessing and arguing what animal is the protagonist of a young-adult novel. In order to answer the research questions we analysed the activity set out in a young-adult book club in Spain. During the session, participants read aloud the parts of the novel where the animal was the narrator. Concurrently, participants were asked to interpret the information while suggesting and arguing which animal could be. The session was recorded and transcribed entirely. For the analysis we selected different fragments: 1) fragments where participants suggest and animal and argue the suggestion 2) fragments where participants argue about the suggestion of a peer. The selected fragments were categorized in an inductive way. As findings it can be seen that participants used eight different kinds of arguments. Most of them, except from category 2, were biological arguments. The arguments most used were "external features" and "diet". As conclusions it can be seen that young-adult novels can be used as a didactic tools in science education. In addition, this kind of activities can help students to explain phenomena scientifically and to argue using evidences. These opportunities are related with: 1) the choice of the novel as the challenge proposed force the participants to base the arguments in biological concepts 2) the oral component that allows peer-regulation that improves the participants' argumentation.

Garden-based learning: Short- and medium-term influence of a school kitchengarden project on elementary school students' environmental literacy

Stella Petrou and Konstantinos Korfiatis

Keywords: Elementary school students, Environmental literacy, Garden-based learning, School kitchengardens

Type of presentation: Oral

Many scholars in the field of environmental education highlight the potential of gardens, as well as of other forms of urban agriculture to serve as everyday life contexts and sites for bringing together social and ecological learning across diverse communities. However, limited attention has been paid to important environmental literacy elements, such as decision making skills, empowerment for action, values, or self-efficacy. The objective of the present research is the study of: a) the effects of a school kitchengarden on participating children environmental literacy, b) the sustainance of the effects after the end of the project.

Fourty-one elementary school students, 8-9 years old, participate in the study. Participants were involved in the creation and cultivation of a kitchen garden for a period of approximately three months. Semi-structured interviews were carried out with 41 participants, before the creation of the kitchengarden (April), after the end of the growing season and the gathering of the crops (June) and at the beginning of the next schoolyear (September). The analysis of the interviews revealed that differences were depicted in variables related more directly with the schoolgarden, while the differences are not so apparent in the case of variables related with the environment in general and not with the school garden in particular. Changes concerning variables related with the schoolgarden tend to last longer in time, especially those concerning knowledge of practical skills, conception of values and self-reported behaviour. The results of the present study confirm the literature statements on the pedagogical importance of a school garden (Block et al., 2012; Blair, 2009): A school kitchengarden project can create important changes on a wide range of environmental literacy elements, which tend to resist in time, at least in the medium-term. The longevity of the changes is an important contribution in the literature on garden-based learning. However, the fact of the smaller improvements on the variables related with the environment possibly implies that the benefits of the schoolgarden project were intensively context-specific. Further research is necessary to clarify this point.

Understanding of evolution through natural selection among students in university education

Rianne Pinxten, Mathieu Desclée and Sven De Maeyer

Keywords: Core concepts, Misconceptions, Natural selection, University education
Type of presentation: Poster

Educating students about evolution through natural selection is vitally important because not only is it one of the structuring themes in biology, it is also widely regarded as difficult for many students to fully comprehend. Full comprehension is only made possible through the understanding of the underlying key-concepts. A fundamental problem is also that many students hold high levels of misconceptions about basic evolutionary principles. We investigated the level of understanding of natural selection in university education in Flanders, Belgium by addressing the following two questions: (1) What magnitude of knowledge of key-concepts of natural selection and which misconceptions characterize students enrolling in university education in Flanders, Belgium? And to which extent is this related to the characteristics of their secondary education and to students' background variables (age, gender, study performance)? (2) What is the learning gain in biology students throughout university biology education, and to which extent is this related to the degree of specialized evolution education? We used 'The Conceptual Inventory of Natural selection (CINS)', a 20-item multiple choice test, which was designed to measure students' understanding of 10 underlying key-concepts, including four core concepts (origin and existence of variation, variation inheritable, and differential survival), and the distribution and magnitude of misconceptions (the 3 distractors in each item address common alternative conceptions). First-year students (N>600) had a mean CINS-score of 11.4 (range 3-20). Multi-level analyses revealed that the amount of biology education and study performance during secondary education, and a male gender positively affected CINS-scores in these students, while the specific educational network students were enrolled in during secondary education, the textbook used and age had no significant effect. CINS-scores in biology students increased throughout university education and with a higher level of evolution education during the master program. Understanding of the four core-concepts was rather low in first-year university students, but increased if students had taken more biology education during secondary education. Likewise, master biology students showed a significantly better knowledge of six of the 10 key-concepts, including two of the four core concepts, then biology freshmen. Considering the percentage and rank of 22 alternative conceptions documented from the CINS-results of first-year university students, their distribution differed from those documented in North-American students, although the most common alternative conception, an example of teleological thinking, was the same in both student groups.

Health and wellbeing – The school garden, a place to feel good

Susan Pollin and Carolin Retzlaff-Fürst

Keywords: Emotinal skills, Health, Schoolgarden, Social skills, Wellbeing
Type of presentation: Poster

Health education is a major topic in natural science subjects. Health as a person's state is composed by physical, mental and social aspects (WHO 1946). The presence of nature can have positive effects on all components of the (subjective) well-being of humans at all ages (Ulrich 1984; Health Council of the Netherlands 2004). In the scholastic context or environment, gardens hold various functions as places for the contact between humans and nature: They are areas for explorative learning, they provide manifold sources for interdisciplinary teaching, they are spots to generate skills and recovery and they are places for nutritional and environmental education (Blair 2009). Generally, school gardens may take over a significant function in view of health education and personal skills of children and adolescents.

As a consequence, practical work and/or any other activity in a school garden lets the place become a point for physical agitation, social interactions and stress reduction. School garden classes and school garden practice in most of the cases are only held in primary school. An analysis shall show that school gardens also could be employed for the health education in higher grades.

Informal nature experiences on green schoolyards

Andreas Raith and Armin Lude

Keywords: Children, Environmental education, Nature experience, Schoolyard
Type of presentation: Oral

There appears to be a trend among children and young people in their relationship towards nature. They tend to have less experiences of nature and their attitude towards nature becomes more abstract and formal. The fact that children often spend most of their day in educational institutions, could enhance the alienation from nature. It could also, however, provide new opportunities for informal nature experiences. If the schoolyards would be redesigned in a natural fashion, the children were able to spend time in nature every day, without perceiving it as a pedagogical tool. In this way, regular opportunities for nature experiences would be available. If a school environment can serve as a reliable source for informal nature experiences, it would represent a significant social capital. For the investigation of this potential it must be clarified to what extent green schoolyards are able to provide areas in which to experience nature. This is the key objective of this research project.

The research design is divided into three phases. The qualitative and quantitative analyses of the observations made in phases I + II, show pronounced age effects. Younger children use green schoolyard areas more frequently and spend more time with natural objects. Moreover, the schoolyard design has also an age-related impact on the use of the green areas. For the individual age cohorts were criteria for the design of the schoolyard established that have either a positive or negative impact on being in green areas and on the interaction with natural objects. The results of the qualitative guided interviews from Phase III about the connection to nature, the reasons for the encountered patterns of behavior and the type of nature experiences will be available by September 2016th.

The contribution of natural history museums to science education

Michael J. Reiss

Keywords: Databases, Evaluation, Learning, Natural history museums
Type of presentation: Poster

This paper reports on a project to answer three questions: (a) What does the literature indicate about how Natural History Museums (NHMs) and schools can complement one another to maximise learning among school-age learners? (b) Can NHMs collect data from visitors in ways that enable better evaluations to be made? (c) What do museum practitioners and school teachers consider makes for an effective visit?

There is mounting evidence that students' knowledge and understanding of scientific concepts takes place in a variety of settings, both in and out of school, and that such knowledge and understanding accumulate over time through being exposed to a wide range of public resources including visits to museums. Young learners' experiences at informal science institutions play a key important role in the development of skills, dispositions, practices and knowledge that are vital in helping students successfully learn about science.

Data are collected by government departments and other organisations for a range of reasons. For example, the government in England collects extensive details on every single student when they enter the school system and updates this with educational and personal attainment data. At a very basic level what researchers need if they are to match NHM data to a national databaseis simply the names of the schools attended by students who have visited an NHM and completed a survey (e.g. evaluating an exhibit). For more detailed analyses, individual student names with their dates of birth and gender would enable a fairly accurate match to individual student records to be made, enabling more sophisticated analyses to be undertaken.

After obtaining ethical approval in both the UK and the USA, individual interviews were undertaken with 17 NHM practitioners and 15 school teachers in a total of five NHMs (two in the US and three in the UK). All five museums emphasised that they are science centres. For example, one practitioner indicated that evaluations of visitor experience showed that many visitors to her museum are enthused by environments which transport them to another place. Teachers reported positively experiences such as students being able to handle museum objects, the breadth of exhibits, the sense of scale, all of which are more fruitfully experienced at a NHM.

The role of school internships for future biology teachers: A comparison between short- and long-term internships concerning stress load and professional competencies

Miriam Rest and Wolfgang H. Kirchner

Keywords: Internships in biology class, Professional competencies, Stress load
Type of presentation: Poster

Students of teachering are faced with many new tasks in biology lessons when they enter school, making internships especially important in teacher training. In the discussion about teacher education, criticism was voiced about an insufficient link between theoretical and practical input. Thus, the government of North Rhine-Westphalia (Germany) implemented a five-month school internship (practical semester) to improve teacher training. The practical semester now replaces the former short-term internship which lasted only four weeks. Whether long-term internships represent an improvement in the area of teacher training is yet to be empirically explored. Since the examined internships differ in many variables (e.g. school subjects) previous investigations yield little generalizable results. Empirical data specifically related to the internship in biology class, is still missing.

To make up for this shortcoming, the present study investigates the development of the future biology teachers' stress load and their self-perceived professional competencies in biology class before, during and after an internship. Using salivary cortisol and perceived stress assessment, stress profiles of student teachers were measured. Moreover, the students indicated their biology specific self-perceived competencies (Gröschner 2015). The students indicated their perceived stress and their competencies through questionnaires using a seven-point Likert scale.

The examined students study biology for a teacher degree. They are registered in a master program and participated in either a short-term internship (N=27) or a long-term internship (N=7, piloting stage). During the short-term internship students felt less stressed than in everyday university life ($p=.000$, ANOVA). In addition, students had a lower cortisol concentration ($p<.05$, ANOVA). Students passing the short-term internship showed a significant increase in self-perceived competencies ($p<.05$, ANOVA). A descriptive observation of the first data concerning long-term internships shows a slight increase in competencies. The perceived stress load seems to be slightly higher during the internship than in everyday university life. Although both groups show an increase in biology specific competencies long-term interns perceive their competencies as higher during as well as after the internship. It is conceivable that long-term internships provide more opportunities for profession-related acting in biology class. Thus, future biology teachers would develop professional competencies better. However, long-term interns reach a higher perceived stress level. This could be related to the fact that these students experience their professional tasks in biology class as more intensive. A moderate level of stress could be considered as a positive challenge (Jantowski/Ebert 2014) and might be beneficial the development of biology specific competencies.

Biology: The ultimate science for teaching an understanding of scientific evidence

Ros Roberts

Keywords: *Concept map, Concepts of evidence, Investigations, Practical work, Validity of data*

Type of presentation: Oral

Recent school science curriculum developments in many countries emphasise that scientists derive evidence for their claims through different approaches; that such practices are bound up with disciplinary knowledge; and that the quality of data should be appreciated. This position paper focuses on the role of Biology to meet this curriculum aim. Biology is an empirical science, using evidence as the basis for making claims. Yet Biological practice is diverse – including, inter alia, observations, lab-based experimentation, field trials, ecological surveys, randomised control trials – so how can we teach, within the time-constraints of the curriculum, to help pupils understand about evidence in Biology? In this paper, this diversity of Biological practice is shown to be the ultimate context for teaching about evidence.

The paper draws on a body of research that presents an understanding of the validity of data as a set of conceptual relationships; and presents these as a concept map. Using diverse examples from Biological practice, the paper shows how Biology teachers can illustrate the application of the network of all these ideas and their inter-relationships, so that pupils develop the necessary 'thinking behind the doing' of biological practice. The paper explores ways in which this understanding of data is inherently related to underpinning disciplinary ideas of Biology. The recognition of a conceptual basis for understanding the quality of data is represented as an ontological shift with respect to widespread characterisations of biological practices addresses some longstanding issues in Biological education research, policy, curricula and practice.

Intrinsic motivation in bilingual courses in an out-of-school lab

Annika Rodenhauser and Angelika Preisfeld

Keywords: Bilingual education, CLIL, Experimentation, Intrinsic motivation, Molecular biology, Out-of-school lab

Type of presentation: Poster

Taking into account (German) students' deficiencies in scientific literacy as well as reading competence and the 'mother tongue + 2' objective of the European commission, bilingual courses on molecular biology (Crime Lab – Genetic Fingerprinting, n = 490) and bionics (A Glue from Snail Slime?!, n = 120) were developed and carried out in an out-of-school lab. Affective and cognitive factors were measured in a pre-, post-, follow-up-test design with intrinsic motivation (Deci & Ryan, 1993) being measured by the KIM (Wilde, Bätz, Kovaleva, & Urhahne, 2009) during the post-test (subscales: interest/enjoyment: ?Bio = 0,84; ?Engl. = 0,93; perceived competence: ? = 0,8; perceived choice: ? = 0,79; pressure/tension: ?Bio = 0,63, ?Engl. = 0,72).

Findings concerning the acquisition of biological content knowledge and the development of biological self-concept in bilingual courses in an out-of-school lab have already been published (Rodenhauser & Preisfeld, submitted; Rodenhauser & Preisfeld, 2015). The recent conference contribution deals with questions concerning the presence of intrinsic motivation under conditions where bilingual learning is combined with phases of practical experimentation. The intent was to learn more about the presence of intrinsic motivation in general, about the causes for the occurrence of pertinent aspects of intrinsic motivation (biology/experiment-related or foreign language-related) and about possible influences of interests and preferences concerning science and foreign languages on intrinsic motivation.

By using t-tests, ANOVAs and a cluster analysis, it was found out that participants of the bilingual courses were intrinsically motivated in general. Besides, it could be observed that the occurrence of intrinsic motivation depends more on the biological/experimental components of the courses than on the foreign language-related components. A more differentiated view was gained by taking into consideration different manifestations of affective variables assessed during the pre-test. By the use of a cluster analysis three different types of participants could by identified. According to the pattern of manifestation of the variables included they were named all-rounders, scientists and foreign language enthusiasts. An ANOVA for the subscales of the KIM with these three groups used as factors, revealed differences in the occurrence of intrinsic motivation depending on group membership.

Subsuming, it can be said that bilingual courses in an out-of-school lab can trigger intrinsic motivation in general and that in terms of intrinsic motivation all-rounders seem to profit from the bilingual courses most.

Do interest and motivation influence students´ test performance while working on context-based tasks?

Mariella Roesler, Nicole Wellnitz and Jürgen Mayer

Keywords: Competency test, Context, Interest, Motivation
Type of presentation: Oral

The students´ interest, as well as their motivation, differ depending on contexts in which biological contents are embedded. Likewise, interest and motivation differ depending on activities like working on tasks that require, for example, combining given information (content knowledge) or working on tasks that require making decisions about socioscientific issues (decision making). In test situations, interest and motivation have an effect on the students´ test performance, but it is still unclear to which extent interest and motivation have an influence on the performance in tests with biological contents.

The aim of this study (funded by the German Research Foundation; MA 1792/6-1) is to analyze the influence of interest and motivation on the performance in written tests with biological contents and real-life contexts. Based on these results, the amount of performance variation can be described through cognitive and affective determinants.

For this purpose, a competency test (N = 144) was developed. The items were constructed to measure the students´ competencies in content knowledge and decision making. The biological contents (e. g. enzymology) were embedded in four different contexts (health, environment, technology and natural resources). During the construction of the items, different task characteristics were systematically varied because it was intended that the items of both activities and of all contexts are equally difficult on an average.

In order to assess interest (situational interest and relevance) and motivation (expectancy and value), standardized questionnaires (N = 123) were adapted. 1881 tenth grade students took a paper-pencil-test, which includes the competency test and the questionnaires about interest and motivation which were inserted after each task (embedded design). Initial results indicate that students demonstrate the same performance when solving items that require content knowledge and decision making and in all contexts. Nevertheless, they are more interested and motivated when solving items that require decision making. Furthermore, the student's interest and motivation vary depending on the context. The context of health, for example, turned out to be particularly interesting and engaging, whereas for tasks from the context natural resources, the students show the least interest and motivation. Moreover, the results indicate that a high item difficulty is associated with a lack of interest and low motivation.

