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QualityTours

Contents

Forward

The ERIDOB Academic Committee has invited researchers in biology Didactics to take part in the "8th Conference of European Researchers in Didactics of Biology". The Conference is held in Braga, Portugal, 13 – 17 July 2010.

The aim of the conference is to give researchers on biology didactics the opportunity to present and discuss their research work and results. Contributions fit into the following strands:

1. Student conceptions and conceptual change
2. Student interest and motivation
3. Student values, attitudes and decision-making
4. Student reasoning, scientific thinking and argumentation
5. Teaching: teaching strategies, teaching environments and educational techno-logy
6. Environmental education and Biology education
7. Health education and Biology education
8. Social, cultural and gender issues
9. Practical work and field work
10. Research methods and theoretical issues concerning research in Biology education.
11. Teachers' knowledge and training

The Academic Committee is thankful to the following ERIDOB members who helped in the review process:

Kerst T. Boersma	**Maria Pilar Jiménez-Aleixandre**	
Silvia Caravita	**Jenny Lewis**	**Maria José Quilez**
Marida Ergazaki	**Grégoire Molinatti**	**Laurence Simonmneaux**
Marcus Hammann	**Christina Ottander**	**Tali Tal**

Welcome to the ERIDOB 2010 conference!

We are delighted to welcome you all to the largest European Researchers in Didactics of Biology (ERIDOB) bi-annual conference ever.

The theme of the conference this year is *Authenticity in Biology Education: Benefits and Challenges*. This theme emerged from discussions that took place at the ERIDOB 2008 meeting in Utrecht. During those discussions it became apparent that various ERIDOB members relate differently to the meaning of the term authenticity. Some expressed views that activities that are carried outside the classroom are authentic, while others thought that authentic activities should engage students in posing questions and designing their own paths to solve them. We hope that the keynote address and some of the other presentations during the conference will enable all of us to re-explore the meaning of the concept of authenticity and discuss possible means to implement it in schools. The theme of authenticity blends wonderfully with many other topics that are of outmost interest to researchers in biology didactics, such as the use of controversial socio-scientific issues in biology classrooms or the introduction of systems thinking into biology education, to name just a few. Altogether, we hope the conference will enable all of us, researchers that originate from 5 different continents around the world, to learn more about our field and about each other.

The 8th ERIDOB conference is hosted by the Research Centre CIFPEC of the Institute of Education, University of Minho. The spacious location of the conference at the University of Minho facilities as well as the city of Braga and its surroundings, offer ample opportunities for both formal and informal interactions among the ERIDOB members.

Approximately 200 proposals were submitted to the conference this year. The academic committee, together with other members of the ERIDOB community, peer-reviewed all the proposals and put together the program that is offered to you in the following pages. We are thankful to all the individuals who invested significant time and effort in organizing this conference. We truly hope you will enjoy the conference, as much as we have enjoyed putting it together.

Anat Yarden and Graça S. Carvalho

Useful Information

❖ Venue

TUESDAY, July 13
– Registration (14:30h – 19:30h) & Reception (19:30h)
Edifício dos Congregados
Av. Central, 100, Braga

WEDNESDAY , July 14 TO SATURDAY, July 17:
– Conference sessions
Complexo Pedagógico II
Campus de Gualtar, Braga

A shuttle-bus from and to hotels will be available between Wednesday and Saturday.
Each morning a shuttle-bus will be at the Hotel IBIS, Hotel D. Sofia, Hotel Turismo and Albergaria Senhora-A-Branca, with departure at 8:30h.
At the end of the daily sessions, buses will take you back to the hotels.
Taxis can also be provided for you in the Hotel Receptions or you can call by using this number: (+351) 253 683 133.

❖ Social Programme

Free Tours: On Thursday (July, 15) on 15.00h four alternative tours will be offered:

a) Braga / Bom Jesus / Braga	b) Braga / Tibães / Braga
c) Braga / Ponte de Lima / Braga	d) Braga / Guimarães / Braga

At the registration desk, you'll be asked to choose your trip and decide at once or until Wednesday 14:00h.
For details, please go to the ERIDOB website:
http://projectos.iec.uminho.pt/eridob/programthursday.html

