CONFERENCE PROGRAMME

CONFERENCE PROGRAMME

ERIDOB

CONFERENCE 2008

EERIDOB 2008

Academic Committee

Dr Marcus Hammann (Secretary)
Westfälische Wilhelms-Universität, Münster, Germany
Dr Graça Carvalho
University of Minho, Braga, Portugal
Dr Mats Hagman
Göteborg University, Sweden
Dr Michael Reiss
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Dr Patricia Schneeberger
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Dr Anat Yarden
Weizmann Institute of Science, Rehovot, Israel
Dr Vasso Zogza
University of Patras, Greece

Local Organizing Committee

Dr Kerst Boersma
Dr Arend Jan Waarlo
Atie Wigmans
Ragna Senf

Contents

Foreword

The ERIDOB Academic committee has invited researchers in Biology Didactics to take part in the "VIIth Conference of European Researchers in Didactics of Biology". The Conference is held at Woudschoten Conference Center, Zeist, from September 16th to 20th 2008.

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

- Student conceptions and conceptual change
- Student interest and motivation
- Student values, attitudes and decision-making
- Student reasoning, scientific thinking and argumentation
- Teaching: teaching strategies, teaching environments and educational technology
- Environmental education and Biology education
- Health education and Biology education
- Social, cultural and gender issues in Biology education
- Practical work and field work in Biology education
- Research methods and theoretical issues concerning research in Biology education.

Welcome to VIIth Conference of ERIDOB in the Netherlands

European Researchers in Didactics of Biology have met every two years since 1996.
The first conference took place in Kiel and it was followed by Göteborg, Santiago de Compostela, Toulouse, Patras and London. In sight of the copper jubilee of ERIDOB the organisers of the 2008 Conference in the Netherlands thought it would be wise to take stock of what has been reached in the past years and how we should proceed as a research community. It's high time for critical reflection and for taking a meta-perspective, all the more because there were few contributions in the strand 'Research methods and theoretical issues concerning research in biology education' over the years. So the conference theme is *The Nature of Research in Biological Education: Old and New Perspectives on Theoretical and Methodological Issues*. One of the two symposia in the conference will pay attention to the conference theme, but we should keep it in mind as well when other papers and posters are presented and discussed.
In trying to characterize the nature of our research activities and to position research in didactics of biology in the field of educational research, we should also regard implications for educational practice.

The range of research topics addressed in the abstracts in this booklet offer plenty of opportunities for inspiration and collaborative learning.

We would like to acknowledge the substantial work of the Academic Committee for double reviewing well over 100 submissions and of Marcus Hammann for compiling the programme on behalf of the Academic Committee.

The 7th ERIDOB conference is hosted by the Freudenthal Institute for Science and Mathematics Education at Utrecht University. Because the conference coincides with the start of the academic year, we had to move to the conference centre Woudschoten in Zeist. This offers ample opportunity for being together and in-depth discussions inside and outside the building. For those who want to get a taste of Utrecht University, one of the options of the social program is a tour of the university campus at the East side of the city with a focus on its modern architecture. The other options include different aspects of the inner city of Utrecht.

We wish you a fruitful and pleasant stay in the Netherlands.

The local organising committee

Arend Jan Waarlo, Kerst Boersma, Atie Wigmans & Ragna Senf

Programme at a glance

Date	Morning	Afternoon	Evening
Tues 16 Sept 08		14:00 onwards Registration 14:00 •17:00 Educational Fair 17:00 •18.15 Welcome Reception	18:30 Dinner and Keynote Address by Prof. Dr. Hub Zwart
Wed 17 Sept 08	08:30 • 10:30 Paper Session I 10:30 • 11:00 Coffee Break 11:00 • 13:00 Paper Session II	14:00 • 15:30 Paper Session III 15:30 • 16:00 Coffee Break 16:00 • 18:00 Paper Session IV	20:00-21:00 Poster Session I
Thurs 18 Sept 08	09:00 • 11:00 Symposium I 11:00 • 11:30 Coffee Break 11:30 • 13:00 Symposium II	13:45 • 18:30 Social Programma 18:45 • 19:15 Bus transfer from Utrecht to Woudschoten	20:00 Conference Dinner 22:00 After Dinner Party
Fri 19 Sept 08	09:00 • 11:00 Paper Session V 11:00 • 11:30 Coffee Break 11:30 • 13:00 Paper Session VI	14:00 • 15:00 Poster Session II 15:00 • 16:00 Poster Session III 16:00 • 16:30 Coffee Break 16:30 • 18:30 Paper Session VII	18.45 • 20.15 Dinner 20:30 • 22:00 ERIDOB Business Meeting
Sat 20 Sept 08	08:30 • 10:30 Paper Session VIII 10:30 • 11:00 Coffee Break 11:00 • 13: 30 Paper Session IX	14:30 End of Conference	

Detailed Program

Tuesday, 16 September 2008

14:00 onwards Registration – Lobby

14:00 • 17:00 Educational Fair

17:00 • 18.15 Welcome Reception

18:30 Dinner and Keynote Address by Prof. Dr. Hub Zwart

Prof. Dr. Hub Zwart (Geleen, 1960) studied philosophy and psychology at the Radboud University Nijmegen. He then worked as a research associate at the Institute of Bioethics in Maastricht from 1988 until 1992, defended his thesis in 1993 (cum laude) and was subsequently appointed as research director at the Center for Ethics at the Radboud University. Right now, he is the scientific director of the Centre for Society and Genomics. He is also professor of philosophy at the Faculty of Science at the Radboud University and chair of the department for Philosophy and Science Studies. During recent years, his focus was on the philosophical, historical and societal aspects of scientific publishing, animal research, the life sciences,

landscape philosophy and science and literature. He was European director of the international student exchange programme Coastal Inquiries. At present, he is interested in genomics as well as science and imagination.

Hub Zwart's lecture will present contemporary life sciences in its societal context and will indicate possible consequences for future biology education. In his inspiring talk, Prof. Hub Zwart will offer conference participants new perspectives.

Wednesday, 17 September 2008

8:30 • 10:30 **Paper Session I**

Strand 4: *Student Reasoning, Scientific Thinking and Argumentation*

Chair: Mats Hagman

8:30 **Marida Ergazaki, Konstantina Saltapida & Vassiliki Zogza**

Young children's reasoning about germs and their ontological status

9:00 **Blanca Puig & María Pilar Jiménez-Aleixandre**

What do 9th grade students consider as evidence for or against claims about genetic differences in intelligence between black and white "races"?

9:30 **Miriam Ossevoort, Edwin van Lacum & Martin Goedhart**

Recognition of scientific arguments in primary literature by bachelor Biology students

10:00 **Kai Niebert & Harald Gropengießer**

Students' and scientists' conceptions of global warming

10:30 • 11:00 Coffee Break

11:00 • 13:00 **Paper Session II**

Strand 9: *Practical Work and Field Work in Biology Education*

Chair: Marcus Hammann

11:00 **Kerstin Kremer, Detlef Urhahne & Jürgen Mayer**

Relationship between students' inquiry skills and beliefs on the nature of science

11:30 Herman H. Schalk, Joop A. van der Schee & Kerst Th. Boersma

The use of concepts of evidence by students in biology investigations: development research in pre-university education

12:00 **Irit Sadeh & Michal Zion**

High school students doing an inquiry project: How do they like it, open or guided?

12:30 **Andrea Möller**

Classifying levels of students' inquiry competence in lower secondary Biology education

13:00 • 14:00 Lunch

14:00 • 15:30 **Paper Session III**

Strand 3: *Student Values, Attitudes and Decision-making*

Chair: Patricia Schneeberger

14:00 **Jérémy Castéra, François Munoz & Pierre Clément**

A gender effect related to teachers' conceptions on biological gender differences: A survey in 12 countries

14:30 **Paul van der Zande, Mieke Brekelmans, Jan Vermunt & Arend Jan Waarlo**
Handling moral dilemmas in context based genetics education: Towards a contemporary and balanced pedagogical approach

15:00 **Marcus Grace, Jenny Byrne, Pam Hanley, Sabina Eggert & Susanne Bögeholz**
Developing science teachers' ability to manage and assess decision-making discussions about biological conservation issues

15:30 • 16:00 Coffee Break

16:00 • 18:00 **Paper Session IV**

Strand 9: *Practical Work and Field Work in Biology Education*

Chair: Graça S. Carvalho

16:00 **Christiane Grube, Stefan Hartmann & Jürgen Mayer**
Modelling inquiry competence and its promotion in a standard based science teaching project

16:30 **Gwenda-Ella Chapel, Patricia Marzin & Muriel Ney**
Do students' ideas about the antigen-antibody reaction change when they are gathered to design an experimental procedure?

17:00 **Janina Jördens & Marcus Hammann**
How do students construct phylogenetic trees?

17:30 **Raquel Gaspar & Susana Nogueira**
Improving awareness and knowledge of preschooler's ideas about birds and their songs

18:30 • 20:00 Dinner

20:00 • 21:00 **Poster Session I**

Strand 5: *Teaching: Teaching Strategies, Teaching Environments and Educational Technology*

Chair: Anat Yarden

Cornelia Sommer
Modelling elementary students' system competency – building models for understanding systems

Ulrike Trier, Annette Upmeier zu Belzen & Dirk Krüger
Students` conceptions of models and modelling and the impact on model competence

Anna Sardà Jorge, Conxita Márquez Bargalló & Anna Marbà Tallada
Understanding the human nervous system through a scale model activity

Jörg Großschedl
Fostering students' understanding of cell biology by using "Concept Mapping" as a metacognitive tool

Lynn du Plessis and Trevor R. Anderson

A teaching and learning strategy and guidelines for the effective use of arrow symbolism in biology diagrams

Anita Wallin

A student's struggling pathway to scientific reasoning about evolution

Saïda Aroua, Maryline Coquidè & Salem Abbes

Treatment of a finalistic obstacle related to biological evolution: study of a teaching case in Tunisia

Jörg Zabel & Harald Gropengiesser

Understanding evolution theory: what can narrative contribute, and is there a "narrative mode of thought"?

Marc Eckhardt, Detlef Urhahne, Olaf Conrad & Ute Harms

Instructional support for learning with computer simulations about the "ecosystem water"

Sara Klein and Michal Zion

Characterization of the comprehension of the biological core concept "Homeostasis", learned explicitly with computerized tools

Stefanie Wüsten, Stephan Schmelzing, Angela Sandmann & Birgit Neuhaus

Quality of instruction in biology

Stephan Schmelzing, Stefanie Wüsten, Angela Sandmann & Birgit Neuhaus

Teachers' pedagogical content knowledge as an influence on quality of instruction in biology lessons

Rute Monteiro, José Carrillo and Santiago Aguaded

Teacher scripts in biology

Fred Janssen & Els de Hullu

A domain-specific planning model for biology teachers

Milena Bandiera

Linking literacy to science education

Anna Marbà Tallada & Conxita Márquez Bargalló

Why do students choose to study Biology?

Thursday, 18 September 2008

9:00 – 11:00 **Symposium I**

Symposium 1: *Hands-on Activities in Biology Education*

Chair: Dirk Jan Boerwinkel

9:00 **Sabine Gerstner & Franz X. Bogner**

Water – basis of life: hands-on learning at working stations

9:20 **Christine S. Geier & Franz X. Bogner**

A learning setting influence on cognitive achievement and intrinsic motivation in anti-smoking education

9:40	**Franz-Josef Scharfenberg & Franz X. Bogner**
	Instructional change of cognitive load in an out-of-laboratory:
	Effects on cognitive achievement and students activities during experimentation
10:00	**Anat Yarden & Michal Stolarsky-Ben Nun**
	Characterization of high-school students' comprehension of molecular genetics
	while practicing hands-on experiments in Teacher-Led Outreach-Laboratories
10.20	*In-depth discussion*
11:00 – 11:30	Coffee Break
11:30 – 13:00	**Symposium II**
	Symposium 2: *Theoretical and Methodological Issues of Research in Biology Education*
	Chair: Michiel van Eijck
11:30	**Roman Asshoff & Marcus Hammann**
	Content analysis of the ERIDOB proceedings and its comparison to an international Science education journal
11:50	**Kerst Th. Boersma & Arend Jan Waarlo**
	On the theoretical in- and output of 'design research' in Biology education
12:10	**Jenny Lewis**
	Science education and Biology education: to what extent are theories in Science education generalisable across disciplines?
12:30	In-depth discussion
13:00 • 13:30	Lunch
13.45 • 18.30	**Social Programme**
	Conference participants who signed up for an excursion can join the social programme. The excursions are from 13.45 • 17.00 hrs. They are followed by drinks at the Botanical Garden of the Utrecht University Museum from 17.00 – 18.30. An extra tour through the botanical gardens is organised. If you would like to join this tour, please contact the organisation committee of the ERIDOB conference.
18.45 • 19.15	Bus Transfer from Utrecht to Woudschoten
20.00:	Conference Dinner
22.00:	After Dinner Party

	Friday, 19 September 2008
9:00 • 11:00	**Paper Session V**
	Strand 8: *Social, Cultural and Gender Issues in Biology Education*
	Chair: Marcus Hammann
9:00	**Michiel van Eijck & Wolff-Michael Roth**
	Representations of scientists in biology textbooks
	Strand 5: *Teaching: Teaching Strategies, Teaching Environments and Educational Technology*
9:30	**Carolin Retzlaff-Fürst**

Stingers in pupils' decision - Modifying student's aesthetic decision of "nettles" and "thistles" through interaction with plants (Urtica dioica, Cirsium arvense)

10:00 **Annette Scheersoi & Sue Dale Tunnicliffe**

Natural history dioramas - dusty relics or useful tools in Biological Education?

10:30 **Ingrid Glowinski & Horst Bayrhuber**

Student labs as out-of-school learning environments promoting interest in gene technology

11:00 • 11:30 Coffee Break

11:30 • 13:00 **Paper Session VI**

Strand 5: *Teaching: Teaching Strategies, Teaching Environments and Educational Technology*

Chair: Michael Reiss

11:30 **Jenny Byrne, Marcus Grace & Pam Hanley**

Children's anthropomorphic and anthropocentric ideas about micro-organisms: do they affect learning?

12:00 **Maike Ehmer & Marcus Hammann**

Promoting year 6 students' understanding of scientific concepts and methods: About the effectiveness of negative and epistemological knowledge

12:30 **Dirk Jan Boerwinkel, Arend Jan Waarlo & Kerst Boersma**

Taking a designer's view: the perspective of 'form and function' as a metacognitive tool in primary science education

13:00 • 14:00 Lunch

14:00 • 15:00 **Poster Session II**

Strand 6: *Environmental Education and Biology Education*

Chair: Vasso Zogza

Beatriz Bravo-Torija & María Pilar Jiménez-Aleixandre

Is raising salmon sustainable? Use of concepts and evidence about ecology

Hauke Hellwig & Annette Upmeier zu Belzen

German and Swedish teachers' concepts in biology classes between environmental education and education for sustainable development

Helena Näs & Christina Ottander

The Space Shuttle - a thematically organised instruction as an introduction to ecology teaching

Martin Scheuch, Erika Keller, Günther Pass & Franz Radits

BD^2 = (Biological Diversity) X (Biology Didactics)

Silvia Schönfelder & Susanne Bögeholz

Developing environmental education to education for sustainable development

Folasade Olubunmi-Esan, Adedokun Adebowale & Abolaji Mayowa

'The Conservation Club Effect': An impact assessment of biodiversity conservation awareness in some selected Nigerian secondary schools

Strand 9: *Practical Work and Field Work in Biology Education*

Angelika Kremer, Kirstin Schlüter

"I know what to do." Ways of scientific discovery processes and problem solving

Sandra Hof & Jürgen Mayer

Developing seventh graders' inquiry skills in different levels of openness: A comparison between direct versus guided-scientific-inquiry instruction

Eric Sanchez, Patricia Marzin, Réjan Monod-Ansaldi, Daniel Devallois

Three criteria to help students to design their own experimental procedures for inquiry-based-learning

Manuel Ganser

Teaching competencies in biological experimentation

Matthias Recke & Ute Harms

Educational value of interactive hands-on exhibits in a natural history museum

Katrin Bätz & Matthias Wilde

Influence of conceptual preparation on learning in a natural history museum

Edward Mifsud, Sue Dale Tunnicliffe & Ralph Levinson

What is the visual impact of wildlife dioramas on primary school children and how is this expressed in drawing?

15:00 • 16:00 Poster Session III

Strand 1: *Student Conceptions and Conceptual Change*

Chair: Mats Hagman

Amauri B. Bartoszeck, Flavio K. Bartoszeck, Pierre Clément & Charles I. Abramson

Investigating children´s conceptions of the brain

Sarah Dannemann & Dirk Krüger

Design and evaluation of an inventory of exercises to determine students' conceptions of vision and perception

Strand 3: Student Values, Attitudes and Decision-making

Anna Uitto, Jari Lavonen, Kalle Juuti, Veijo Meisalo & Reijo Byman

The contribution on gender, school and residential area in explaining the interest in biology by lower secondary school students

Melanie Basten & Matthias Wilde

Organ donation and the attitude-behaviour gap

Alexandra Pleus & Annette Upmeier zu Belzen

A longitudinal study in the context of attitude development of learners and the transition between primary school and secondary school in Berlin

Zélia Anastácio

Human reproduction in the context of sex education: Portuguese primary school teachers' conceptions and obstacles about the reproductive system and about children's representations before formal teaching

Sarah Huch

Students´ attitudes and values regarding the subject "sexual orientations" considering gender aspects

Strand 4: *Student Reasoning, Scientific Thinking and Argumentation*

Clas Olander

Spontaneous and scientific reasoning - students´ grappling with content and language patterns

Strand 5: *Teaching: Teaching Strategies, Teaching Environments and Educational Technology*

Anna Tapola

Human dignity in teacher training – A challenge for Biology education

Michael Reiss

Imagining the world: the significance of religious worldviews for science education

Margareta Ekborg, Claes Malmberg, Christina Ottander & Agneta Rehn

Science for life - development of a conceptual framework for construction and analysis of socio-scientific cases

Michael Ewig & Sarah Uckelmann

English textbooks used in German bilingual biology teaching – a comparison with respect to the current German curriculum

Cláudia Ferreira, Rosa Branca Tracana, Maria Eduarda Ferreira & Graça S. Carvalho

Analysis of pollution and the use of resources topics along the school textbooks of 17 countries

Maria Pettersson

Teacher reasoning on what they can plan for in a Biology course in upper secondary school, Sweden

16:00 • 16:30 Coffee Break

16:30 • 18:30 **Paper Session VII**

Strand 5: *Teaching: Teaching Strategies, Teaching Environments and Educational Technology*

Chair: Anat Yarden

16:30 **Marion Haugwitz & Angela Sandmann**

The influence of context-oriented instruction and concept maps on interest and achievement

17:00 **Markus Lücken & Doris Elster**

"Biology in Context" (bik): Using learning communities to realize context- and competence oriented biology education

17:30 **Doris Elster, Markus Lücken & Helmut Prechtl**

Professional development and teacher learning: results of the evaluation within the project Biology in Context

18:00 **Niklas M. Gericke & Mariana Hagberg**

The use of historical models of gene function in upper secondary school textbooks

20:30 • 22:00 **ERIDOB Business Meeting**

Saturday, 20 September 2008

8:30 • 10:30 **Paper Session VIII**

Strand 5: *Teaching: Teaching Strategies, Teaching Environments and Educational Technology*

Chair: Graça Carvalho

8:30 **Michael Germ, Andreas Müller & Ute Harms**

The importance of exercise and generative learning for biology teacher education

9:00 **Sabine Marsch & Dirk Krüger**

Biology teachers: How they teach and how they talk about it

9:30 **Amelia Letitia Abrie**

Student teachers' attitudes towards and readiness to teach evolution in a changing South African environment

10:00 **Gesa Kramer, Sandra Nitz, Claudia Nerdel & Helmut Prechtl**

Influence of biology-related communication on knowledge representation

10:30 • 11:00 Coffee Break

11:00 • 13:30 **Paper Session IX**

Strand 4: *Student Reasoning, Scientific Thinking and Argumentation*

Chair: Patricia Schneeberger

11:00 **L.E. Mnguni, T.R. Anderson & K.J. Schönborn**

The nature of visual literacy in the molecular life sciences

11:30 **Carl-Johan Rundgren & Lena A. E. Tibell**

Critical features of visualization of protein function – An empirical study of students' meaning-making of diagrams and an animatio

12:00 **Adrianna Gómez Galindo**

Analysis of the use of drawings and scale models in the construction of multimodal explanations by primary students when studying the sense of sight

Strand 5: *Teaching: Teaching Strategies, Teaching Environments and Educational Technology*

12:30 **Graça S. Carvalho, Artur Gonçalves & Catarina Dantas**

Addictive substances problematic approaches in textbooks of 16 countries

13:00 **Rosa Branca Tracana, Cláudia Ferreira, Maria Eduarda Ferreira & Graça S. Carvalho**

Biodiversity in school textbooks of 13 countries

13:30 • 14:30 Lunch

14:30 End of Conference

Abstracts

Student teacher's attitudes towards and readiness to teach evolution in a changing South African environment

Amelia Letitia Abriew

Type of presentation: oral

This paper investigates South African student teachers' attitudes towards and knowledge of the theory of evolution. Although evolution has been accepted as the central concept in biology by the scientific community, the exclusion of this topic from the school curriculum throughout the 20th century means that large sections of the general public are strongly opposed to this theory. The topic of evolution was only introduced to the South African curriculum in 2002, through the Revised National Curriculum Statement. In the Natural Sciences, grades 7 to 9, core concepts that are needed to understand an evolutionist view of life are covered although the word evolution itself is not referred to. In 2008, Grade 12 learners will, for the first time, be introduced to the concept of evolution and teachers are expected to spend about 25% of the teaching time on this topic. Current student teachers, schooled in a system that deliberately omitted the concept of evolution, have to interpret this new curriculum through an unfamiliar paradigm.