The interrelationship of value and knowledge in students' socioscientific inquiry-based learning

Carl-Johan Rundgren, Martin Eriksson and Shu-Nu Chang Rundgren

Keywords: Argumentation, Decision-making, Environmental toxins, Socio-scientific issues

Type of presentation: Oral

Socioscientific issues (SSI) are emerging issues globally nowadays, and at the same time, become an important research field in science education internationally. Accordingly, teaching and learning of SSI and the related skills of inquiry and argumentation are recognized in school science today. This study is based on the EU FP7 project PARRISE (No. 612438) aiming to promote socioscientific inquiry-based learning (SSIBL). In addition to the design of the six-step SSIBL teaching module shown in this presentation, the study aims to investigate how students' knowledge and values interact in students' SSI-decision-making. A total of seven students (4 males and 3 females) from a science-major program at an upper secondary school in Sweden were invited to participate in the SSIBL teaching module on environmental toxins in fish from the Baltic Sea. The findings showed that, even though the students were aware of the risks of eating fatty fish from Baltic Sea, still, two distinct groups of SSI-decisions could be identified. For those who agreed that Sweden should have a permanent exemption from the EU regulation for dioxins in fatty fish from the Baltic Sea, the main arguments were connected to values and the reasons related to the consumers' right of free choice and responsibility to keep informed about the risks. The further implication to research and education on enhancing SSIBL will be discussed at the presentation.

Promoting children's understanding of forest ecosystem composition: Field studies vs. conventional classroom teaching

Eliza Rybska, Katarzyna Bialas and Costas P. Constantinou

Keywords: Analysis of children's drawings, Field studies, Forest ecosystems
Type of presentation: Poster

We report on an intervention study, which sought to investigate the influence of gender, living environment (urban or rural) and teaching approach on children's understanding of the animal composition in a complex forest ecosystem. We compared two conditions, conventional classroom teaching and field study activities. Field studies have attracted attention as a possible means to employ sensory experience in the process of developing meaning, a special case of application of embodied cognition theory. The participants in the study were 175 children from eight intact classes of grades 1 and 3 in Polish primary schools. The forest was chosen as an example of a commonly existing ecosystem in Poland, with rich biodiversity. We collected data in the form of (a) animal species named in recorded whole group discussions with the classes; (b) children's drawings prior to and after the intervention, and (c) reflective discussions with the children on their drawings with emphasis on animal descriptions and their inter-dependence on forest plants. Before the intervention, children mostly mentioned large mammals and some birds. After both forms of intervention, the participating children were able to mention a broader range of animals and they could also articulate how the plant layer diversity influenced the presence of animals in the forest. The findings also revealed that living environment and teaching approach both had a significant influence on learning progress. Overall, gender did not have a significant influence. However, girls from rural areas showed the highest improvement. Boys from urban areas showed the least gains. We discuss possible interpretations for our findings as well as educational implications for curriculum and teacher professional development.

Conceptions of the students about amphibians and reptiles

Zofia Sajkowska and Eliza Rybska

Keywords: Conceptions, Conceptual change, Herpetology
Type of presentation: Poster

Much research in science education over the past three decades has been documenting students' misconceptions in a wide range of subject areas. This is also true for biology education field. Those personal conceptions are often deeply rooted, instruction-resistant and remain even after instruction, and by that very difficult to change. Misconceptions are not strictly dedicated to students. There are research that reported an occurrence of misconceptions in knowledge presented by student teachers in biology, the teacher or present in the textbook. On the other hand misconceptions as part of students/learner personal knowledge which are used by them in everyday life. The learner prior knowledge is important for teachers in successful teaching process that is built on constructivism basis.

In current paper will be presented students' conceptions about amphibians and reptiles – as the part which was crucial for whole project - including designing teaching sequence in order to receive a conceptual change. The aim of the project is to demonstrate the conceptions and opportunities arising from the Polish students ideas about amphibians and reptiles. Results of the project will complement research about students conceptions and use of it in didactic process. The methods used to investigate students' concepts were questionnaires and in-depth interviews. Data received were categorized and submitted to statistical analysis. The main claiming's exposed by following investigation are students conceptions about amphibians and reptiles in the area of classification, environment and adaptation The most important outcome was, even though conceptions of the students was very diverse, at the same time in some areas were consistent, especially in the capacity of correct assigning kind of skin to living environment.

BioDiv2Go – Does the location-based geogame „FindeVielfalt Simulation“ increase the valuing of local biodiversity among adolecent players?

Sonja Schaal, Steffen Schaal and Armin Lude

Keywords: Digital game-based learning, Enjoyment, Interest, Knowledge, Valuing of biodiversity

Type of presentation: Oral

The valuing of biodiversity is considered to be a condition precedent to its conservation. Therefore, the aim of BioDiv2Go project is to use mobile technology to combine game-based and location-based learning and to provide sensuous experiences discovering local biodiversity. The Geogame FindeVielfalt Simulation (FVS) was developed for adolescent visitors of German youth hostels. The players are involved in a narrative keeping the traditions of their ancestors´ heritage. Here, decisions are needed to balance biodiversity and economic success. They discover the natural environment, solve tasks at several places, have to make decisions in dilemmatic situations and subsequently they manipulate a simulation in the game. Those who collect enough biodiversity-credits and gain money stand the challenge of the ancestors.

The theoretical framework is derived from the Competence Model for Environmental Education (Roczen et al., 2014) and consists of the components Biodiversity related Knowledge (BRK), Situational Content-related Interest (SCI) as indicators for the valuing of biodiversity and General Ecological Behaviour (GEB) as a personal prerequisite. According to the Uses and Gratification Theory, the Game-related Enjoyment (ENJ) is added. For the assessment a scale to measure BKR was developed, piloted and analysed according to the Rasch-model with a very satisfying model fit (see Schaal et al., 2015). For SCI, ENJ and GEB established scales are used. The FVS Geogame was piloted in a field study during spring and summer 2015. The results suggest, that the players appreciated the FVS Geogame to a high degree and the majority of the players enjoyed playing it. The pre-post-test shows, that the Situational Content-related Interest (SCI) did not significantly change in average but the Biodiversity related knowledge (BRK) slightly increased. The strong correlation between the GEB and the SCI, as well as the results of an ANOVA-analysis, indicate that players with a higher GEB as a personal prerequisite are the more interested. The fact that Biodiversity related Knowledge (BRK) is not directly correlated with the General Ecological Behaviour (GEB) points towards the fact that within the FVS Geogame there is something to learn for every player, regardless of its requirements according to the GEB.

The main study starting in April 2016 will provide an increasing number of players and therefore more complex analysis will be presentable at ERIDOB 2016.

A role-play based tutor training in biology-teacher education: Optimizing tutor-student interactions in the context of an outreach lab

Franz-Josef Scharfenberg and Franz X. Bogner

Keywords: Biology pre-service teacher education, Cross age tutoring, Outreach biology education

Type of presentation: Oral

How, as component of their pedagogical content knowledge (PCK), preservice teachers (PSTs) may develop adequate tutorial decisions in biology education is an open research question. Within our PST-education module Learning and Teaching in an Outreach Lab, we have implemented PSTs as being tutors, based on assignment-assistance tutoring approach. Being responsible for two student work groups, PSTs assume the tutor's role during all the experimental phases of the combined student module Genetic Fingerprinting. Previous research has pointed to the need for optimizing tutor-student interactions. As role changes provide both reflection-in-action and reflection-on-action, we chose role-playing as essential part of our tutor training. Our two-step training consists of role play (in the tutor's role, reactions on authentic student questions) and a group discussion. Based on listening theory, the three-step training included an assignment exercise (classifying authentic tutor-student interactions) as additional evaluation step. 36 PSTs and 260 upper secondary biology students participated on our study. In quasi-experimental design, we included one control group without participating on training (n=12) and two treatment groups (n=12, each) participating on one training variant, each. We audiotaped all the tutored experimental phases (4288 min). We transcribed and content-analytically categorized 2865 interactions (ten categories; e.g., premature answer). Finally, we quantitatively and cluster-analytically analysed the identified PST interaction patterns.

Generally, our students mostly experimented without any tutor interaction. However, in comparison to the control group, we found less interaction time and frequencies for our trained tutors. Second, control and both training groups differed in tutor-student interaction patterns. For instance, the control group PSTs provided more non-requested interventions as randomly to be expected while the training groups PSTs provided less as randomly to be expected. Third, based on their prevalent interactions, we extracted four PST interaction types: (a) high-level intervening tutors (highest levels of non-requested interventions), (b) intervening and talking tutors, (c) prematurely answering tutors, and (d) rules complying tutors (best fulfilling our tutoring approach). We found the intervening types only in the control group and prematurely answering tutors only in the two-step training group. Rules complying tutors were prevalent in the three-step training group. In sum, participating on tutor training (especially as three-step mode) furthered more adequate tutor-student interactions. We discuss chances for biology-teacher education and argue for the tutor training as we did as strategy for developing an essential teacher's PCK component.

Teachers learning in a citizen science project: PCK for nature in the backyard

Martin Scheuch, Tanja Panhuber and Suzanne Kapelari

Keywords: Butterflies, Citizen science, Observation, PCK, Species identification, Wild bees

Type of presentation: Poster

Student-scientist-partnerships in the form of citizen science projects involving schools will become the focus of the 'sparkling science' programme run by the Austrian government in the near future. This study investigates the knowledge and skills needed by biology teachers to support students in citizen science projects which require scientific observation and species identification. For this purpose, teachers' pedagogical content knowledge (PCK) that was developed during the citizen science project "Nature in the Backyard" of the University of Natural Resources and Life Sciences Vienna will be explored and portrayed. PCK is a conceptualization of teachers' professional knowledge for teaching specific topics. Five teachers of lower and higher secondary schools will be interviewed following the guidelines of the PCK conception by Loughran et al. (2012) and qualitative content analysis will be employed to present findings in the form of two Resource Folios. These Resource Folios consist of Content Representations (CoRe) and Pedagogical and Professional Experience Repertoires (PaP-eRs) that both represent the teachers' knowledge considering the teaching of wild bees and butterflies respectively. Of special interest will be findings concerning the key role of teachers in supporting scientific observation and species identification in regard to the two taxa as those are two major challenges for students involved in the project. From these findings, we will derive aspects of how to support students to overcome these difficulties and we expect overall findings that can be useful for similar citizen science projects in biology.

Diagnosis of inquiry competencies using hands-on experiments with Mongolian gerbils

Iris Schiffl and Carina Wurdinger

Keywords: Competency diagnosis, Hands-on experiments, Inquiry competencies
Type of presentation: Oral

Science standards have been developed in Austria since 2005. First competency structure models were stated and evaluated. Followed by the creation of prototypic tasks to make the meaning of the competencies clear to teachers. At the moment the goal of science standards research in Austria is the development of diagnosis instruments for teachers. The main project therefore is the “Instrument for Informal Competency Measurement” (IKM) conducted by the Federal Institute of Research, Innovation and Development of the Austrian school system (BIFIE) (Schiffl & Weiglhofer, 2016). But this diagnosis instrument is only planned for the use in junior classes and has to deal with restrictions due to computerized testing. The aim of the presented study is to complete the diagnosis of inquiry competencies in biology by using hands-on experiments with focus on 8th to 12th grade. Therefore levels for inquiry competencies were stated following the results of the evaluation of the competency levels for BIFIE´s diagnosis instrument (Schiffl, Weiglhofer & Remplbauer, 2015) and the empirical data for levels of biological inquiry competencies of the IQB-country comparison study (Mayer, Wellnitz, Klebba & Kampa, 2013). These competency levels were turned into tasks which on the whole represent the inquiry circle (Pedaste et al., 2015). These tasks were given to students in 8th, 10th and 12th grade in hands-on experiments with Mongolian gerbils to evaluate their inquiry competencies and to monitor competency development during these years of school. The results show that during 8th grade lower competency levels can be found than in 10th or in 12th grade. On the whole data show a competency improvement for all inquiry competencies from 8th to 12th grade except for analysing data where maybe too much information was given to the students and so facilitated right answers on a higher level even in 8th grade.

Smartphone games in the context of ESD - Fostering connectedness to nature with geogames

Joachim Schneider and Steffen Schaal

Keywords: Connectedness to nature, Education for sustainable development, Educational technology, Environmental education, Game-based learning

Type of presentation: Oral

Geogames are complex location-based games with mobile electronic devices (Schlieder, 2014). Whereas some authors still estimate the use of mobile electronic devices (MED) in Environmental Education (EE) critical, other studies reveal the potentials of this technology. The distraction of nature is assumed to be the main obstacle of MED in outdoor settings. So this study analyses the effect of Geogames on the connectedness to nature.

Two interventions are compared: According to the framework of the project BioDiv2Go (Schaal et al., 2015) a Geogame to the topic of preservation of the wildcat and managing the local forest resources was developed. Embedded in a narrative the players explore the habitat of the wildcat by solving tasks in the field. With successful completion of each task they are allowed to manipulate a simulation game to managing the forest. Reaching high scores necessitates the balancing of wildcat protection and successful forest management. The other intervention is a treasure hunt with MED and similar tasks in the field but without a narrative and a simulation game. Both interventions are played in groups of 3-4 students and last 90 – 120 minutes.

So the aim of the study is to asses if location-based games with MED are suitable to foster connectedness to nature and if there are differences between a complex Geogame and a simpler treasure hunt. For the measurement two established scales are used in a pre-post-test-design: the inclusion of nature in self (INS, Schultz, 2002) and the disposition to connect to nature (DCN, Brügger et al. 2011). Whereas the INS has been applied to evaluate interventions in previous research (Kossack & Bogner 2012, Liefländer et al. 2013), the DCN is used the first time in a pre-post-design, for it is part of the BioDiv2Go-framework (Schaal et al., 2015).

The results reveal a significant increase of the INS for both game formats, with the strongest effect for the lowest pre-INS values. For having to process the DCN-scale with IRT-models only a positive trend in this data could be referred up to date. According to the both game formats no significant difference is detectable. So the main effect of location-based games seems to be the outdoor activity guided by the MED, not the complexity of a Geogame.

Teachers' beliefs about argumentation - A comparison in the context of the disciplinary cultures of biology and language education

Julia Schwanewedel, Finja Grospietsch and Patricia Heitmann

Keywords: Argumentation, Disciplinary cultures, Teachers' beliefs
Type of presentation: Oral

The paper reports the theoretical background, design and results of a qualitative study on biology and language teachers' beliefs about the characteristics of argumentation in education. The ability to argue is considered important as a cultural practice but also as a tool fostering learning. Consequently argumentation is promoted in nearly all school subjects. However, it is unclear whether teachers understand and practice argumentation in comparable ways in different subjects. In this context, we analysed teachers' beliefs about argumentation. Specifically, we investigated biology and language teachers' beliefs about argumentation with regard to (1) general beliefs about argumentation, (2) practical implementation of argumentation in biology/language lessons, and (3) criteria in assessing students' argumentations.

The sample consisted of ten teachers from German secondary schools, five biology teachers and five teachers of German language. For the investigation of their beliefs problem-centred interviews were performed. We conducted computer-assisted qualitative content analysis with MAXQDA in order to identify and categorize the teachers' beliefs.

Data analysis led to a categorization with ten major categories comprising a total of 379 codes describing the beliefs about argumentation in language education and 332 codes describing those in biology education.

Comparative analysis showed differences in eight of the ten major categories between biology and language teachers' beliefs. Commonalities appear with regard to the beliefs about factors influencing argumentative abilities of students. Both biology and language teachers are convinced that communicative competences and reading abilities strongly influence argumentation. Results further unveiled differences concerning learning goals associated with argumentation, the relevance of content-knowledge, the selection of suitable instructional topics as well as the consideration of curricular standards. The largest differences were identified in terms of the assessment of students' argumentations especially the role of linguistic and content-related criteria like the quality of arguments or the scientific accuracy of argumentations.

The results allow us to conclude that biology and language teachers' hold different beliefs about argumentation as well as its implementation and assessment in educational processes. These differences can be explained in the context of different disciplinary cultures. The findings help to differentiate disciplinary cultures in the context of schools, and prospectively better understand their action-guiding or action-controlling function in instructional processes. Furthermore the findings may be fruitful for facilitating the transfer of knowledge between the two subjects with regard to argumentation – for example in the form of joint training modules.

Do students who are exposed to a contaminated environment develop a sense of connectedness to nature?

Wisam Sedawi, Ben-Zvi Assaraf Orit and Michael Reiss

Keywords: Children, Connection, Nature, Pollution

Type of presentation: Oral

The literature suggests that early childhood experiences and emotional connectedness are necessary in order to develop lifelong positive attitudes towards the environment.

Does growing up in a hazardous, polluted environment affect one's connection to nature? The purpose of this study is to examine this question among children who live in the Bedouin villages near the Hebron stream in Israel's Negev desert. Since these villages are not recognized by the state, they do not receive municipal funding and suffer from a lack of infrastructure, such as waste removal and disposal. The primary environmental hazard is the Hebron Stream, which regularly flows with sewage water and has piles of garbage along its bank. children spend a significant amount of time playing outside in the area surrounding the stream. Their village's method of waste disposal involves dumping garbage in the valley and incineration.

We gave 118 fifth-grade students from two different schools in the unrecognized village a open questionnaire, consisting of 24 statements, that measures four aspects of connectedness to nature: nature enjoyment, empathy to creatures, a sense of oneness and a sense of responsibility. Students were asked to choose six statements, three of which they agree with and three of which they disagree with, along with an explanation their choices.

The findings reveal the students' emotional attitudes towards nature. Students express nature enjoyment; however, they shy away from direct, physical contact with their natural environment because it is "dirty" or "disgusting." In general, students feel empathy for creatures, yet, many avoid touching flowers and petting animals because they fear getting hurt. Students demonstrate an ambiguous sense of responsibility; on the one hand, they believe they can have no impact on the environment, while on the other hand, they see a positive environmental outcome from picking up trash.