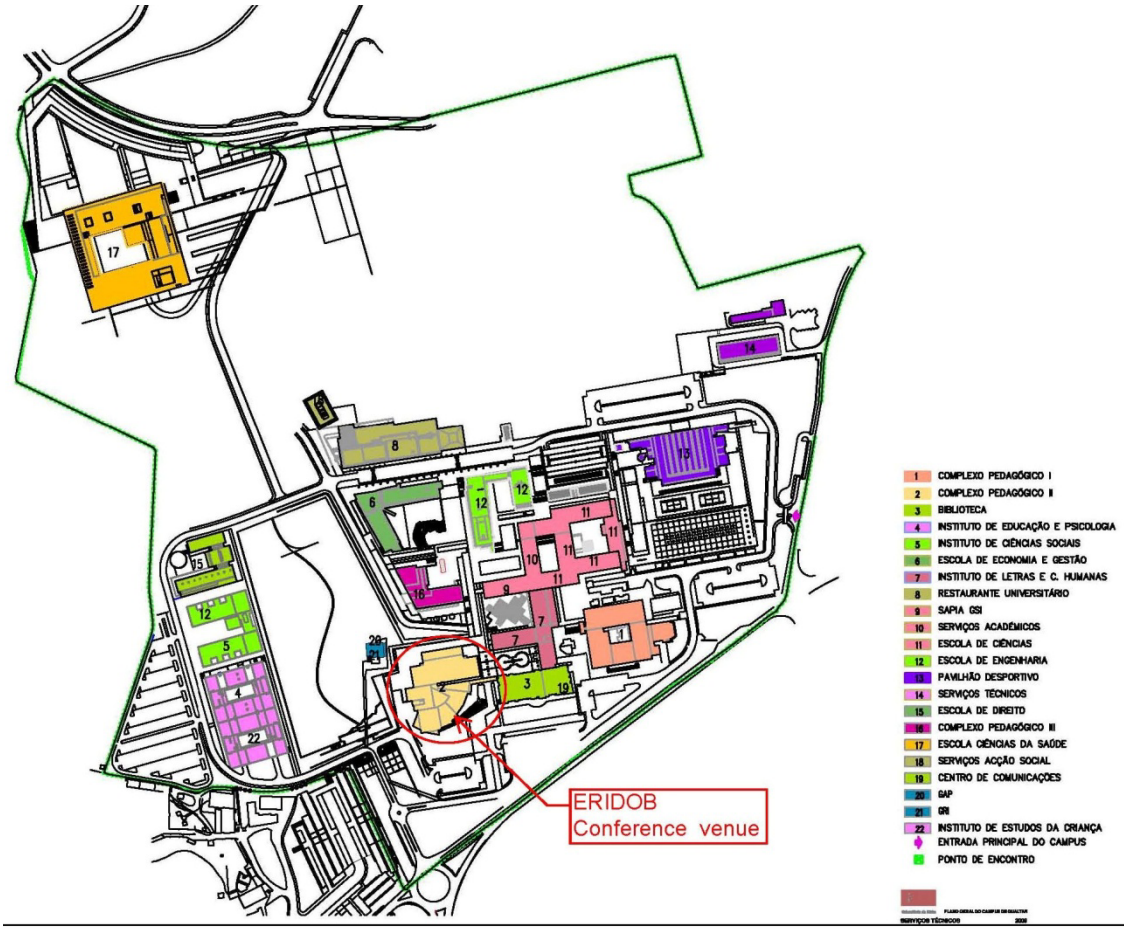
Conference diner: On Friday (July, 16) by 19:30h buses will take you from the Conference hall to the Restaurant "Abadia d'Este" for the Conference diner. At 22:30h buses will take you back to the hotels.

❖ Internet Access

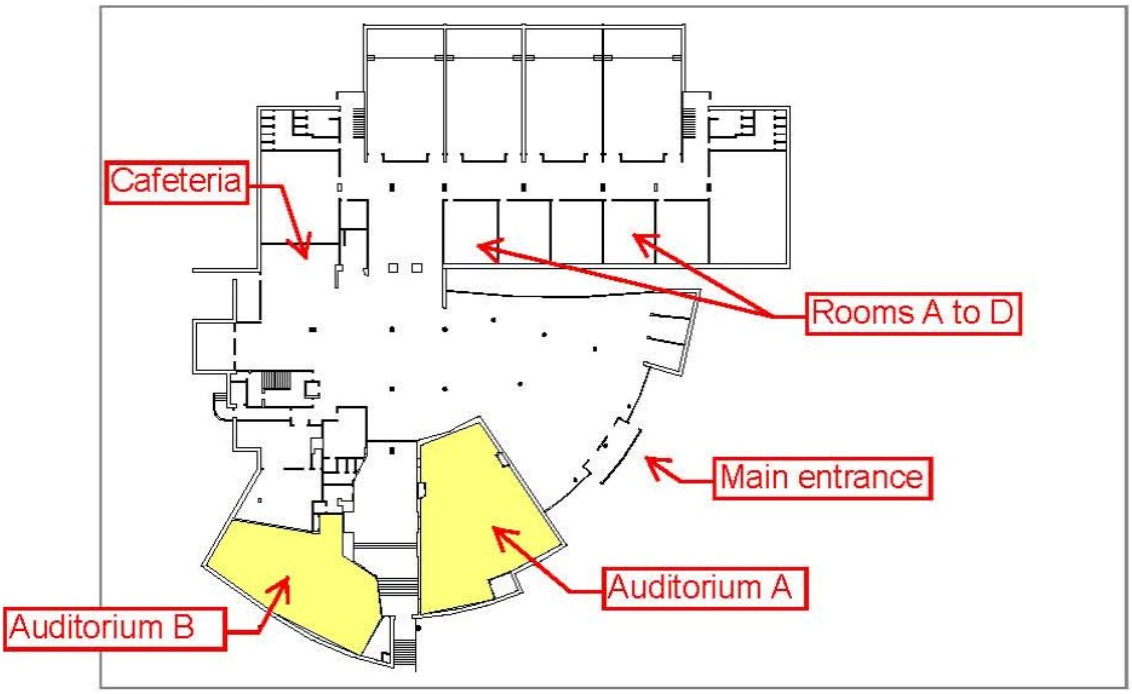
Technical help is provided at the IT staff located near the computers close to the reception desk, to enable you to get an internet access with your own laptop.