This quantitative study explores the attitudes of student teachers towards the theory of evolution and the extent of their knowledge of the topic. The influence of students' religious background on their attitudes is examined. A questionnaire, consisting of Likert-style and open ended questions, was developed and handed out to those BEd students from the University of Pretoria's Faculty of Education who intend to teach biology in the secondary school. These student teachers' current and preferred sources of information are also investigated.

Nearly all the student teachers who volunteered information indicated that they are religious. Eighty six percent believe that God created all living things and 48% do not accept evolution. The majority of the participants take part in religious activities once a week or more. The results show that these students are more likely to find evolution incompatible with their belief system and to reject the theory of evolution, than the less devout. Although 69% of the participants felt that they were adequately prepared to teach evolution, the data show that these student teachers have a poor understanding of evolutionary theory and that they support many misconceptions. The participants obtained their information from a variety of sources, some very biased. The implications of the data for teaching of evolution in the secondary schools in South Africa and for teacher's training are discussed.

Acknowledgement:
This work was supported by the Research Development Programme of the University of Pretoria

Human Reproduction in the Context of Sex Education: Portuguese Primary School Teachers' Conceptions and Obstacles about the Reproductive System and about Children's Representations before Formal Teaching

Zélia Anastácio

Type of presentation: poster

Human reproduction is a topic included in the programme of the third year of the Portuguese primary school. Primary school teachers have expressed difficulties to deal with this topic as well as to deal with sex education. Considering the existence of legal and scholar guidelines for this domain, it seems interesting to investigate teachers' conceptions about human reproduction and sexuality. It is essentially, because conceptions are in the origin of several obstacles, which are in opposition to the learning and to the teaching practice. The aim of this research is to identify primary school teachers' conceptions and obstacles to teach reproductive system in the context of sex education. The research starting point was a questionnaire construction and validation. The validated instrument was applied to a large sample with 486 primary school teachers from the northern region of Portugal. For this work we will present the results from two open questions: *i) represent, through a subtitled schematic drawing, the reproductive apparatus (male and female) and the fertilisation; ii) represent, now, how you think a primary school pupil should draw the reproductive apparatus (male and female) and the fertilisation, before its learning.* After data collection, a database was constructed and statistical tests were applied using the software SPSS. The drawings analysis revealed eight different categories to the female reproductive apparatus (most frequent category: "ovary, fallopian tubes, uterus, vagina") and five categories to the male reproductive apparatus (most frequent category: "penis, testicles, external"). About the fertilisation, in terms of cells, three categories emerged and the most frequent was "spermatozoon, ovule". Concerning the localisation of the process the majority did a representation not contextualized in the reproductive apparatus. Influent factors tend to be religious practice (teachers more practitioners represented more simple categories), age and time of career (older teachers with more professional experience represented more simple categories than the younger ones). Teachers' conceptions about children mental representation of the reproductive systems indicated a minor diversity of categories for the reproductive apparatus (most frequent category for female apparatus; "simple"; most frequent category for male apparatus: "penis, testicle, external") and a great reduction in the representation of the fertilisation, expressing that children only have the idea of a close contact between a male and a female. How these conceptions are similar to the expressed by textbooks it seems a didactical obstacle, and the influence of religious practice can be interpreted as a social obstacle.

Treatment of a Finalistic Obstacle Related to Biological Evolution: Study of a Teaching Case in Tunisia

Saïda Aroua, Maryline Coquidè & Salem Abbes

Type of presentation: poster

Tunisian students, like others all over the world, have Lamarckian misconception. They consider that biological evolution is individual transformation as a consequence of the action of environmental factors. To survive, living beings must change to adapt to the new environmental factors. Then, they must change because they feel an internal will to change. This misconception is in relation with an epistemological obstacle. It prevents students from understanding the mechanisms of biological evolution. We propose to name this obstacle in relation with a finalistic conception "will to adaptation".

Our research proposes a remediation on biological evolution, which treats, by a didactic strategy, these two obstacles: Lamarckian misconception and an underlying obstacle "will to adaptation".

We tested the teaching designed in normal class conditions with Tunisian students of a scientific terminal grade (18-21 age). To follow the destabilization and the identification of the obstacles by the students, we combined analysis of classroom discourses with those of the pre and post-teaching interviews.

The teaching design was based on a didactic strategy of obstacle treatment (Astolfi & Peterfalfi, 1997; Peterfalvi, 2000) which takes in four stages: diagnosis and destabilization of the obstacle, alternative construction to the misconception and identification of the obstacle among the students. Each stage is composed of classroom discourses alternately in small groups and in the whole subgroup class. These discourses included epistemological reflections about the earliest tetrapods (which were aquatic and quite unsuited for life on land), and about evolutionary processes, like mutation, recombination, speciation and natural selection. For the assessment of the teaching strategy, all the conversations (pre and post teaching and class debates) were recorded and transcribed finely to proceed at a content analysis (macroscopic and microscopic one). We characterized obstacles (misconception and the underling obstacle), their destabilisation among the students and their identification by some of them.

Content Analysis of the ERIDOB Proceedings and its Comparison to an International Science Education Journal

Roman Asshoff & Marcus Hammann

Type of presentation: oral

The aim of the present study is to summarize, categorize and present a coherent overview on the ERIDOB research activities over the last ten years and compare it to research in biology education published in the International Journal of Science Education (IJSE). A total of 130 papers published in the ERIDOB conference proceedings were categorised according to the categories described by Tsai & Wen (2002), which are as follows: (1) Teacher Education; (2) Teaching; (3) Learning - Conceptions; (4) Learning - Contexts; (5) Goals and Policy; (6) Culture, Social, and Gender issues; (7) History, Philosophy, Epistemology, and Nature of Science; (8) Educational Technology; and (9) Informal Learning. In order to gain a more precise view of the state of European research in didactics we have chosen one of the leading science education journals, the International Journal of Science Education (IJSE), classified the articles of the years 1998, 1998, 2000, 2002, and 2004 according to the categories described above and contrasted them with the ERIDOB categorization. This cross-check between the papers from the ERIDOB proceedings and the research articles from IJSE allows us to present data on the research focus in these two publication venues. Our research findings show that the ERIDOB publications focus on the categories (3) Learning – Conceptions and (4) Learning – Contexts, whereas publications of the IJSE are more balanced within the categories (1), (2), (3), and (4). As expected, English-speaking countries contributed most articles to the IJSE, whereas contributions from Europe (except the United Kingdom) are marginal. In further analysis, these differences are more closely examined, in particular in the category "Learning – Students Conceptions and conceptual change."

Linking Literacy to Science Education

Milena Bandiera

Type of presentation: poster

More than 30 years of exploring the relationship between literacy (i.e. the ability to read and write) and science learning has revealed the importance – precisely in a constructivistic perspective – of some skills peculiar to scientific habits, such as rigour, reasoning and argumentation, and that can be trained and easily appraised by means of written tasks. Careless orthography bears witness to the harmful influence of e-mail, SMSs, and blogs that privilege quickness over unambiguousness. Lexically inadequate discipline-specific language and conceptually incorrect discourses affect both literacy and science literacy (see Yore, Pimm & Tuan, 2007).

A coherent constructivistic approach to science teaching was adopted in an effort to make it easier for university Biology teachers' to understand whether and how students are gaining from educational activities. Data were collected through analysing the formal and substantive aspects of questionnaires filled out by students who had attended a science lecture. Orthographical and syntactical mistakes (i.e. that would have been corrected by a lower secondary school teacher), lexical inaccuracies (misspelled or improperly used words that prevented or altered understanding of the text), and cultural and conceptual inadequacies (indicating an improper interpretation of the ideas and concepts treated in the lecture) were foregrounded. Analysis of 219 questionnaires resulted in an average of 2.9 spelling and syntactical, 3.9 lexical, and 1.5 cultural and conceptual "errors" per questionnaire.

A total of 111 subsequent questionnaires recorded students' opinions regarding the causes of such glaring evidence of illiteracy.

University teaching methods and organization were found to be unsatisfactory on the level of effectiveness. Relevant acquisitions concerned, first of all, which and how many student errors impeded science understanding and, secondly, how students resorted to "cutting and pasting" their incomplete and distorted notes when composing their summaries, instead of making rational selections and personally re-elaborating the texts. Supported, therefore, is the potential validity of school practices aimed at building linguistic literacy within the science curriculum, along with teaching strategies that foreground a targeted use of language (discussion, argumentation, reading and writing) in pre-university science classrooms, leading to cognitive benefits for students that might help counteract the alarming spread of linguistic and scientific illiteracy. Actually, the data suggest the wider adoption of critical reading, writing and debating also at university.

Investigating Children´s Conceptions of the Brain

Amauri B. Bartoszeck, Flavio K. Bartoszeck, Pierre Clément & Charles I. Abramson

Type of presentation: poster

This paper reports data, part of a cross-sectional study about the use of students´ drawings as a means of probing the development of 195 pre-school children (4 to 6 year-olds) and 681 primary school pupils 1st Grade through 4th Grade (7 to 10 years of age) conceptions of the human brain. The aims of the present study is to analyze how the conception of the brain develops, how they represent their brains, and whether it is based on historical models or current scientific knowledge, in their interaction with school and society at large.

The methodology involved the presentation of a contour of the head and neck drawn on the blackboard in the classroom, and children were asked to draw what they think they have inside their heads. After the drawings were collected some pupils were interviewed to explain their drawings. Classification of the collected drawings were interpreted on the perspective of historical models of the brain and scored following a 5 level rating scale depicting degrees of neuro-anatomical resemblances. Gender and age were taken into consideration.

The results show that younger students are adepts of mental ideas in their representations, i. e. what the brain does, but progressively as they get older, start to develop a more neuro-anatomical representation of the brain. Knowledge obstacles for learning about the nervous system and elementary neuroscience implications are discussed.

Organ Donation and the Attitude-Behaviour Gap

Melanie Basten & Matthias Wilde

Type of presentation: poster

Theory: Performance is often not consistent with corresponding attitudes (Ajzen & Fishbein, 1970). This attitude-behaviour gap can also be observed in the domain of organ donation. In Germany, 85 % of adolescents report a positive attitude towards organ donation but only 11 % of them possess an organ donor card (Forsa Survey, 2003). Rationale: In our study we investigated different prospects to bridge this gap. Using Gold's, Schulz's, and Koch's (2001) integrated model of individual attitudes towards organ donation a complex study was conducted. Research question: What impact do knowledge, issue involvement (Petty & Cacioppo, 1986), and perceived behavioural control (Ajzen & Madden, 1986) have on the attitude-behaviour gap in organ donation?
Methods: In our pre-post-test study we examined six treatments: 1st treatment: Pupils receive a singular informing lesson plus 3x3 lessons with three experts with questionnaire and an offer of organ donor cards. 2nd and 3rd treatment: Pupils are presented a singular informing lesson with questionnaire and with / without an offer of organ donor cards. 4th and 5th treatment: Pupils fill in the questionnaire with / without an offer of organ donor cards. 6th treatment: Pupils are offered an organ donor card and afterwards questioned with a short post-test. Thereby we controlled for the effects of the questionnaire itself, the effects of an offer of organ donor cards (perceived behavioural control), of the singular informing lesson (knowledge) and of the lessons with experts (issue involvement). Every treatment is represented by two 11th classes (i.e. at least 38 pupils per treatment) of the highest stratification level. In average the pupils were 17 years old. The attitude was measured by a questionnaire in accordance to Parisi's and Katz's (1986) two dimensions of pro- and antidonation. The behaviour was recorded qua possession of an organ donor card.
First results confirm that both treatment 2 (with offer of organ donor cards, N = 38) and treatment 1 (N = 50) led to a significant increase in the possession of organ donor cards (Fisher's exact test: treatment 2: $p < .001$**; treatment 1: $p < .001$**). Further, treatment 1 reported a significantly more persistent opinion towards organ donation (Chi-square test: $Chi^2 = 27.21$, $p < .001$**). Presumably, this outcome was due to a higher issue involvement (cp. Skumanich & Kintsfather, 1996).

Influence of Conceptual Preparation on Learning in a Natural History Museum

Katrin Bätz & Matthias Wilde

Type of presentation: poster

Theory: For every extracurricular learning situation the necessity and the possible benefit of preparation need to be taken into account. Constructivism regards previous knowledge as an important influence on learning processes (Gerstenmaier & Mandl, 1995). Every given individual constructs his or her own reality in accordance to previous knowledge. For museum learning Falk and Dierking (2000) regard previous knowledge as a fundamental factor of the personal context in their "Contextual Model of Learning".
Rationale: In our study we manipulated the previous knowledge of pupils by planned precursory instructions on the oncoming subjects in a natural history museum. These lessons contained conceptual preparation without concerning the contents of the museum.
Research question: Is conceptual preparation beneficial for museum learning?
Method: We conducted the pre-post-test-study with 97 5th graders of the highest stratification level (Gymnasium) in the Natural History Museum of Berlin. Our control group visited the museum without previous lessons. These lessons consisted of sequences of "learning by teaching" (cp. Renkl, 1997). Subjects of the lessons were general "concepts" that might be helpful during the museum visit, e. g. mating behaviour, but never specific contents presented at the museum, e. g. mating behaviour of sticklebacks. The cognitive assessment was accomplished by open and closed items. Cronbachs Alpha was ∂ = .67.
Results: Regardless of the treatment the museum visit led to knowledge gains from pre-test ($M = 3.49$; $SD = 1.56$) to post-test ($M = 5.62$; $SD = 2.89$): $t = 7.61$; $df = 96$; $p < .001$; $d = 0.92$. Furthermore the conceptual preparation was successful. The group with previous lessons had better cognitive achievement than the control-group: In pre-test the previous-lessons group ($M = 3.61$; $SD = 1.58$) and the control group ($M = 3.39$; $SD = 1.54$) presented no significant difference ($t = 0.68$; $df = 95$; ns). In post-test the previous-knowledge group ($M = 6.46$; $SD = 2.70$) and the control group ($M = 4.86$; $SD = 2.87$) differed significantly ($t = 2.81$; $df = 95$; $p < .01$; $d = 0.57$). Some evidence suggests the previous-lesson group succeeded in more demanding tasks. The findings will be discussed.

On the Theoretical In- and Output of 'Design Research' in Biology Education

Kerst Th.Boersma & Arend Jan Waarlo

Type of presentation: oral

In this paper the (nature of the) theoretical output of design research in biology education is discussed. Since design research is theory-driven attention is given to theoretical input as well. The discussion is based on a small-scale meta-analysis of five PhD studies being part of a Dutch research programme in biology education.

Every study yields a field-tested design for a series of lessons about a specific biological topic, but also explores the wider applicability of that design in biology education. This results in a so-called didactical structure, i.e., a generalized sequence of domain specific learning and teaching (LT) activities. Didactical structures make the theoretical output of the PhD studies. These structures may be helpful in future design activities in biology education and serve as theoretical input.

All analyzed studies have a theoretical input from the educational sciences and in the form of biological principles. Initially, educational support was found in social constructivism. It helped in defining the playground for designing LT strategies, but it did not indicate how to define and sequence learning and teaching activities. Recently some support is found in the cultural-historical theory and the theory of situated cognition. Biological principles play a distinctive role in all five studies as content of intended learning outcomes, but also in defining and sequencing LT activities.

Analysis of the designs resulting from the five studies shows that most of them applied didactical structures originating from earlier studies on the didactics of the different science subjects and mathematics. The didactical structure(s) used as input still can be recognized in the final design. In three cases new didactical structures were developed. The most recently completed studies yielded composite didactical structures. The table below shows types of didactical structures, including functions and range of application.

Didactical structure	Function	Subjects of application
Problem posing approach	Development of students' domain-specific learning motives	All (social) science subjects
Learning by designing	Concept formation by redesigning	Biology and technology
Yo-yo strategy	Coherent understanding of complex systems	Biology
Form-function heuristics	Elaborating form-function relationships	Biology and technology
Concept-context approach	Meaningful and transferable understanding	All (social) science subjects
Emergent modeling	Developing abstract models	Mathematics, all (social) science subjects

Taking a Designer's View: the Perspective of 'Form and Function' as a Meta-cognitive Tool in Primary Science Education

Dirk Jan Boerwinkel, Arend Jan Waarlo & Kerst Boersma

Type of presentation: oral

This presentation describes the development of a model of the form-function perspective and the translation of this model in a tool for constructing knowledge in primary science education. The idea behind this is that expert strategies may serve as a good model for acquiring knowledge.
Strategies experts use to study phenomena include domain-specific strategies that are characteristic for the ways experts in a specific domain formulate and investigate questions. These domain-specific strategies are here called perspectives. The perspective of form and function is an example of a strategy in use both by biologists and technical designers.
The analysis of the perspective of form and function was carried out by studying literature about the historical development of biological research and about design procedures. A model of the perspective of form and function was developed in which the different questions and heuristic strategies could be placed. It proved possible to make one model both for biological and technical examples.
The question whether primary school students can acquire the perspective of form and function as a metacognitive tool was investigated with developmental research. Based on the model of the perspective of form and function a learning and teaching strategy is developed to acquire this perspective. The scheme of the 'designers' spectacles' is created as a metacognitive tool for the students. The scenario based on the learning and teaching strategy includes design activities (from function to form) and analysis activities (from form to function) both about technical and biological phenomena.
The results of the lesson series were that the 'designers' spectacles' helped the students and the teachers in analysing and comparing of technical and biological designs. The lessons stimulated design activities, increased observation skills and understanding of design.

Is Raising Salmon Sustainable? Use of Concepts and Evidence about Ecology

Beatriz Bravo-Torija & María Pilar Jiménez-Aleixandre

Type of presentation: poster

This work makes part of a study about argumentation and knowledge evaluation on marine resources management. The study is part of a project on students' use of evidence and scientific models. The objective is identifying students' difficulties in solving a problem about sustainable fish farming: 1) To examine the difficulties that students experience for mobilizing relevant concepts; 2) To examine the use of evidence to justify their claims. This examination is part of designing a teaching sequence on the depletion of fish stocks and the conditions for sustainable fish farming. The rationale draws from argumentation studies (Jiménez-Aleixandre, 2008) and socio-scientific issues (SSI). The process of design involved a) identifying the concepts required for solving the problem; b) constructing a teaching sequence around an authentic problem; and c) exploring the students' difficulties for solving a task making part of it, which is reported here.

The context is a controversy about the establishment of new fishing farms on the Galician coast. Different social actors aligned themselves from ecologists criticizing the plans, to media criticizing the government for banning farms in particular locations. The sequence involves the production of a report about the convenience of building a turbot farm. In order to explore the difficulties, a similar paper and pencil task, focusing on salmon, was used as an examination item with university biology students (N=46), who were asked to: a) identify ecology concepts needed; b) compare the ecological efficiency of eating herbivore and carnivore fish; c) identify conditions under which aquaculture would be a solution to fisheries depletion. It has to be noted that both turbot and salmon are carnivores. The responses were analyzed according to a) their use of relevant ecological concepts, such as energy flow or trophic pyramid, and b) their use of available evidence to justify claims. The results show that only seven (15%) students used relevant concepts as energy flow or trophic pyramid. A 60 % of the students identified eating herbivores as more efficient than eating carnivores, but only a few were able to produce appropriate evidence for it. Educational implications: the difficulties experienced by university students have to be considered in the design of the teaching activities in order to develop the target competencies in secondary school students.

Children's Anthropomorphic and Anthropocentric Ideas about Micro-organisms: Do They Affect Learning?

Jenny Byrne, Marcus Grace & Pam Hanley

Type of resentation: oral

There are different views about whether anthropomorphic and anthropocentric ideas assist or hinder learning in biology. This paper provides data about what anthropomorphic and anthropocentric ideas children have about micro-organisms and microbial activity, and if they affect their understanding of crucial concepts pertaining to microbiology. The research was carried out in primary and secondary schools in the South of England and involved a total of 416 children aged 7, 11 and 14 years. Children were asked to draw a micro-organism and then annotate their drawing, and a 10% sample from each age group was followed up with a semi-structured one-to-one interview.

Results show that anthropomorphic and anthropocentric ideas about micro-organisms are apparent in the responses from all age groups across several key concepts, for example; morphology, location, disease and health, and microbial applications. Anthropomorphic ideas do seem to help children to explain their understanding of some aspects of micro-organisms and microbial activity. However, the imbalance in children's anthropocentric views of micro-organisms appears to prohibit them considering other aspects of micro-organisms; for example, the importance of their role in decomposition and cycling of matter, or their beneficial technological applications. Furthermore, the focus on humans and the danger micro-organisms are thought to pose to their health creates a hostile view of micro-organisms. Implications for learning microbiology are discussed.

Addictive Substances Problematic Approaches in Textbooks of 16 Countries

Graça S. Carvalho, Artur Gonçalves & Catarina Dantas

Type of presentation: oral

Addictive substances, such as alcohol, tobacco and illegal drugs, represent a serious problem in the actual society. Young people are very vulnerable to these substances consumption, so in this context UNESCO has recognized the school as an important setting for addiction prevention, included in the global plan of the Health Education. School can be the place where young students may contact with drugs and fall into such world. In contrast, it may also be the place where young people may became aware of this reality and become empowered to make choices in a responsible way towards a healthy lifestyle. The aim of this work was to identify differences and similarities in textbooks drug prevention approaches within 16 countries involved in the European project "Biohead-Citizen". For this we used the "Biohead-Citizen" specific grid for substances abuse (alcohol, tobacco and other drugs). The specific issues of each grid were grouped in three indicators: physical, psychological and social effects.