The analysis shows that students living in the polluted environment of the unrecognized Bedouin villages have mixed feelings about their connection to nature. While they express nature enjoyment and empathy to creatures, they fear direct engagement. These findings suggest that a polluted environment can negatively impact the way children relate to their natural environment.

Views of students in agriculture about the issue of "pest animals" – Wolves in France

Laurence Simonneaux and Jean Simonneaux

Keywords: Ethical position, Pest animal, Socially acute question, Wolf

Type of presentation: Oral

This research is part of the CASSIS (Communication About SocioScientific Issues) project which is a collaborative research project between four universities in France, England (2) and New Zealand. This project is focused on a particular Socially Acute Question (SAQ) – the problem of controlling 'pest animals' when they influence farming practices. In France, we analysed views of students from different kinds of agricultural training on the issue of the wolf. In particular, we analysed the registers they mobilize (cognitive or emotive or both), their engagement in the issue and their ethical position.

Pupils' views of their outdoor learning

Pia Sjöblom and Maria Svens

Keywords: Learning environments, Learning in nature, Outdoor learning
Type of presentation: Oral

Research has shown that there is substantial evidence that outdoor education has many positive effects on pupils' learning. However, research has also revealed that there is a need for more research-based knowledge about learning in nature. The overall aim of this study is to investigate pupils' views of their learning during a nature school day. An observation and focus group study inspired by the ethnographic approach was conducted in order to investigate the learning process outdoors. The respondents consisted of two classes with a total of 30 ten- and eleven–year-old pupils that attended an outdoor learning programme conducted by a nature school in Finland. Two researchers participated in two nature school days with different classes, observing the whole day and videotaping some activities. They also visited the schools the next day to conduct focus group interviews. The results of the analysis of the data show that according to the students, their learning during the day can be summarised in the following themes: cognitive learning, affective learning, psychomotor learning, social learning and no learning. The students brought out the following differences between the classroom and the outdoor learning environment: differences in motivation, concreteness, concentration, health topics and learning topics. There were also a few students who stated that there is no difference between learning in these learning environments. In most cases the outdoor environment was the learning environment that the students preferred. The results are reflected against previous research and the implications for environmental education are discussed.

Development and evaluation of a project class “human evolution” on the basis of authentic teaching materials

Ira Synoracki, Miriam Rest and Wolfgang Kirchner

Keywords: Authentic materials in biology class, Human evolution, Practical work, Marketplace method

Type of presentation: Poster

The topic human evolution is mostly discussed using materials such as textbooks and papers. Rarely teachers use films or alternatives to approximate human evolution to pupils such as visiting museum. In contrast mostly of other topics (e.g.: examination of bulb cells) are discussed in school using experiments or authentic materials. Although it was showed that authentic materials in school cause positive effects on pupils because they gain a higher standard knowledge than pupils taught without authentic materials (Liebold, Klautke 1999), teacher still discuss human evolution mainly without authentic materials. To examine the effects of such materials, regarding human evolution, a project course was designed using 4 “places” dealing with different perceptions of human evolution. The project course took place as the method “marketplace”. To receive information about the effect of authentic materials as they are used in the project course, data was collected using questionnaires with pre-, post- and follow up-design. It was sampled by means of three opened questions at three different point in time (before, immediately after and one week after the project). Furthermore, the changes concerning interests in the topic and work with authentic materials were recorded (Wilde et al. 2009). Information about, for example, interest and motivation were indicated using a six-point scale from “strongly disagree” to “strongly agree” (Wilde et al. 2009). Additional environmental factors were recorded, for example: interest in school subject biology and information about the test person (age, sex and grade). The sample comprised 58 pupils (34 female, 24 male; Ø age: 17.4). As control group 63 pupils (43 female, 20 male; Ø age: 17.0) participate only in the questionnaires, not in the project.

Pupil who participated in the project showed a significant development corresponding to the standard knowledge ($p \leq 0{,}001$, ANOVA), interest in work with authentic materials ($p \leq 0{,}05$, ANOVA) and in human evolution ($p \leq 0{,}001$, ANOVA). In contrast, the control group did not show any of these results. Thus teaching with authentic materials has a positive influence on learning.

Prevalence and characterization of threshold concepts in dynamic visualizations of evolution

Lena A.E. Tibell, AndreasGöransson, Gustav Bohlin, Konrad Schönborn, Gunnar Höst, Daniel Orraryd, Nalle Jonsson, Jörgen Stenlund, Jan Anward, Daniela Fiedler and Ute Harms

Keywords: Evolution, Threshhold concepts, Visualization

Type of presentation: Oral

Decades of research have established that evolution remains a difficult topic to teach and learn. Various concepts, such as variation, inheritance and selection, are important for learners to grasp in order to understand evolutionary processes. However, recent research suggests that a class of more abstract concepts, termed thresholds, such as randomness and probability as well as temporal and spatial scale is important for learning evolution. Given the important role of visual representations in science and science education, we have previously surveyed the presence of these thresholds in online dynamic visualizations. This study revealed a clear lack of certain thresholds such as randomness and small spatial and temporal scales. To provide further insight we currently present a study that describes 1) What aspects of the thresholds are expressed in the collected dynamic visualisations? 2) The distribution of thresholds among different types of visualizations (e.g. animations, videos and simulations) and 3) The modalities and semiotics used to express the thresholds. We have analysed a sample of 127 online dynamic visualizations of evolution. A content analysis was performed based on seven threshold aspects: temporal scale, temporal scale indicator, spatial scale, spatial scale indicator, connections between organizational levels, randomness and probability. Analysis revealed that 64 % of the visualizations contained one or more thresholds, and of these 60 % in the oral (i.e. through narration) and 70% in the visual form. The most common threshold was temporal scale, followed by spatialscale. Temporal scale was often indicated visually through representations of timers, time lines or geological strata. Visual indicators of spatial scales were rare while connections between organizational levels were seldom explicit or elaborated upon. In the few cases where randomness was identified, it was mostly expressed orally. Probability on the other hand was expressed as numbers, graphs or colours, and most common in simulations. So far, we conclude that some thresholds are few in number within dynamic visualizations and they are conveyed in different modalities as well as visual designs. Further semiotic analysis will unveil potential directions for future improvements of visualizations intended to communicate evolutionary processes with respect to teaching and learning contexts.

Understanding immunobiological processes – The development and evaluation of a teaching unit based on learning potentials

Sonja Tinapp and Jörg Zabel

Keywords: Conception, Design-based research, Differentiation, Experiential realism, Immunobiology

Type of presentation: Poster

Which experiences in microcosm and macrocosm help pupils understand abstract immunobiological processes? Empirical studies on microorganisms (Hörsch 2007, Schneeweiß 2010) and the immune system (Prout 1985, Trauschke 2008) show that pupils due to their lack of experience in microcosm rely on metaphors to understand the processes (Trauschke 2008). The learners metaphorically transfer existing conceptions and schemes from their own experiences (source domain) to the indirectly experienceable microcosm (target domain) (Gropengießer 2007). Despite several decades of pupil conception research, new instruction strategies have not yet influenced everyday biology lessons substantially. This study utilises the research results in teaching practice by using the Design-Based Research approach (Van Den Akker, Gravemeijer, Mckenny & Nieveen 2006). The teaching unit will be developed in iterative cycles of design, testing, scientific analysis and re-design. This approach uses the real conditions of a naturalistic classroom context. The Model of Educational Reconstruction (Gropengießer & Kattmann 2013) provides a theoretical framework for the development and evaluation of the teaching unit. The theory of experientialism (Gropengießer 2007) forms the basis for the design of the teaching unit in the test phases. Three research cycles are intended, each with two naturalistic Yr. 7 classes (n= 6 x 25) at a secondary school in Saxony, Germany. The collection of the individual learning potentials will be carried out using a questionnaire concerning pathogens, infectology and immunology in an open-question format. Theory-based design hypotheses (Trauschke 2008, Schneeweiß 2010) will be formulated, based on the individual learning potentials and known metaphorical concepts and figures of thought from other studies. The hypotheses will be developed according to an internal differentiated lesson on themes of immunobiology. The learning opportunities will be tested and evaluated in the first cycle on two Yr. 7 classes. The revised learning opportunities will then be applied in subsequent cycles. During the cycles, the documentation and evaluation will be carried out using classroom observation, a questionnaire and interviews with key questions to five selected pupils (theoretical sampling). The results of the preliminary study of the questionnaire show that the existing learning potentials on the subject of immunobiology were satisfactorily collected. Figures of thought from other studies on pathogens (pathogens as human beings, pathogens as attackers, bacteria as animals), infectology (human body as a container) and immunology (body defenses as humans, conflict in the body) could be confirmed empirically. Evaluation results of the first cycle will be presented at the conference.

Students' environmental concerns and perceptions of forest ecosystem services

Gregor Torkar

Keywords: Ecology, Environmental concern, Forest ecosystem services, Secondary school students

Type of presentation: Oral

Alarming environmental changes encouraged scientists to begin promoting the idea of services offered to humans by biodiversity and natural systems in order to get support for conservation. The concept of ecosystem services is the way to communicate societal dependence on various ecosystems. Schools have an important role in educating students for active and responsible behaviour towards the environment. Four hundred and ten Slovenian students from secondary schools in north-western Slovenia completed a questionnaire testing for the influence of different types of environmental concern on attitudes to forest ecosystem services. Students' attitudes to forest ecosystem services were investigated via 15 statements about provisioning, regulating, cultural and supporting services. Student's types of environmental concern were investigated using a questionnaire with 13 items. Students acknowledged the high benefits of provisioning, regulating, cultural and supporting services provided by forests. They all, regardless of the type of environmental concern, recognize and value different benefits obtained from regulating and cultural ecosystem services. Importance of different provisioning and cultural services varies among students with different types of environmental concern. Education about ecosystem services could be an effective means of communication stressing importance of various ecosystems and our dependence on ecological life support systems.

Between freedom and rule – How can we understand students' moral conceptions about livestock farming and meat consumption?

Nadine Alexandra Tramowsky and Jorge Groß

Keywords: Cognitive metaphor theory, Livestock farming, Meat consumption, Moral arguments, Students' conceptions

Type of presentation: Oral

Learners are regularly faced with moral decisions such as "is it allowed to slaughter animals to satisfy my needs for meat and if so, how should they be kept, so that I can eat meat without feeling guilty?" Behind these decisions are diverse moral concepts that are also applied in biology class. If you ask Eva (15 y.) why animals can be eaten, she argues as follows: „The human being is on top of the world and can decide about everything and has continuously evolved. I think that puts humans above animals." The aim of this research is (1) to empirically collect moral arguments and judgements of vegetarian and meat consuming students based on everyday issues (livestock farming and meat consumption), (2) then to analyse the genesis and structure of moral conceptions as well as (3) how such existing cognitive structures can be used in this theory of mind (Lakoff & Johnson, 1999) in order to encourage learning about moral conceptions (MCs) in biology classes. From this perspective, we have developed an evidence-based instrument to explore MCs about livestock farming and meat consumption. In 1999 the philosophers and linguists George Lakoff and Mark Johnson already claimed that human thinking is based on experience and structured by metaphors. Based on this theory of mind, we will show that also MCs are structured by metaphors. Our study is based on this hypothesis. Thus, we have developed an evidence-based instrument to explore MCs about livestock farming and meat consumption. These findings result from 15 interviews and 5 teaching experiments (Komorek & Duit, 2004) about livestock farming and consumption of meat (11-16 y.). Consequently, we explored characteristic students' conceptions and examined metaphors within moral arguments and judgements by qualitative content analyses (Gropengießer, 2008). The results show how different moral arguments and judgements can be made by persons who eat meat and by those who do not. In this lecture, it is discussed how metaphors decide about moral thinking and how they can be helpful to create fruitful learning environments.

Teleological and causal explanations: Students' preference and acceptance judgments as well as the reasons they give for their choice

Friederike Trommler, Helge Gresch and Marcus Hammann

Keywords: Argumentation, Causality, Explanation, Teleology

Type of presentation: Oral

This study confronted students with teleological and causal explanations and investigated students' preference of one type of explanation over the other, the extent to which students accept both types of explanation and the reasons students give when asked to explain their choice. In a questionnaire with forced-choice items focusing on ten phenomena on human biology, teleological explanations outnumbered causal explanations in terms of students' preference. When asked to indicate their degree of acceptance of teleological explanations and also of causal explanations on rating scales, students' signaled high acceptance for both, but their acceptance of teleological explanations was significantly higher than their acceptance of causal explanations. Interviews with a subsample revealed that students reasoned etiologically, i.e. teleologically and causally, to explain their preferences. However, students also referred to a number of non-etiological reasons (i.e. familiarity, complexity, and five more reasons). The given reasons varied within an individual student and also for a particular phenomenon across different students. Interviews also showed that students had difficulties recognizing teleological explanations as such and eventually difficulties in evaluating the causality correctly. Consequently, biology education should explicitly address the nature of biological explanations and the language that goes with it.

Guiding to guide: Teaching pre-service teachers to guide inquiry-based learning

Masha Tsaushu and Irit Sadeh

Keywords: Inquiry teaching, Pedagogical content knowledge (PCK), Open inquiry
Type of presentation: Poster

The study presents an action research following the course Teaching an Inquiry Project in Biology enrolled by pre-service biology high school teachers. Previous publications have shown a positive effect between pupil functioning in inquiry-based learning and teacher efforts to facilitate scientific literacy, initiative, responsibility, and motivation. These studies have also shown that inquiry-based instruction in teacher preparation programs can enhance pedagogical content knowledge (PCK). This study was framed by the socio-constructivist theory and the acknowledgment of inquiry learning as a knowledge-building activity. Based on these ideas, we assumed that pre-service teachers experiencing 'hands-on' open inquiry 'as students' along with inquiry teaching 'as teachers' will promote both inquiry skills and inquiry teaching skills. Data were collected and analyzed qualitatively through: (a) comparison of students' first and final versions of inquiry reports, submitted to the instructor or to their peers, and (b) interpretation of students' reflections on their learning experience in the course. The main element of the course found to contribute to student inquiry skills was their actual conducting of an inquiry project. The element found most significant in acquiring inquiry teaching was the course instruction, which served as model of inquiry teaching. This was facilitated through continuous discussion about the course pedagogy, increasing students' awareness to teaching strategies applied by the instructor. The element that promoted both inquiry learning and inquiry teaching skills was peer feedback, given on various inquiry outcomes in several milestones of the inquiry project, conducted by the students. We believe that the model described here can be used in teaching open inquiry guiding in PCK programs. Playing the role of pupils, along with constructed and explicit analysis of the instructional means applied at each step of the process, constructs better understanding of the essence of open inquiry and the pedagogy of teaching it.

Working approaches contributing grade nine students' attitudes and performance in biology

Anna Uitto

Keywords: Attitudes, Biology instruction, Performance, Working approaches, SEM
Type of presentation: Oral

The aim of the study is to clarify the contribution of different working approaches, students' self-concept and attitudes towards biology as school subject in the performance in biology of ninth grade students. A survey data collected with a questionnaire from 2 989 students in 133 comprehensive schools was analyzed. The learning performance in biology was assessed through a test including multiple choice questions, as well as open questions measuring pupils' knowledge and conceptual skills in biology. The attitudes were studied applying Fennema-Sherman attitudes measure composing of three different attitude dimensions, "Liking Biology as a school subject" "Self-concept in Biology" and "Experiencing Utility in Biology" measured with five-point Likert scales. Working approaches were also studied with five-point Likert scale, measuring how often a specific approach was used in biology instruction. Explorative factor analysis (EFA) was used to analyse the data. Significant correlations between the factor scores of attitude, performance and working approach indicated that a hypothetical model predicting performance in biology could be constructed. Structural equation modelling (SEM) was used to test the hypothetical model on the contribution of working approaches on positive attitudes to biology and performance in biology. The fit of the final model was good (RMSEA = 0.045, CFI = 0.96, TLI = 0.95). The performance in biology was most strongly predicted by self-concept, but inquiry-based and teacher-led approaches had also some direct effect. The self-concept was most strongly predicted by positive attitude to biology as school subject, which in turn preceded general student-centred and teacher-led approaches. In conclusion, both teacher-led and inquiry-based approaches are important in learning of biology, but the way they influence performance was varying.

Seeking teacher and students opinions about the use of a motivational context-based biology teaching-learning module – A case study

Ana Valdmann and Miia Rannikmäe

Keywords: Context-based teaching, 3-stage model, Teaching strategies
Type of presentation: Poster

For an educational reform to succeed, teachers need to adjust their perceptions to the reform's new curricula and strategies and cope with new content, as well as new teaching and assessment strategies. Developing students' scientific literacy through context-based biology and higher order thinking skills was the framework for establishing a new biology curriculum for Estonian school students. We developed the "Gym versus running. Is a trained person more durable, strong, smart and beautiful?" module, which focuses on context-based biology and higher order thinking skills. Module introduces an understanding of circulation and respiration system as per the Biology curriculum. Learning will start with relevant socio-scientific scenario, which motivated students to learn biology. Through inquiry learning in groups, students used data-loggers to acquire more knowledge of the morphology and function of these systems. They also learn about using the gym and running on the body systems of athletes and discuss which form of training is preferred and why. Finally discussion and socio-scientific decision-making will take place. Our research objectives were (a) to identify the challenges and difficulties biology teachers faced, as well as the advantages they found, while teaching "Gym versus running. Is a trained person more durable, strong, smart and beautiful?" module; and (b) to investigate how teachers and students coped with context-based teaching/learning. 9 teachers who taught the module were included. Research tools included interviews, feedback questionnaire and meeting records. Among different challenges teachers faced while teaching the module essay was mentioned more often both by students and teachers. The teachers felt that they lack the necessary skills to evaluate. Teachers and students need a tool for argumentation and reasoning, in biology lessons have received little attention to the argumentation. We concluded that context-based teaching with socio-scientific health problem and inquiry based learning are effective tools for students to acquire more knowledge in anatomy and physiology which are parts of biology syllabus.