Conference rooms

- **Campus plan and ERIDOB Conference venue**



- **ERIDOB Conference venue:**
  Auditorium A & B (oral presentations) and Rooms A to D (posters)



PROGRAMME OVERVIEW

JULY – ERIDOB 2010

Town centre – Av. Central, 100

TUESDAY – 13

14:30 – 19:30	Registration
19:30	Welcome Reception

Campus – Gualtar

WEDNESDAY – 14

09:00 – 09:15	Opening Session			
09:15 – 10:30	Keynote Speaker – Richard A. Duschl (USA)			
10:30 – 11:00	Coffee break			
11:00 – 12:30	Paper *Session I*			
	Auditorium A		Auditorium B	
	Symposium – 1	(181): 182 – 185	Symposium – 2	(162): 163 – 166
12:30 – 14:00	Lunch			
14:00 – 15:00	Poster *Session I*			
	Room A	Room B	Room C	Room D
	Strand – 1 38 – 19 – 114 – 27 – 50 – 139 – 143 – 151 – 115 – 70 – 63 – 149 – 145	Strand – 5 142 – 93 – 73 – 104 – 80 – 81 – 18 – 68 – 45 – 1 – 130	Strand – 6 41 – 51 – 25 – 17 – 57 Strand – 7 40 – 92 – 20 – 87	Strand – 9 94 – 86 – 98 – 152 – 26 – 21 – 67– 123 – 153 – 88
15:00 – 16:00	Poster *Session II* (see Poster Session1)			
	Room A	Room B	Room C	Room D
16:00 – 16:30	Coffee break			
16:30 – 18:30	Paper *Session II*			
	Auditorium A		Auditorium B	
	Strand – 2	49 – 54 – 66 – 99	Strand – 5	30 – 78 – 79 – 105

Thursday – 15

9:00-10:30	Paper *Session III*			
	Auditorium A		Auditorium B	
	Symposium – 3	(186): 187 – 190	Symposium – 4	(167): 168 – 171
10:30 – 11:00	Coffee break			
11:00 – 12:30	Paper *Session IV*			
	Auditorium A		Auditorium B	
	Strand – 1	9 – 64 – 155	Strand – 3	12 – 52 – 96
12:30 – 14:00	Lunch			
14:00 – 15:00	Auditorium A			
	Business Meeting			
15:00	Tour			

Friday – 16

Paper *Session V*

9:00 – 10:30	Auditorium **A**		Auditorium **B**	
	Symposium – 5	(172): 173 – 176	Strand – 11	120 – 7– 136

10:30 – 11:00 Coffee break

Paper *Session VI*

11:00 – 12:30	Auditorium **A**		Auditorium **B**	
	Strand – 4	107 – 108 – 118	Strand – 6	4 – 137 – 135

12:30 – 14:00 Lunch

Poster *Session III*

14:00 – 15:00	Room **A**	Room **B**	Room **C**	Room **D**
	Strand – 1 178 – 179 – 180 – 39 – 75 – 150 Strand – 3 6	Strand – 2 91 – 112 – 111– 48 – 77 Strand – 8 5 – 55 – 133 – 110 – 71	Strand – 4 3 – 14 – 158 – 156 – 53 – 22 – 31 – 23 – 10	Strand – 11 103 – 125 – 144 – 69 – 97 – 65 – 33 – 116 Strand – 5 8 – 72

Poster *Session IV* (see Poster Session 3)

15:00 – 16:00	Room **A**	Room **B**	Room **C**	Room **D**

16:00 – 16:30 Coffee break

Paper *Session VII*

16:30 – 18:30	Auditorium **A**		Auditorium **B**	
	Strand – 4	160– 101 – 127 – 35	Strand – 5	13 – 15 – 90 – 146

19:30 Conference Diner

Saturday – 17

Paper *Session VIII*

9:00 – 10:30	Auditorium **A**		Auditorium **B**	
	Strand – 4	28 – 121 – 157	Strand – 5	56 – 82 – 122

10:30 – 11:00 Coffee break

Paper *Session IX*

11:00 – 12:30	Auditorium **A**		Auditorium **B**	
	Strand – 4	36 – 85 – 100	Strand – 5	102 – 119 – 138

12:30 -12:45 Conference closing session

12:45 – 14:00 Lunch

Sunday – 18

07:00 – 20:40 **After Conference Douro river cruise:**

One-day tour through the Port wine vineyards

PROGRAMME

PROGRAMME

Town centre – Av. Central, 100

TUESDAY – 13

14:30 – 19:30 Registration

19:30 Welcome Reception

Campus – Gualtar

WEDNESDAY – 14

Chair: Carvalho, G.S. - Portugal

09:00 - 9:15 Opening Session

09:15 – 10:30 Keynote Speaker – Richard A. Duschl – USA
Instruction-assisted development of inquiry: The dual space of philosophy and psychology