In general, countries present different approach levels according to the kind of substance (alcohol, tobacco and illicit drugs). These issues are explored preferentially in text but in some countries one of these issues is not referred. The comparative analyses highlighted the Finland data; however we should take in account the national curriculum, because it is the only country with a specific Health Education teaching discipline.

A Gender Effect Related to Teachers' Conceptions on Biological Gender Differences: A Survey in 12 Countries

Jérémy Castéra, François Munoz & Pierre Clément.

Type of presentation: oral

In the context of the European research project Biohead-Citizen, 5189 in-service and pre-service teachers filled in 12 countries (most in Europe, but also in Africa and Middle East), a questionnaire containing 16 questions related to the existence and origins of differences between men and women.

The paper is focused on the analysis of different concepts that pre-service teachers and in service teachers have, on biological gender differences, as possible interaction between scientific knowledge (K), values (V) and social practices (P). The questions of our questionnaire are mainly built to analyse possible interaction between K and V.

Most of the 16 questions are dealing with biological and social differences between men and women. Some of them are related to innate determinism of human beings features, and others on scientific knowledge linked to genetic determinism and cerebral epigenesis. Six samples of teachers filled the questionnaire in each country: pre-service and in-service teachers in primary schools and in upper schools for biology as well as for language. The data obtained from these questionnaires have been analysed using multivariate analyses (*Principal Component Analysis, Between-analysis and Principal Component Analysis with respect to orthogonal Instrumental Variables*).

The results show that the questions related to scientific knowledge distinguish the biologists to the others teachers. Independently, the answers to questions related to sexist or hereditarianist values show clearly differences between countries (Northern countries being less sexist than the Mediterranean ones). The sexist variables show a significant gender effect. The amount of males / females being different from one country to an other, and also inside the six samples in each country, we suppressed the influence of the countries and the influence of the groups of (future) teachers, showing that the gender effect is still significant independently to these variables: females are significantly less sexist than males.

Do Students' Ideas about the Antigen-Antibody Reaction Change When They are Gathered to Design an Experimental Procedure?

Gwenda-Ella Chapel, Patricia Marzin & Muriel Ney

Type of presentation: oral

This study is a preliminary work before the development of the CoPEX software that helps students and teachers to design experimental procedure. To this date, there are no other intelligent learning environments for this task. An experiment was done in two high schools during an immunology course (a lecture and a practical work). It is done in ecological conditions with students majoring in science (ISCED level 3A-16/18 years old). Students designed (imagined, wrote and executed) their own experimental procedure to obtain data and answer to the practical work's question.

The first focus of the study was to know how students' ideas about the immunology topic, the link between antigen and antibody, evolved after the course. The second focus was to determine the main principles used by students to solve the problem (how to show the complementarity between the two molecules), first during a reflection phase on the design and second during the procedure writing phase.

To give an answer to these questions, a corpus was analysed. This corpus consisted of written answers from pre/post test sessions, and lab answer sheets with the students' experimental procedure from a laboratory session. The tests were compared to see how the students' answers evolved after the course. The lab answer sheet's analysis enabled to know if the students wrote in their experimental procedure the two main principles discussed in whole class and if they had thought about these in the first question.

This study showed that students' ideas about antigen, antibody and immune complex evolved with the immunology course, and after the course came closer to scientific knowledge. Moreover, we found that few groups invoked the two main principles in the reflection phases and, in spite of the whole class discussion, only part of the groups used the two principles in the procedure writing phase.

Design and Evaluation of an Inventory of Exercises to Determine Students' Conceptions of Vision and Perception

Sarah Dannemann & Dirk Krüger

Type of presentation: poster

The aim of this investigation is to develop an inventory of exercises to determine students' conceptions of vision and its essential parts, human perception and its limits. The inventory is designed for daily school practice. The results should enable teachers to design lessons considering students' conceptions. Depending on the most prominent identified conceptions of 9th- and 10th-graders specific interventions are developed and evaluated within a teaching unit.

The poster focuses on the research design. It presents a selection of constructed items and first results of the pretest. The pretest is designed to test the quality of the created inventory in two different ways. Firstly, its ability to differentiate between the results of students and biology undergraduates is tested. Secondly, the conceptions investigated with the inventory are compared with students' concepts identified in single interviews.

The methodology includes the production of diagnostic items by using students' and scientific conceptions of vision and perception that have been identified so far. The items contain drawings, predictions of experiments, and closed questions to elicit students' current conceptions. Subsequently, the items are evaluated by comparing pretests using the results of the different sample groups (students and undergraduates) and contrasting the findings from the inventory with the findings from the problem-centered, semi-structured interviews. The interview guide consists of open-ended questions. If the identified conceptions of the test and the interview coincide, the constructed items of the test are validated.

The intermediate results that are presented on the poster include the design of the inventory, a variety of different items, and outcomes of the pretest concerning its evaluation. The pretest results will show if a diagnosis of conceptions with standardized items succeeds in principle.

Instructional Support for Learning with Computer Simulations about the "Ecosystem Water"

Marc Eckhardt, Detlef Urhahne, Olaf Conrad & Ute Harms

Type of presentation: poster

Computer simulations reconstruct processes or dynamics in a particular system. They offer learners access to experiments that are often difficult to carry out in the classroom. However, for successful knowledge acquisition with computer simulations instructional support is needed, as learning with computer simulations does not typically result in the desired learning outcomes. The main objective of our project "SimInstrukt" (funded by the Deutsche Forschungsgemeinschaft) is to answer the question which kinds of instructional support may improve knowledge acquisition, particularly learning principles in biology, when working with computer simulations. In two well known problematic domains of inquiry learning – data interpretation and self-regulation – instructional support for learning with computer simulations on the topic "ecosystem water" are developed and tested. In a first study a computer program containing a computer simulation was designed. This learning software was tested by students. Data were collected by a variety of instruments like logfiles, questionnaires and half-structured interviews. Based on these results the prototype of the computer program was revised. In a second study particular instructional measures concerning data interpretation and self-regulation were developed and tested with students. The effectiveness of these instructional measures on students´ learning outcome (factual, procedural, conceptual and intuitive knowledge), the ability to work in a learning environment that offers a high degree for self-control and the ability to interpret experimental data is investigated in a third step of our project. The data are raised in an experimental setting using a 3x2-factorial design with a pre- and a post-test. In our contribution results of the first and the second study will be shown and discussed. The software was positively estimated by the students with regard to content, design, handling and comprehensibility. Pre- and post-tests used in the second study revealed knowledge increase. However, preliminary analysis of variance yielded no significant differences on instructional measures and learning outcomes.

Promoting Year 6 Students' Understanding of Scientific Concepts and Methods: About the Effectiveness of Negative and Epistemological Knowledge

Maike Ehmer & Marcus Hammann

Type of presentation: oral

This paper presents the results of two studies on promoting year 6 students' (1) concept knowledge of the human circulatory system and (2) methodical knowledge of scientific experimentation.
International comparative studies, like the PISA study, revealed severe weaknesses of German students concerning the application of scientific concepts and methods. In the studies presented an approach is introduced for enhancing competencies in school science by imparting two complementary dimensions of knowledge: so-called positive knowledge, i.e. knowledge about aspects of the scientific domain of interest, and negative knowledge which includes knowledge about aspects which do not belong to that domain. Understanding the contrast between both dimensions of knowledge is supposed to generate more complex and applicable knowledge. Additionally, in terms of methodical knowledge about scientific experimentation, epistemological knowledge, i.e. knowledge about the nature of the scientific knowledge, is employed in order to achieve a more profound student understanding than with methodical knowledge alone.
The results of two intervention studies with grade 6 students on acquiring (1) concept knowledge in the domain of the human circulatory system, and (2) methodical knowledge in the domain of scientific experimentation are presented. In both studies, paper and pencil tests were conducted in order to investigate into the effects of the interventions on student understanding.
For the acquisition of concept knowledge, negative knowledge proved very effective (study 1): Students who acquired negative knowledge possessed a significantly better understanding of crucial aspects of the circulatory system concerning (1) the functional differentiation of the systemic and pulmonary circulation, and (2) the necessity of a repeated pressure generation after the low-pressure passage of the lungs, which lead to better results in applying the knowledge in problem tasks. In contrast, students who acquired only positive knowledge had problems to go beyond the level of reproducing knowledge.
For the acquisition of methodical knowledge of scientific experimentation the results are less clear-cut (study 2): While the students did not differ significantly in their methodical and epistemological knowledge, students who acquired negative knowledge revealed a more profound understanding of the method of scientific experimentation, e.g. they were significantly more successful in identifying confounded experiments and in evaluating experimental data. The acquisition of epistemological knowledge did not prove effective in this respect.

Representations of Scientists in Biology Textbooks

Michiel van Eijck & Wolff-Michael Roth

Type of presentation: oral

Science curricula are thought to contribute to students' stereotypic images of scientists. In order to get a better understanding of this problem, we investigated how scientists are represented in biology textbooks. We selected evidence for how ten noted scientists are represented in four Canadian high school and college textbooks, providing us with 96 texts and 106 inscriptions. Drawing on semiotic and cultural-historical activity theoretical frameworks, we conducted two analyses. A coarse-grained, quantitative analysis of the prevalence and structure of these representations exhibited bias towards particular scientists' representations and particular types of texts and inscriptions therein, suggesting a domain-specific rhetorical structure. A fine-grained, qualitative analysis of scientists' representations revealed that high school and college textbooks represent: (a) objects of scientific practice as projected or anticipated independently from human activity; (b) scientists' individual actions aiming at the creation of non-tangible tools and rules by means of observation, modification, or manipulation of given, tangible objects; (c) scientific practice as isolated due to which the simultaneous belonging to different practices hardly determines the goals of scientists' actions; and (d) scientists as part of a small community of mainly other scientists who subsequently determine each other's individual actions.

Science for Life - Development of a Conceptual Framework for Construction and Analysis of Socio-scientific Cases

Margareta Ekborg, Claes Malmberg, Christina Ottander & Agneta Rehn
Type of presentation : poster

The aim of this paper is to describe the development of a conceptual framework, which can be used as an analytical tool for understanding and constructing socio-scientific cases (SSI). This work is the first step in an evidence-based research project aiming at investigating if, how and why students and teachers in secondary school develop knowledge and interests when working with SSI in science. The framework focuses on content and features of the SSI. It will be used as a tool for analyzing what components of the tasks are most influential on interest and learning in work with SSI in secondary school. The six components were chosen to reflect what we know from research literature about what might have an impact on interest and learning. It is possible to find variants within each component. Six socio-scientific cases were constructed which will be discussed. They are relevant according to characteristics of SSI and to the national curriculum. The framework consists of a matrix with the six components and six cases. It is possible to find variants within each component. Here follows a brief description of the components and the cases.

Components

1. Starting point- the authentic setting. It can be fictive and non-fictive e.g. TV-programme or novel.
2. School science subject
3. Nature of the scientific knowledge-base and evidence -
4. Social content - e.g. media power, economy, ethics.
5. Use of scientific knowledge for e.g. decision –making, clarifying, risk assessment
6. Type of conflict – on an individual group or structural level

Cases

1. You are what you eat? Critical scrutinizing of a TV-programme.
2. Laser treatment and near sightedness. Personal homepage. To decide if it is worthwhile to go through such a treatment and about who should pay.
3. To hear or not to hear? Excerpt from novel. Analysis of different views and arguments.
4. Me, my family and global warming. Family situation. To produce a realistic plan for how to decrease the carbon dioxide emissions of the family.
5. Are mobiles hazardous? Newspaper articles. To decide about the consequences for use of a mobile or how to choose when buying a new one.
6. Climate-friendly food in school? School canteen. To suggest changes and to write a letter to the headmaster.

Professional Development and Teacher Learning: Results of the Evaluation within the Project "Biology in Context"

Doris Elster, Markus Lücken & Helmut Prechtl

Type of presentation: oral

The paper reports results of a qualitative evaluation of the German project Biology in Context (bik) as part of a three year longitudinal study on teacher development in learning communities (school-sets). In the bik sets teachers and researchers are seen as experts in their respective fields cooperating and learning from each other. They elaborate teaching materials based on theoretical competence models; the teachers test them in their own classrooms and reflect their experiences in the bik set.

The focus of the paper is one three levels: On the personal level the paper centres on the identification of teacher profiles in dependence on the openness to modify the own teaching culture according to guidelines of the German National Educational Standards with context orientation and the integration of competence models as the core elements. On the school level we want to know how far the bik approach affects the daily work of the teachers. On the system level the paper focuses on the identification of successful and hindering factors for cooperation in the learning communities and implementation of the bik innovation.

The methods we used are structured interviews with teachers (N=37), set-coordinators (N=10) and researchers (N=6) at the beginning of their collaboration in the *bik* school-set, after one year after of joint working and at the end of the project. Each individual interview lasted about one hour and was taped. During the interview a mind map was developed together with the interviewee. These mind maps and the transcripts of selected parts of the tape records were analyzed according to the paradigm of qualitative contents analysis.

Some results: 1.We can identify three different teacher profiles regarding the willingness to carry out innovations, teacher self concepts, concepts of teaching and learning, intention to change the concept of teaching and learning, networking and reflection culture. 2. The daily work of the teachers is principally influenced by the *bik* innovation – but change needs time. 3. Cooperation and networking is reported the most effective factor which supports the teachers. Organizational demands and restricts by the school administration are the most hindering factors of the implementation of the *bik* innovation.

Young Children's Reasoning about Germs and their Ontological Status

Marida Ergazaki, Konstantina Saltapida & Vassiliki Zogza

Type of presentation: oral

This study aims at highlighting young children's intuitive reasoning about germs and developing a learning environment for supporting them in recognizing germs as living entities by drawing upon their biological functions. Our focus is set on preschoolers' conceptualization of the ontological status of germs, as well as on how this might be enhanced in the context of a new learning environment. This paper is particularly concerned with tracing young children's ideas about the nature of germs, their biological functions and ontological category, while it also attempts to explore how these ideas could be elaborated meaningfully.

35 preschoolers (age 4.5-5.5) gave us individual, semi-structured, interviews, lasting 20-30 minutes each. First, we traced children's ideas about what germs are, where they may be found, whether they are good or bad and living or non-living and how they may look like if drawn on a piece of paper. Then children were required to attribute each of the biological functions of eating, breathing, moving, reproducing and dying to a dog, to a chair and to germs. Finally, children were asked to create a story in which germs would have a key-role.

According to the analysis of part of our 35 interviews within the environment of the qualitative analysis software 'NVivo', children seem to relate the word 'germs' mainly with illness and define germs as *'the things that make us ill' or as 'poison', 'dirt', 'dust flying in the air', 'small insects'* and *'things upon animals'*. Our informants claim that germs are found in unhealthy snacks (*'chips, chocolates, gums, candies'*), in our body (*'teeth', 'mouth of sick kids', 'inside us'*) or in the external environment (*'soil', 'air', 'dirt', 'dust',' everywhere'*). Germs appear to be *'bad'* and considered more often as *'living'* than as *'non-living'*. Nevertheless, even when all the biological functions appear to be attributed to germs, their classification as living entities by children does not have to do with these functions. In fact, such classification may appear even when *none* of these biological functions is attributed to germs.

An overview of the learning environment designed in the light of the above is finally discussed. Educational activities offering children the opportunity to have a visual contact with germs (*'microscope activity'*), get familiar with the *'good germs'* idea (*'puppet-show activity'*), predict (*'category-based reasoning activity'*) as well as experience germs' breathing eating, reproducing and dying (*'yeast activity'*) and finally activate these functions as life-criteria (*'living - nonliving activity*), are briefly outlined.

English Textbooks Used in German Bilingual Biology Teaching – a Comparison with Respect to the Current German Curriculum

Michael Ewig & Sarah Uckelmann

Type of presentation: poster

Since the 1960s some school subjects have been taught bilingually in Germany according to a treaty between Germany and France. Over the last 15 years Biology has lead the way among the science school subjects being taught bilingually with English as working language. Benefits of bilingual education for the language acquisition are well stated, whereas effects for the learning of Biology still remain to be investigated. One aspect of research in this field refers to the school textbooks used in bilingual education in Biology. As there are no special textbooks available for bilingual Biology education in Germany, the textbooks used in these classes are taken from the countries of the working language. Due to the fact that the same curriculum has to be applied as in the German-speaking classes, it has to be examined if (I) the foreign language textbooks cover the required contents, (II) if they do not overstrain the learners linguistically, and (III) if they contain types of exercises that meet the requirements of the German standards of education.

In order to answer these questions, the study compares two German and two English textbooks that are used frequently in either German-speaking or bilingual grade 8 classrooms in the federal state of North Rhine-Westphalia; in this federal state some 20 schools offer bilingual education in Biology and an official curriculum for this kind of teaching is available. Focusing on the topic of the carbon cycle, the study arrives at the conclusion that (I) English textbooks do not cover certain topics that are required by the German curriculum, that (II) they do not overstrain students linguistically and that (III) they mainly contain types of exercises that focus on the reproduction of knowledge.

In terms of teaching Biology bilingually it seems to be advisable

- not to use only one English textbook concerning a specific topic;
- to assist students taught bilingually in applying German textbooks to the matter of interest;
- to construct or translate additional exercises matching the German standards of education.

Analysis of Pollution and the Use of Resources Topics along the School Textbooks of 17 Countries

Cláudia Ferreira, Rosa Branca Tracana, Maria Eduarda Ferreira & Graça S. Carvalho

Type of presentation: poster

This work was developed within the European research project "Biohead-Citizen" (Biology, Health and Environmental Education for a better Citizenship), with the participation of 19 European and African countries: Portugal, France, Germany, Italy, Cyprus, Estonia, Lebanon, Tunisia, Finland, United Kingdom, Hungary, Lithuania, Malta, Poland, Romania, Algeria, Morocco, Mozambique and Senegal. The goal of the present study was to analyse the progression of some conceptions in the textbooks of 17 countries that participate in this project, within the topics: *pollution* and the *use of resources*. The analysis of these topics showed that the following issues are highlighted: i) the planet is seen as a resource for humankind instead of a resource shared with other living beings; ii) it is given a much heavier importance to technologies in sustainable development rather than to changes of individual and social behaviour, specially in European western countries textbooks; iii) it is conferred unlimited trust in science and technology solutions instead of using the principle of precaution; iv) Concerning *ethical and socio-economic issues*, the ethical debate goes to a second plan when compared to the socio-economic one; v) Comparing Portuguese textbooks with Mozambique ones, concerning the conception *individual responsibility vs social responsibility*, about *use of resources* topic, Mozambique textbooks are rather more centred in a strategic perspective, essential to their economic expansion, based in the prevention of the waste of resources, and the preoccupation with sustainable ***use of resources***; *vi*) Analysing images from textbooks, we verified that images from the textbooks give special attention to humans' action or to the results of their action. There is not much emphasis given to ecological, social, and economic sustainability in the analysed textbooks. The findings of the present study show that a change of textbooks is recommended in order to give more emphasis to the human role in solving *pollution* problems and so contributing to improve pupils' citizenship.

Teaching Competencies in Biological Experimentation

Manuel Ganser

Type of presentation: poster

Due to national science education standards published in 2004 there has been a growing need for teaching units that take into account pupil's competencies in experimentation. The key objective of the work presented here is the development and evaluation of biology teaching units that focus on the cumulative training of pupil's competencies in the three dimensions of experimentation based on the SDDS-model by David Klahr. We assume that an explicit training of the experimental method that takes into account student-conceptions and preexisting levels of competencies is sufficient to increase the pupil's competency levels in the three dimensions of experimentation. Thus, in close cooperation with teachers, scientists and school administrators, three teaching units have been developed. Each unit includes three tasks of graded complexity according to evidence-based competency levels. Pupil's competencies are assessed in a pre-/posttest design using reliable multiple-choice items that have been previously developed in our group. Selected pupils are also interviewed via problem-orientated interviews containing an open-response item to gain qualitative insights into individual impact of the teaching units on the development of competencies in experimentation. The findings of this evaluation study are presented.

Improving Awareness and Knowledge of Preschooler's Ideas about Birds and their Songs

Raquel Gaspar & Susana Nogueira

Type of presentation: oral

This paper is part of an EU funded project to foster life science and curiosity in early childhood education, Portugal, where classroom activities and teacher guidelines were created. One of these activities focuses on birds and their songs. Here we report 1) children's attitudes and ideas about this subject and 2) a strategy to improve them.

The focus of this paper is supported by the constructivism and the conceptual change learning theories and is directed through two practical questions: 1) preschool children's initial attitudes and ideas about birds and their songs and 2) how can these be changed. Data was collected in three classrooms of 4 to 5 year old children living in a city, in a small town and in a rural village.

The methodology of this work has three steps. First, children's initial attitudes about birds in the wild and ideas were recorded. The behaviour of the two groups living closer to nature towards the presence of birds was observed, photographed and later categorized. Children were questioned about aspects of birds and their songs during classroom conversation; their answers, comments and questions were audio recorded and categorized. Secondly, an instructional strategy was conducted based on children's initial ideas in order to create a conceptual change. Finally, children were again observed and questioned, 1 to 14 days after.

During the initial field trip, children were not aware of the presence of birds. During group discussion, children were able to point structures (and functions), habitats and behaviours from typical birds and to enumerate different bird species. Children from the city enumerated less bird characteristics and species, mostly domestic birds. All children had poor knowledge about bird vocal communication and showed mainly anthropomorphic but also teleological explanations about why birds sing. When asked to imitate bird songs, their immediate answer was uniform: "piu piu piu piu" revealing a culturally transmitted pattern. To overcome children's initial ideas concerning bird vocal communication, models, images of birds and their songs were presented; comparison with other vocal animals and rhythmic vocal mimicry of bird songs were used. Some children were then able to associate a song to a particular bird, to distinguish between different bird songs and to mimic them. Back in the field, all children were aware of birds.