Geographical and mobile information technologies and phenology in European schools: State of the art

Linda La Velle, Jan Georgeson and Egidijus Čeponis

Keywords: Geographical information technology, Mobile technology, phenology
Type of presentation: Poster

This paper describes the initial groundwork for a major trans-European project, PhenoloGIT, which aims to design, build and test a collaboratively created educational environmental information platform, supported by state-of-the-art mobile technology and Geographical Information Technologies (GIT), to be used by teachers and students in primary and secondary schools across Europe. A needs analysis and best practice report is presented on the current use of GIT and mobile digital technologies to gather phenological data by schools across four European countries: Spain, Denmark, Lithuania and the United Kingdom. A brief literature review and theoretical framework for the study are presented.

Descriptions of the protein synthesis in upper secondary biology and chemistry textbooks – An educational data mining approach

Sara J. Wahlberg and Niklas M. Gericke.

Keywords: Concepts, Protein synthesis, Upper secondary school, Textbooks
Type of presentation: Poster

The protein synthesis is a central process in all living organisms. Due to its importance it makes up a small but significant part of the genetics course in both biology and chemistry at secondary school. The process of the protein synthesis is often presented in a simplified way as a linear process in which the concepts of DNA, gene and protein make up the outer conceptual framework, i.e. the start and end products of the protein synthesis. We call these the core concepts. In order to be able to go from the genetic material to the finished protein, there are also structures that actively take part in the production of proteins from the genetic information. We call the concepts that describe these structures the transfer concepts: mRNA, tRNA, intron, exon, amino acid and peptide. When learning the protein synthesis, the student is faced with this diversity of closely related concepts. Previous research has shown that this vast and rich content specific vocabulary of genetics might be a cause for learning difficulties, and since it is known that the average science textbook may well succeed maximum amount of technical words to learn than what is recommended, this aspect of biology and chemistry textbooks become important to study. The aim for this study were therefore to investigate the use of the content specific vocabulary consisting of the core and the transfer concepts, which then were analysed regarding 1) the frequency of these concepts used in the textbooks, and 2) which and how often these different concepts were related to each other. The methodology for analysing the content specific vocabulary was taken from informational sciences, more precisely educational data mining procedures. Textbook passages describing the protein synthesis in the textbooks were analysed by a for the purpose developed computer programme.

The main conclusion of the results is that the biology textbooks tend to explain the protein synthesis more at a principal level by always coming back to and repeat the core concepts, i.e. the start and end products of the protein synthesis, totally omitting some of the intermediaries such as peptides, while the focus of the chemistry books is to describe the different steps of the biochemical process of the protein synthesis emphasizing the transfer concepts. From these findings the hypothesis is put forward that the biology textbooks could make a better case for deep learning.

Development and use of test instruments to study the diagnostic-based practical knowledge of prospective teachers

Julia Warnstedt and Corinna Hößle

Author keywords: Diagnostic-based practical knowledge, Teacher education, Vignette-based instruments

Type of presentation: Oral

Given growing social heterogeneity - also reflected in the school context - both the advancement of, as well as the systematic study of the diagnostic competence of teachers becomes ever more important. Diagnostic competence can be understood as teachers' abilities to make explicit statements about learning conditions and features of learners, which are obtained in a reflected and methodologically controlled process (Hesse & Latzko, 2011). Furthermore, diagnostic competence includes the ability of teachers to provide learning processes by matching appropriate tasks and instructions to the knowledge and skills of learners (Artelt & Gräsel, 2009). In addition to an adequate assessment of learners' attributes, the construct of a diagnostic-based practical knowledge underlying this study requires particularly the capacity to correctly assess the suitability of teaching strategies with regard to promoting learning processes. The study to be presented aims at operationalizing and surveying the diagnostic-based practical knowledge of prospective biology teachers in the form of vignette-based test instruments.

The vignettes include complex teaching situations that present learners' conceptions or learning difficulties as well as various options for action proposed by experienced teachers (n = 50). The surveyed students (n=185) are instructed to rate the options in a rating scale format. In addition, the participants have to support their judgements with reasons instructed by open-ended-questions. The vignette-based instruments were optimized in two pilot phases and used within the scope of first surveys. The data collected by means of open-ended-questions were analyzed by using a specially developed criteria system. In addition, the rating of the novices was compared to the opinions of ten experts.

The results confirm and extend the theoretically elaborated construct of diagnostic-based practical knowledge. Within the didactic intervention, the surveyed prospective teachers improved their skills in description and reflection of learners' characteristics as well as critical aspects within the options of teachers' action. Significant differences between prospective teachers and the control group are detected. The findings underscore the validity of the test instruments, which can be used for applied measurement of diagnostic-based practical knowledge. Moreover, the results provide important information on the development and structure of the diagnostic-based practical knowledge of prospective teachers.

Stress responses of high school students towards tasks accompanied by molecular or symbolic representations

Friederike Westermann, Wolfgang H. Kirchner and Nina Minkley

Keywords: Cortisol concentration, Molecular representations, Stress responses, Students' interests, Subjective stress perception, Technical language

Type of presentation: Poster

Technical language is an important part of biology education and students should be able to use and understand it. Molecular representations are part of the biological language, but many students have difficulties to understand them (Bernholt et al. 2012). Therefore, they may induce various stress responses, when students are confronted with them. In order to investigate the stress potential of molecular representations and the modulating effect of students' interests and attitudes towards biology, 183 students were randomly assigned to one of three different treatment groups and one control group. In each group the students have to solve the same biological tasks, which differ only in the accompanied images (molecular or symbolic representations and everyday-images).

Students who were confronted with molecular representations felt significantly more stressed, compared to other groups. Nevertheless, salivary cortisol concentration did not differ between groups, but was weakened compared to the control group, indicating more stress. Additionally students with high interest in biology showed a better test performance, though the extent of their interest and attitudes did not correspond with their perceived stress or physiological stress response. However, the test performance correlates positively with their rating of understanding of biological topics and their individually rated qualification for biology studies after the task.

These findings suggest that molecular representations are perceived as a stressor. Additionally, students' interests and attitudes play an important role in school, as their test performance and interest seem to support each other. Also a positive enhancement seems to be important when students' biological understanding and individually rated qualification for biology studies correlate positively with test performance and valuated task difficulty. Therefore, positive feelings and positive enhancement can probably enforce students self-concept in class.

Exploring aspects of scientific media literacy in relation to upper secondary school biology curriculum

Jonna Wiblom, Carl-Johan Rundgren and Maria Andrée

Keywords: Biology curriculum, Design principles, Digital media production, Educational design research, Scientific media literacy

Type of presentation: Poster

In a time of a vast expanding media landscape, digital media has reached such an extent that it now represents a new form of literacy. Recognizing scientific media literacy as important for citizenship in the modern age it has been suggested that aspects of accessing, evaluating, analyzing and creating digital media should be a part of science education. However, a number of studies points to difficulties of integrating online learning situations within existing educational curricular structures. As a consequence, teachers often use digital media as a tool to support the learning activities that already takes place in the classroom, rather than exploring the possibilities of embracing a wider range of curricula goals by integrating digital media as a part of education. The aim of this study is to explore and develop relevant aspects of scientific media literacy in the encounter between a biology education practice and the digital media landscape. In close cooperation with two science teachers, an educational design research study was conducted at an upper secondary school in Sweden. As a part of the biology curriculum students were engaged in critical evaluation of health related online resources, followed by students' own media production of webpages and podcasts. The results after two cycles of interventions indicates that the formulated design principles supported the design of the interventions in various ways, and a tool for critical evaluation of online resources structured students' source critique. However, various aspects of autenticity ought to be considered when integrating digital media in science education, and a high level of specificity regarding the articualtion of subject specific capabilities in relation to subject content appears to be crucial for the assessment of students' achievements. As for the future, a further articulation of the meaning of subject specific capabilities is suggested to visualize, promote and assess relevant aspects of scientific media literacy in biology education.

Biodiversity in the digital world – Creating experience with local biodiversity by using digital media

Judith Wiegelmann, Alexander Finger and Jörg Zabel

Keywords: Biodiversity, Model of Educational Reconstruction, Student conceptions
Type of presentation: Poster

In order to participate responsibly in the public dialogue on biodiversity and sustainable development, students have to know recent findings and assumptions from biodiversity research. International research approaches focus on biodiversity not only under biological aspects. Furthermore, they connect biodiversity with the concepts ecosystem functions, ecosystem services and human wellbeing (Naeem Et Al 2009). Especially the scientific concepts ecosystem functions e.g. soil formation (Xylander 2015) and ecosystem services e.g. food and drugs (Beck 2015) will be used to emphasize the importance of biodiversity for humans as well as prerequisites for sustainable use (Wittig & Niekisch 2014).

To protect biodiversity, the Convention on Biodiversity (CBD) demanded including the topic into educational programs in 1992 already. In recent years a lot of studies investigated student conceptions on biodiversity (Menzel 2007, Rod 2011) and different knowledge of ecology (Hammann & Asshoff 2014). According to Menzel (2007), students have a limited understanding of biodiversity. They reduce biodiversity to diversity of species and the beauty of nature (Menzel 2007, Rod 2011). But what do students know about ecosystem functions and ecosystem services, and how do they understand both concepts? The main objectives of this study are (1) to analyze student conceptions on ecosystem functions and ecosystem services, (2) to outline individual learning processes and (3) to derive teaching strategies.

Using the Model of Educational Reconstruction (Duit Et Al. 2012) as theoretical framework, we compare scientific theories and concepts to the student conceptions in order to structure teaching-and-learning activities. Student conceptions will be identified by guideline-based and problem-centered individual interviews in grade 9 (n=6). Subsequently, the structured interventions (teaching-and-learning activities) will be tested and evaluated by teaching experiments (Duit & Komorek 2001) in groups of three with students at the age of 15 (n=18). To reconstruct the students' learning processes, we use retrospective surveys based on guideline-based interviews (Groß 2007). All data will be analyzed through Qualitative Content Analysis (Mayring & Gläser-Zikuda 2003).

Our first teaching approach includes interventions with differently colored gummy bears (Schulz & Sachs 2011). Using a model experiment, we want to explain ecosystem functions e. g. stabilizing bio-communities (Beck 2015), and ecosystem services based on the biodiversity levels diversity of species and interactions. A future prospect is to emphasize the relation between biodiversity and humans.

SYMPOSIA ABSTRACTS

SYMPOSIA 1:
LEARNING BIOLOGY IN INFORMAL SETTINGS

CHAIR: SUE DALE TUNNICLIFFE

This symposium of the Learning Biology in Informal Settings SIG brings together five papers reporting on research conducted in Germany, Israel, the UK and the US. A key feature of informal contexts is that they offer distinctive, and often unexpected, experiences that can promote curiosity, questioning and learning which is not always seen or possible in other settings. Central to these experiences are the nature of the space and the interactions that take place both between visitors and between visitors and the environment. In the symposium we will consider the nature that the, often special, objects and surroundings play in learning, especially through provoking focused talk, and explore the role that the nature of the visitor expectation and expertise plays in promoting meaningful experiences.

The first three papers bring together recent research into visitor experience at natural history museum collections. The first reports on a major project exploring how museums in the UK and US support learning and understanding of science and how these types of data can be better shared and used across collections. With a specific focus on visitor experience, the second and third papers examine how visitor awareness of collections can be heightened through innovative approaches in organisng natural history displays and through pre-visit stimuli. These approaches lead to new types of noticing in both children and adults and an increase in curiosity and the asking of questions – characteristics which promote increased learning about biology. The fourth paper examines school student experience in the special setting of medical simulators where the visitor is able to gain first-hand experience of hands-on activities related to medicine and surgery. These experiences are shown to have positive effects on both learning and attitudes towards biology. In the final paper, the focus shifts towards pre-service biology teachers by examining how a training experience at a large botanical garden promotes an inquiry-based focus on learning in biology. While revealing the benefits of such training, this work also demonstrates some of the challenges of working in special environments which, for some, can be somewhat overwhelming.

PAPER 1

The unexpected: Provoking questions at natural history dioramas

Annette Scheersoi and Sue Dale Tunnicliffe

Keywords: Biological conservation, Leisure visitors, Situational interest, Natural history museum

This study of using the 'unexpected' in a German natural history museum shows the potential for catching leisure visitors' attention and interest as a starting point to develop these visitors' understanding of complex socio-cultural issues such as biological conservation. The unexpected in this instance was a rhino specimen without a horn in a natural history diorama (thieves had broken into the diorama and taken off the rhino's horns). The museum staff decided not to replace the horns but to present the rhino deliberately without its horns to create visitors' awareness of conservation issues. Our visitor observation study shows that the visitors' attention was indeed caught by this specimen and that questions were provoked. However, the visitors' interpretation of the phenomenon was often inaccurate. Therefore, in a second part of the study, explanatory information was provided. Our data show that this additional information enabled visitors to construct an informed dialogue and to gain an understanding and further awareness of biological conservation issues. We conclude that the unexpected in a natural history diorama can provoke interest and a sustained focus on the object and further thinking about the related biological content. However, visitors need to be given the explanatory information in order to fully understand the exhibits' message and to prevent inaccurate interpretation.

PAPER 2

Why do parrots talk?: Co-investigation as a model for promoting family learning in natural history galleries.

Emily Harris and Mark Winterbottom

Keywords: Family learning, Learning, Learning talk, Natural history museum, Object based learning

Research into how and what families learn in science museums and other informal science learning settings suggests that parental explanations and parent-child interactions play an important role in shaping children's learning experiences. (Ash, 2003, 2004; Borun, Chambers, & Cleghorn, 1996; Borun & Dritsas, 1997; Crowley & Fender, 2007; Diamond, 1986; Gutwill & Allen, 2010; Hilke, 1988; Melber, 2007; Palmquist & Crowley, 2007; Szechter & Carey, 2009; Zimmerman, Reeve, & Bell, 2008). Our case study set out to explore learning happening within family groups during a visit to a natural history gallery. We sought to gather a 'family eye' of these visits in order better understand how families interact in this context, particularly what they talk about and whether and what they learn. The focus of analysis was on learning happening within and across the family groups rather than individual (child) learning within the family roup situation.

The research took place in a traditional natural history gallery brimming with taxidermy specimens, many displayed within original Victorian dioramas, and which is popular with family visitors, despite the lack of family-friendly interpretation. Data collection and analysis methods were influenced by a growing body of literature – particularly in the UK and US, which looks for learning in family visitor talk (Gutwill & Allen, 2010; Palmquist & Crowley, 2007; Tunnicliffe, 2000; Zimmerman, Reeve, & Bell, 2010). We audio-recorded conversations of 18 families exploring the gallery together after being introduced to some object-based learning games which fostered a 'climate of inquiry' and which were designed to spark dialogue between family members. Our findings indicate that families adopt a range of interactional approaches for building meaning together in the context of the museum gallery. We argue that these can be viewed as sitting on a spectrum of family learning strategies that vary according to the level of co-investigation and cooperation between group members. Our findings therefore suggest that family learning could be supported in informal learning contexts through interpretation strategies that encourage family dialogue and co-investigatory behaviours. Our research opens up discussion about the relationship between facilitated and un-facilitated experiences in museums and how the design of facilitated experiences, for example, hands-on workshops, can mediate wider post-facilitation learning experience within informal learning settings.

PAPER 3

Learning about the human body with medical simulators

Tali Tal and Sameer Dallashe

Keywords: Attitudes, Hands-on, Human body, Interest, Medical simulators

This study took place in ”A medical simulators unit”, of a science-center in Israel. The sophisticated human-like simulators enable learning about human body systems and about their function in a hands-on environment. Students are able to monitor heart functions, ”catheterize human hearts”, deliver a baby, experience basic functions while intoxicated, etc. We aimed to answer the following research questions: (1) what characterizes the simulation-based learning environment? (2) Have students' attitudes toward biology changed following their experiences? Our theoretical framework is based on constructivist and sociocultural theories. Students are active learners, they work collaboratively, discuss ideas and debate and consider alternatives in a problem-based environment. The contextual model of learning is expressed in the personal context as students are encouraged to address their own experience such as knowledge and experience with diseases and medical conditions. In the social context, almost all the experiential activities are done in small groups where students have to discuss and work together to handle ”the medical situation” and the physical context consists of a variety of objects that are to be operated by the students. Overall, this environment has similar characteristics to other museum settings by allowing the exhibit to direct curiosity and learning.