10:30 – 11:00 Coffee break

Paper *Session I*

11:00 – 12:30 Auditorium A

Symposium – 1

Coordinator: (181) – van Eijck, M. – The Netherlands
Approaches for authenticity in biology education: Challenges and benefits of underlying perspectives
Discussant: Lewis, J. – United Kingdom

182 – Jiménez-Aleixandre, M. P., Fernández-López, L. – Spain
The meaning of authentic practices: A proposal illustrated by 9th Grade students' generated projects

183 – van Eijck, M. – The Netherlands
Addressing the dynamics of science in curricular reform for scientific literacy: Towards authentic practices in the case of genomics

184 – Willingale-Theune, J., Manaia. A., Gebhardt,P., De Lorenzi, R., Nastasi,T., Haury, M. – Germany
Stimulating critical thinking behind scientific discovery

185 – Yarden, A., Gelbart, H. – Israel
Supporting learning of high school genetics using authentic research practices: The teacher's role

WEDNESDAY – 14

11:00 – 12:30 Auditorium B

Symposium – 2

Coordinator: (162) – Saunders, K. – New Zealand

Benefits and challenges in teaching and learning about controversial socio-scientific issues in biology classrooms

Discussant: Simonneaux, L. – France

163 – Dawson, V., Venville, G. – Australia
Argumentation strategies used by teachers to promote argumentation skills about a genetics socio-scientific issues

164 – Levinson, R., Kent, P., Pratt,D., Kapadia, R., Yogui, C. – United Kingdom
Developing a pedagogy of risk in socio-scientific issues

165 – Reis, P. R., Hilário, T. – Portugal
Contributions of "blogging" about controversial socio-scientific issues in the promotion of students' scientific literacy: A case study

166 – Saunders, K.– New Zealand
A pedagogical model for inquiry into controversial socio-scientific issues in secondary biology classrooms

12:30 – 14:00 Lunch

Poster *Session I*

Room A	Room B	Room C	Room D

14:00 – 15:00 Room A

Chair: Krüger, D. – Germany

Strand – 1 – Student conceptions and conceptual change

38 – Anastácio, Z., Fernandes, G. – Portugal
Primary school children conception's about body and about sexual/gender identity

19 – Sommer, C., Brandstädter, K., Harms, U. – Germany
How do we understand systems? - System competency at the elementary level

114 – Pleus, A., Upmeier Zu Belzen, A. – Germany
Transition from primary to secondary school as well as the transitions between biological subjects – an interview based study

27 – Lopes, B. S., Pedrosa-de-Jesus, M. H, Moreira, A. – Portugal
"Questions in Biology" – A strategy designed to promote students questioning

50 – Grünkorn, J., Krüger, D. – Germany
Model competence in biology education – Validation of a theoretical model of model competence using open-ended Items

139 – Terzer, E., Upmeier Zu Belzen, A. – Germany
Model competence in biology education - Operationalization and validation of a theoretical model of model competence using multiple-choice Items

143 – van der Velde, G. G. D., Boerwinkel, D. J. – The Netherlands
Secondary school students conceptions and opinions on forensic genomics

151 – Wellnitz, N., Mayer, J. – Germany
Structures and levels of competence of different scientific methods - *observation, comparing and experimentation*

WEDNESDAY – 14

115 – Radits, F., Rauch, F. – Austria
Inquiry learning in life science projects through collaboration of students and scientists

70 – Kidman, G. – Australia
Slowmation animation: Highlighting pre-service biology teacher conceptual change

63 – Jelemenská, P. – Austria
Changes in student's understanding of evolution: Teaching evolution on the case of the Galápagos finches

149 – Vidic, T., Tomazic, I. – Slovenia
Following the footsteps of the Neanderthals – project for gifted pupils

145 – van Hees, K., Knippels, M -C., Reumer., J. – The Netherlands
In search of design criteria for teaching evolutionary thinking an exploration of authentic research practices

14:00 – 15:00 Room B

Chair: Hammann, M. – Germany

Strand – 5 – Teaching: teaching strategies, teaching environments and educational technology

142 – van Graft, M., Tank, M.K., Verheijen, S. – The Netherlands
Animal survival: Learning by inquiry and design in primary science education.

93 – Mazereeuw, M., Boersma, K. T.– The Netherlands
Connecting school and work placement: An educational design for learning about animal reproduction

73 – Korsager, M. – Norway
Inquiry based biology teaching in ecology

104 – Nessler, S., Schlüter, K. – Germany
Does knowledge of nature of science (NOS) improve prospective teacher skills in constructing and performing open inquiry lessons to meet scientific educational standards?

80 – Lhoste, Y., Schneeberger, P. – France
How to help pupils to change their questioning to build up biological problems?