This work suggests that putting this strategy into common practice could contribute to the change of children awareness and knowledge to birds and their songs.

A Learning Setting Influence on Cognitive Achievement and Intrinsic Motivation in Anti-smoking Education

Christine S. Geier & Franz X. Bogner

Type of presentation: oral

The present study reports empirical data from an educational anti-smoking intervention targeted to fifth graders of secondary schools (N = 415). The aim of this study was to monitor the cognitive achievement and intrinsic motivation by focusing on an empirical comparison of two different learning settings. It was realized within the framework of the EU-project BIOHEAD (Biology, Health and Environmental Education for better Citizenship), a large transnational study surveying how different aspects of citizenship may be promoted by Biology, Health and Environmental Education in Biology teaching.

To assess a potential setting influence on student-centred learning within this connection, the intervention was conducted at two different learning settings: A classroom-based group (I-1) received an intervention at school and an out-of-school group (I-2) obtained the identical intervention at an outreach setting in a youth camp. A control group (I-0) was not subjected to any specific intervention. Amongst the factual knowledge in the smoking issue itself and its health consequences, the preventive intervention mainly focussed on a promotion of general social skills in order to help to resist smoking and to advance attitudes towards health consciousness. This was specifically realized by learning at different workstations where the pupils could autonomously work in cooperative student-centred groups. The empirical measurement originated from an achievement test based on 13 cognitive items and four subscales of the 'Intrinsic Motivation Inventory' (25 items). In both learning settings similar cognitive levels were achieved while the out-of-school group showed a higher decrease rate and lower intrinsic motivation scores in interest and perceived choice with different gender effects. Our study adds new evidence for the effectiveness of student-centred learning schemes in relation to the learning setting especially in an interdisciplinary context.

The Use of Historical Models of Gene Function in Upper Secondary School Textbooks

Niklas M. Gericke and Mariana Hagberg

Type of presentation: oral

This paper presents a study of the occurrence of implicit models describing the phenomena of gene function in Swedish biology and chemistry textbooks for upper secondary school with the purpose to identify and construct the implicit models in the textbooks. In the national Swedish curricula for the upper secondary school science program (age 16-19) the use of models is emphasized as a crucial ingredient in education. Historical scientific models of gene function have been outlined in a previous study. In this study the textbook models were categorized and analyzed using the previously outlined historical models as a grid. One result was that the use of hybrid models in the textbooks is frequent. Further the results show that the most commonly used textbook models demonstrate most correspondence with two of the historical models. Also, these categories appeared to have a lower level of hybridization and could be linked to specific subject matter contexts. An implication of this might be that students' conceptions more tend to resemble those views corresponding to the commonly used stable historical models than others. Our findings also indicate a lack in the textbooks of applying the ambitions of the Swedish curricula to use models as a device in teaching and learning.

The Importance of Exercise and Generative Learning for Biology Teacher Education

Michael Germ, Andreas Müller & Ute Harms

Type of presentation: oral

This paper deals with an attempt to upgrade the quality of teaching biology didactics in university courses for prospective biology teachers. Teacher education needs to a certain extent the integration of the three disciplines 'educational sciences', 'subject-related didactics' and the respective scientific discipline that corresponds to the subject. A lack in such integration leads to the acquisition of rather "inert", isolated knowledge components.

As exercise tasks in school settings are regarded a helpful means to support knowledge acquisition, in this study therefore exercise tasks were developed for biology teacher education based on the model of generative learning. These tasks should facilitate the integration of biology didactics and general educational science studies in biology teacher education and should help the teacher students to apply and consolidate their knowledge about basic pedagogical and psychological concepts in terms of teaching biology.

An exemplary part of this task pool was evaluated in university courses of biology didactics, collecting data by different methodological approaches: the content analysis of the students' answers to the tasks, a pre-post-designed questioning of the participants and the use of specific task-related questionnaires. By this means, particular difficulties in dealing with the tasks could be identified. On the basis of these findings the task pool will be revised and advanced. All in all, the results indicate that working with the tasks positively affects the construction of usable knowledge and facilitates the connection between the different disciplines of biology teacher education, whereas there is obviously no effect on the students' interests in biology didactics and educational sciences. Altogether the implementation of the tasks, which predominantly was rated rather positively, may be regarded as a valuable addition to teaching techniques for contemporary biology teacher education.

Water – Basis of Life: Hands-on Learning at Working Stations

Sabine Gerstner & Franz X. Bogner

Type of presentation: oral

The empirical study compares two teaching methods, a teacher-centred and a hands-on instruction. The following questions were discussed: Does hands-on activity affect 5th grade pupils` achievement scores? Does an additional pupil-centred, hands-on consolidation phase improve pupils` scores?
397 pupils from fifteen 5th grade classes of Bavarian secondary schools participated in this study. Four treatment groups were established: Group-I participated in a teacher-centred double-lesson (90 min). Group-II took part in a hands-on instruction which lasted also 90 minutes. After both treatments, a knowledge consolidation phase of 45 min was added. To test whether "Concept Mapping" is a capable approach for a consolidation phase, a third treatment group was introduced which only took part in the hands-on activity. A knowledge questionnaire was designed and used three times testing the pupils' previous knowledge, newly acquired and long-term knowledge. To exclude any test-effects, a control group was established, only answering the knowledge tests. Additionally the Intrinsic Motivation Inventory (IMI) was applied. The study showed for pupils, attending the teacher-centred lessons, a higher short-term learning success. However, student-centred approaches provided lower decrease rates. Concept Mapping positively affected the increase in knowledge although it was taught first time ever in all classes. Students of the teacher-centred approach felt fewer tension compared to the hands-on approach.

Student Labs as Out-of-School Learning Environments Promoting Interest in Gene Technology

Ingrid Glowinski & Horst Bayrhuber

Type of presentation: oral

The paper reports data from a study concerning the potential of student labs to promote students' interest in gene technology. This study focuses on the special conditions student labs provide as a new kind of learning environment. Affiliated with universities and research institutes students have an opportunity to take insight in authentic and relevant science and to find another access to the sciences than in school lessons. Students' hands-on activities in student labs play a significant role during the general one day stay and are, therefore, a major research concern. Gene technology provides many occasions for contextualized and authentic learning approaches (e.g. DNA-fingerprint, hereditary disease) and is therefore a well suited subject for analysing students' interest in the student lab as learning environment.

In total 378 upper secondary students completed a questionnaire after they attended a student lab.

Objective of the study was to analyse differences in student perceptions of the student lab conditions based on student attributes (gender, individual interest in the sciences) and based on the grade of integration of their labwork in the student lab in regular classroom lessons. The focus of the paper are students' perceptions of student labs a new learning environment with a special regard to their interest in gene technology.

Information on the students' perception was obtained from a learning environment inventory specifically developed for this study. A questionnaire was constructed according to the person-object- theory of interest and with reference in some aspects to instruments already developed for analysing students' interest in labwork and gene technology.

With regard to interest and knowledge in gene technology factor analysis respectively led to three distinct and independent factors demonstrating that students' enhanced interest and knowledge in gene technology are multi-component concepts. Scales can be characterized as interest/knowledge in general aspects of gene technology, interest /knowledge in gene technology with a strong relation to the conducted experiments in the student lab , and interest/knowledge in labwork and authentic science concerning gene technology. Correlations and regression analyses were conducted with a view to determining the size and direction of relationships as well as the degree to which the relationships were modified by gender, level in school, individual interest and integration in regular school lessons.

Analysis of the Use of Drawings and Scale Models in the Construction of Multi-modal Explanations by Primary Students when Studying the Sense of Sight

Adrianna Gómez Galindo

Based on work supported by the 'Consejo Nacional de Ciencia y Tecnología' (CONACYT) and the 'Secretaría de Educación Pública-Subsecretaria de Educación Básica' (SEP-SEB), Mexico, Grant 48374.

Type of presentation: oral

In biology classes, the use of drawings and scale models is usual. At the same time, several studies have shown students' difficulties to generate representations of biological processes. In this communication, we are interested in analysing the way in which students and teachers construct representations (drawings and scale models or 3d representations) when explaining a biological phenomenon: the human sight. We consider representations within a narrative story, with a sequentially in their production. The overall aim of the activity of representing is to construct theoretical explanations on phenomena of the world.

Our data consists of conversations between teacher and students, and of students' productions. Data was collected in the context of a teaching sequence directed to years 4 and 5 of primary school (students aged 9-11). We randomly chose a team of three students and we identified the ideas that they represented in three drawings and one scale model. We also investigated the role of the teacher in the generation of those representations.

Results show that representations become more and more abstract, integrating ideas that were constructed in previous activities. The entities and relations represented by the students are constrained by different factors; among them, we highlight: 1) the teacher's intentionality, evidenced by her questions and indications; 2) the kind of semiotic register that is used (scale model or drawing), permitting visualisation of certain entities related to the use of different materials; 3) argumentation and meaning negotiation between teacher and students; and 4) the context of the activity.

We could say that, during the construction of multi-modal explanations in the classroom, a complex interaction is generated between the proposed activities, the teacher's role and the use of different representations.

Results indicate that representations function as mediators between students' initial ideas and the theoretical model of reference used to explain. The functionality of mediation had to do with the teachers' activity, which centred students' attention in specific aspects of the model of sight and generated processes of regulation between the represented entities and students' ideas, as well as with the phenomenon to be explained.

Developing Science Teachers' Ability to Manage and Assess Decision-Making Discussions about Biological Conservation Issues.

Marcus Grace, Jenny Byrne, Pam Hanley, Sabina Eggert, Susanne Bögeholz

Type of presentation: oral

Biological conservation scenarios provide powerful examples of the importance and complexity of making decisions about socio-scientific issues. Recent studies have demonstrated how students can perform decision-making activities, but there is a lack of research about science teachers' abilities to teach these skills. Few teachers have experienced training, and are therefore reluctant to engage their students in decision-making discussions. Decision-making in relation to socio-scientific issues has recently been introduced in the new school science curricula in England and Germany.
This study evaluates the impact of a half-day professional development course on decision-making about biological conservation for English and German science teachers. The course culminates in teachers delivering a lesson, and the research evaluates the effectiveness of the lesson in terms of gains for students and teachers. During the course, teachers consider their own views on the conservation issues (as these views might influence how they teach). They grade a selection of students' opinions according to a hierarchical scheme of personal reasoning. They then take part in a discussion about the conservation issues using a decision-making framework, and consider whether the discussion has altered their views. While delivering the lesson they measure their students' personal reasoning about conservation issues, and their involvement in the same decision-making discussion. The researchers have previously used these activities successfully with students, but this has little value unless teachers themselves are able to produce equally effective results.
The main research questions are:

- How effective is the training course at modifying teachers' views about biological conservation issues?
- How effective is the training course at developing teachers' ability to manage and assess decision-making discussions about biological conservation.

Further data will be collected and analysed in spring 2008, but initial findings show that most teachers so far from both countries modified their views on the conservation issues following the discussion. However, there appear to be differences in views on culling (killing) animals between the teachers from England and Germany, and this may affect how they teach their students. The teachers who have so far delivered the lesson have felt confident about managing the decision-making discussions, and successfully assessed students' involvement and progression in personal reasoning about biological conservation. Their prior concerns were rapidly dispelled and they reported a positive impact on their students' understanding of the issues and their decision-making skills, and they were enthusiastic about incorporating this approach into their teaching in future.

Fostering Students' Understanding of Cell Biology by Using "Concept Mapping" as a Metacognitive Tool

Jörg Großschedl

Type of presentation: poster

The problems students have in structuring conceptual knowledge in cell biology has been documented in numerous studies. Expertise research assumes that deficits in applying cognitive and metacognitive learning strategies can be held responsible for problems in building coherent knowledge structures. This study investigates whether the acquisition of conceptual knowledge by reading a text about "membranous systems" can be improved by using innovative learning strategies ("Concept Mapping"; "Concept Mapping" plus instructional support with a metacognitive guideline) as compared to taking notes. An experimental intervention study with a pre-/posttest control group design using two experimental groups and one control group was carried out to clarify the question. Forty four people (M=17.7 years), participants of the 3rd preliminary round of the International Biology Olympiad, took part. Factual and conceptual knowledge were recorded as dependent variables and also checked in the pretest. Multiple choice tests as well as similarity judgments tests (SJTs) were applied to record learning progress. SJTs capture the semantic similarity of concepts, which are compared with each other pairwisely. The acquired data are translated into network representations (PFNets) using the software Pathfinder KNOT®. The quality of the PFNets was assessed by comparison with a reference system and quantified by a graph theoretic index called csim. csim was analyzed concerning its sensitivity in capturing learning progress and its concurrent validity for capturing factual and conceptual knowledge. SJTs proved to be sensitive assessment instruments for capturing learning progress. csim seems to be more sensitive to conceptual aspects ($r=.39$; $p<.01$) of knowledge than to factual aspects ($r=.15$; ns). A MANOVA with repeated measurements found no significant differences between pre- and posttest concerning conceptual knowledge acquisition between the groups. However, the control group outperformed the treatment groups in factual knowledge acquisition ($F[2, 43] = 3.75$; $p < .05$; $d = 0.86$). According to different studies of mathematantics we assume that short time training cannot improve learning progress. Mathematantic effects can be observed when learners who possess efficient learning strategies try to use a strategy other than the one they are familiar with. By instructional support we obtained no positive effects concerning knowledge acquisition.

Modelling Inquiry Competence and its Promotion in a Standard Based Science Teaching Project

Christiane Grube, Stefan Hartmann & Jürgen Mayer

Type of presentation: oral

This paper reports data from a study in lower secondary school. Inquiry skills of 1600 students (aged 10 to 16 years) were tested in a pre-post test at the beginning and the end of a school year. Half of the tested students participated in the project "Biology in Context" which aimes a standard based and competence orientated inquiry learning.

We aimed to create a competence model which describes crucial inquiry skills. Here, we wanted to differentiate empirically four central skills: "formulating questions", "generating hypothesis", "planning of investigation" and "interpreting data". Furthermore, we wanted to investigate the impact of some student characteristics on the increase of inquiry skills. Moreover, this study was aimed to evaluate the potential influence of the participation in the project "Biology in Context" on the progression of student's inquiry skills.

The test was elaborated in a multi matrix design with 24 open-ended test items (six items per proposed skill). We analyzed the data using the Item-response-theory. For all four proposed skills different unidimensional rasch analyses were done with ConQuest. Then, a four-dimensional model was estimated and latent correlations of the four proposed skills were performed. Personal parameters were estimated with different variables such as gender, age, and grade. Afterwards, a factor analysis and correlation analyses as well as comparison of averages in SPSS were done.

Our findings lead us conclude that scientific inquiry can be described as the postulated four-dimensional construct. The multidimensional construct is more consistent than the unidimensional construct, due to a lower model fit. Small to medium-sized correlations were found between the four skills. Factor analysis showed that the four factors are based on one common competence. Even students with higher biology subject knowledge showed higher levels of inquiry competence, the increase of inquiry skills seems not to be influenced by the biology subject knowledge. The lower student's inquiry skills are at the beginning of the school year, the higher are the increases in inquiry skills. Gender and age group did not influence the increase of inquiry skills. In the age group of 13 – 16 year olds, students participating in the project "Biology in Context" had a larger increase in inquiry skills than students from control groups.

Our results indicates that competence orientated open inquiry lessons may provide students inquiry competences. This underlines the importance of open inquiry lessons to promote students ability to understand how scientists work and to reflect scientific findings.

The Influence of Context-Oriented Instruction and Concept Maps on Interest and Achievement

Marion Haugwitz & Angela Sandmann

Type of presentation: oral

The present study investigates the effects of context-oriented instruction and concept mapping as a learning strategy regarding students' interest and learning achievement. One target of the study is to determine whether context-oriented learning has an influence on interest and learning outcome. As there is no sufficient empirical evidence for the effect of context-oriented instruction on achievement as of yet, the study has a second intention: to foster meaningful learning by using the concept mapping technique as a learning aid.

40 students participated in the pilot study and 254 students in the main study. In the intervention phase, students do biological experiments about the heart and the blood circulation in small groups during five consecutive sessions. While working with the learning material, students have the possibility to cooperatively learn biology. Subsequent to every experimental phase, the students are asked to recapitulate their learning outcome.

Students are divided into context-oriented versus non-context-oriented conditions and concept mapping versus summarizing conditions. As a result of the two-factorial design, four treatments are realised, each varying the context-orientation (yes versus no) and the recapitulation strategy (concept mapping versus summarizing).

The effects of the interventional study are measured by achievement tests and motivational questionnaires (pre, post, and attendant). A pre-test is conducted one week beforehand. One week after the intervention phase, a post-test is performed. After every session in the intervention week, the students complete an achievement test as well as a questionnaire concerning their situational interest on the actual learning task.

The results of the pilot study indicate that the implemented context-oriented instruction has negative effects on knowledge acquisition. In terms of situational interest no differences were detected, however the use of the concept mapping technique was able to enhance the learning outcome. According to the findings that not every real life context is interesting for students, the main study is conducted with newly constructed and evaluated contexts. Results of the main study show positive effects of context-orientation on situational interest as well as on achievement (pre/post). Positive effects of concept mapping could be replicated.

In conclusion, the study indicates that only on interestingness evaluated contexts are able to enhance interest and achievement. Additionally, concept mapping seems to be an appropriate technique in biology education to link specific concepts meaningfully and to foster knowledge acquisition.

German and Swedish Teachers' Concepts in Biology Classes between Environmental Education and Education for Sustainable Development

Hauke Hellwig & Annette Upmeier zu Belzen

Type of presentation: poster

The interdisciplinary environmental education in Germany influenced by international and national policy documents is in transformation towards education for sustainable development. This still emerging but dynamic concept encompasses a new vision for education seeking to empower students to accept responsibility for creating a sustainable future.

Investigations to characterise environmental education from a teacher's perspective have been conducted in a couple of European countries.

In a Southern Region of England it was clearly stated by science teachers that they preferred to maintain the integrity of their subject rather than be involved in extensive interdisciplinary teaching. In Sweden three teaching traditions in environmental education have been elaborated: fact-based, normative and pluralistic.

In Germany it is not known in which way biology teachers get influenced in realising biology classes by implementation of the sustainable perspective on environmental education in a top-down process. Systematic research on environmental education is recognised as a deficiency among German researchers.

This study originates from the interest in how biology teachers act at the meeting point of environmental education and sustainable development. The goal is to identify qualitatively differentiable concepts of biology teachers concerning their environmental classes in Germany and Sweden. The focus lies on this target group because the quality of education is considered primarily depending on teachers' efforts.

A concept is characterised by the consistent specification of the basic features for the analysis of classes: explanation context, aims, thematic and methodological structuring as well as it is determined by the latent leitmotivs (intuitive curricula).

Data for the as-is analysis of the teachers' concepts are acquired by a Likert-scale and analysed following the classic test theory. The qualitative basis of the closed questionnaire is a wide item pool collected from biology teachers by an open questionnaire and interviews in both countries. In a pilot survey conducted in Germany five dimensions were identified using factor analysis and the scales were validated by a preliminary investigation. In the quantitative part the final instrument was applied on national level in Germany in April 2008. Using cluster analysis the German teachers' concepts on environmental biology will be investigated and the results will be related to the Agenda 21 theory as well as to the findings in Sweden where four concepts can be distinguished and described. Intended for reference the survey in Sweden was conducted in 2007.

Developing Seventh Graders' Inquiry Skills in Different Levels of Openness: A Comparison between Direct versus Guided-Scientific-Inquiry Instruction

Sandra Hof & Jürgen Mayer

Type of presentation: poster

One important demand in science education is to provide students with competences of scientific inquiry. In contrast to this, the international student assessment programmes show that students in secondary biology education reveal a lack of competence mainly in the field of science process skills. The purpose of this study is to investigate, how seventh graders' develop inquiry skills under various kinds of instruction. The first aim of this research is to investigate, whether there is a better progress in the inquiry competence after an intervention, which is constructed for the promotion of inquiry skills. Second aim is to answer the question, whether the promotion of inquiry skills limits or increases the amount of science content (in the context of photosynthesis). The outcomes of two learning environments are compared: Direct instruction versus guided-scientific-inquiry. In direct instruction, most of the phases of the inquiry process are led by the teacher. In contrast, guided scientific inquiry teaching uses a larger amount of student-centred methods.

The study took place in seventh-grade science classes at secondary schools in Germany. In total, 250 seventh graders and their teachers participated in the study. The experimental group consisted out of four classes, with further four classes control group. The research design included a set of pre-instruction and post-instruction tests on process skills and the content of photosynthesis as well as a ten week intervention. The intervention that consists of 12 activities and investigations was designed and taught by the first author. These activities included for example designing experiments to examine the relationship between variables, collect data and interpret these. Several sources of data (pre-test, post-test, students' production and teachers' description of level of openness to make sure that they taught in the intended ways) were collected over ten weeks.

Results of the pre-test show a low competence in the four inquiry skills formulating questions, generating hypotheses, planning of investigation, and interpreting data. As expected, students have low score in the knowledge test in the topic of photosynthesis, which can easily be explained by the fact that photosynthesis has not yet been taught at that time. Further results of the pre-test as well as the comparison between pre- and post-test will be presented at ERIDOB.

Students´ Attitudes and Values Regarding the Subject "Sexual Orientations" Considering Gender Aspects

Sarah Huch

Type of presentation: poster

Based on the obligatory European educational concept of "gender-mainstreaming" (treaty of Amsterdam 2002) biology lessons should teach students to respect, tolerate, and deal responsibly with all sexual variations of life style without discrimination (BVerfG 2002). The aim of this research project is to investigate students' attitudes and values towards the subject of "sexual orientations" regarding gender aspects. In addition the project focuses on providing the still missing empirical basis for the development of differentiated and gender-oriented sexual education in biology lessons.