In this mixed-method study, we followed 131 students who study ”The human body” unit in 10th grade, and who visited the simulators-unit three times. Data were collected through observations of 12 school visits to the simulators unit, pre-post semantic differential questionnaires with respect to ”biology”, and through interviews with ten students, who were randomly selected. The interview analysis obtained seven characteristics of learning pointed by the students. Out of 229 relevant statements, the vast majority addressed active and hands-on learning. About half of the statements addressed learning that is motivated by interest, need and relevance, and 20-25% addressed collaborative learning, experiential and joyful learning, and good connection to the school curriculum. Intellectual enrichment and the ability to question were addressed by 18 and 9% respectively. The observation analysis obtained six categories; five that were already identified in the interviews: active-learning, collaboration, asking questions, relevance and connection to the school-curriculum and a new one: the opportunity to interact with peers and with adults. The analysis of the students' attitudes toward biology showed a significant improvement among all participants. In conclusion, we suggest that learning about the human body in simulatorsenvironment promotes meaningful learning.

PAPER 4

Budding biology teachers: What have botanical gardens got to offer inquiry learning

Melissa Glackin and Christine Harrison

Keywords: Botanical gardens, Inquiry-based learning, Pre-service secondary teachers, Teacher views

This paper explores pre-service biology teachers' views of inquiry-based learning when introduced for the first time during a teacher education programme outside the classroom in a botanical garden. Teachers have diverse ways of conceptualizing inquiry and the value of inquiry based learning. This is particularly evident when teachers are introduced to inquiry pedagogy within a new context. Studies have found that both inquiry-based learning and teaching in settings outside the classroom, such as botanical gardens, increase student curiosity, engender collaborative learning and offer opportunities for authentic science learning. However, research consistently shows that teachers have diverse ways of expressing inquiry and that implementation of both inquiry lessons and teaching outside is challenging. Currently, there is a gap in the literature about how preservice biology teachers' views of inquiry-based learning might be influenced when introduced in a setting other than the classroom, in particular a botanical garden.

This paper draws on data from a small exploratory pilot study. Semi-structured interviews were conducted with eight participants who were pre-service secondary biology teachers. The participants attended a day visit with university tutors to the Royal Botanical Gardens, Kew. The views of pre-service biology teachers Emerging from the initial analysis are two themes. First, pre-service teachers, at the early stage of their teacher preparation programme linked inquiry-based learning to students developing skills in asking and answering questions and observing the world around them. However, the data suggests that frequently participants conflate inquiry learning with learning in a unique or unfamiliar setting such as a botanical garden. Second, the majority of participants were concerned about managing students' inquiry-based learning. A tension was identified between how openended an inquiry-based activity could be whilst ensuring student focus. Further, participants were concerned about the practical management of inquiry-based learning. When these themes are considered together, they bring a unique set of challenges that sometimes overwhelm pre-service teachers.

SYMPOSIA 2: SOCIO-SCIENTIFIC BASED INQUIRY IN THE CONTEXT OF BIOLOGY TEACHING

CHAIR: RALPH LEVINSON

Many contemporary biological issues, particularly those concerning health and the environment, depend on political as well as scientific judgments. Such issues include considerations of the effects of climate change on biodiversity, the marketing of pharmas, the consequences of increased antibiotic resistance, and the possibilities of life choices afforded by advances in genomics. The political and social effects of these developments and disturbances in life technologies have resulted in new political configurations such as biocitizenry and biopolitics.

These technological developments have global, social and personal effects. For example, vaccination of cattle in one part of the world can influence bacterial mutations which affect human and animal species globally. These have personal and social consequences both in terms of moral choices made in abstaining from antibiotics and the creation of a social consensus about the prescription of medicines and the risks involved. Socio-scientific inquiry based learning (SSIBL), an EU FP7 funded project incorporating 17 universities from eleven different countries brings together four conceptual pillars associated with the creation and application of scientific and political knowledge. These pillars are inquiry based learning (IBL), citizenship education (CE), socio-scientific issues (SSI) and Responsible Research and Innovation (RRI). The model for SSIBL, which is aimed at teacher professional development, is that students develop questions based on socio-political and scientific issues which involve the participation of stakeholders (i.e. those parties with an interested in the development and application of a technology) where addressing the questions presuppose a decision which involves action.

This symposium brings together four papers of research into the initial implementation of SSIBL. The first paper (U.K.) expands on the theoretical issues in formulating a model based on the four pillars. In the second paper (France), researchers draw on the concept of “démarche d’enquête” rather than inquiry, as a process in teacher education which promotes socio-scientific reasoning, social justice, ethical justice and democratic citizenship. Colleagues from The Netherlands report the results of an intervention with pre-service teachers to plan SSIBL lessons. The final paper from the U.K. discusses the results of research with 284 pre-service teachers in implementing SSIBL in their practise schools.

PAPER 1

Toward socio-scientific inquiry-based learning

Ralph Levinson

Keywords: Citizenship, Inquiry, Pedagogy, Responsible research and innovation, Socio-scientific issues

Many contemporary biological issues, particularly those concerning health and the environment, depend on political as well as scientific judgments. Such issues include considerations of the effects of climate change on biodiversity, the marketing of pharmas, the consequences of increased antibiotic resistance, and the possibilities of life choices afforded by advances in genomics. The political and social effects of these developments and disturbances in life technologies have resulted in new political configurations such as biocitizenry and biopolitics.

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PAPER 2

Socio-scientific inquiry in pre-service education: Challenges and opportunities

Andri Christodoulou, Ruth Amos and Marcus Grace

Keywords: Citizenship education, Socio-scientific issues, Teacher training

Socio-Scientific Inquiry-Based Learning (SSIBL) is a pedagogy which connects the study of socio-scientific issues (SSIs) with inquiry-based learning (IBL) and citizenship education (CE; Levinson, 2014). This paper features a training program in which pre-service biology teachers (PSTs) collaborate in designing and reflecting on SSIBL learning and teaching activities. It addresses how PSTs valued the SSIBL-pedagogy and what challenges and opportunities they foresee. Within the context of a 20?week pre?service teacher course, two cohorts of biology PSTs (n=27) were involved in training on SSIBL, consisting of two 1,5 hour face?to?face meetings and the development of a design for a SSIBL?lesson in groups of 3 or 4 PSTs. Qualitative methods were used to evaluate the SSIBL framework as experienced by the PSTs and consisted of classroom observations, collection of lesson designs and a questionnaire.

The results indicate that the SSIBL-training enabled PSTs to bring socio-scientific controversies to their classroom practice and to engage students in personal decision-making. Integrating social and scientific inquiry proved to be more difficult as it was mainly translated in an inquiry to generate more factual knowledge to be able to check the different claims by stakeholders. However, PSTs considered the SSIBL-approach to be of added value to biology lessons in general and to their own teaching repertoire in particular. The main obstacles mentioned by the PSTs for implementing SSIBL in biology education is the time consuming nature both in designing these activities as in the time needed for social an ethical inquiry in classroom practice. Moreover, they considered SSIBL difficult to manage due to its open and deliberative character, and they experienced inflexibility at their training school since it not matched the school planning. So, more effort is needed to support PSTs in guiding an open-ended inquiry in classroom practice. The training activities are being adapted at this moment and implemented in a next course for student biology teachers.

PAPER 3

Pre-service teachers' experiences of learning to teach biology through a socio-scientific inquiry-based learning (SSIBL) approach

Marie-Christine Knippels, Roald Verhoeff and Paulien Postma

Keywords: Inquiry-based learning, Pre-service teacher education, Socio-scientific issues, SSIBL

In recent times there is increased interest in how issues surrounding science for and with society are conceptualised, presented and discussed in science classrooms in a way that promotes active citizenship. One approach to enabling this way of teaching science is through socio-scientific inquiry-based learning (SSIBL).To promote the teaching of science through SSIBL, teachers need to have the appropriate teaching repertoire. Our aim was to work with secondary science pre-service teachers to explore the process of developing teaching skills consistent with SSIBL during their training year. Using a qualitative, interpretative design to capture in-depth views and perspectives of pre-service teachers (PSTs), we designed a series of professional development sessions that focused on exploring PSTs' views of inquiry, and its place within science education; how inquiry is practised in their placement schools, and how they could use IBL around issues of relevance to society within their teaching practice. The research methods used include focus groups, interviews, lesson observations and evaluations, and field notes. Participants included 284 pre-service science teachers in two UK Higher Education Institutions (HEI). Our findings suggest that PSTs viewed SSIBL as a valuable approach for increasing both student attainment and engagement, by providing alternative ways to the traditional 'teaching-to-the-test' approaches they had previously experienced either as students themselves or as training science teachers. Although PSTs experienced challenges with implementing SSIBL, initially on aligning it with the curriculum and subsequently organising and managing the learning environment, they continued to value this approach. We argue that it is crucial for PSTs to experience SSIBL in action for developing teaching skills consistent with SSIBL. The majority of PSTs initially planned and taught SSIBL lessons using biology topics, which suggests that using biology topics provides particular affordances for developing competence and confidence in teaching using a SSIBL approach, which could then be applied in the teaching of other science disciplines.

PAPER 4

The devices of the "démarche d'enquête": The example of the cartography of controversy

Lucas Nedelec, Gregoire Molinatti, Jean Simonneaux, Laurence Simonneaux, Nicolas Herve and Amelie Lipp

Keywords: Cartography, Démarche d'enquête, Socially acute questions, Socio-scientific inquiry, Teachers training

The SSIBL approach targets several educative goals (knowledge, skills, values and dispositions about democratic deliberation and sustainability). In our SSIBL implementation in France, we crossed these goals with the Socially Acute Questions (SAQs) approach. By this articulation, the main proposition is to develop a "démarche d'enquête" (socio-scientific inquiry) process that we distinguish from the classical inquiry based-learning method with this principal difference: the démarche d'enquête is an open-ended investigation with a plurality of potential solutions in an unstable context. In this communication, we focus on one specific tool of the démarche d'enquête which is the cartography of controversy. This tool has been used during a pre-service training program for life and earth sciences teachers (upper secondary school level) and we interrogate its potentiality about the "reporting the inquiry" and "reflexivity/subjectivity" steps of the démarche d'enquête. We used a qualitative analysis of the cartographies made during the practices and the discussions during their presentations by the groups of teachers. The conclusion is that the cartography is a relevant device for the implementation of the socio-scientific inquiry because the production of the map allows negotiations inside the group about the representations of the controversy and its actors, the identification of the uncertainties and the place of the students themselves as citizens and as teachers. The relevance of the cartography tool depends more on the dynamic of questioning that their use permitted than on its concrete result.

SYMPOSIA 3: ENVIRONMENTAL LITERACY – GROUNDED IN THEORY AND APPROVED IN ENVIRONMENTAL/ SUSTAINABILITY EDUCATION PRACTICE

CHAIR: FRANZ X. BOGNER

The present symposium orchestrates on an empirical data basis the theoretical foundations of the concept of environmental literacy by confirming its four major pillars: (i) Attitudes and values, reported behavior and knowledge dimensions. The first one integrates the 2-MEV scale with its repeatedly independently two higher order factors producing a dichotomous empirical model of the values: Utilization (U) and Preservation (P) based on sets of consistent attitudes originated from factorized sets of items. (ii) The second one calibrates the previously established instrument for monitoring ecological behaviour (GEB), by using Rasch-type models of sets of reported behaviours which are containing the overall ecological engagement of individuals. (iii) The third one comprises three major sections: (a) knowledge about how the environmental system works and how natural processes operate; (b) knowledge about how to achieve resource conservation and environmental preservation; and (c) knowledge about how best to achieve resource conservation. (iv) Finally, connectedness with nature attributes the affective component of the total model.

Based on the described theoretical ground, we present seven exemplary educational interventions from three different countries representing educational interventions in formal and informal contexts, always based on empirical data following the model's vision. Preferentially in a quantitative context, learning environments for primary and secondary school children are portrayed, highlighting the preparation offered by the teachers and the children's learning outcomes. A German contribution uses an inquiry-based climate change module to extract its effects on the above described model. One contribution from the US highlights the value and connectedness involvement during earth education programs as well as its courses over a five-year period. A Swedish contribution investigates the effectiveness of education for sustainable development as a teaching approach including pluralistic and holistic perspectives in the classroom. Another two presentations from Germany focus on the portion of how personality (as further external factors) may predict individual willingness for conservation, as well as how individual willingness to protect honeybees is conflicted by perception of hazards and conservation. A Swedish explorative study using cluster analysis investigates student understandings of the relationships between the environment and the economy. Finally, a Swedish study compares the development of a gender gap between students' of different ages regarding their sustainability consciousness.

PART 1:

PAPER 1

Quantifying environmental citizenship: Sound integration of established psychometric models

Franx X. Bogner

Keywords: Attitudes, Behaviour, Knowledge, Literacy model

Based on a sample of approximately 1,900 students, we calibrated previously established instruments for ecological behaviour (GEB), environmental knowledge with Rasch-type models and attitudinal preferences towards nature (by applying the 2-MEV scale). By using path modelling, our theoretically anticipated competence structure revealed a modest behaviour effect on the behaviour set; attitude toward nature turned out to be, as expected, the stronger determinant of behaviour. Overall, we propose the literacy model that has the potential to guide us into more evidence-based ways of promoting the over-all ecological engagement of individuals.

The measured behaviour score receives its support from the GEB scale, developed in the 1990ies and repeatedly independently confirmed since that time. The battery acronymed as General Ecological Behaviour contains a concise set of behaviour in describing an individual with his/her preferences in daily life. The set of selected behaviour based on a 40 item-set is covering six domains: energy conservation, mobility and transportation, waste avoidance, consumerism, recycling, and vicarious behaviours towards conservation. The 2-MEV consists of the secondary factors Utilization (U) and Preservation (P). Maximum likelihood factor analysis confirmed the both hypothesized orthogonal factors U and P. Both domains construct the 2 factor Model of Environmental Attitudes (2-MEV, employing the term to indicating sets of consistent attitudes. Meanwhile, the 2-MEV model was repeatedly tested by independent groups in confirming the two orthogonal, robust factors of Preservation and Utilization.

In its current stage, the derived knowledge model includes (a) knowledge about how the environmental system works and how natural processes operate; (b) knowledge about how to achieve resource conservation and environmental preservation; and (c) knowledge about how best to achieve resource conservation —that is, knowledge about various behaviours' effectiveness in terms of energy savings or reduced carbon dioxide emissions.

PAPER 2

Ecological values & connectedness to nature: Are we measuring different constructs?

Bruce Johnson, Constantinos Manoli and Buxner Sanlyn

Keywords: CNS, 2-MEV, Path modelling

The present study investigated whether the Connectedness to Nature Scale Revised (CNS-R) (Frantz, Mayer & Salle, under review) and the Model of Ecological Values Scale (2-MEV) (Johnson & Manoli, 2010, Wiseman & Bogner, 2003) measure different constructs, whether they can detect changes due to participation in education programs, and if those changes are different for the two scales. Results of both exploratory and confirmatory factor analyses show that the CNS-R measured a construct very similar to the 2-MEV's factor of Preservation and not an emotional connection to nature (Perrin & Benassi, 2009). In addition, using the pre and post-scores from upper elementary students who attended Earthkeepers, an earth education program, a correlation analysis between the two scales revealed a positive association of the CNS-R and the 2-MEV's value of Preservation. In addition, both CNS-R and 2-MEV scores experienced similar statistically significant increases from pre- to post-program. We conclude the CNS-R is a valid measure for the assessment of environmental learning programs for children; however, we urge researchers not to use the scale in conjunction with other scales, such as the 2-MEV, measuring very similar constructs.

Key Objectives: Do the Connectedness to Nature Scale Revised (CNS-R) and the Model of Ecological Values Scale (2-MEV) measure different constructs? Can these scales detect changes due to participation in education programs? Are these changes different for the two scales?

PAPER 3

The effectiveness of education for sustainable development: Pluralism and holism in the classroom

Jelle Boeve-de Pauw, Niklas Gericke, Daniel Olsson and Teresa Berglund

Keywords: Educational effectiveness, ESD, Holism, Pluralism

With the UN declaration of the Decade of Education for Sustainable Development having come to end last year, and the Global Action Programme moving into place, the eyes of educators, policy-makers and scholars are turning toward the evaluation of the implementation of Education for Sustainable Development (ESD) within formal education. Empirical studies are a missing link in the discourse around ESD, where decisions and implementation strategies are heavily based on policy recommendations and gut feelings by practitioners. We used data from 2413 students in grades 6, 9, and 12 from 51 schools across Sweden to study the effectiveness of ESD. In line with the current debate on the definition of ESD, we quantified the extent to which teaching can be labelled as holistic and/or pluralistic. Through a series of descriptive analyses and the estimation of structural equation models, our results indicate that ESD can indeed impact on student outcomes in terms of their sustainability consciousness. As students perceive the teaching in their school as more holistic they also report higher levels of sustainability knowingness. Parallel, higher levels of reported pluralism in the classroom result in more frequent sustainability behaviors. The results also show that the size and shape of these ESD-effects are grade specific. Furthermore the study zooms in on the facilitating role that ESD certification systems play in the context of formal education in Sweden, in terms of facilitating holism and pluralism in schools. Implications for research and practice of these results are discussed.