81 – Lock, R. – United Kingdom
Teaching time, and approaches to teaching and learning: The post 16 Nuffield Biology and Salters Nuffield Advanced Biology experience

18 – Brando, F.R, Andrade, M. A. B. S., Meglhioratti, F. A., Caldeira, A. M. A. – Brasil
The assessment of didactic activities from a hierarchical proposal

68 – Kampa, N. – Germany
Developing a competence test in biology

45 – Gomez-Galindo, A. A., Guerra-Ramos, M.T., Lopes-Valentín, D. M. – Mexico
Model-based innovation in science curriculum: the case of teaching and learning the nervous system

1 – Aguiar, C. A, Carvalho, A. A., Maciel, R. – Portugal
Exploring Pod casting in biology teaching

130 – Sminia, H., Boerwinkel, D. J., van Gelder, C. – The Netherlands
Empowering teachers to use bioinformatics tools in biology education

WEDNESDAY – 14

14:00 – 15:00 Room C

Chair: Tracana, R.B – Portugal

Strand – 6 – Environmental education and Biology education

41 – Silveira, M-J.F., Barros, S.G., Losad, C. M. – Spain
Biodiversity in compulsory education textbooks

51 – Gual Oliva, M., Bonil Gargallo, J. – Spain
The city as an urban ecosystem: A pathway to a causal thinking

25 – Colucci-Gray, L., Camino, E., Marchetti, D., Angelotti, M. – United Kingdom
Flows of energy and matter cycles in the ecosystems: A conceptual tool to deal with issues of global sustainability

17 – Borg, C., Höglund, H-O. – Sweden
Education for sustainable development – One in two teachers believe they lack the necessary knowledge

57 – Hasslöf, H., Ekborg, M., Sonesson, K. – Sweden
Subject meets subject - a study about teachers interchange in education for sustainable development

Strand – 7 – Health education and Biology education

40 – Scheid, N. M. J., Pansera-de-Araújo, M. C, Frison, M. D., Boff, E. T. O. – Brasil
Biological concepts signification in study situations to the basic education

92 – Mayerhofer, N., Márquez, C. – Spain
Initial models for elementary students on dental caries

20 – Carver, R. – Norway
Media analyses in biology class! A case study of how media framing activities can improve upper secondary school students' understanding of gene-environment interaction

87 – Lewis, J., Makocho, P., Gerein, N. – United Kingdom
HIV/AIDS education in Malawian secondary schools: are the pupils' needs being addressed?

14:00 – 15:00 Room D

Chair: Reiss, M. – United Kingdom

Strand – 9 – Practical work and field work

94 –Meier, M., Mayer, J. – Germany
Identifying and describing students competencies during experimentation in science

86 – Makashvili, M., Slovinsky, E. – Georgia
On the methods of teaching integrated science in the middle school years

98 – Meyer, A., Lorenzen, S., Meyer-Ahrens, I., Wilde, M. – Germany
Lessons with living harvest mice – an empirical study on motivational and cognitive learning effects

152 – Wierdsma, M., Knippels, M-C., van Oers, B., Boersma, K.T. – The Netherlands
Recontextualising cellular respiration

26 – Cruijsen, C., van Mil, M. H. W. – The Netherlands
Biomedical students as teachers and science communicators; developing a training program for the mobile DNA labs

21 – Almeida, P., Fonseca, H. M. A. C., Castro, G. – Portugal
Laboratory work and fieldwork in biology: promoting students' questioning competence

WEDNESDAY – 14

67 – Kamp, M. J. A., Sminia, H. – The Netherlands
Context based education in the zoo

123 – Scheersoi, A., Tunnicliffe, S. D. – Germany
"Is it dangerous?"- Interest of zoo visitors as a key to biological education

153 – Wilhelmsson, B., Ottander, C., Lidestav, G. – Sweden
Teachers' motive for outdoor teaching in the school forest

88 – Marbà–Tallada, A., Márquez, C. – Spain
Students' attitudes towards science while studying biology: The incidence of the behavioural component.

Poster *Session II* (see Poster Session 1)

15:00 – 16:00	Room A	Room B	Room C	Room D
	Chair: Zogza, V. Greece	Chair: Schneeberger, P. France	Chair: Krüger, D. Germany	Chair: Olander, C. Sweden

16:00 – 16:30 Coffee break

Paper *Session II*

16:30 – 18:30 Auditorium A

Strand – 2 – Student interest and motivation

Chair: Reiss, M. – United Kingdom

49 – Groß, J., Kattmann, U., Scheersoi, A. – Germany
Science meets society: an exhibition on evolution at IKEA

54 – Hammann, M., Jördens, J., Tyrrell, S. – Germany
Situational interest in evolutionary topics, contexts and activities

66 – Kalali, F. – France
« Me and the environmental challenges »: A survey of French students' environmental attitudes (ROSE). The case of secondary school of Paris and Creteil

99 – Meyer-Ahrens, I., Schröder, K., Wilde, M. – Germany
How does pupils' choice in biology lessons influence intrinsic motivation?