Following this educational premise it is necessary to revise those views founded on biologistic thinking which e.g. derives ethical norms from the mere biological function of reproduction.

In the centre of sexual education lies an extended understanding of sexuality, which does not recognise gender roles as merely biological, but also as socially, culturally, and historically founded. In this context the equivalence of sexual orientations plays a primary role. To know about students' attitudes and values is of high importance because they are the foundation of bioethical moral judgement (standards of education, KMK 2004). Attitudes and values consist of cognitive, affective and behavioural components (Stroebe 2003, Eagly & Chaiken 1998).

106 8th graders were asked about their attitudes and values towards sexual orientation, regarding gender aspects. The questionnaire exclusively consisted of open-response items, giving the pupils the possibility to freely express themselves. All data was analysed by qualitative content analysis according to Mayring (2003) assisted by MAXQDA 2007.

The analysis shows gender-oriented attitudes which mostly indicate acceptance of diverse sexual orientations, generally referring to principles of self-determination, the freedom of individual personal development, and human equality laid down in the basic civil rights. Another important point is the universality of love. Pressure against non-heterosexuality, imposed on society by media and education, is criticised.

However, same-sex relationships are mostly rejected, based on religious, biologistic or social rationale, or on emotional responses like disgust.

Based on the results of the qualitative analysis, items for a quantitative questionnaire containing Likert-scales will be designed to examine in a nationwide sample if and how often students' differentiable attitude expressions towards gender-orientation can be found. The results will help to develop educational approaches and recommendations for biology lessons for the first time.

On the poster, a summary of students' attitudes and values resulting from the qualitative study will be presented, together with the planned design of the quantitative questionnaire.

A Domain-specific Planning Model for Biology Teachers

Fred Janssen & Els de Hullu

Type of presentation: poster

Research on teacher planning from the 50's until the mid 80's was largely confined to developing prescriptive and descriptive general planning models. Research has shown that these general models do not provide enough guidance for teachers' lesson planning. Therefore we develop a domain-specific planning model for biology teachers.

The model is subdivided into three dimensions; each consists of several building blocks. The first dimension (content) is derived from analysis of main ways of thinking (perspectives) in the life sciences. The second dimension refers to common aspects of the learning process in main contemporary teaching-learning theories. The third dimension, form, consists of representation forms and the grouping of pupils.

The main question of our explorative research study was: do lessons designed using the domain-specific model differ from lessons designed without the perspectives, and, if so, in what way do they differ? Fifteen student teachers of biology participated in our research. They first studied a school textbook about the topic the human skin. Then they designed a lesson about this topic twice, first without and then with the model.

The lesson plans were analysed according to differences with the textbook and between without and with the model. The domain-specific model was used to analyse all the lessons in terms of content, process, and form.

Our explorative research showed that there are clear differences between lessons student teachers made without and with the model. Most lessons teachers design without the model closely follow the book, which was structured according to a transmission approach. Instead the lesson plans teachers design with the model were more accordance to innovative visions of teaching and learning. They often put content in a meaningful context intended to motivate pupils to ask questions about the content. And in one third of the cases they stimulate pupils to find their own answers.

However, this research has some limitations. The first limitation is the small size of our research group, it would be useful to repeat this research with larger group of student teachers. Secondly, in order to get insights into how the model influence student teacher planning we suggest using thinking aloud en stimulated recall techniques. In addition, further research should focus on teaching practice and reflective evaluations on the basis of lesson plans.

How Do Students Construct Phylogenetic Trees?

Janina Jördens & Marcus Hammann

Type of presentation: oral

This paper reports data from a qualitative study of student conceptions about how to construct a phylogenetic tree. A group of altogether 15 students (9th grade comprehensive school) was interviewed using two different tasks: 1. invented amphibians (Klob 1981) and 2. Caminalcules (Gendron 2000). The tasks were handled by 7 students and 8 students respectively. The students underwent a teaching unit on evolutionary biology before the study, thus they were aware of the context.
We investigated how students construct phylogenetic trees. Our research questions are:

- How do students construct phylogenetic trees?
- How do they reason their choice of the origin and the "terminal" forms respectively?
- How do they explain evolutionary change?

The methodology involves "thinking aloud"-protocols during the construction of a phylogenetic tree and semi-structured, problem-oriented individual interviews with the students. The transcriptions of audio- and videographical documentations are interpreted by means of qualitative content analysis.
The procedure of the students to construct a phylogenetic tree is characterised by three steps: (i) getting an overview of the organisms, (ii) comparison and evaluation of character states, (iii) phylogenetic construction. The analyses of the interviews show a clear dependence of the students` procedure of phylogenetic construction, respectively the resulting phylogenetic trees and the students` conceptions on evolution and evolutionary mechanisms.
Selected student conceptions are:

- Some students explain the bifurcation of the phylogenetic trees for example as a result of cross-breeding of two species, which gives birth to one or more new species.
- When the students selected an ancestral species as the origin of the phylogenetic tree they generally characterised it by a lack of features. As terminal forms the students often chose organisms that resembled animals existing today.
- The students` idea of the further development of ancestral organisms consists for example in the continuous addition of characters or gradually improvement of locomotion and adaptation.

Student conceptions about the process of phylogenetic reconstruction differ from scientific conceptions and must be taken into consideration when teaching the topic. Our focus lies on a systematic study of this hitherto unexplored field of student conceptions and we also plan to evaluate the new teaching approach in the future.

Characterization of the Comprehension of the Biological Core Concept "Homeostasis", Learned Explicitly with Computerized Tools

Sara Klein and Michal Zion

Type of presentation: poster

Homeostasis is a biological core concept that represents the biological essence of living organisms. Homeostasis relates both to the conditions of the inner environment and to the processes and regulatory mechanisms which maintain these conditions. Homeostasis is characterizes by the main principles of complex systems, such as: heterogeneity of components, multiple levels of organization, emergence and tight interdependence of structure-function-behavior.

Concerning comprehension of the concept of homeostasis, there are difficulties which can arise from the need to join the concrete-sensory aspects of homeostasis with the scientific aspects which are abstract and complex. Thus, there is a necessity for formal mental processes, such as system thinking and micro-macro integration.

Recent researches indicated that the concept of complex systems must be taught explicitly, providing „new explanatory framework" and „new intellectual horizons", for learning complex system-related concepts, such as homeostasis. Adding to this, technological tools might have the potential of supporting the process of learning complex system ideas and principles. Thus, the aim of the research is to investigate the comprehension of the concept of homeostasis, as an example of a complex system.

The present research examined the effect of two approaches of instruction (Explicit / Implicit), combined with computerized learning environment, on the comprehension of the homeostasis concept of high school students, majoring in biology. The explicit approach was: Teaching declaratively all the characteristics of homeostasis and then, applying and identifying them in physiological phenomena and processes. The implicit approach was: Teaching biological-physiological phenomena and processes while leading the students towards revealing the concept of homeostasis. We used a variety of computerized tools, all of which have been focused on the function of a certain complex system: lactose operon.

271 biology students from Explicit and Implicit instruction approaches answered two questionnaires, which dealt with eight features of homeostasis, such as: dynamics, feedback, multi-systems, environments, and hierarchical levels of organization. It was found that explicit instruction accompanied by computerized learning environment was favorable, regarding the comprehension of the majority of features of homeostasis. Thus, it is recommended to teach a core-concept such as homeostasis, which represents complex system, by implementation of explicit instruction integrated with computerized learning tools.

Influence of Biology-related Communication on Knowledge Representation

Gesa Kramer, Sandra Nitz, Claudia Nerdel, Helmut Prechtl*

*person who presents the paper

Type of presentation: oral

The competence to communicate about scientific issues is part of scientific literacy which enables people to participate in social discourse on scientific research and development.

This paper reports on a research project that focuses on subject related communication in biology lessons. The study is part of the German project "Biologie im Kontext" that deals with the promotion of competences in biology education. Subject related communication is one out of four competence areas specified in the German national educational standards. According to these, this competence area comprises the ability to acquire biological knowledge from a variety of sources of information as well as to exchange this knowledge with others in a way that is appropriate to a given context and the addressee.

Starting from this definition a theoretically derived model is suggested in order to clarify the structure of the competence of biology related communication. The competence model is based on research about students' beliefs, expertise and domain specific lexicon. Furthermore, it is taking into account theories and research findings about the mental processing of information as well as expert-layman communication and argumentation. This model consists of two main dimensions, the individual representation of content knowledge and the ability to communicate biological knowledge in dialog. Both are subdivided into several sub-competences. Each of them represents one of the relevant aspects mentioned above.

The overall aim of the presented study is the empirical validation of the suggested model. Therefore the postulated dimensions and sub-competences have to be validated empirically. This means they must be detectable, gradable and distinct from each other. Furthermore any interrelations of sub-competences within and across the two dimensions are to be analysed.

The focus of this paper is to determine and to qualify how a dialogical communicative situation influences the individual representation of knowledge.

In a pre-post-test design students' (9^{th} and 10^{th} grade) individual knowledge was measured by a questionnaire and by individual concept maps. In order to stimulate subject specific dialogues students in pairs created collaborative concept maps. These dialogues were videotaped for further evaluation. So far the concept maps have been investigated using graph theory and qualitative content analysis.

The first results of graphical analysis reveal that the dialogical communication of biological content benefits the individual representation of biological knowledge. In order to further qualify this interrelation we analyse the students' statements by means of qualitative content analyses. Detailed results will be presented and discussed.

„I Know What to Do." Ways of Scientific Discovery Processes and Problem Solving

Angelika Kremer & Kirsten Schlüter

Type of presentation: poster

During experimentation in school, group work is often used as a way of allowing students to communicate, argue about and organise the experiments they will do. Through this group work pupils reach decisions on how the experiment will be done, and who will fulfil which business. One possible way of introducing science to young people is to use inquiry-based science teaching. In that manner of teaching children formulate their own questions, produce their own hypotheses, and plan the experiments independently that test the hypotheses made. This self-determined form of science can result in a high level of variability been seen in the knowledge-building processes being used. The aim of this study is to examine this variability.

A video study has been used to investigate which elements of the scientific process and levels of the problem-solving ability are demonstrated by children of grades 4 and 8 and by prospective biology teachers. A random sample consisting of 4 groups (2 male, 2 female persons) of each age (n=48) was used. We videotaped and prepared a transcript of their discussions as well as the student's activities during the inquiry process. The method of investigation followed the rules of qualitative data analysis (Mayring 2000). The aim, using these observations made in a concrete learning situation, is to develop an evaluating matrix reflecting how knowledge is gained in an inquiry process.

First results concerning the 4th grades are presented here: The data demonstrates that children spend a lot of time in talking, while little of this time is actually used for„doing science". Only 8% of the whole discussion involves elements of scientific inquiry (hypothesis, experimental idea, observation, explanation). The rest of the time children are involved in simply „doing the lesson". Single groups do not follow the scientific inquiry process.

The quality of the learning processes presented here can not be determined by just comparing it with an idealised scheme of the scientific discovery process, which follows the sequence of generating hypothesis, planning experiments, observing, and forming explanations. The variety of possible experiments suggested is of interest in the evaluation of independent problem-solving. The groups were (in parts) able to construct meaningful experiments without elucidating a hypothesis with the experiments they conducted.

Relationship between Students´ Inquiry Skills and Beliefs on the Nature of Science

Kerstin Kremer, Detlef Urhahne & Jürgen Mayer

Type of presentation: oral

The development of an adequate understanding of the nature of science (NOS) is a generally accepted educational objective in international science education standards documents. Students should learn to understand the purpose of science as well as the general assumptions, values and beliefs underlying scientific knowledge. So far, the fostering of students´ understanding of the nature of science has been widely neglected in german schools. Due to these circumstances our research wants to elucidate deficiences in german science education as well as predict strategies in developing substancially improved NOS views. Towards this aim the study presented here assesses relationships of students´ inquiry skills and their beliefs on the nature of science.

NOS beliefs and inquiry skills of 299 participating lower secondary students (154 female, 145 male) were assessed. The participating students went to fifth (n = 31), sixth (n = 50), seventh (n = 50), eighth (n = 58) and ninth (n = 110) class. Students´ inquiry skills were assessed by a paper-and-pencil-test with open items assessing the skills "Formulating questions", "Generating hypotheses", "Planning of investigation" and "Interpreting data". Students´ beliefs on the nature of science were measured by a 44-item questionnaire containing statement items on the seven NOS dimensions source, certainty, development, justfication, simplicity and purpose of science as well as creativity of scientists.

Relying on the data, students´ partly insufficient beliefs on the nature of science became apparent. Students´ beliefs are higher developed when students are in higher classes. Moreover, students with higher developed skills in formulating scientific questions, generating hypotheses, planing experiments, and interpreting data show more improved beliefs on the nature of science. Especially the dimensions source, certainty, development, justification and purpose of science are significantly correlated to the inquiry skills. Moreover, it becomes evident from the data that inquiry skills are one however not the only factor influencing students´ NOS views. From this finding the conclusion could be drawn that in addition to the fostering of inquiry skills, informed NOS understanding may be initiated by alternative ways of instruction, e.g. by addressing important aspects of the nature of science in an explicit and reflective manner.

Science Education and Biology Education: To What Extent are Theories in Science Education Generalisable across Disciplines?

Jenny Lewis

Type of presentation: oral

From many years there has been a growing concern, particularly among researchers in biology education, about the extent to which research findings from one context (most usually physics education) can be applied directly to other contexts (particularly biology education). Starting with a potentially very useful theoretical construct – Learning Demand – this paper explores the issue. An initial analysis identifies some aspects of the construct which need slight modification when applied to a biological context. The way in which this construct was used to inform the design of a plant nutrition teaching sequence is presented and leads to the conclusion that, with slight modification, the construct can usefully be applied to biological contexts.

"Biology in Context" (bik): Using Learning Communities to Realize Context- and Competence Oriented Biology Education

Markus Lücken & Doris Elster

Type of presentation: oral

In the German project "Biology in Context" (bik) learning communities, consisting of teachers, researchers and representatives of the educational administration, develop context- and competence-oriented tasks and instructions over a period of three years. Three aspects were addressed to evaluate the effectiveness of this project: (1) the implementation processes were analyzed by looking at the development of teachers' attitudes and behaviour as well as of students' competencies and interest in biology education. Based on Ajzen's theory of planned behaviour, influence factors on teachers' behaviour concerning the implementation of competence-oriented instruction were suggested: teachers' attitude, their perceived support by colleagues and principals as well as their self-efficacy. (2) The process of teacher professionalism was evaluated in a formative way during the regular meetings of the learning communities. (3) The amount of dissemination of the bik-conception was investigated by querying principals and colleagues of the participating schools.
146 teachers and about 2500 students participated in the evaluation research. Longitudinal Data is available from the start of the project and from two follow-up-tests after one and two years of the current project. The process of teacher professionalism in the learning communities was documented with questionnaires and protocols and complemented with qualitative interviews. In addition, 95 colleagues and 62 principals of the participating schools were queried with questionnaires to get information about the dissemination of bik within the schools.
First, examples of successful instruction in bik are presented to illustrate the outcome of the project. The results of the implementation evaluation show that, though teachers' attitudes towards context- and competence oriented teaching did not change during the first year of the project, their self-efficacy had increased significantly resulting into a stronger intention to implement the bik-approach in their classroom. In addition, multiple regression analyses confirmed our prediction model. Additional regression analyses suggested that students' perceptions of competence oriented education influenced students' interests in biology education and their self-assessment of their competencies.
The results concerning the process of teacher professionalism revealed that teachers increasingly reflect upon their classroom behaviour and cooperate with the other members of their learning communities. The data from dissemination research indicated that colleagues and principals do indeed support the engagement of the bik-teachers. In general, bik was quite successful in changing biology classroom activities into more competence-oriented biology education and in implementing the bik approach. The use of learning communities has turned to be an effective approach for teacher professionalism in biology education.

Why Do Students Choose to Study Biology?

Anna Marbà Tallada & Conxita Márquez Bargalló

Type of presentation: poster

There is a widely held perception that careers in science, engineering and technology are very unattractive and hold little appeal for young people (European Commission, 2004). However, some students keep on studying science. In Catalunya, Biology seems to be in a better position than Physics or Chemistry. Determining which factors influence biology enrolment choices and compare them with other science degree enrolment factors would help us in thinking how can improve current students willingness to study science after the compulsory school.

The research reported in this work is concern with student perception of which factors had influenced them to enrol a science career. Some of the factors reported in the literature that influence or not the enrolment decisions are peers, teachers and parents as well as the learning environment.

Even though the relation of peers attitudes and student attitude are tenuous (Dalgety & Coll, 2004) some researches have reported evidences of peer influence in student enrolment (Kremer & Walberg, 1981; Panizzon & Levins, 1997; Talton & Simpson, 1987).

There is no agreement regarding parents influence on student science enrolment. For example (Schibeci, 1989) suggests that the home background has no influence to student attitude toward science. However, some other researches have shown that this influence exists (Crawley & Black, 1992; George & Kaplan, 1998; Woolnough, 1994). For example, George & Kaplan (1998) conclude that parental involvement has significant effects on science attitudes because of the participation of extracurricular science activities or visiting libraries and museums.

Regarding teachers and learning environment, there is a great agreement about its influence. For example, some evidences of the influence of the learning environment could be found in George & Taylor (2001). These authors reveal that students who enjoyed their learning experiences in junior science achieved good results in science were confident in their ability are more likely to enrol in physics. Other researchers document the importance of teacher's role in enrolment decision (Haladyna, Olsen, & Shaughnessy, 1982; Wright & Hounshell, 1981).

Acknowledgement

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Biology Teachers: How They Teach and How They Talk about It

Sabine Marsch & Dirk Krüger

Type of presentation: oral

Metaphors are pervasive in everyday life, not only in language but also in thought and action. Experiences of a source domain (e. g. *experiences on a journey*) are transferred to an abstract target domain (e.g. Teaching and Learning is a journey). In this research project, the relationship between metaphors of teaching and learning processes and the performance in class is analyzed. Interviews with biology teachers reveal their conceptual metaphors about teaching and learning, and video observations are used for evaluating their teaching style.

The theoretical basis of this investigation consists of Moderate Constructivism (Reinmann & Mandl 2006) and Experiential Realism (Gropengießer 2007), including the Cognitive Theory of Metaphor (Lakoff & Johnson 1980). As criteria for analyzing biology lessons, the following criteria of constructivist learning environments were used: active, constructive, collaborative, self-directed and contextualized.

Systematic Metaphor Analysis (Schmitt 2003) and Qualitative Content Analysis (Mayring 2003) were used to examine the interviews. The results are conceptual metaphors of teaching and learning from different source domains (e.g. Learning and teaching is a journey). For analyzing the video taped lessons a category system that combines qualitative and quantitative aspects of constructivist criteria was developed to evaluate the biology teachers' way of teaching.

The following example of a conceptual metaphor is specified in detail and connected to the performance in class. The teaching and learning process can be described as a journey from a start to a goal. The interviewed teachers used different alternatives of this concept to describe their individual roles as biology teachers, for example, the teacher as a mountain tour guide, which is a rather constructivist picture of a teacher, or the teacher as a ship that carries the students over the sea, which reveals more instructional beliefs about teaching and learning. The different notions of the conceptual metaphor Learning and teaching is a journey suggest that metaphors not only affect the way we talk but also the way we act, causing different teaching styles. The first thing that we saw was that teachers who use constructivist metaphors of teaching and learning create more constructivist learning environments than teachers who use instructional principles.

The summary of our results leads to the assumption that there is a tight connection between metaphorical principles and performance in class. Therefore we assume metaphors as helpful tools in biology teacher education to change conceptions of teaching and learning to a more constructivist view.

What Is the Visual Impact of Wildlife Dioramas on Primary School Children and How Is This Expressed in Drawing?

Edward Mifsud, Sue Dale Tunnicliffe & Ralph Levinson

Type of presentation: poster

This study analysed the drawings of animals and plants made by 7 to 8 year old (Year 4) children immediately before and after a visit to the dioramas at the Natural History Museum, Mdina, Malta. The objective of the study was to gain insight into children's understandings of animals and plants, habitats and human constructed artifacts through observations of new dioramas of Maltese habitats at the museum. The theoretical framework draws on informal learning, constructivism and previous research on children's understanding of the natural world. A methodology was developed to interpret the children's drawings and to assess the differences between what they thought they would see and what they remembered following the museum visit. The drawings were analysed using a systemic network used to provide categorical data, with the ordinate categories of the network emerging from the drawings. The majority of the pre-visit drawing from the children showed expressed models of basic isolated animal outlines familiar to children in urban environments, with an almost complete lack of plant live. Drawings were flat with no perspective and context. The post-visit drawings were much richer in detail, number of items included and had a context indicating that children had accommodated some observations into their mental models. The results indicate that looking at such dioramas enables the children to observe with meaning and recall biological details of what they saw and set this within the context in which the specimens were viewed.