PART 2:

PAPER 4

As personality predicts individual willingness for conservation

Christine Thorn and Franz X. Bogner

Keywords: Environmental attitudes, Personality traits, Llinear model

As the relationship between environmental preferences and personality needs clarification, we measured environmental attitudes and personality traits of 301 adolescents. We quantified environmental attitudes using the 2-MEV scale with its two higher-order factors Utilization and Preservation, and personality via the BIF-10 scale covering Extraversion, Agreeableness, Conscientiousness, Neuroticism and Openness. The personality trait 'Openness to Experience' correlated positively with Preservation and negatively with Utilization. This relationship illustrates the individual view towards conservation and the exploitation of nature depending on the trait "Openness to Experience". Conclusions for educators are discussed.

PAPER 5

Individual willingness to protect honeybees: Perception conflict of hazards and conservation

Mona Schoenfelder and Franz X. Bogner

Keywords: Conservation, Dangerousness, Individual perception

The current loss of biodiversity requires a push for awareness towards conservation. Within this consequence, especially the loss of pollinators in line with potential protection strategies acquires great attention in media. By contrast, pollinating insects like bees erase considerable concerns as they are considered as fearful animals. Negative emotions such as fear and aversion often produce obstacles to support conservation and to reinforce appropriate initiatives for protection. Consequently, our study focused on monitoring perceptions about bees in the context of dangerousness and conservation by applying a semantic differential (SD) based on different adjectives aligned with "I think bees are…". Additionally, open questions were applied to unveil and understand individuals' perceptions of dangerousness and conservation of bees. We collected data of students from primary and secondary schools and university in two perspectives: novices (n = 499) and experts (beekeepers, n = 153). An exploratory factor analysis of the SD responses revealed three major factors: Interest, Dangerousness, and Conservation & Usefulness. All of them correlate significantly among each other. Although all subgroups showed an overall high willingness to protect bees, the perception of danger scored medium. In this context, the individual experience of having got stung was shown the most prevalent reason for expressing fear. Based on these results we designed and conducted an intervention for secondary school (n = 192) reducing the perceived dangerousness through resolving misinformation or myths, and supporting individuals' interest for the species.

PAPER 6

An explorative study of student understandings of the relationships between the environment and the economy

Teresa Berglund and Niklas Gericke

Keywords: Clustering, ESD, Modelling

Role of the economy in relation to ecosystems and sustainable development (SD) has been discussed and debated for decades. One focus in the debate has concerned how economic growth or economic development influences the environment and whether economic growth is compatible with the goal of a sustainable environment. It has been argued in research that environmental and sustainability education should encompass critical and reflective perspectives on current economic structures and ways of organizing society. This study investigates in what ways Swedish upper secondary students perceive the relationships between economic growth, economic development, and SD, and in particular, if different views can be related to differences in the way the students perceive environmental aspects in SD. Students in grade 12 (18-19 years of age) from 15 schools participated by responding to a questionnaire and a total of 638 responses were included in statistical analysis. The students attended a mix of urban and rural schools across Sweden of different sizes and from different socio-economic conditions. The students' views on the role of the economy in SD were explored by cluster analysis. The explorative analysis engendered four clusters of views, all differing in the ways of viewing economic objectives in SD. The largest group was composed of students that indicated positive stances towards economic growth and economic development in SD. A smaller group revealed clearly critical stances, and two groups had other ways of viewing the relationships. A second analysis was made to test differences in the way the clusters perceive SD and its underlying environmental, economic and social dimensions, measured in terms of knowingness, attitudes, and behaviors in the composite construct of sustainability consciousness (SC). This analysis indicated that the clusters differed in their perception of the environmental dimension of SC. Thus, the results indicate a relationship between students' perceptions and attitudes towards environmental issues and standpoints regarding the role of the economy within SD. Furthermore, the results indicate that a proportion of students are aware of the tensions between environmental sustainability and economic objectives in SD, but also that the most substantial part of the students do not question current ways of organizing society. Therefore, our results suggest that critical analysis of present economic structures is largely missing in environmental and sustainability education.

PAPER 7

The gender gap in environmental and sustainability education - A cross sectional study of Swedish students from grade six, nine and twelve

Daniel Olsson and Niklas Gericke

Keywords: Cross section, Sustainability education

A gender gap has been found to exist in environmental education where girls display greater knowledge, more positive attitudes and higher pro-environmental behavior than boys. In this study we extend previous environmental and sustainability education (ESE) research by investigating students' broader consciousness of sustainability.

Gender socialization has commonly been suggested as an explanation for the occurrence of the gender gap and the main idea of this theory is that children are continually influenced by their surroundings that evoke gender stereotypes of the society into the children's identities, and the effect of this process is believed to increase with age. However, ESE has been suggested to remedy the gender gap, and the underlying idea is that the complexity of environmental issues makes it inevitable to use more progressive pedagogical approaches that also remedy the gender gap. However, this assumption is not empirically tested. Therefore, we have investigated how the effect of gender might relate to ESE-certification programs. In addition we also studied if the gender gap varies with age. These two aims were accomplished by studying Swedish students' sustainability consciousness (SC) in grades six, nine and twelve. The study consists of a nationwide sample including students from two cohorts of schools in the three grades respectively. One group of schools has received ESE certifications (predominantly within the eco-school program) and the other group consists of comparable schools without such certifications. Totally 2413 students participated. To collect data we used a Likert-scale questionnaire instrument measuring the concept of SC. SC is a comprehensive concept including knowingness, attitude and behavior aspects of the environmental, economic and social dimensions of sustainability and has been thoroughly validated in previous studies.

We found that the girls consistently report stronger SC and higher mean values in the environmental, economic and social dimension than boys. Second, we found the effect size of the girl-boy difference to increase for each grade. This results support the hypothesis of the gender socialization theory. Third, our findings reveal a larger gender gap in students' SC in the certified schools in comparison to students in non-certified schools. Hence at a first glance our result seems to totally contradict that ESE could remedy the occurrence of a gender gap, but more thorough analysis gave with hand that these outcomes could be explained by that the certified ESE-schools do not practice progressive teaching approaches as recommended by the literature, but more normative environmental teaching approaches.

SYMPOSIA 4: FOSTERING A PHILOSOPHICAL STANCE TOWARD SCIENCE: THOUGHTFULNESS AND CREATIVITY IN THE BIOLOGY

CHAIR: JÖRG ZABEL

When dealing with socio-scientific issues in science education, decision-making mainly focuses on ethically relevant knowledge and arguments. Developing content knowledge and argumentation represents the cognitive dimension of decision-making competence. Without the corresponding social, empathic and communicative skills and creative moments, however, biology education remains soulless. Beyond reinforcing argumentation skills, openness and sensibility of a broad array of morally relevant intuitions should be fostered. The role of intuitive judgments requires sensibility and care on the part of participants. Meaning-making in biology education influences student awareness of evolution, biological functions of their body and environmental issues, among others. In the biology classroom, students should be encouraged to interact with the content in the light of their beliefs and experiences. Developing thoughtfulness in biology lessons, in this sense, means to foster creative and unstructured moments, in order to leave room for spontaneous ideas, uncertainty and open dialogues.

We see thoughtfulness and openness for intuitive judgments as prerequisites for decision-making processes in the biology classroom. While the papers of this symposium focus on different biological topics, they all discuss teaching styles and learning environments that allow the voice of the student to speak unhindered in socially or ethically relevant science contexts. (1) Bergmann & Zabel focus on the rise of neuroscience in the last two decades, and explore students' decision-making in relation to the emerging technological opportunities and ethical challenges of manipulating and enhancing mental processes. (2) Dittmer discusses philosophical reflections in the genetic laboratory. The social-intuitionist model of moral judgment (Haidt, 2001) allows a deeper understanding of decision-making based on culturally embedded beliefs about a science-based world. Those ethically relevant and almost implicit beliefs are discussed as "everyday myths" (Dittmer & Gebhard, 2011). (3) Knippels et al. explore future scenarios about synthetic biology in activating students' mental frameworks as a first step in the opinion-forming process. (4) Levinson & Surendran employ Levinas's commitment to the Other to inform a pedagogy which incorporates simultaneously an ethics of Nature and respect for the student voice. Finally, (5) Lübke & Gebhard present case studies about decision-making in which students reflect on their "everyday myths" while thinking about genetic engineering. During this process moments of irritation can enhance thoughtfulness.

PAPER 1

The role of moral intuitions in students' decision-making on neuroethical issues

Alexander Bergmann and Jörg Zabel

Keywords: Decision-making, Intuition, Moral reasoning, Neuroscience, Socio-scientific issues

The rise of neuroscience in the last two decades led to important new but also controversial perspectives on the human brain. By this time, it is often hard to separate science from science fiction within the public dialogue: We are not able to 'hack the brain' and, although we use functional neuroimaging-technologies, we have not found a 'soul' in our brain yet. When teachers and students talk about neuroscience, these so-called neuromyths occur quite often. As parts of our everyday language they constitute an integral but mostly unconscious component of our perception and understanding of neuroscience. Together with other contextspecific notions, phantasies, moral connotations and intuitive judgements, they structure the way we think, talk and argue in ethical discourses (Haidt, 2001; Combe & Gebhard, 2007). In order to foster the students' understanding of neuroscience and their decision-making competence at the same time, we have to unlock the potential of these intuitions in the biology classroom. Therefore, our main objectives are (1) to identify and systematize the moral intuitions and intuitive beliefs that students activate when talking about neuroscience, and (2) to analyse how these intuitions influence the students' discourse on euroscientific and neuroethical questions.

We conducted and videotaped eight group discussions in grade 9 and 10 of a German grammar school (N=32). The group discussions were designed as though experiments, in each of which four students had to discuss the moral dimension of three (imaginary) neuroscientific research proposals as members of an ethical commission. We analysed the data based on the 'reflexive grounded theory' methodology (Breuer 2010). The participants of our study, while being aware of its benefits and technological potential, still perceived neuroscientific research as something predominantly dangerous. For example, the discussions were maintained by the fear of mechanization of man via transhuman forms of life, by the fear of manipulation and thought control via neuroimaging or by a critical attitude against biological reductionism. Our results suggests that the exchange of intuitive beliefs about neuroscience appeared as a good starting point to explore the scientific facts as well as the ethical and philosophical dimension of this new and complex socio-scientific issue.

PAPER 2

Everyday myths about genetic fingerprinting: Philosophizing with students in the experimental Lab

Arne Dittmer

Keywords: Decision-making, Everyday myths, Genetic fingerprinting, Intuitive judgments, Philosophizing with children

"Genetic Fingerprinting" is a popular topic for teachers when imparting the basics of genetics and genetic engineering to students. While the focus of students' laboratories for genetics traditionally lies on hands-on activities and conducting experiments, the paper presented an approach, which more focused on minds-on activities and strongly includes competencies such as argumentation, reflexivity and creative thinking in the laboratory work. Using the example of genetic fingerprinting and according to the social-intuitionist model of moral judgment (Haidt, 2001), this paper highlights the significance of intuitive beliefs concerning socio-scientific issues, such as genetic engineering. The social-intuitionist model of moral judgment allows a deeper understanding of decision-making processes, which are based on culturally embedded beliefs about a science-based world. In the project "Dialogues on Biotechnology: Ethics and Experiments in the Genetic Lab" we investigate beliefs concerning perspectives on mankind and the world, which operate mostly intuitively. Those ethically relevant and almost implicit beliefs are here called "everyday myths" (Gebhard, 1999). Embedded in contexts such as "Biotechnology in Science Fiction" and "Genes and Environment", pre-service biology teachers have the opportunity to discursively work out chances and risks of genetic engineering together with school students. On the one hand is it a project to qualify pre-service biology teachers for a more dialogue-oriented way of teaching. On the other hand we are interested in the beliefs of school students about genetic fingerprinting. In this paper reconstructed student's perceptions concerning genetic fingerprinting are being introduced. The data was gained in group discussions according to the "philosophizing with children" approach (Nevers, 2009) and analyzed by interpretations rules following the "grounded theory" methodology (Thomas & James 2006).

PAPER 3

Techno-moral-vignettes in socio-scientific issues-based education on synthetic biology

Marie-Christine Knippels, Alexandra Slegers and Arend Jan Waarlo

Keywords: Opinion-forming, Socio-scientific issues, Synthetic biology, Value development

Synthetic biology (Synbio) is a new high-profile area of research in biology that develops rapidly and entails both promises and perils. Future applications of Synbio will have an impact on society and our personal lives and it is important that students are able to form an opinion on Synbio-related socio-scientific issues (SSIs). Essential requirements for informed opinion-forming and decision-making in SSI-based education are that, next to scientific knowledge, self-knowledge and societal knowledge (i.e. being aware of your values, beliefs, and assumptions and those of others as well as knowledge about the motives and strategies of influential stakeholders) should inform the decision-making process (Waarlo, 2014). Moreover, Roeser (2006) suggests to start from emotions in discussing risky technologies, since emotions serve as warnings to make clear which values are at stake. A promising way of introducing Synbio-related SSIs in biology education are techno-moralvignettes, which are future scenarios in which possible applications, implications and moral dilemmas are being introduced in an imaginative and empathetic way. In this study we explore the classroom interaction around techno-moral-vignettes in terms of opening up personal frames and fostering dialogue, in two upper-secondary biology classes (n=17, 15 years old; n=25, 16 years old). Students were asked to read the vignette and to write down their initial thoughts and feelings, after which they clarified in pairs their initial reactions and questions. Next, a dialogue in small groups of three to four students was initiated to further explore and articulate their own values and beliefs and those of others. Classroom observations were made, students worksheets collected, small group discussions audiotaped, and semi-structured 10-minute interviews with the teacher and two students per class were conducted. Results indicated that the vignette evoked a diversity of initial emotions and feelings. Sharing and inquiring these initial thoughts in small groups of peers uncovered a wide range of values and beliefs, indicating that students' mental frameworks are activated and reflected on, which is an essential and promising first step in the decision-making process in SSI-based biology education.

PAPER 4

Towards an ethics of nature: A pedagogy of openness

Ralph Levinson and Shone Surendran

Keywords: Habitat, Pedagogy, Praxis, Inferential articulation, knowledgeability

Learning of science can often seem remote from the objects of study. This theoretical paper, using an example from an observed pre-service lesson as an illustration, proposes three preconditions for a pedagogy of science that incorporates an ethics of Nature. The first is drawn from a concept of realising ourselves as ethical subjects through an acceptance of our commitments to the Other, which applies both to the teacher's relationship to her students as well as to nature more generally. Secondly, the incorporation of the rational process of meaning-making in a normative context through inferential articulation: a commitment to giving and taking of reasons. The third is the 'knowledgeability of the teacher', in steering a course between teaching the underpinning knowledge on habitat ecology, the Levinasian concept of the Said (le Dit) and the opening of one's knowledge and experience to be ruptured by the Other: an openness to transformation. Such knowledgeability of the teacher opens up spaces for students to make meaning of their understanding of science to their ethical responsibilities and social justice.

PAPER 5

Does thoughtfulness need irritation? Case studies about decision-making in biology class

Britta Lübke and Ulrich Gebhard

Keywords: Bildung, Decision-making, Everyday myths, Genetic engineering, Thoughtfulness

This paper makes the assumption that the reflection of everyday myths initially creates irritation in the reflecting subjects. In consequence, this irritation can become incentive for further learning and serve as a trigger for educational processes.

The theoretical part refers to Ulrich Gebhard's (2007) concept of everyday myth as well as Kerstin Oschatz's (2011) empirical finding that the experience of irritation while reflecting everyday myths can be positively incorporated into teaching and learning contexts in the biology classroom. Firstly, an overview of the latest research on the area of everyday myths will be given. Secondly, the everyday myths will be linked to the worldview theory of Cobern. Furthermore, this paper refers to Hans-Christoph Koller's Theory of transformative Bildung (2012) which describes a crisis as an incentive for higher-learning-processes.

According to this understanding, the aim of biology classes – besides teaching subject matter – is to support a general thoughtfulness and the ability of self-reflection in order to enhance high quality decision-making.

The empirical part of this paper aims at describing and identifying irritation as a key factor for explicit reflection of everyday myths as well as thoughtfulness in general. Major emphasis will be put on the learners' decision-making processes about genetic engineering. Two biology classes of the eleventh grade were accompanied for two months. Different methods were used to approach moments of irritation and decision-making processes: classroom observation, analysing learners' documents, and semi-structured qualitative interviews. The data were analyzed by means of Grounded Theory.

The results indicate that some students are more experienced than others, while dealing with moments of irritation in thinking-processes. In this case, irritation does not end these processes, but instead of ending them, it leads to new questions and thoughts. In case of students, who are not used to deal with irritation, these moments usually end the thinkingprocess. The findings also show the important role of the teacher to promote decision-making and foster thoughtfulness.