16:30 – 18:30 Auditorium B

Strand – 5 – Teaching: teaching strategies, teaching environments and educational techno-logy

Chair: van Eijck, M. – The Netherlands

30 – Dannemann, S., Krüger, D. – Germany
Evaluation of a diagnostic inventory to determine students' conceptions of vision and perception

78 – Larsson, C., Höst, G ., Anderson., T., Tibell, L. – Sweden
Using a teaching-learning sequence (TLS), based on a physical model, to develop students' understanding of the process of self-assembly

79 – Banner, I., Lewis, J., Broughton, K. – United Kingdom
Teaching about behaviour as an explanatory framework for biology

105 – Niebert, K., Gropengießer, H. – Germany
"It is not the CO_2 itself, it's the imbalance!" Conceptual reconstruction on the global carbon cycle in global warming

THURSDAY – 15

Paper *Session III*

9:00 – 10:30 Auditorium A

Symposium – 3

Coordinator (186) – Carvalho, G. S. – Portugal
International comparative study on biology, health and environmental education: Teachers' conceptions and textbook analysis in 19 countries
Discussant: Yarden, A. - Israel

187 – Berger, D., Bernard, S., Tracana, R. B. – France
Health and sex education: Teachers' social representations, conceptions and practices

188 – Clément, P., Caravita, S., Valente, A., Laurent, C., Cerbara, L. – **France & Italy**
Teachers' conceptions about the Environment and Environmental issues (EE).
A comparative study across nine Mediterranean countries

189 – Silva, C., Ferreira, C., Castéra, J., Carvalho, G. S. – Portugal
The importance given to environmental factors in the expression of genetic diseases in Portuguese and French textbooks

190 – Quessada, M-P., Clément, P. – France
The origins of humankind: A survey of school textbooks and teachers' conceptions in 14 countries.

9:00 – 10:30 Auditorium B

Symposium – 4

Coordinator: (167) – Simonneaux, L. – France
Support and obstacles linked to the teaching of SSIs in familiar and authentic contexts
Discussant: Ekborg, M. – Sweden

168 – Bravo-Torija, B., Jiménez-Aleixandre, M. P. – Spain
Research-based design of a teaching sequence on marine resources management promoting authentic practices

169 – Grace, M., Lee, Y.C., Wallin , A., Byrne, J., Asshoff, R. – United Kingdom
The science and values that students use in making decisions about a familiar socio-scientific issue: a four nationality comparison

170 – Simonneaux, J., Lena, J-Y., Jeunier, B., Chalmeau, R., Julien, M. – France
Attitudes and representations of pupils and adults on sustainability during the setting up of an agenda 21 project.

171 – Vidal, M., Simonneaux, L. – France
The use of companion modelling in "territories" of socio-environmental authenticity in the teaching of biodiversity

10:30 – 11:00 Coffee break

THURSDAY – 15

Paper *Session IV*

11:00 – 12:30 **Auditorium A**

Strand – 1 – Student conceptions and conceptual change

Chair: Boersma, K.T. – The Netherlands

9 – Schrenk, M., Baisch, P. – Germany
Can primary school students achieve a basic understanding of scientific concepts of the cycling of matter?

64 – Jördens, J., Asshoff, R., Kullmann, H., Hammann, M. – Germany
Interactions between student conceptions and teaching materials on evolution of life

155 – Zabel, J. – Germany
Darwin's mental landscape: Mapping students' learning trajectories in evolution theory

11:00 – 12:30 **Auditorium B**

Strand – 3 – Student values, attitudes and decision-making

Chair: Ben-Zvi Assaraf, O. – Israel

12 – Basten, M., Wilde, M. – Germany
Who does and who does not? The decision of German adolescents concerning post-mortem organ donation

52 – Paraskeva- Hadjichambi, D., Korfiatis, K., Hadjichambis , A. Ch., Arianoutsou, M. – Cyprus
Charismatic threatened plant VS road development: Value driven decision-making through computer-based, scaffolded learning activities

96 – Menzel, S., Bögeholz, S. – Germany
What influences young peoples' commitment to protect biodiversity in Chile and Germany?

12:30 – 14:00 **Lunch**

14:00 – 15:00 **Auditorium A**

Business Meeting (all participants are invited to attend)

15:00 **Tour**

FRIDAY – 16

Paper *Session V*

9:00 – 10:30 **Auditorium A**

Symposium – 5

Coordinator: (172) – Puig, B. – Spain

Use of evidence and argumentation in science learning

Discussant: Boersma, K. T.– The Netherlands

173 – Molinatti, G. – France

Argumentation, norms and normativity: discourses analysis concerning human embryonic stem cells

174 – Puig, B., Jiménez-Aleixandre, M. P. – Spain

Students' understanding about evidence for evolution

175 – Simonneaux, L., Habib, C. – France

The reasoned arguments of a group of future biotechnology technicians on a controversial scientific issue: human gene therapies.

176 – van der Jagt, S., Schalk, H., van Rens, L. – The Netherlands

Teachers and students' use of concepts of evidence in assessing the quality of an in inquiry

9:00 – 10:30 **Auditorium B**

Strand – 11 – Teachers' Knowledge and training

Chair: Zogza, V. – Greece

120 – Rozenszajn, R., Yarden, A. – Israel

Conceptualization of in-service biology teachers' pedagogical content knowledge (PCK) at the initiation of a long term professional development program

7 – Papadopoulou, P., Stasinakis, P., Athanasiou, K. – Greece

Study of evolution theory teaching: students' conceptual ecologies and teachers' perceptions

136 – Stolpe, K., Björklund, L. – Sweden

Being able to see the wood for the trees: Expert teachers' observational skills in complex environments explained by a neurocognitive model of learning.