The Nature of Visual Literacy in the Molecular Life Sciences

L.E. Mnguni, T.R Anderson and K.J Schönborn

Type of presentation: oral

The use of external representations (ERs) for teaching and learning in the Molecular Life Sciences (MLS), is rapidly increasing. Some research has shown that ERs can have a superior advantage over text alone, while other studies have indicated a number of concerns coupled with the use of ERs for education purposes. Such problems may emanate from the lack of visualization skills. The current study aimed to investigate the nature of visual literacy (VL) by identifying what visualization skills might compose optimal (expert) visual literacy in the MLS and, to devise a means of measuring the VL levels of MLS students. Towards these aims, we addressed the following research questions: *i*) What visualization skills are used in MLS? *ii*) What is the order of difficulty of these visualization skills? and *iii*) Can visualization skills be used to define specific levels of VL in the MLS? A literature search was used to identify potential visualization skills. These were used to develop probes in the context of Biochemistry. The probes were administered to 3rd year Biochemistry students who were also interviewed. Results were analysed qualitatively and quantitatively. The later analysis utilized the Rasch model to generate an item difficulty map. The results showed that relevant visualization skills can be identified, reliably measured in students, and ranked according to level of difficulty using the Rasch model. The results also revealed that VL is both context based, in that it requires specific Biochemistry propositional knowledge, and multifaceted in nature in that it is composed of an infinite number of visualization skills suggesting a continuous scale, rather than discernable levels. The probes also enabled the identification of various visualization and non-visualization difficulties which contributed to the differences in VL levels between Biochemistry students. In conclusion, the results showed that the devised probes, and item difficulty map, were effective in providing an indication of a students' relative VL levels in the Biochemistry class under study, but that further research is required to fully establish its use as a generic test for VL in the MLSs.

Classifying Levels of Students' Inquiry Competence in Lower Secondary Biology Education

Andrea Möller

Type of presentation: oral

Although inquiry competence was officially integrated in the 2004 German Federal Education Standards, results of international student assessment programs as well as several educational research analyses show that German students in lower secondary biology education (grades 5-10) still lack competence especially in the field of scientific problem solving and science process skills. The aim of our study was to empirically differentiate and classify levels of inquiry competence in order to create a tool for studying the development of students' inquiry competence. The levels will enable a systematic promotion of individual inquiry competences and their assessment.

On the basis of 24 open test items a multi-matrix design was used to test 1553 German students (grades 5-10) on their inquiry competence. The used items equally represented the four inquiry skills "formulating questions", "generating hypotheses", "planning of investigation", and "interpreting data". For each skill five competence levels were predicted, hierarchised after degree of difficulty based on levels of complexity and a qualitative grading according to problem-solving processes.

All five predicted qualitative competence levels for each skill were identified in the students' test answers. The percentages of lower levels in all four skills decreased, while higher levels increased with grade. Age alone had no impact on inquiry competence levels. The percentage of students that reached none of the predicted competence levels is found highest in the inquiry skills "formulating questions" and "planning of investigation". Higher levels are positively correlated with biology subject knowledge. The percentage of level 3, which represents the requirements of national education standards, increases with grade, however less than expected. Overall, students' inquiry abilities are lower than required in the German Federal Education Standards for biology education in grade 5-10.

Our results strongly suggest that scientific inquiry has to be implemented as a standard within the German science curriculum. In addition, the findings of this work may provide guidelines for teachers on how to assess and work on students' competences individually. Implications for the development of novel teaching concepts that are adjusted to different performance levels will be discussed.

Teacher Scripts in Biology

Rute Monteiro, José Carrillo and Santiago Aguaded

Type of presentation: poster

The awareness of the scripts by teachers is of a crucial importance when reflecting about their practice and may lead to an improvement in their teaching actions. In this study, supported by classroom video recordings, we have modelised the teaching of a novice teacher, using a modelling instrument (MI) by Monteiro (2006) and Monteiro et al. (2007), that allows the identification of scripts implemented by teachers in their classes and, simultaneously, the characterisation of beliefs, goals and knowledge that come into play when a teacher teaches about the biology topic of *Diversity of Plants*. The teaching modelisation enables teachers to identify their self scripts and, consequently, to have the opportunity to access their own thought as beliefs, goals and knowledge, underlying their action. Additionally, the teacher could construct new action sequences or even reconstruct his scripts, incorporating more innovate or desirable aspects, maintaining its compatibility for action.

The Space Shuttle - a Thematically Organised Instruction as an Introduction to Ecology Teaching

Helena Näs & Christina Ottander

Type of presentation: poster

This paper presents students' and teachers' work with a thematically organised instruction, the Space Shuttle (figure 1), which was used as an introduction to an ecology unit. Our aim was to examine three classes (eight graders), their ordinary classrooms' learning environments and what opportunities they got to learn. The study is qualitative and an ethnographic method is used including observations and interviews. Data presented will show the classrooms' working atmosphere, students' discussions and the subject content.

During the first lesson with the space shuttle the discussions about populations and ecosystems were intense. Deeper questions around complex topics quickly appeared, but the students got stuck and changed subject. The teachers' circulated in the classroom but didn't intervene much. When the students presented the space shuttle task three lessons later, the students' subject content knowledge showed no progress compared to the first lesson. The task's potential in ecology teaching and students' opportunities to learn during their work will be presented and discussed.

Students' and Scientists' Conceptions of Global Warming

Kai Niebert & Harald Gropengießer

Type of presentation: oral

The enhanced greenhouse effect, leading to global warming is one of the greatest challenges facing humankind in the 21st century (IPCC 2007). Translating public concern for global warming into effective personal action, requires knowledge about the causes and risks of climate change (UNCED 1992; Bord et al. 2000). Empirical studies show that students' conceptions of causes, mechanisms and consequences of global change are different from scientists' concepts (Schreiner et al. 2005). One main difficulty in understanding global climate change is the lack of direct experience. The aim of this study is to develop evidence-based and theory-guided interventions and communication strategies to teach aspects of global warming.

This study is framed by two different theories of learning: A moderate constructivist epistemology (Riemeier 2007) which states that students construct their own conceptions and the theory of experiential realism (Gropengießer 2007) which is used in order to gain a deeper understanding of students' conceptions of global warming. From this perspective the following questions were investigated: (1) Which conceptions do scientists and students have of global warming? (2) Which different and shared views can be drawn between students' and scientists' conceptions of global warming? (3) Which every-day-concepts can foster or hinder conceptual development in understanding global warming?

The research design is based on the model of educational reconstruction (Kattmann 2007). An interview study (n = 16) with semi-structured guideline-oriented interviews was conducted to find out students conceptions of global warming. Scientists' conceptions were analysed from different scientific textbooks (Smith & Smith 2006, Campbell & Reece 2002, Schönwiese 2003) and the latest assessment report on climate change of IPCC (IPCC 2007).

The interviews as well as the textbooks and reports were analyzed using qualitative content analysis (Mayring 2002) and systematic metaphor analysis (Schmitt 2003).

Based on the theory of experiential realism three different concepts of the causes of global warming were found. All these concepts use container schemata of the global carbon cycle to explain the causes of global warming. They differ in the number of containers and the pathway of carbon-flow between the containers. Students and scientists explain the mechanisms of global warming with three different container schemata, as a flowing of energy between the container *atmosphere* and its environment, outer space.

Besides this, different receptions of the term *warming* and *heating* were found in the metaphor analysis.

Spontaneous and Scientific Reasoning - Students´ Grappling with Content and Language Patterns

Clas Olander

Type of presentation: poster

Learning science involves learning to talk science or more precisely mastering the social language of school science. From the learner's perspective their first and "native" language is expressed with spontaneous and informal reasoning, which grows from every day experiences. In that respect it is school science that offers students an alternative way of explaining natural phenomena, when introducing a more formal reasoning. This difference in articulating phenomena, informal and formal, is what the notion of learning demand refers to. Differences are visible in the use of conceptual tools, their epistemological underpinning and ontological base. If the differences in relation to a specific topic are large you could expect learning and teaching extra challenging. Such an area is the evolution of life on earth, which is this study's´ topic.

This paper reports from a study were students after following a teaching intervention did reason significantly more in line with a scientific view than a comparable national sample did. The teaching strategy was to introduce the theory of evolution as a tool with many opportunities to discuss students´ own ideas. Teaching in science often makes use of concepts, theories and/or models; these can be applied in at least two different ways. First, as end points i.e. facts the students are supposed to learn more or less by heart and secondly as means; tools that scaffold student's meaning-making. It was in the latter way the teachers planned their use theory. Aim of the paper is to investigate how the teaching strategy was perceived by the students, who all were fifteen years old. Which themes and critical features in relation to conceptual issues do students raise and what language patterns do students themselves discern when talking in peer group activities.

Analysis of talk in group discussions shows that students negotiate meaning while probing key terms´ potential as explanation, although seldom explicitly uttering the actual key terms. Furthermore students do discern different thematic patterns and they oscillate between informal and formal reasoning. It means shifts between personal, specific and situated reasoning to more generalised and impersonal expressions. Theoretically this way of constituting learning demands could be seen as a methodological development and it has the potential of enhancing teachers' performance of assessment for learning.

'The Conservation Club Effect': An Impact Assessment of Biodiversity Conservation Awareness in Some Selected Nigerian Secondary Schools

Folasade Olubunmi-Esan, Adedokun Adebowale & Abolaji Mayowa

Type of presentation: poster

This study determined the effectiveness of Conservation clubs in facilitating positive Environmental knowledge, attitude, and skills among Nigeria secondary school students, through an informal School-based environmental intervention strategy. The Study adopted ex-post facto design, using 10 schools Randomly selected to know the level of conservation Awareness of students (Biology students inclusive). The schools were carefully selected to cover the Bio geographical location of the state. The subjects Involved in the study were 600 students from the randomly selected schools within Ibadan metropolis of Oyo-State, Nigeria. The instrument used to collect data was an environment knowledge scale (EKS). Student's performance on the environmental knowledge Scale of 300 environmental conservation club members was compared to that of 300 non-members. Inferential statistics of independent 't' test was used to compare both groups. From the result obtained it showed that club members performed significantly better than non-members; and among environmental conservation club Members themselves that male and females did not differ significantly. Based on the findings, it is recommended that to fosters awareness, environmental knowledge, attitude, values, commitment, skills and environmental responsibilities in students and the whole nations for sound use of the earth's resources and for the protection and improvement of our environment for the present and future generations, environmental education programmes should be advocated to increased the understanding of the students. The school curriculum should incorporate environmental education programmes. Also, environmental education must be properly communicated to the students in a way that will bring about favourable conceptual knowledge, behaviour and strategies that will foster sustainable development.

Recognition of Scientific Arguments in Primary Literature by Bachelor Biology Students

Miriam Ossevoort, Edwin van Lacum & Martin Goedhart

Type of presentation: oral

This paper reports data that are part of a larger research project with a main focus on the development of a curriculum for scientific argumentation for bachelor biology students. The aim of our study was to discover whether students are able to identify the argumentative framework of primary literature. Therefore, the students had to recognize and paraphrase the fundamental components (research question, methods, results and conclusion) of a research article. In addition, we evaluated the usefulness of the Toulmin argumentation model as a tool for students to make explicit to what extent claims are supported or refuted.

A group of ten third-year bachelor biology students individually read a scientific article ('letter to Nature') concerning a new vaccination method against Ebola. Each student had to reformulate the research question, methods, results and conclusion and underline the corresponding text fragments. The answers of the students were analysed for factual correctness, categorical correctness and completeness. Furthermore, the methodology included a questionnaire about the students' experience with reading and analyzing primary literature (perceived difficulty, time consumption, ect) and their perceptions of their abilities to read scientific articles. Two weeks after the individual assignment, the group of ten students were divided into two subgroups. In a group session, each subgroup had to agree about the main conclusions described in the research article and write these on a poster. Thereafter, the teacher presented the Toulmin model and the group was asked to apply this model on the content of their poster. All written documents were collected and all conversations were video-taped and transcribed.

The results show that all students indicated that they did not learn to read primary literature in a systemic and critical way. Furthermore, a majority of the students failed to phrase the research question, methods, results and conclusions of the article in a complete and accurate way. The argumentative framework written on a poster during the group discussion was incomplete and differed from the students' individual answers on the assignment. The Toulmin model was helpful.

This study shows the necessity of developing a curriculum in which students learn to identify, validate and construct scientific arguments. Some criteria for the design of such curriculum were revealed.

Teacher Reasoning on What They Can Plan for in a Biology Course in Upper Secondary School, Sweden

Maria Pettersson

Type of presentation: poster

As part of a research study on what science content teacher choose for teaching evolution in a biology course, 21 experienced teachers are interviewed on how they plan their courses. This study reports on how teachers interpret the curriculum and how they make the content appropriate for their students. In this paper I investigated if there are any possibilities for the teachers to make choices of what and how to teach. Generally, the study reports on how the teachers reason on the character of the biology course.

The main findings of this study are that the teachers regard biology as a school subject as quite well defined. They find the content in biology as a school subject similar from year to year, with little changes. There are few pedagogical reasons for a specific hierarchical sequence in teaching biology so that there is no fixed sequence necessary according to the teachers. I conclude that teachers are quite free to make decisions on what to teach in this course. From the interviews it is seen that there is a variety of aims and plans for the courses.

Teachers describe the aims for the course to be orientating, for literacy and for further studies. They also argue that the course will give students abilities to be prepared for further studies, strengthen the students "self", prepare them for democracy and for science literacy, change students' ways of interpreting the world around them, understand different worldviews. (especially the scientific worldview),realize that biology is interesting and "*to show biologist are "enthusiastic and well-informed*", and understand the identity of biology as "school content".

The biology course is characterised in different ways, but by many as an ecology course, with fieldwork. Evolution is taught both as an implicit perspective and as a defined topic in the course.

A Teaching and Learning Strategy and Guidelines for the Effective Use of Arrow Symbolism in Biology Diagrams

Lynn du Plessis & Trevor R. Anderson

Type of presentation: poster

In previous qualitative studies we showed that students experience a wide range of difficulties with the interpretation of arrow symbolism in biology diagrams. Categorisation of these difficulties suggested that they could be ascribed to the great diversity of modes of presentation, purpose and meaning of arrow symbolism; to difficulty with surface- and deeper-levels of reasoning; and, to students' inadequate frames of reference. Empirical data from this study, together with an extensive literature review, subsequently informed the development of a 3-tier non-linear model to explain the process of interpretation of arrow symbolism and to pin-point and/or predict any related difficulties. These findings led to the formulation of the following research question, addressed in the present study: What measures can be developed to improve students' use of arrow symbolism in biology diagrams? The aim, therefore, was to identify suitable teaching and learning strategies and guidelines to prevent and remediate difficulties with the interpretation of arrow symbolism. To address this question, student responses to two series of probes and interviews were classified by inductive analysis into categories of difficulty according to their potential source, namely the diverse modes of presentation, purpose and meanings of arrows; reasoning difficulties; and, inadequate frames of reference. These categories were then matched to the appropriate facet of the 3-tier, non-linear model and possible sequences of interpretation suggested by the model were identified. The categorisations and interpretation sequences were then integrated with guidelines and strategies presented in the literature in order to develop an instructional strategy to improve the use of arrow symbolism in teaching and learning. The following research outcomes were achieved:

A 12-point strategy for interpretation of arrow symbolism suitable for educators to educate students in the interpretation of arrow symbolism; and,

An interactive checklist or set of guidelines for guiding students when practising the skill of arrow interpretation.

In our opinion, these strategies and guidelines are comprehensive in that they address all known student difficulties with arrow symbolism in teaching and learning with biology diagrams.

A Longitudinal Study in the Context of Attitude Development of Learners and the Transition between Primary School and Secondary School in Berlin

*Alexandra Pleus & Annette Upmeier zu Belzen**

*person who presents the poster

Type of presentation: poster

This longitudinal study is based on researches on learners' attitudes towards school in general and Natural Sciences for primary school (Christen 2004) as well as Biology for secondary school levels (Upmeier zu Belzen & Christen 2004).

Central aspects of this work are the transitions between the subjects "Sachunterricht" and Natural Sciences as well as between Natural Sciences and Biology. Another point of view is the general importance of the topic biology within these subjects.

Transitions often implicate problems like social disparity, pressure to perform and are realized as meaningful incidences.

Previous researches pointed out that the methodical design of education influences the attitude development. These studies don't take into account how Biology as a discipline is constituted and perceived. In the social psychology more influencing factors are identified like the climate of class, behave with classmates and their behaviour as well as essentially the teacher.

In course of the longitudinal study three data collections have been made between 2006 and 2008. The attitudes of 1543 learners at four primary schools and two secondary schools are identified by closed questionnaires. The sample contained pupils from grade 1 to grade 6.

In the framework of interviews causes for attitude development with regard to the transition should be identified by the research. The design of the interviews depends on conclusions of the second data collection. Pupils of four primary schools will be interviewed pre and past the transition in 2008.

The first out of three waves of data collection in 2006 has shown the distribution of different attitude levels in Berlin and it allows a comparison with previous results of other regions of Germany. Furthermore the conclusions of the quasi-longitudinal study point out that Berlin with the six years of primary school and the school subject Natural Sciences taught in grade 5 and 6 generally produce a more positive attitude development. This assumption is supported by the conclusions in 2007 after the second data collection.

What Do 9th Grade Students Consider as Evidence for or Against Claims about Genetic Differences in Intelligence between Black and White "Races"?

Blanca Puig & María Pilar Jiménez-Aleixandre

Type of presentation: oral

The work reported here makes part of a study about secondary school students' use of evidence and argumentation about biological determinism, belonging to a research project about the use of evidence. The objective is to examine what do students consider appropriate evidence for or against claims about genetic differences in intelligence between black and white persons. The study is framed in argumentation studies (Erduran & Jiménez-Aleixandre, 2008; Toulmin, 1958) and in the literature about socio-scientific issues in science learning (Molinatti, 2007; Sadler & Donnelly, 2006), in particular the issue of biological determinism. The participants are an intact group of 9 graders, 14-15 years old (N = 24) and their teacher. The students were presented with Watson's claim, in October 2007, about black people being less intelligent than white, and with four pieces of information related to the influence of environment on people or animal performances, and asked to evaluate these four items in terms of evidence for or against Watson's claim. The data collected include individual written responses and recordings in video and audio of students' discussions in small groups. Using discourse analysis methodologies the students' verbal and written utterances were coded, in terms of their appreciation of the role of evidence; the categories emerged in interaction with data. The students' responses were also examined in terms of whether they reflected biological determinism or interaction perspectives. The results show that there is a wide range of their appreciation of the role of evidence, which we think is best represented as a continuum from students exhibiting a clear understanding about what means support or rebuttal for a claim, to others who are not able to distinguish claim from evidence. There were differences in the acknowledgement as evidence of the information presented in the four items. Although most students rejected what they perceived to be a racist claim, there is a certain proportion using implicit determinist views. The consistency of individual responses in each of the four items, and among written and verbal utterances is explored. The interactions among the understanding of evidence and the ethical dimensions related to a claim that a majority of students perceived as being racist are also examined. Implications for the teaching of genetics are outlined.

Educational Value of Interactive Hands-on Exhibits in a Natural History Museum

Matthias Recke & Ute Harms

Type of presentation: poster

Interactive hands-on exhibits are common and favourit tools of modern exhibition architecture in Science Centers. Numerous research works about the educational value of hands-on exhibits and about visits in Science Centers support that cognitive activities and learning processes take place (Tulley & Lucas 1991). However, also incorrect explanations are being generated (Afonso & Gilbert, 2007). Furthermore, conceptual knowledge and complex learning processes stimulated by museum visits are very difficult to investigate (Falk & Storksdiek 2005).

In this study we investigate the educational value of a typical interactive hands-on exhibit, which will be integrated in a conservative and classical natural history museum. In the department of mammals we form a distinct area about the theme "Hearing" (title: "Huge Ears - Good Audio Sense"), which is supplemented by a hands-on exhibit that promotes this meaning very strongly. Step by step, this constellation will be extended by various information media like pictures, textual explanations and objects to emphasize clearly the antithesis, that big ears are not definitely necessary for being able to hear very well.

We intend to achieve a cognitive conflict by promoting a creative and thematic guideline which seems to be inconsistent at first, but lead to the awareness, that hearing is a complex theme with various aspects. We integrate distinct elements into the didactic of the exhibition that should enhance a cognitive conflict and lead to a change of visitors´ conceptions about the presented theme.

The research questions are:

- What kind of learning processes and experiences occur when visitors deal with the opposed information?
- Does a cognitive conflict support the educational value?
- Which factors influence the generation of a cognitive conflict?

The investigation will be conducted by interviews as well as criteria- and performance- based questionnaires with students and regular visitors. The variations in the exhibition´s didactic (information media and guideline) mark the independent variable, the gain of knowledge and indicators of conceptual learning processes will be the measurable dependent variable. A pre- and posttest measurement using a control-group design will be established to investigate the process of a conceptual change and concrete knowledge gains.

Imagining the World: the Significance of Religious Worldviews for Science Education

Michael Reiss

Type of presentation: poster

For many science educators the relationship between science and religion, i.e. what is sometimes referred to as the 'science/religion issue', may appear somewhat outside the scope of science education. However, a range of factors suggests that this perspective may be too narrow. These factors include a greater awareness of the benefits of dealing explicitly in the school classroom with the nature of science (Lederman, 2007) and, more particularly, the increasing significance of creationism and intelligent design in a number of countries (Jones & Reiss, 2007), particularly, but not just, the USA.

Here I attempt first, to examine whether 'science' and 'religion' can better be seen, for the purposes of school science education, as distinct or related worldviews, focusing particularly on scientific and religious understandings of biodiversity. Secondly, to explore the ways in which people can see the natural world in a certain way, depending on their worldview, by looking at two contrasting treatments of penguin behaviour. Thirdly, to draw some initial conclusions as to what might and what might not be included about religion in school science lessons.

Part of the methodology consists of a conceptual analysis of the possible relationship between the domains of science and religion; part of it consists of a discourse analysis of the film *March of the Penguins* and the children's book *And Tango Makes Three*.

The results show how important worldviews are for how people can understand aspects of the natural world. At the very least, science educators and teachers need to take account of religious worldviews if some students are better to understand the compass of scientific thinking and some of science's key conclusions, including the theory of evolution. Little is to be gained and much lost by ridiculing non-scientific worldviews. It is perfectly possible, I argue, for a science teacher to be respectful of the positions that students hold, even if these are scientifically limited, indeed, to engage with these positions, while clearly and non-apologetically but sensitively helping students to understand the scientific worldview on a particular issue, whether biodiversity or otherwise.