Author Index and participants at the conference

In alphabetical order

Programme Index (page/s)	Abstract index (page/s)	Last name	First name	Affiliation	Country	E-mail
32	40	Abrie	Amelia	University of Pretoria	South Africa	mia.abrie@up.ac.za
23	41	Agadi	Dina-Dalia	Ben-Gurion University of the Negev	Israel	nedina16@gmail.com
38	42	Ageitos-Prego	Noa	Universidade de Santiago de Compostela	Spain	noa.ageitos@usc.es
33	43	Airey	Jeremy	University of York	United Kingdom	jeremy.airey@york.ac.uk
32	44	Aivelo	Tuomas	University of Helsinki	Finland	tuomas.aivelo@helsinki.fi
37	45	Ampatzidis	Georgios	University of Patras	Greece	ampatzidis@upatras.gr
26	46	Ariely	Moriah	Weizmann Institute of Science	Israel	moriah.ariely@weizmann.ac.il
28, 33	47, 104	Arnold	Julia	IPN Kiel	Germany	arnold@ipn.uni-kiel.de
25	48	Banner	Indira	University of Leeds	UK	i.banner@education.leeds.ac.uk
28	50	Basten	Melanie	Bielefeld University	Germany	melanie.basten@uni-bielefeld.de
26	51	Baytelman	Andreani	University of Cyprus	Cyprus	baytel@ucy.ac.cy
34	52	Beck	Christina	Technical University of Munich	Germany	christina.beck@tum.de
34	53	Beckmann	Valerie	Universität Osnabrück	Germany	valerie.beckmann@biologie.uni-osnabrueck.de
23, 27, 33	41, 54, 137	Ben-Zvi Assaraf	Oriit	Ben-Gurion University of the Negev	Israel	ntorit@bgu.ac.il
27, 29	169, 172	Berglund	Teresa	Karlstad University	Sweden	teresa.berglund@kau.se
29	175	Bergmann	Alexander	Universität Leipzig	Germany	alexander.bergmann@uni-leipzig.de
38	55	Berne	Birgitta	Lindåsskolan	Sweden	birgitta.berne@telia.com
		Berry	Drew	The Walter and Eliza Hall Institute	Australia	berry@wehi.edu.au
37	56	Betzitza	Ulrike	University of Education Weingarten	Germany	Betzitza@ph-weingarten.de
		Bichão	Helena	NTNU - Norwegian University of Science and Technology	Norway	Helena.Bichao@ntnu.no
25	58	Bissinger	Kerstin	University of Bayreuth	Germany	kerstin.bissinger@uni-bayreuth.de
30	59	Blank	Robert	University of Education Weingarten	Germany	robi-blank@web.de
31, 36	60	Boerwinkel	Dirk Jan	Utrecht University	the Netherlands	D.J.Boerwinkel@uu.nl
25, 27	94, 169	Boeve-de Pauw	Jelle	University of Antwerp	Belgium	jelle.boevedepauw@uantwerp.be

25, 27, 29, 37	58, 132, 167, 170, 171	Bogner	Franz X	University of Bayreuth	Germany	franz.bogner@uni-bayreuth.de
28	141	Bohlin	Gustaf	Linköping University	Sweden	gustav.bohlin@liu.se
32	62	Brandstetter	Miriam	University Duisburg Essen	Germany	miriam.brandstetter@uni-due.de
32	63	Brauer	Lea	Carl-von-Ossietzky Universität Oldenburg	Germany	lea.brauer@uni-oldenburg.de
24, 30	64, 65	Braund	Martin	Cape Peninsula University of Teachnology	South Africa	martin.braund@york.ac.uk
23	66	Bravo-Torija	Beatriz	University of Zaragoza	Spain	bbtorija@unizar.es
38	67	Brocos	Pablo	Universidade de Santiago de Compostela	Spain	pablo.brocos@usc.es
32	68	Brucker-mann	Till	University of Cologne	Germany	bruckert@uni-koeln.de
		Brugurie	Catherine	University of Lyon/UCL	France	catherine.bruguiere@univ-lyon1.fr
25	69	Buessing	Alexander	University Osnabrueck	Germany	alexander.buessing@biologie.uni-osnabrueck.de
25	70	Bursjöö	Ingela	City of Gothenburg	Sverige	ingela.bursjoo@centrum.goteborg.se
26	71	Byrne	Jenny	Southampton University	United Kingdom	j.byrne@soton.ac.uk
24, 28	73, 128	Chang Rundgren	Shu-Nu	Stockholm University	Sweden	shu-nu.chang-rundgren@edu.su.se
33, 34	110	Christenson	Nina	Karlstad University	Sweden	nina.christenson@kau.se
23	163	Christodou-lou	Andri	University of Southampton	United Kingdom	a.christodoulou@soton.ac.uk
36, 38	74	Clément	Pierre	University Aix-Marseille	France	clement.grave@free.fr
26	75	Cohen	Hagit	Bar-ilan	Israel	hagitc10@gmail.com
33	76	Dannemann	Sarah	Leibniz Universität	Germany	dannemann@idn.uni-hannover.de
36, 37	77	Dempster	Edith	University of Kwazulu Natal	South Africa	dempstere@ukzn.ac.za
29	176	Dittmer	Arne	University of Regensburg	Germany	arne.dittmer@ur.de
31	79	Eckes	Alexander	Bielefeld University	Germany	alexander.eckes@uni-bielefeld.de
		Edfors	Inger	Linnaeus University	Sweden	Inger.edfors@lnu.se
34, 36	13, 112	El-Hani	Charbel	Federal University of Bahia	Brazil	charbel.elhani@gmail.com
23, 37	45, 80	Ergazaki	Marida	University of Patras	Greece	ergazaki@upatras.gr
24	81	Erichsen	Anne	University of Kassel	Germany	anne.erichsen@uni-kassel.de
31	78	Ewig	Michael	Universität Vechta	Germany	michael.ewig@uni-vechta.de
		Fernández Monteira	Sabela	Universidade de Santiago de Compostela	Spain	sabela.fernandez.monteira@usc.es
28, 34	72, 83, 141	Fiedler	Daniela	Leibniz Institute for Science and Mathematics Education (IPN)	Germany	fiedler@ipn.uni-kiel.de
30	84	Flash Gvili	Inbal	Weizmann Institute of Science	Israel	inbalfg@weizmann.ac.il

26	85	Flodin	Veronica	Stockholm University	Sweden	veronica.flodin@mnd.su.se
32	62	Florian	Christine	University of Duisburg-Essen	Germany	christine.florian@uni-due.de
37	86	Förtsch	Christian	LMU München	Germany	christian.foertsch@bio.lmu.de
25	95	Frieß	Sabrina	Pädagogische Hochschule Heidelberg	Germany	SabrinaFriess@gmx.net
33	43	Gale	Francesca	Wellcome Trust Sanger Institute	England	francesca.gale@wellcomegenome-campus.org
33	87	Ge	Yun-Ping	National Changhua University of Education	Taiwan, Republic of China	yunpingge@yahoo.com.tw
24	88	Gerhard	Marc	Goethe-University	Germany	gerhard@bio.uni-frankfurt.de
22, 27, 29, 35, 36, 38	150, 169, 172, 173	Gericke	Niklas	Karlstad University	Sweden	niklas.gericke@kau.se
23	66	Gil Quílez	Maria José	Universidad de Zaragoza	Spain	quilez@unizar.es
22	160	Glackin	Melissa	King's College London	United Kingdom	melissa.glackin@kcl.ac.uk
28	141	Göransson	Andreas	Linköping University	Sweden	andreas.c.goransson@liu.se
23, 33, 38	163	Grace	Marcus	University of Southampton	United Kingdom	mmg1@soton.ac.uk
30	90, 145	Gresch	Helge	University of Münster	Germany	helgegresch@uni-muenster.de
31	113, 144	Groß	Jorge	University of Bamberg	Germany	jorge.gross@uni-bamberg.de
34	91	Großschedl	Jörg	University of Cologne	Germany	j.grossschedl@uni-koeln.de
30	97, 102, 145	Hammann	Carl Marcus	Münster University	Germany	hammann.m@uni-muenster.de
28, 34	72, 83, 91, 141,	Harms	Ute	IPN - Leibniz Institute for Science and Mathematics Education	Germany	harms@ipn.uni-kiel.de
22	160	Harrison	Chris	King's College London	United Kingdom	Christine.Harrison@kcl.ac.uk
24	92	Hendrichs	Marti	Vienna International School	Austria	mahendrichs@gmail.com
35	93	Holmqvist	Mona	University of Gothenburg and Malmö	Sweden	mona.holmqvist@mah.se
24	61	Hughes	Carys	University of Southampton	United Kingdom	c.f.hughes@soton.ac.uk
25	95	Jäkel	Lissy	University of Education Heidelberg	Germany	jaekel@ph-heidelberg.de
38	67	Jimenez Aleixandre	Maria Pilar	Universidade de Santiago de Compostela	Spain	marilarj.aleixandre@usc.es
25, 27	96, 168	Johnson	Bruce	University of Arizona	USA	brucej@email.arizona.edu
30	97	Jördens	Janina	Zentrum für Didaktik der Biologie / WWU Münster	Germany	joerdens@uni-muenster.de
25, 35	99, 101	Kaasinen	Arja	University of Helsinki	Finland	arja.kaasinen@helsinki.fi
24	100	Kaiser	Irina	University of Kassel	Germany	i.kaiser@uni-kassel.de

25	95	Kiehne	Ulrike	University of Education Heidelberg	Germany	kiehne@ph-heidelberg.de
		Klu	Selom	University of KwaZulu-Natal	South Africa	wkselom@hotmail.com
23, 29	164, 177	Knippels	Marie-Christine	Freudenthal Institute for Science and Mathematics Education/ Utrecht University	The Netherlands	m.c.p.j.knippels@uu.nl
32	119	Korfiatis	Konstantinos	University of Cyprus	Cyprus	korfiati@ucy.ac.cy
26	103	Krell	Moritz	Freie Universität Berlin	Germany	moritz.krell@fu-berlin.de
28, 33	47, 104	Kremer	Kerstin	IPN - Leibniz Institute for Science and Mathematics Education	Germany	kremer@ipn.uni-kiel.de
		Kvello	Pål	NTNU	Norway	pal.kvello@ntnu.no
35	105	Laius	Anne	University of Tartu	Estonia	anne.laius@ut.ee
33	106	Lampert	Peter	University of Vienna	Austria	peter.lampert@univie.ac.at
35	107	Lazaridou	Charalambia	University of Cyprus	Cyprus	pamlaz1@gmail.com
35, 36	108	Lee	Yeung Chung	The Education University of Hong Kong	China	yclee@ied.edu.hk
23, 27, 29	116, 161, 162, 178	Levinson	Ralph	UCL-IOE	United Kingdom	r.levinson@ucl.ac.uk
		Lidesten	Brittmarie	Uppsala University	Sverige	britt-marie.lidesten@bioresurs.uu.se
31	109	Lombard	François	Geneva University - TECFA/IUFE	Switzerland	francois.lombard@unige.ch
29	179	Lübke	Britta	Universität Hamburg	Germany	britta.luebke@uni-hamburg.de
27, 32	122, 131	Lude	Armin	Ludwigsburg University of Education	Germany	lude@ph-ludwigsburg.de
34	110	Lundström	Mats	Malmö University	Sweden	mats.lundstrom@mah.se
		Mambrey	Sophia	Universität Duisburg-Essen	Germany	sophia.mambrey@uni-due.de
		Mattsson	Jan-Eric	Södertörn University	Sweden	jan-eric.mattsson@sh.se
36		McComas	Bill	University of Arkansas	USA	mccomas@uark.edu
34, 35	111	Mc Ewen	Birgitta	Karlstad University	Sweden	birgitta.mcewen@kau.se
31	113	Messig	Denis	University of Bamberg	Germany	denis.messig@uni-bamberg.de
37	114	Mifsud	Edward	University of Malta	Malta	edwmifs@gmail.com
24, 34	115, 152	Minkley	Nina	Ruhr-Universität Bochum	Germany	Nina.Minkley@rub.de
33	43	Moore	Alistair	University of York Science Education Group	United Kingdom	alistair.moore@york.ac.uk
23	165	Nedelec	Lucas	University of Montpellier	France	lucas.nedelec@univ-montp2.fr
22	12	Nehm	Ross	Stony Brook University	USA	ross.nehm@stonybrook.edu
30, 36	117	Olander	Clas	Malmö University	Sweden	clas.olander@mah.se
27, 29	169, 173	Olsson	Daniel	Karlstad University	Sweden	daniolss@kau.se
23	118	Pau	Isabel	Universitat Autònoma de Barcelona	Spain	isabelpau4@gmail.com

34	120	Pinxten	Rianne	University of Antwerp	Belgium	annie.pinxten@uantwerpen.be
34	121	Pollin	Susan	Universität Rostock	Germany	susan.pollin@uni-rostock.de
24, 38	42, 82	Puig	Blanca	University of Santiago de Compostela	Spain	blanca.puig@usc.es
32	122	Raith	Andreas	Ludwigsburg University of Education	Germany	raith@ph-ludwigsburg.de
24, 27, 36	123, 137	Reiss	Michael	UCL Institute of Education	United Kingdom	m.reiss@ucl.ac.uk
25, 35	124, 140	Rest	Miriam	Ruhr University Bochum	Germany	miriam.rest@rub.de
34	121	Retzlaff-Fürst	Carolin	Universität of Rostock	Germany	Carolin.retzlaff-fuerst@uni-rostock.de
26	125	Roberts	Ros	Durham University	United Kingdom	Rosalyn.Roberts@durham.ac.uk
35	126	Rodenhauser	Annika	Universität Vechta	Germany	annika.rodenhauser@uni-vechta.de
31	127	Roesler	Mariella	University of Kassel	Germany	mariella.roesler@uni-kassel.de
24, 28, 35	73, 128, 153	Rundgren	Carl-Johan	Stockholm University	Sweden	carl-johan.rundgren@mnd.su.se
25, 34	129, 130	Rybska	Eliza	Adam Mickiewicz University	Poland	elizaryb@gmail.com
27	131	Schaal	Sonja	Ludwigsburg University of Education	Germany	schaal02@ph-ludwigsburg.de
27	131, 135	Schaal	Steffen	Ludwigsburg University of Education	Germany	schaal@ph-ludwigsburg.de
37	132	Scharfenberg	Franz-Josef	University of Bayreuth	Germany	franz-josef.scharfenberg@uni-bayreuth.de
22	157	Scheersoi	Annette	University of Bonn	Germany	a.scheersoi@uni-bonn.de
24, 25, 33	92, 106, 133	Scheuch	Martin	University of Vienna, AECC-Biology	Austria	martin.scheuch@univie.ac.at
37	134	Schiffl	Iris	University of Salzburg	Austria	iris.schiffl@sbg.ac.at
32, 34	68, 89	Schlueter	Kirsten	University of Cologne	Germany	kirsten.schlueter@uni-koeln.de
33	57	Schmiemann	Philipp	University of Duisburg-Essen	Germany	philipp.schmiemann@uni-due.de
27	135	Schneider	Joachim	University of Education Ludwigsburg	Germany	schneidejoach@stud.ph-ludwigsburg.de
29	171	Schönfelder	Mona	University of Bayreuth	Germany	mona.schoenfelder@uni-bayreuth.de
38	136	Schwanewedel	Julia	Leibniz-institute for Science and Mathematics Education	Germany	schwanewedel@ipn.uni-kiel.de
27	137	Sedawi	Wisam	Ben Gurion university	Israel	wisams@post.bgu.ac.il
23, 28	138, 165	Simonneaux	Laurence	ENFA	France	sylvie.fernandes@educagri.fr
23, 28	138, 165	Simonneaux	Jean	ENFA	France	sylvie.fernandes@educagri.fr
32	139	Sjöblom	Pia	Åbo Akademi University	Finland	psjoblom@abo.fi
28	141	Stenlund	Jörgen	Örebro University	Sweden	jorgen.stenlund@oru.se
34	110	Stolpe	Karin	Linköping University	Sweden	karin.stolpe@liu.se
		Svensson	Brita	Uppsala university	Sweden	brita.svensson@ebc.uu.se

22	159	Tal	Tali	Technion – Israel Institute of Technology	Israel	rtal@technion.ac.il
30	59	Tardent Kuster	Josiane	University of teacher education	Switzerland	josiane.tardent@phzh.ch
29	170	Thorn	Christine	University Bayreuth	Germany	Christine.Thorn@uni-bayreuth.de
23		Thörne	Karin	Karlstad University	Sweden	karithor@kau.se
28	141	Tibell	Lena	Linköping University	Sweden	lena.tibell@liu.se
24	142	Tinapp	Sonja	Universität Leipzig	Germany	sonja.tinapp@uni-leipzig.de
28	143	Torkar	Gregor	University of Ljubljana	Slovenia	GREGOR.TORKAR@PEF.UNI-LJ.SI
31	144	Tramowsky	Nadine	University of Bamberg	Germany	nadine.tramowsky@uni-bamberg.de
30	145	Trommler	Friederike	University of Münster	Germany	trommler@uni-muenster.de
24	146	Tsaushu	Masha	Technion – Israel Institute of Technology	Israel	tmasha@gmail.com
22, 33, 37	49, 114, 156, 157	Tunnicliffe	Sue Dale	UCL IOE	United Kingdom	lady.tunnicliffe@mac.com
31, 32, 35	44, 101, 147	Uitto	Anna	University of Helsinki	Finland	anna.uitto@helsinki.fi
31	79	Urhahne	Detlef	University of Passau	Germany	detlef.urhahne@uni-passau.de
24	148	Valdmann	Ana	University of Tartu	Estonia	anavaldmann@gmail.com
26	149	la Velle	Linda	University of Plymouth	United Kingdom	linda.lavelle@plymouth.ac.uk
23	164	Verhoeff	Roald	Utrecht University	The Netherlands	r.p.verhoeff@uu.nl
35	150	Wahlberg	Sara	Karlstad University	Sweden	sarawahl@kau.se
25		Walan	Susanne	Karlstad University	Sweden	susawala@kau.se
32	151	Warnstedt	Julia	Carl-von-Ossietzky University	Germany	julia.aline.warnstedt@uni-oldenburg.de
30, 37	56, 59	Weitzel	Holger	University of Education Weingarten	Germany	weitzel@ph-weingarten.de
26	154	Wiegelmann	Judith	University of Leipzig	Germany	judith.wiegelmann@uni-leipzig.de
28, 31	50, 79	Wilde	Matthias	University Bielefeld	Germany	matthias.wilde@uni-bielefeld.de
22	158	Winterbottom	Mark	University of Cambridge	United Kingdom	mw244@cam.ac.uk
26, 30, 36	46, 84	Yarden	Anat	The Weizmann Institute of Science	Israel	anat.yarden@weizmann.ac.il
24, 26, 28, 29	98, 142, 154, 174, 175	Zabel	Jörg	Universität Leipzig	Germany	joerg.zabel@uni-leipzig.de
26	75	Zion	Michal	Bar Ilan University	Israel	michal.zion@biu.ac.il

EXCURSIONS AT WEDNESDAY AFTERNOON

ALSTER VALLEY AND GUSTAF FRÖDING'S MEMORIAL CENTRE
Gustaf Fröding's memorial centre is located in an 18th century manor house, 8 km east of Karlstad, with a view of Lake Vänern. We will walk the nearby trails, experience the beautiful landscape, and visit the former home of the famous poet Gustav Fröding. Swedish 'fika' will be served, meaning traditional Swedish buns and biscuits with coffee or tea. It is important that you wear steady shoes and clothes suitable for the weather. The coach leaves from Hotel Scandic City at 2 pm and from Hotel Scandic Winn at 2.10 pm. The hike starts at 2.30 pm and ends around 5 .00 pm. After the refreshments ('fika'), there will be a guided tour of the Fröding exhibition at 4.00 pm. The guides for this trip are Karin Thörne and Stina Eriksson. Karin Thörne is a member of the organizing committee.