10:30 – 11:00 Coffee break

Paper *Session VI*

11:00 – 12:30 **Auditorium A**

Strand – 4 – Student reasoning, scientific thinking and argumentation

Chair: Jiménez-Aleixandre, M. P. – Spain

107 – Olander, C., Ingerman, A – Sweden

Exploring argumentation patterns in the classroom: Towards an interlanguage of talking science

108 – Ossevoort, M., Lacum, E., Goedhart, M. – The Netherlands

A lesson in scientific argumentation: Experience with research articles by undergraduate life science students.

118 – Riemeier, T., Fleischhauer. J., Rogge, C., Aufschnaiter, C. – Germany

How can the quality of students' argumentations and their conceptual development be interrelated?

FRIDAY – 16

11:00 – 12:30 **Auditorium B**

Strand – 6 – Environmental education and Biology education

Chair: Wallin , A. – Sweden

4 – Amos, R., Reiss, M. – United Kingdom
The benefits of residential fieldwork: Insights from ecological and environmental experiences during a 4-year initiative for inner-city students in the UK

137 – Tal, T., Morag, O. – Israel
Development and employment of the FiNE model for learning in nature

135 – Stanisavljević, J., Đurić, D., Stanisavljević, L. – Serbia
The analysis of the efficiency of applying problem-based learning to biology instruction in terms of elementary school ecology curriculum

12:30 – 14:00 **Lunch**

Poster *Session III*

Room A	Room B	Room C	Room D

14:00 – 15:00 **Room A**

Chair: Anastácio, Z. – Portugal

Strand – 1 – Student conceptions and conceptual change

178 – Asunta, T., Havu-Nuutinen, S., Óskarsdóttir, G., Sigurjónsdóttir, H. – Finland & Iceland
Children's understanding of animals in Finland and in Iceland

179 – Byrne, J., Dale-Tunnicliffe, S., Patrick, T., Grace, M. – United Kingdom & USA
Children's understanding of animals in their everyday life in the UK and USA

180 – Ferreira, C., Silva, C., Tracana, R. B., Bartoszeck, A. Carvalho, G. S. – Portugal & Brasil
Portuguese and Brazilian children's understanding of animals in specific habitat niches

39 – Fonseca, M.J., Franco, N. H., Brosseron, F., Tavares, F., Olsson, A., Borlido-Santos, J. – Portugal
Children's attitudes towards animals: evidence from a primary school context in Portugal

75 – Kubiatko, M., Vaculová, I. – Czech Republic
Elementary school pupils knowledge a nd attitudes toward butterflies and mosquitoes

150 – Weber, A. – Germany
Learning about plants in the context of everyday life and nature experience

Strand – 3 – Student values, attitudes and decision-making

6 – Asshoff,R., Kullmann, H., Hammann, M. – Germany
Assessing students' attitudes and interests towards evolution – a methodological approach and survey

FRIDAY – 16

14:00 – 15:00 **Room B**

Chair: Clément, P. – France

Strand – 2 – Student interest and motivation

91 – Mavrikaki, E., Koumparou, H., Kyriakoudi, M., Papacharalampous, I., Trimandili, M. – Greece
What do Greek students think about biology?

112 – Petersen, M. – Denmark
Using students own observations to enhance the interest in biology – a model for combining cognitive and affective sides of learning

111 – Pedrosa-de-Jesus, M. H., Lopes, B. S. – Portugal
Promoting 'quality interactions' through questioning - a case study with a biology undergraduate course

48 – Enochson, P. G., Dempster, E., Redfors, A., Tibell, L. – Sweden
Students' ideas about the human body and health in school settings in Sweden and South Africa

77 – Kummer, B., Randler, C. – Germany
Learning about adaptations of animals at the zoo - results of an empirical study

Strand – 8 – Social, cultural and gender issues

5 – Caldeira, A. M. A., Araújo, E. S. N. N., Carvalho, G. S. – Brazil & Portugal
Brazilian teachers' conceptions about creationism and evolution

55 – Hanley. P. – United Kingdom
Cross-curricular teaching of origins of life: Opportunity or threat?

133 – Šorgo, A., Dolinšek, J. A., Špernjak, A. – Slovenia
Knowledge about and attitudes toward evolution among students in Slovenia

110 – Pansera-de-Araújo, M. C., Knapp, J. S. F., Scheid, N. M. J., Boff, E. T. O., Frison, M. D. – Brasil
Human population aging in basic education: What do the teachers think?