Stingers in Pupils' Decision -Modifying Student's Aesthetic Decision of "Nettles" and "Thistles" through Interaction with Plants (Urtica dioica, Cirsium arvense)

Carolin Retzlaff-Fürst

Type of presentation: oral

Some plants sometimes are not being liked by Humans because they are spiny or look ugly. Sometimes bad experiences with plants compound this problem. Such an emotional rejection might hinder people from developing an interest in these plants and their habitats. We analysed the aesthetic decision of pupils about such "less attractive plants" like nettles (*Urtica dioica*) and thistles (*Cirsium arvense*, the Standard English name in its native area is Creeping Thistle). We tried to modify their opinion by presenting the same plant in another perspective and interaction with these plants. The study is based on the model of Retzlaff-Fürst (2000) that, at a detailed perspective, the aesthetic decision is based on the form of biological objects, while content related factors become less important. The model was already successful implemented for the assessment of the aesthetic decision about different invertebrates. Here we present results of a preliminary study with 34 pupils of year 8 and 28 pupils of year 9. The test plants were fresh exemplars of nettles (*Urtica dioica*) and thistles (*Cirsium arvense*).

The methodical procedure was as follows: Pupils of year 8 and year 9 were told to observe living plants before and after a 2-hour-practical (intervention) and give an aesthetic judgement. During the intervention – called plant workshop – the pupils conducted various observations with living nettles (*Urtica dioica*) and thistles (*Cirsium arvense*). The respective aesthetic judgements were recorded in a questionnaire.

The first results showed that the aesthetic judgements of pupils of year 8 and year 9 are not established. We confirm the hypothesis, that the aesthetic decision of pupil about living organisms is not consistent, but can changes with the perspective plants are looked at. On the contrary to former results with living creepy crawlies (*Porcellio scaber*, *Oniscus asellus* -Woodlouse, *Lithobius forficatus* -Centipedes-, *Arion ater* -Black slug-) we cant confirm that the decision was more positive for the detailed perspective than for the normal perspective (Retzlaff-Fürst 2005). The aesthetic decision in normal perspective was little more positive before and after intervention than in detailed perspective.

Critical Features of Visualization of Protein Function – An Empirical Study of Students' Meaning-Making of Diagrams and an Animation

Carl-Johan Rundgren & Lena A. E. Tibell

Type of presentation: oral

Ever since Watson's & Crick's first image of the double helix of DNA was published in 1953, the use of visualizations in molecular life science has continued to grow in importance. Several studies of students' interpretation of images and other forms of visualizations have been conducted in science education research, especially physics. These studies have shown that ambiguities, simplifications and potentially misleading elements in the design of visualizations can give rise to unexpected difficulties or alternative interpretations.

In this study we are using *variation theory* as a framework for our analysis. According to variation theory, which can be characterized as a theoretical development and framework for phenomenographic research, variation in how a phenomenon is experienced by a learner is decisive for the learning outcome. According to variation theory, there are some critical features that correspond to the aspects of a phenomenon that makes the student grasp the content. The key objective of this investigation is to study which *critical features* of biomolecular processes involving proteins can be discerned using still images as compared to an animation.

In the study, a set of 107 students taking different variants of the natural science program in the second (grade 11) or third (grade 12) year of their upper secondary education answered a questionnaire with open-ended questions, focusing of the structure, function and occurrence of proteins. From those students, 20 were interviewed in semi-structured, revised clinical interviews. The interviews focused on the structure and function of proteins and were structured around two 2D visualizations of proteins redesigned from examples in text books used in their biology and chemistry courses, and an animation. The analysis of the interview transcripts yielded three categories of critical features relating to learning biomolecular processes, which caused a major part of the difficulties students experienced when interpreting the visualizations: 1) Features that shows the complexity of biomolecular interactions arising from the multitude of different molecules that are simultaneously interacting with each other. 2) Features that shows the dynamic and random character of movement of the particles, including the unimaginable speed at which reactions occur. 3) Extrapolation from 2D to 3D and visualizing 3D-structures. Our findings indicate that different visualizations can convey different critical features, and also give rise to different conceptual difficulties. Ways to deal with these sources of difficulties may be to use multiple or dynamic representations and to explicitly teach how to interpret visualizations.

High School Students Doing an Inquiry Project: How Do They Like It, Open or Guided?

Irit Sadeh & Michal Zion

Type of presentation: oral

Educators don't agree which way of teaching inquiry is better, guided inquiry or open inquiry, regarding different aspects like: acquiring types of knowledge, attitude toward science, acquiring basic inquiry skills and dynamic inquiry skills. Most of the teachers prefer to teach and conduct guided inquiry projects in the class. The purpose of this study was to investigate which type of inquiry is better for biology students. This paper examines the influence of two different inquiry learning approaches (Open/Guided) on the student's attitude toward their inquiry project during their biology studies in Israeli high schools.

Students from guided and open inquiry learning approach (N= 295 divided between the two groups) answered a questionnaire about the contribution of doing the project (cognitive and emotional), the time it took, and the documentation and dynamics they were exposed to while doing it. The students also answered questions regarding the different stages of the inquiry and their part in the inquiry team, and wrote their opinion about things they liked or disliked in the project.

The result of a quantitative content analysis of their answers showed significant differences between the two groups: open inquiry students were more satisfied and felt they gained more from the project, while guided inquiry students felt that too much documentation was required through the project. Significant differences were also found in the time and difficulties concerning to different stages of the inquiry process. Open inquiry student felt they spent more time in the first stages of the project while guided inquiry students felt they spent more time in writing the final paper. Open inquiry students felt more involved in their project than their counterparts. Open inquiry students felt more cooperative with others on one hand and more autonomous learners on the other hand.

Teachers who teach open inquiry can get support for their demanding way of teaching, without being concern from possible frustration of the students due open inquiry, while teachers who teach guided inquiry should pay attention to those findings; maybe they need to give their students more freedom, to make their students more satisfied.

Three Criteria to Help Students to Design Their Own Experimental Procedures for Inquiry-Based-Learning

Eric Sanchez, Patricia Marzin, Réjane Monod-Ansaldi & Daniel Devallois

Type of presentation: poster

In this paper, we address the question of the design of experimental procedures for Inquiry-Based-Learning. We try to determine the type of situation that teachers have to implement in classroom in order to allow students to design the experimental procedures by themselves. The research is based on the implementation of two labwork (1h30) courses 108 16-18-year-old students (last year of upper secondary school), in years 2005 and 2006. The first, an immunology laboratory work, involved the design of the experimental procedures to assess the Antibody-Antigen (Ab-Ag) model. The students had to determine a serial of tests, which show that the Ab-Ag link depends on the spatial combination of the two molecules. The second, a palaeontology labwork, consisted in the determination of the procedures to measure the facial angle (to characterize the prognathism) of an *hominine*a skull, in order to determining the specie of the skull.

Data sources of the research included audio, video-taping and students' written documents, in order to determine the difficulties that they faced and the strategies that they choose.

The findings of this research emphasized that the students success in designing their own experimental procedures when the teaching design allows them to use three criteria to assess the quality of a their experimental procedures. The first criterion is the *relevance* of the experimental procedures, which must fit the preliminary research question. The second criterion is *reproducibility.* The experimental procedures must applied to different situations and lead to obtain high-quality results without variation for a given situation. The last criterion is *communicability*. The written procedures are precise and another student can use them to realize the same labwork. The findings of this research underline that different aspects of the teaching design can help the students to use these criteria such as choosing the tasks devoted to students, making he scientific model explicit and implementing collaborative work.

Understanding the Human Nervous System through a Scale Model Activity

Anna Sardà Jorge, Conxita Márquez Bargalló & Anna Marbà Tallada

Type of presentation: poster

The human nervous system is usually studied in a quite descriptive way. Rarely is it taught as a tool to explain processes and reactions of our body. This article proposes a way of approaching the study of the human nervous system through the use of a scale model. The construction of the scale model allows teacher to visualize which representations students have and facilitates the teaching intervention. 90 secondary pupils, ages 14-15 were asked to build a scale model which represents how the body perceives and reacts to a hairpin prick. Specifically, the scale model should answer both questions: Why do you think that you are capable of feeling a prick on your skin? And, Why do you sometimes feel one prick, and sometimes two?

Just before the build of the scale model, students answered both questions individually. At the end of the activity pupils were asked to evaluate their classmates' scale models as well as their own ones, using an evaluative sheet. The evaluative sheet was made by consensus and focus on the explicative value of the scale model: they should evaluate whether it answers both questions, the originality and the aesthetics. Students also have to answer how this process had helped them to understand some aspects of the functioning of the nervous system and both initial questions.

From the activity analyse we can conclude: a) This activity helps the pupils to formulate different questions, the necessity to look for information in order to answer them, and to decide in a cooperative way using scientific knowledge. b) pupils note that the scale model helped them to understand better which processes contribute to the sensorial perception, in particular some internal aspects of the process. This aspect was also evaluate analysing previous and post scale model construction answers, and, c) the teacher as well as the pupils show their satisfaction in working this way, which has been translated into a deeper implication in the suggested task.

Acknowledgement

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The Use of Concepts of Evidence by Students in Biology Investigations: Development Research in Pre-university Education

Herman H. Schalk, Joop A. van der Schee & Kerst Th. Boersma,

Type of the presentation: oral

To enhance the quality of student biology investigations and to stimulate the students to ensure this quality, two versions of a teaching and learning strategy were designed and tested by means of development research. Learning to ensure the quality of investigations requires the understanding of empirical evidence. For this purpose *concepts of evidence* (CoE) were introduced to the students in an introductory lesson. The two versions differed in the way students were invited to reflect upon the use of CoE. Focus in the evaluation of the strategy was the extent to which the student reports explicitly or implicitly showed the use of CoE (*is the strategy good enough?*).

50 students from the 11th grade (age 16-17) of two urban high schools carried out open investigations in biology. The students designed and carried out their investigations in groups of two or three. Oral feedback was given by the teachers. In addition, 25 students received written feedback during their investigations twice. The other 25 students suspended their investigations four times to carry out specially designed tasks in which they reflected upon the CoE in other investigative contexts. Differences in the use of CoE of these groups were analysed.

The methodology included the analysis by two independent researchers of the final reports with regard to the use of the CoE. The results were compared with those of an analysis of 169 student investigation reports of six other high schools in which there had been given no explicit attention to CoE. Also, a written test for the use of CoE was administered before and after the investigation projects.

The results show that the group of 50 students as a whole performed better than the students of the other high schools, which were mostly 12th-graders. Also, their results on the post-test were significantly higher than those on the pre-test. Within the group of 50, students who did the reflection tasks, performed better on the test, but worse in their reports compared to students who were not invited to reflect upon the CoE outside their own investigations. Therefore, the question which version of the successful teaching and learning strategy leads to the best results ends in a draw. It seems fruitful to combine the strengths of both: explicit, written feedback on the use of CoE in their own investigations together with recontextualizing the concepts in the context of other investigations.

Instructional Change of Cognitive Load in an Out-of-Laboratory: Effects on Cognitive Achievement and Students Activities during Experimentation

Franz-Josef Scharfenberg & Franz Bogner

Type of presentation: oral

This paper describes the evaluation of an instructional change with the aim to decrease students' cognitive load (CL) during hands-on teaching in gene technology. Altogether, 231 12th graders of secondary schools (18 A-level courses) attended a day-long module including authentic experiments in an out-of-school lab.

We followed a quasi-experimental design with a treatment and a control group. In the first one (*n*=114), we added short additional phases of focused discussions before experimenting with regard to the relevance of each experimental step. Students noted down their deliberations on their work-sheets. The latter one (*n*=117) followed the instruction we previously have described. We surveyed (i) the mental effort as measure for CL at nine points in time during the teaching unit (applying a widely used rating scale), (ii) cognitive achievement (using the informal test in a pre-post-test design with follow up test previously being published), and (iii) pupils' activities in the experimental phases. For the latter one we videotaped 20 work groups (in total, *N*=131) of each design group. We calculated scores for CL in different phases of the unit, for cognitive changes during the schedule, and for instructional efficiency. Inter-group differences were analysed. After categorisation of pupils' activities as being previously described we grouped the students in four clusters by performing two independent cluster analyses, respectively (adjusted contingency coefficients: .90/.95).

Analysis unveiled positive effects of the instructional change with regard to the treatment group, especially for students with a high level of CL in theoretical phases. They self-esteemed their CL within the interpretation and discussion as significantly lower. At the cognitive level we found a higher achievement in the long-term. Instructional efficiency of the experimental phases and the interpretation and discussion phase was significantly increased. At the activity level, we found independently of the treatment students labelled as 'all-rounders' and as 'passive students'. Nevertheless we revealed the clusters 'observers' as well as 'high-experimenters' only in the control group whereas the treatment conditions unveiled two new types: 'managers' and 'scribes'.

In total, positive effects pointed to a decrease in CL, especially in the sub-sample with a high level of intrinsic load. Introducing the focused discussions may have caused a separation of content specific discussions from the real working phases. At the level of students' activities the rather undesired types 'observers' and 'high-experimenters' disappeared maybe caused by the higher level of communication we found. The new type 'manager' may confirm this conclusion.

Natural History Dioramas - Dusty Relics or Useful Tools in Biological Education?

Annette Scheersoi & Sue Dale Tunnicliffe

Type of presentation: oral

The key objectives of our study are to find out which specific features in dioramas in natural history museums, which combine preserved organisms and painted or modelled landscapes, draw the attention of visitors and encourage sustained and then focused observations rather than a glance by visitors. Moreover, we want to elicit the interpretation visitors give to the aspects upon which they focus and identify the origins of their interpretation. Such information will inform strategies that can be used to provide effective learning environments at natural history dioramas.

This paper reports data from observational studies of visitors in natural history museums in several countries. The behaviour of visitors was observed, their comments recorded. Additional structured interviews were conducted with some visitors, children's drawings were used to examine their ideas.

Analysis of the data indicates that visitors are especially attracted by young animals (babies) and by very big or dangerous animals as well as by unexpected settings. Visitors explain/interpret using their own knowledge with little reference to the information given by the museum (texts). They tell stories and comment about artefacts within the diorama that they can relate to personally. The comments of visitors can be categorized into at least four main themes: personal, factual, aesthetic and cultural. The predominant theme of responses depends on the age, gender and the visitors' frames of reference.

We conclude that specific natural history dioramas attract visitors and can provide ideal initial conditions for teaching biological science in an out-of-school setting for all categories of learners – dioramas can be accessed and interpreted in different ways according to the highly variable scientific knowledge, interests and experiences of the visitors.

BD² = (Biological Diversity) X (Biology Didactics)

Martin Scheuch, Erika Keller, Günther Pass & Franz Radits

Type of presentation: poster

In 2007 the AECC-Bio started a programme in biology teachers´ further education. It consists of three courses – each divided into three modules spread over a year. Module I focuses on biodiversity, outdoor education, and didactical implications. A strong emphasis is put on offering possibilities for the teachers to exchange their expertise. In Module II the teachers plan and carry out teaching sequences in their schools. They support each other by meeting in "communities of practice", where ideas are discussed and school projects are designed. Module III is dedicated to the presentations of the teaching activities and the reflection upon the experiences. In 2007 about 50 teachers (secondary level 1 and 2) were participating.

The purpose of this paper is to evaluate the courses in terms of three questions:

- Which educational implications are necessary to make biodiversity a fruitful topic at school?
- Does our three module curriculum fit the needs of the teachers?
- Do "communities of practice" appear to be helpful elements in teacher further trainings and how do they have to be designed?

Getting the teachers' expertise concerning those questions seems most important, because their role is crucial in linking biodiversity with schools.

Our research design meets the triangulation of the aspects: by means of research diaries, feedback questionnaires with pre-defined categories, and qualitative interviews. One course involved an external observer. Short guided interviews were conducted as well as a guided group interview with the teacher trainers after the course. After having finished all three courses, we are planning to conduct semi-structured depth interviews with a representative sample of the participants.

Analysis will be conducted via qualitative content analysis (Mayring 2002). The frame for our interpretation will be the theories of "communities of practice" (Wenger 1998) "learning communities" (Lave 1991) and the "constructivist approach for teaching and learning" (Reinmann & Mandl 2006, Riemeier 2007).

Preliminary results show that our further education programme is appreciated by the teachers, for its manifold possibilities:

To deepen biological knowledge, to get further training in methods and methodological skills, to implement biolological topics at different school levels (e.g.: research approaches, outdoor and environmental education approaches), to communicate with scientists, colleagues and other experts in biology education. Our subsequent steps will be the critical validation of these first impressions and the information gathered.

Teachers' Pedagogical Content Knowledge as an Influence on Quality of Instruction in Biology Lessons

Stephan Schmelzing, Stefanie Wüsten, Angela Sandmann & Birgit Neuhaus

Type of presentation: poster

In this study, the influence of teachers' pedagogical content knowledge (PCK) on quality of instruction in biology will be examined. The focus of the theoretical background is directed to research on teachers' professional knowledge, especially teachers' PCK and on research on quality of instruction.

Studies which examined the teachers' PCK showed that teachers' content knowledge correlates positively high with PCK. PCK shows a positive correlation to an effective instruction and students' achievement. (Brunner et Al., 2006). General quality criteria that account for an effective instruction have already been identified (Fraser et Al., 1987; Wang, et Al., 1993). It is expected, however, that these general quality criteria must be complemented by subject-specific criteria (Helmke, 2007; Neuhaus, 2007).

In order to identify subject-specific criteria, expert interviews were conducted with seven science educators (major biology). Furthermore in a quasi-experimental video study 47 lessons of 47 biology teachers were videotaped and students' knowledge and learning motivation measured in a pre-post test design (a multiple-choice-achievement test, a concept map, and a questionnaire). The findings of both studies were used to develop an instrument to measure biology teachers' PCK. This questionnaire will be validated by a questionnaire, in which the students evaluate the instruction quality of the biology lesson. Both questionnaires will be evaluated in a pilot study. In the main study, the teachers' questionnaire will be used on 150 biology teachers together with the student's questionnaire to measure teachers' PCK as well as quality of instruction in their biology lessons. Positive correlations between teachers' PCK and students' evaluation of the lessons are expected.

Through the interviews the following important subject-specific quality criteria could be identified: All experts asked (N=7) regard *thinking in biological systems, thinking in models* and *using student-oriented terminology* as subject-specific quality criteria. Four of them consider *using science methods, working with natural objects or reflecting on anthropomorphism* a quality criterion. In the video study, criteria which have a strong influence on students' achievement were identified. *Instruction clarity*, showed a positive correlation with students' correct relations in the concept mapping ($r = 0.47$, $N = 47$, $p = 0.002$).

In this study important knowledge components of biology teachers' PCK as well as important subject-specific-quality criteria for a good biology instruction were described. The instruments developed here can be used for further research on teachers' effectiveness as well as quality of instruction in the fields of didactics of biology.

Developing Environmental Education to Education for Sustainable Development

Silvia Schönfelder & Susanne Bögeholz

Type of presentation: poster

A working group of scientists and Environmental Education practitioners developed a Leitbild with goals, sub-goals and quality criteria for new courses offered by an Environmental Education centre. The goals and sub-goals focus on Sustainable Development Education, especially Biodiversity Education, as well as on curricular learning in order to greatly support school education. They are an innovative addition to already existing ecology education concepts. The development and implementation of innovative courses has been formatively evaluated. The main evaluation interest was to find out whether quality criteria – concrete operationalisations of the determined goals and sub-goals - are achieved. We gained research data by observing courses. Besides observations we used focus groups to determine goals and quality criteria. First results show that practitioners generally fulfil quality criteria well. Only some deficits were detected, for instance, for quality criteria as, to help students to identify values of nature, or to point out the role of species which are perceived as potentially negative.

Modelling Elementary Students' System Competency – Building Models for Understanding Systems

Cornelia Sommer

Type of presentation: poster

This paper reports our research about primary school students' abilities in system competency. System competency is understood as the ability to handle systems. In this context this means the organization of systems, like identifying system elements and their relationships, and recognizing system borders.

Until now, most research in system competency addresses the abilities of older students and adult. However, only little is known about younger students' system competency. In our research done with younger students we found different levels of system competency within one age cohort. In the study starting in summer 2008, we want to examine the cause of this age effect. In this context we concentrate on cognitive abilities as possible influences on system competency.

We are interested in the questions whether the different expressions of system competency are to be ascribed to different amounts of knowledge about the system in question or to different amounts of experience with systems in general or to the systems` different content. In addition we want to elucidate the effect of age-dependent differences in cognitive development on system competence development.

The design of the study combines two interventions. The students, firstly, (275 fourth and six grade students) learn about two different systems, a biological and a non-biological one. The interventions shall guarantee factual knowledge about the systems which is the precondition for the development of system thinking.

The interventions will be framed with a pre- and a posttest. In both the students' factual knowledge about the particular system will be tested. The abilities of the students in system competency will be tested in the posttest with a combination of concept maps and multiple choice items as well as some open questions.

In order to evaluate the concept maps, quantitative and qualitative indices will be considered. The free answers will be categorized according to their contained degree of system competency.