BOAT TRIP ON LAKE VÄNERN
This boat trip takes you into the archipelago of the third largest lake in Europe, Lake Vänern, on board the steamship 'Polstjärnan'[the North Star], built in Göteborg in 1928. The destination is the island Långholmen, where Swedish 'fika' is served, and where you can take a walk on a path around the island. The stop at Långholmen is planned for one hour. Swedish 'fika' means typical Swedish buns and biscuits with coffee or tea. During the boat trip it is possible to visit the captain's bridge and the engine room to see and listen to the old steam engine. It is important that you wear steady shoes and clothes suitable for the weather. The boat trip starts at 'Inre hamnen' [the inner harbour], centrally situated in Karlstad (see marking on the hand-out map). We expect you to find the spot without problem. The trip starts at 2 pm and we will be back at about 6 pm. The guide for this trip is Birgitta Mc Ewen, a member of the organization committee.

KAYAK TOUR AT THE KARLSTAD WATERFRONT

We will launch kayaks and paddle in Lake Vänern and the River Klarälven under the instruction and guidance of some of the world's top adventure racers, who will make sure that we will be safe and sound in this extraordinary experience. Swedish 'fika', which means traditional Swedish buns and biscuits with coffee or tea, is included. The coach leaves at 2 pm (Scandic Winn) and at 2.10 pm (Scandic City), respectively. You need to wear outdoor clothes and steady shoes for the kayak tour, so be dressed accordingly when the coach arrives at the hotels. The activity starts at 2.30 pm and will finish at about 6.00 pm. Please note that there will be a short walk (10-15 minutes) from Mariebergsskogen (city park) to the central city after the kayak tour. The guide for the kayak tour is Nina Christensen, one of the members of the organizating committee.

THE NOBEL MUSEUM IN KARLSKOGA

The Nobel Museum in Karlskoga, the Björkborn Manor, features Alfred Nobel, the inventor, industrialist, donor and founder of the Nobel Prize awards. This is where Alfred Nobel lived during the final summers of his life. He built a laboratory near the Manor, in which he continued his research in areas such as propellants and how to create artificial rubber. This laboratory has survived and now houses an exhibition of his work and related industries. In the Manor itself, visitors can learn more about Alfred as a person. The museum opened with summer exhibitions on Alfred Nobel in Karlskoga in the 1970s. In 1982 the Alfred Nobel Björkborn Foundation was instituted, operating under the name of The Nobel Museum in Karlskoga. Swedish 'fika' will be served, which means traditional Swedish buns and biscuits with coffee or tea. The coach leaves from the KCCC at 2 pm. The journey starts at 5 pm, and should be back back at the hotels Scandic Winn and Scandic City at about 6 pm. The guide for the trip is Susanne Walan, a member of the organizing committee.

INTERNET ACCESS

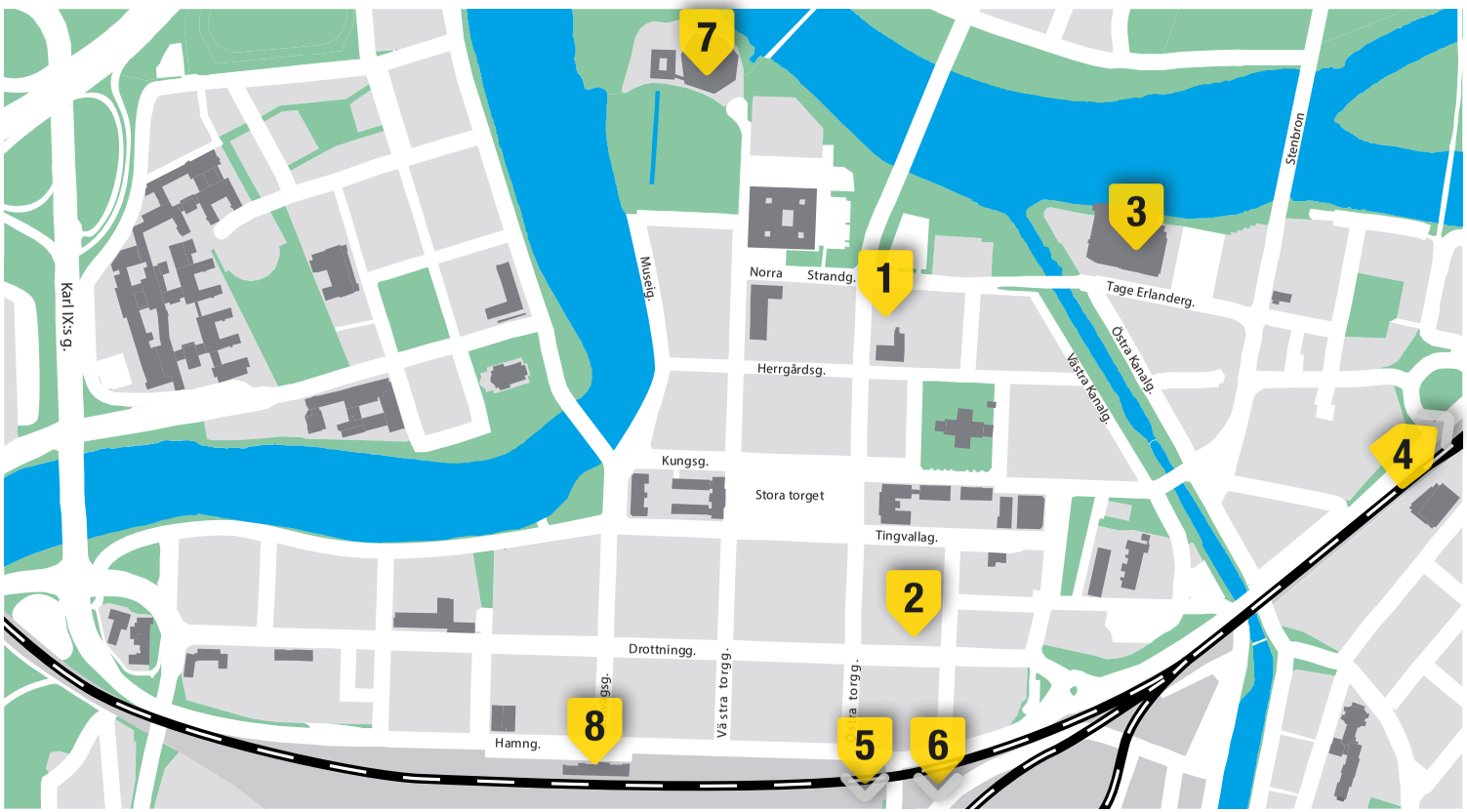
During the conference you will have free access to internet.
Eduroam is avaiable at both venues: Karlstad University and Karlstad Congress Culture Centre.

At Karlstad University you can also get a personal guest account. Printed paper letters with information of the personal guest account will be provided in house 12 at Karlstad University.

At Karlstad Congress Culture Centre there is also an additional free net called: Karlstad CCC Guest. There is no need for login or password to get access to the network.

LOCAL TRANSPORTATION

Your name badge works as a bus ticket on the city buses (public transport bus).
Line No 1 is a direct line between the University and City Centre that takes about 10 minutes (http://karlstad.se/Karlstadsbuss/Tidtabellerkartor/). The busses departure approximately every 10th minute from the city square (Swedish: “Stora torget”) that is situated within short walking distance from the pre-boked hotels (a couple of minutes). The busses also stop right outside the conference hotel Scandic Karlstad City.



KARLSTAD CITY

ACCOMMODATION:

1 SCANDIC WINN
NORRA STRANDGATAN 9-11

2 SCANDIC CITY
DROTTNINGGATAN 4

VENUE:

3 KCCC

4 KARLSTAD UNIVERSITY

SOCIAL PROGRAM:

5 KAYAKING,
KARLSTAD KANOTKLUBB

6 BOAT TRIP WITH
POLSTJÄRNAN DEPARTS
FROM ”INRE HAMN”

RECEPTION:

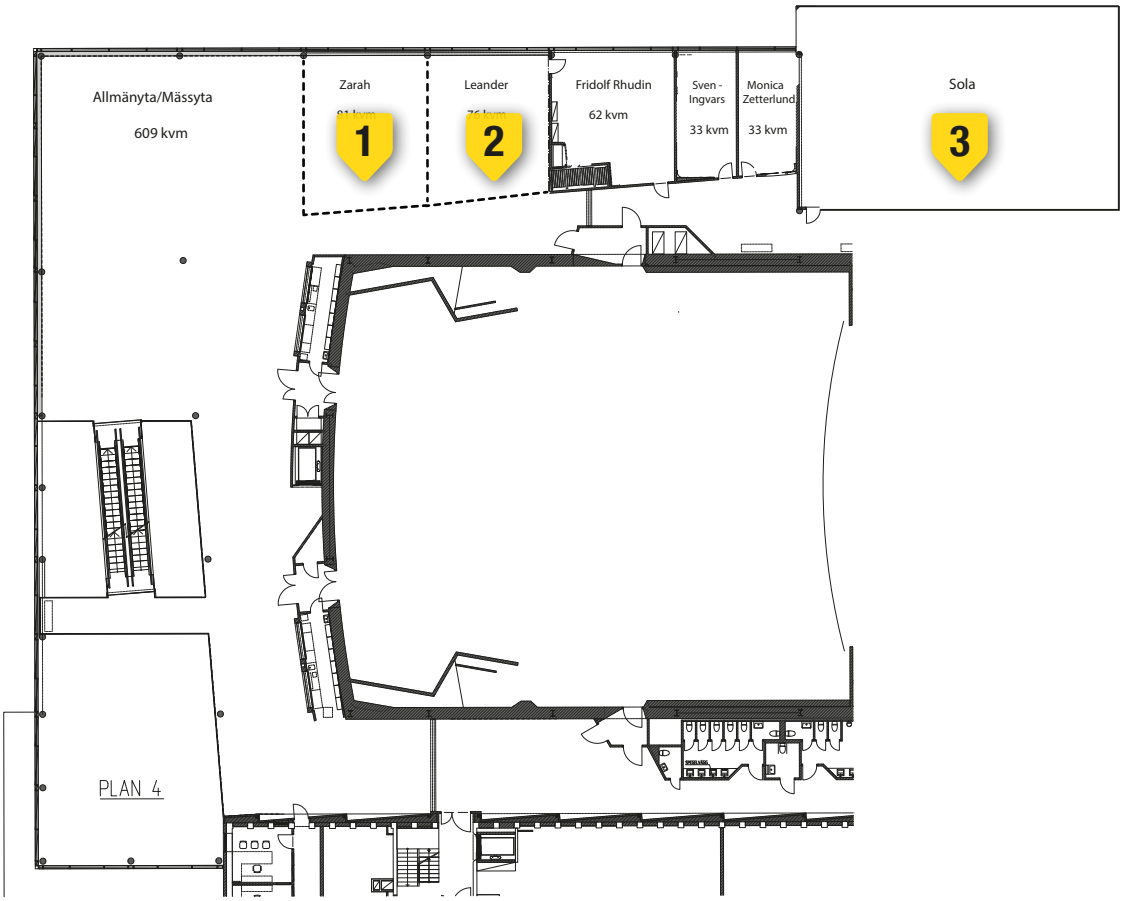
7 VÄRMLAND MUSEUM

DINNER:

3 KCCC

TRAVEL:

8 RAILWAY STATION

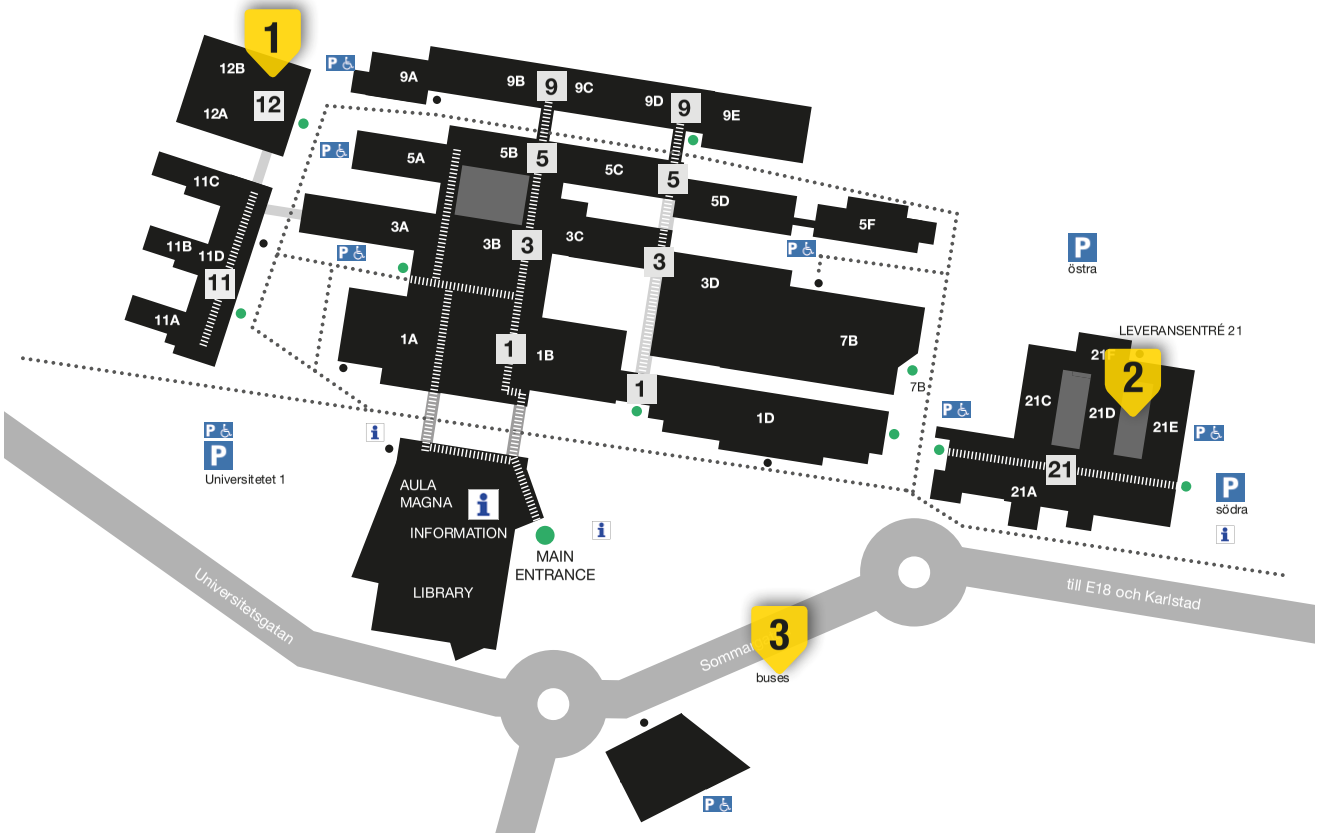


KARLSTAD CCC

1 ZARAH

2 LEANDER

3 SOLA



KARLSTAD UNIVERSITY

1 VENUE

2 LUNCH WILL BE SERVED HERE

3 BUSSTOP

eridob
European researchers
in didactics Of biology

SMEER, CENTRE OF
SCIENCE, MATHEMATICS
AND ENGINEERING
EDUCATION RESEARCH

KAU.SE/ERIDOB-2016