Human Dignity in Teacher Training – A Challenge for Biology Education

Anna Tapola

Type of presentation: poster

This poster reports some results from a more comprehensive study. The study as a whole aimed to analyse certain aspects of discourse of human dignity within teacher education. The purpose of this poster is to highlight some key findings that are significant for biology education, within teacher education and elsewhere (for example in school). The study was a discourse analysis and the corpus (11.557 words) consisted of letters written by preservice teacher. All students contributed voluntarily, and the letters where analysed as constituents in the formation of discourse. Findings show that at least four different sub-discourses – *Discourse of Problematic Bodies, Discourse of Conformity, Discourse of Recycling, and Discourse of the Unconditional Human Status* – can be found within a main *Discourse of Human Dignity*. The first three sub-discourses involve elements that can contradict or jeopardise human rights, and thus threaten equality and other fundamental core values that are supposed to form the basis of democratic education. At least two of the sub-discourses include pronounced elements of biology subject matter, for example physiology, ontogenesis, and matters concerning organ transplants. Consequently, the *Discourse of Human Dignity* in this context includes biology-related arguments that may put human rights and democracy in peril. These finings have bearing on biology education, not least concerning bio-ethical issues. Finally, the findings are also significant for teacher education – and certainly biology teacher education – if such training shall include any kind of democratic aspects. In this sense human dignity becomes a challenge for biology education.

Biodiversity in School Textbooks of 13 Countries

Rosa Branca Tracana, Cláudia Ferreira, Maria Eduarda Ferreira & Graça S. Carvalho

Type of presentation: oral

Biodiversity is the variation of life forms within a given ecosystem, a biome or within the whole Earth. Biodiversity is often used as a measure of the health of biological systems. In this work we analysed the topic "Biodiversity" in the textbooks from ten European countries (Estonia, Finland, France-Lyon, France-Montpellier, Germany, Hungary, Italy, Lithuania, Malta, Portugal, and Romania), two African ones (Morocco, Senegal) and another from the Middle East (Lebanon), since the first grade (6 years old pupils) till the end of the secondary school (12 years old). We used a grid constructed in the context of a European Project "Biohead Citizen" (Biology, Health and Environmental Education for better Citizenship). The results showed that (i) the textbooks highlight the beauty of nature instead of the preoccupation to preserve it; (ii) low importance is given to the preservation of the environment. So it is necessary to give more attention to the textbooks in order to change them to contribute to a make pupils aware of the importance of biodiversity for the future of the planet.

Students` Conceptions of Models and Modelling and the Impact on Model Competence

Ulrike Trier, Annette Upmeier zu Belzen & Dirk Krüger

Type of presentation: poster

Various studies identified that students have an insufficient understanding of scientific models. The concepts of models as produced by students differ from the scientific conception of models and modelling (Grosslight et al. 1991). This gap is especially relevant in science subjects, where models are the major learning and teaching tools (Harrison & Treagust 2000). They are essential for the acquisition of flexible, transferable, and applicable knowledge (Leisner 2005). Model competence is therefore a profound part of scientific literacy (Gilbert & Boulter 2000, Driver et al. 1996).

In our research, model competence relates to Gelman and Greeno's (1989) general competence definition. Accordingly, model competence encompasses conceptual knowledge about models and their attributes, conceptual knowledge about the process of model building, and practical skills (performance). Model competence enables a learner to autonomously solve problems using scientific models (Leisner 2005). Previous studies in schools showed that students have a limited perception of models as far as the above three aspects of model competence are concerned. In this context, we study (I) typical mental concepts of students about models and modelling, (II) the qualities of students' conceptions and their influence on students` using specific models, and (III) how the model competence is affected by interventions.

To research the quality of students' conceptions, we collect data on students' (grade 9 to 11) relevant concepts of models and modelling to identify their influence on the practical use of models in semi-structured interviews with interventions. An initial questionnaire has shown unsystematic conceptual knowledge and a lack of recognizing the role of models for scientific reasoning (Terzer & Upmeier zu Belzen 2007). Simultaneously, we assemble established scientific conceptions from academic literature and employ the approach of educational reconstruction to contrast students' with scientists' conceptions of models, modelling and scientific use of models and align them to produce appropriate interventions, which are aiming at conceptual reconstruction of students' conceptions (Kattmann et al. 1997).

The interviews with their interventions will give an account of student's actual levels of conceptual knowledge about models and model building and their practical skills. This evaluation approach can also be utilised to test the improvements effected by the targeted interventions and to test the general dependencies between the two conceptual aspects and the practical skills of model competence.

The Contribution on Gender, School and Residential Area in Explaining the Interest in Biology by Lower Secondary School Students

Anna Uitto, Jari Lavonen, Kalle Juuti, Veijo Meisalo & Reijo Byman

Type of presentation: poster

Variation in students' interests in biological phenomena was studied between gender, school and residential area (rural, densely populated, urban and metropolitan area of Helsinki). The survey was carried out with the international ROSE questionnaire and Finnish 9th grade students. Mixed methods were used in the analysis. Likert-scaled items were first categorized with explorative factor analysis(* to interest context factors, which loadings were used as a model to calculate corresponding sum factors. Kruskal-Wallis test was used to find out differences in the interest context factors; interest in abstract biological phenomena, animals, applied biology, human health, sex and reproduction and human body in extreme conditions. Schools were arranged according to students' average interest rank and their responses to the open question '*Myself as a scientist*' in the six most contrasting top and bottom schools were studied in detail. Gender was the most important factor to explain interest and girls were usually more interested in biological phenomena than boys. Residential differences were significant but low, and mostly due to rural boys' lower interests. Schools were significantly different from each other. The qualitative categorization of students' responses to the open question revealed significant differences between the two most contrasting group of schools, thus confirming the results of the quantitative analysis. Students of the top-interest-schools preferred science to other subjects and they had better skills to use biological concepts than students in the bottom-interest-schools. Motivating teaching was assumed to be an important reason to results. The results are discussed in the framework of PISA 2006 study.

A Student's Struggling Pathway to Scientific Reasoning about Evolution

Anita Wallin

Type of presentation: poster

The focus of this paper is one student's learning pathway as she progresses from a non-scientific to a more scientific reasoning pattern concerning the theory of evolution by natural selection. This case study is one part of a project with the overall purpose to investigate how upper secondary school students develop an understanding of this theory. Different methods were used to evaluate the knowledge of the 79 students in the sample: pre-tests and interviews before teaching began, problem-solving situations, logbook entries, video recordings of group discussions, and interviews during the teaching period. Long-term retention was tested by using a post-test, approximately one year after teaching. The student in focus was the only student who actually talked about her own progressive learning during the interviews. Altogether 58 students were interviewed, and since many students were interviewed twice, 91 interviews were performed in total. The interviews focused either on the concept of variation or on the concept of natural selection. In the interview about natural selection during the teaching period this student reasoned scientifically about evolutionary changes in terms of different survival rates and different reproduction rates among individuals in a population. In the pre-test and in the interview prior to the teaching, she had expressed entirely non-scientific ideas. Throughout the interview she was simultaneously aware of her way of thinking and reasoning before teaching began, the way she was reasoning at the time of the interview, and the ideas presented by the teacher in class. It becomes obvious that she was struggling with the theory of evolution at the very moment of the interview. The concept of randomness in connection with the concept of mutation seemed to be the most difficult concepts for her. However, later on, this student seemed to be able to solve the problems expressed in this interview, as she was reasoning scientifically throughout the post-test one year after teaching. She was one of 20 students who consistently expressed non-scientific ideas in the pre-test when the teaching started, but later consistently expressed scientific ideas in the post-test. Her one year learning pathway is analysed using a conceptual change model.

Quality of Instruction in Biology

Stefanie Wüsten, Stephan Schmelzing, Angela Sandmann & Birgit Neuhaus

Type of presentation: poster

A huge number of isolated, subject-independent factors influencing students' learning achievement have been identified within the scope of teaching quality research so far (Fraser, 1987; Wang et al.1993). An analysis of the interaction of these factors often remained disregarded, as well as the interaction of those with subject-specific factors (e. g. Helmke, 2004).
The aim of this project is to scrutinize the importance of empirically described general criteria of teaching quality for biology lessons, to add subject-specific criteria and to check the interaction of both aspects. Therefore, the project is divided into two parts: a preceding video study and a following intervention study.
Concerning the video study, 45 biology lessons on the topic "blood & blood circulation" (*Wadouh & Jatzwauk, 2007*) are assessed highly-inferent on a four-stage Likert scale by two Raters using event sampling. For this event sampling, the lessons are subdivided into specific units (introduction, repetition, practicing, safeguarding etc.) which are further on used to evaluate the lesson quality with regard to the instructions. The generalizability coefficient calculated by the program GT is used to examine the reliability (Ysewijn, 1997). To analyze the videos concerning fundamental quality criteria, international and empirically documented quality criteria as well as their observable indicators were compiled in a codification manual, formulated in their specific biological manifestation if possible. Furthermore, quality criteria of biology lessons exclusively were added through an analysis of the educational standards and by consulting experts (Schmelzing, 2007). Afterwards, the obtained video data will be related to the students' achievement data by using multiple regressions.
The following intervention study serves to check the obtained data from the video study experimentally. For that, subject-specific and subject-independent criteria of teaching quality will be varied in 2*2 designs to examine their influence on students' learning achievements as well as their increase of interest.
Besides the development of theoretical knowledge about the interaction of subject-dependent and subject-independent quality criteria, a catalogue containing the most important teaching quality criteria for biology lessons will be presented at the end of this project. In addition, a set of lesson material will be produced which is based on the identified factors of teaching quality in biology.

Characterization of High-school Students' Comprehension of Molecular Genetics while Practicing Hands-on Experiments in Teacher-Led Outreach-Laboratories

Anat Yarden and Michal Stolarsky – Ben Nun

Type of presentation: oral

In this paper we describe our recent attempts to examine high-school students' comprehension of molecular genetics while practicing hands-on experiments in a unique outreach laboratory setting. In contrast to most outreach laboratories, in which the academic personnel teaches the visiting classes, we offer a unique setting in which the high-school biology teachers themselves teach their own students at our institute laboratories, following an appropriate professional training. This setting was entitled Teacher-Led Outreach-Laboratories (TLOL). One of the laboratory activities we developed in the framework of TLOL focuses on DNA manipulations while linking between gene and phenotype. Since one major obstacle for students is the formation of a conceptual continuum between a certain trait and the associated molecular mechanism, we wondered if the laboratory activity can help to overcome this obstacle. Both quantitative and qualitative methodological approaches were used to probe high-school students' comprehension of molecular genetics (12^{th} graders, n = 121). Students' written questionnaires, aiming to probe their visual representations and conceptual understanding of molecular genetics, were handed to the students before and immediately following the laboratory activity. Approximately 4-6 weeks following the laboratory activity semi-structured interviews with selected students were carried out. In addition, we recorded the verbal interactions during the laboratory sessions as well as collected laboratory classroom observation field notes. Using the qualitative tools we were able to show that students' visual representations of plasmid DNA significantly improved following the activity as well as their procedural understanding with regards to DNA manipulations. Those results were expressed in the students' written responses as well as their drawings of DNA molecules in the test tubes. Students' interviews revealed that students' comprehension of molecular genetics was retained a few weeks following the activity.

Understanding Evolution Theory: What can Narrative Contribute, and Is There a "Narrative Mode of Thought"?

Jörg Zabel & Harald Gropengiesser

Type of presentation: poster

This study attempts to explore how students make sense of adaptation phenomena and what their narratives reveal about their understanding of evolutionary processes. Before and after a teaching sequence on evolution theory, 107 lower secondary school students explained the evolution of modern whales from their terrestrial ancestors by writing narrative or non-narrative texts on the issue. Text analysis, combined with student interviews, revealed students' conceptions and their individual methods of making sense of adaptation phenomena. Whereas in their pre-teaching texts the students predominantly described intentional and individual adaptation processes, their post-teaching texts featured mainly Darwinian explanations. Those students who chose to write narratives often used common story plots and motives. Some of these plots, e.g. stories based around a social outcast, appeared to help students to understand key concepts of Darwin's theory. In some cases, the author's understanding of the scientific conceptions could be related to an underlying biographical experience. The data provide some examples of narrative meaning-making in science and suggest that the narrative paradigm is appropriate to investigate and to strengthen individual and emotional aspects of understanding science. In contrast, Bruner's assumption of two distinct and mutually exclusive modes of thought, a narrative and a scientific one, is rather challenge d by our data.

Handling Moral Dilemmas in Context Based Genetics Education: Towards a Contemporary and Balanced Pedagogical Approach

Paul van der Zande, Mieke Brekelmans, Jan Vermunt & Arend Jan Waarlo

Type of presentation: oral

The current emphasis on teaching science in context puts new demands on teachers, e.g. dealing with genetics related controversial issues in the classroom. This paper reports on the first results of a design research project aimed at enhancing biology teachers' expertise in terms of taking students' intuitions and emotions seriously in handling moral dilemmas. Recent neurobiological and psychological research suggests that intuition and emotion play a crucial role in moral reasoning, and thus puts informed decision-making into perspective. We wondered if and how in good opinion-forming teaching practices intuitions and emotions are already being addressed, and how this could inform our design activities. The research project started with exploring good teaching practices and students' informal reasoning when confronted with moral dilemmas prior to formal education on this topic.

Fifteen pre-university students were interviewed individually after having confronted them with genetics related real-life situations: what would you do, and why? Next, eight biology teachers known for their good practice were interviewed about their pedagogical approach, the learning activities they are using and their perceptions of student reasoning. The findings were compared with those reported in the literature on moral reasoning and moral education.

Experienced teachers confirm the aforementioned neurobiological insights by reporting that they perceive intuition and emotion in students' reasoning. The students actually demonstrated a mixed reasoning pattern when confronted with real-life dilemmas. They all used intuitive, emotive, and rationalistic considerations during the interviews. However, neither the literature review nor the interviews with the teachers revealed a coherent pedagogical approach for addressing intuitive, emotive, and rationalistic considerations in a balanced way. Yet, some indications for moral reflection on a social intuitive basis could be found in psychological literature. Until now, these indications have not been translated into learning activities. Suggestions how to translate them into a design concerning context based genetics education are discussed in this paper.

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Didactics of Biology in Utrecht University

some facts and figures

The Department of Biology Education is part of the Freudenthal Institute for Science and Mathematics Education (FIsme), which was founded in 2006 as one of the research institutes of the Faculty of Science of Utrecht University. Other participants in FIsme are the Departments of Mathematics, Physics and Chemistry Education, and IVLOS Institute of Education. IVLOS provides teacher education, study-skills training, and services.

FIsme is the only research institute in the Netherlands that covers biology, chemistry, mathematics, and physics education with four separate chairs. Currently, approximately 140 people are working at FIsme: 80 in mathematics education and 60 in science education, including non-scientific staff and PhD students. Approximately 60 out of 140 people are involved in didactical research.

Besides, FIsme participates in the bachelor programmes of the Faculty with introduction courses on science education and communication. The bachelor courses prepare for the master programme Science Education and Communication, including tracks on teacher education, science communication, health education, and environmental education.
Many staff members are involved in curriculum development for science and mathematics education as well, both at national and at school level. FIsme plays a leading role in innovation of science and mathematics curricula in the Netherlands.
In 2006 Kerst Boersma (biology) was appointed as the first scientific director of FIsme. In July 2008 he retired, and was succeeded by Jan van Maanen (mathematics).
In September 2008 20 people are working at the Department of Biology Education, including 6 staff members, 3 postdocs, and 11 PhD students. The following staff members of the department and postdocs are involved in the research programme:
Prof. dr. Kerst Boersma Chair: Didactics of biology (former head of department)
Dr. Dirk Jan Boerwinkel (postdoc) Genomics education / Didactics of biology
Dr. Dieuwke Hovinga Environmental education
Dr. Marie-Christine Knippels (postdoc) Didactics of biology
Prof. dr. ir. Kris van Koppen Special chair: Environmental education
Dr. Roald Verhoeff (postdoc) Genomics communication / Didactics of biology
Prof. dr. Arend Jan Waarlo Didactics of biology / special chair: Genetics & Health Communication (temporary head of department)

The research of the Department of Biological Education is embedded in the research programme of FIsme, entitled 'Context-based science and mathematics education'. In the last 10 years the research focus was in particular on systems thinking. Recently, research projects were acquired aimed at supporting the biology curriculum innovation in the Netherlands, according to the so-called concept-context approach.

The History of Woudschoten Conference Centre

In 1896 the Dutch Christian Students Society was founded. The society rented several villas from 1917 until 1932, where they gathered during weekends and held conferences. During the roaring twenties three members of the society took the initiative to build a conference centre. These members were Rutgers, Nachenius and Dudok de Wit. Together they formed the Woudschoten foundation with the goal: 'Ut omnes unum sint'.
Money was raised amongst members and supporters of the Students Society and in 1928 the foundation was able to buy 52 acres of land at the Woudenbergseweg in Zeist. They built a simple barrack and camped on the land. In 1931 the necessary amount of EUR 136,134.06 was raised and the construction of the centre was started. On August 27th 1932 the conference centre was opened officially. The Dutch Christian Students Society finally had a centre, which was to be used for their purposes and was owned by the Woudschoten Foundation. From the beginning other groups and foundations with a Christian background could gather at Woudschoten as well, since the revenue was needed to maintain the premises.

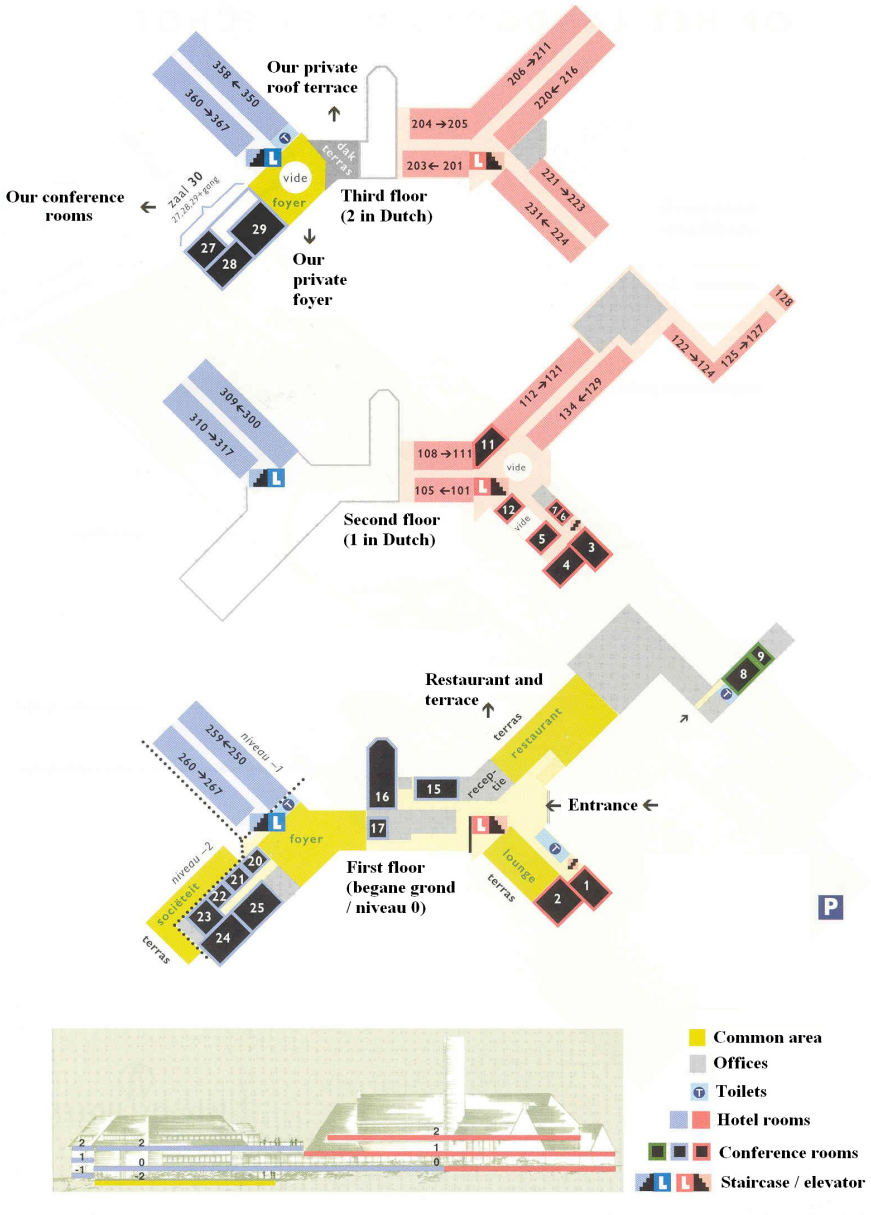
The front entrance of Woudschoten Conference Centre

At the end of 1951 Woudschoten was very well known and an increasing number of foundations and societies used Woudschoten to hold their conferences. A clear transition occurred from using the centre during weekend meetings, towards using it on week days for business purposes. The economy was strong and there was an increase in demand from commercial organizations to, for

instance, train personnel at Woudschoten. On the other hand the role as a confessional sorority decreased. At the end of the seventies the share of meetings held by the Dutch Christian Students Society was down to only 3% in total.
In the seventies renovations commenced to transform the centre to a location more suitable for conferences. The former living room was turned into a lounge and bar, a reception was built and several extra conference rooms were constructed. The sleeping wards were changed into bed rooms suitable for two persons. The interior was modernised and the benches were taken from the old chapel to make it suitable for more purposes.

In 1985 the Dutch Christian Students Society was nullified. The Woudschoten Foundation had to make a plan to ensure the continuation of the centre. They decided that they wanted to continue Woudschoten as a commercial conference centre. The centre would be open to everyone, but with a special focus on students reflecting on the world and religion.
In 1994 an amount of EUR 5,445,362.50 was invested in a new wing that was opened in 1995. The original building was renovated at the same time. In 2007 Woudschoten celebrated her 75th anniversary. And the story continues. In 2008 Woudschoten has started to build another new wing. In 2009 an additional 36 hotel rooms and 10 conference rooms will be taken into use.

Map of Woudschoten Conference Centre



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