71 – Bögeholz, S., Koch, S., Barkmann, J.,– Germany
Indonesian biology teacher and agronomy students' perception of commons dilemmas

14:00 – 15:00 **Room C**

Chair: Molinatti, G. – France

Strand – 4 – Student reasoning, scientific thinking and argumentation

3 – Alzaghibi, M., Leach, J., Lewis, J. – United Kingdom
Localizing a teaching sequence about photosynthesis in Saudi high schools

14 – Berne, B. – Sweden
Students´ argumentation in biotechnology issues: An action research study in lower secondary school

158 – Quílez, M.J.G., Ambite, M., Laborda, M., Peña, B. M, Gándara, M. – Spain
The model of digestion: Negotiating scripts for a theatrical performance

156 – Zagal, M. A. Z. – Spain
Discourse analysis and human evolution in a context of board game

53 – Hadjichambis, A. Ch. – Cyprus
Ecosystem knowledge and system-thinking skills of K12 biology students

FRIDAY – 16

22 – Rundgren, S-N. C., Rundgren, C-J., Chang, C-Y. – **Sweden**
Are you SLiM from a biological perspective? Evaluating scientific literacy in media regarding biological terms

31 – Medeiros-Silva, R. C., Catells-Llavanera, M. – **Brazil & Spain**
Students' discussions about socio- scientific issues (ISS): Kind of arguments and scientific knowledge, beliefs and values on which the students argue to defend or attack some positions.

23 – Christenson, N., Rundgren. S-N. C., Höglund, H-O. – **Sweden**
Upper secondary students' use of scientific knowledge in arguing socioscientific issues

10 – Bardy-Durchhalter, M., Radits, F. – **Austria**
Students' scientific reasoning and thinking in authentic learning environments

14:00 – 15:00 **Room D**

Chair: Boersma, K.T. – The Netherlands

Strand – 11 – Teacher's Knowledge and training

103 – Münchhoff, K., Sommer, C., Harms, U. – **Germany**
The influence of teachers' content and pedagogical content knowledge on the development of students' system competence in biology

125 – Scheuch, M., Heidinger, C., Keller, E., Radits, F., Pass, G. – **Austria**
Biology teachers PCK development during an in-service teacher training course in ecology

144 – van der Zande, P., Vermunt, J. D, Brekelmans, M., Waarlo, A. J.
– **The Netherlands**
Expertise development of biology teachers in a community of practice

69 – Keller, E., Ullram, S. – **Austria**
What can teachers learn in an open enquiry-based learning environment?
The development of pedagogical content knowledge (PCK) through "Lernwerkstätten" in science teaching.

97 – Merkel, R., Upmeier zu Belzen, A. – **Germany**
Case Method of Teaching to promote cross-linked thinking in the master of education

65 – Jüttner, M., Spangler, M., Neuhaus, B. – **Germany**
Professional knowledge of biology teachers - Development of measurement instruments for biology teachers' pedagogical content knowledge and content knowledge

33 – Dübbelde, G., von Aufschnaiter, C. – **Germany**
Subject-matter related diagnostic competence: A four year longitudinal study to examine the structure and development of diagnostic competence of prospective science teachers

116 – Reitschert, K. – **Germany**
Concretising and evaluating the subject-specific competence profile for biology in teacher education

FRIDAY – 16

Strand – 5 – Teaching: teaching strategies, teaching environments and educational techno-logy

8 – Babai, R., Yaniv, P. – Israel
Several CASE lessons have a positive long-term effect on students' control of variables reasoning scheme ability

72 – Korfiatis, K., Prountzou, M. – Cyprus
Comprehending species interactions through computer simulations

Poster *Session IV* **(see Poster Session 3)**

15:00 – 16:00	Room A	Room B	Room C	Room D
	Chair: Pansera-de-Araújo, M. C. – Brasil	Chair: Caldeira, A. M. A. Brazil	Chair: Lewis, J. United Kingdom	Chair: Boerwinkel, D. J. The Netherlands

16:00 – 16:30 Coffee break

Paper *Session VII*

16:30 – 18:30 Auditorium A

Chair: Grace, M. – United Kingdom

Strand – 4 – Student reasoning, scientific thinking and argumentation

160 – Hipkins, R. – New Zealand
Conceptualising the transfer of learning in "21st century" terms

101 – Möller, A. – Germany
Exploring qualitative levels of scientific inquiry competence:
A longitudinal study on the development of scientific inquiry competence of biology students from grade 5 to 10

127 – Schmiemann, P., Sandmann, A. – Germany
Modelling Students' Competencies in the Area of Heredity

35 – Ekborg, M., Ottander, C. – Sweden
Working with socio scientific issues in secondary school: Students' learning in a case about global warming

16:30 – 18:30 Auditorium B

Chair: Boerwinkel, D. J. – The Netherlands

Strand – 5 – Teaching: teaching strategies, teaching environments and educational techno-logy

13 – Ben-Zvi Assaraf, O., Tripo, J., Yarden, A. – Israel
Characterizing three levels of systems thinking amongst 10th grade students while studying human biology

15 – Boersma, K. T., Waarlo, A. J., Klaassen, K. – The Netherlands
Rethinking the introduction of systems thinking in biology education

90 – Masson, A-L., van Mil, M. H. W. – The Netherlands
Improving student images of molecular mechanisms in chromosome segregation

146 – van Mil, M. H. W., Boerwinkel, D.J., Waarlo, A. J. – The Netherlands
A model of expert thinking for developing molecular biology education

19:30 Conference Diner

SATURDAY – 17

Paper *Session VIII*

9:00 – 10:30 **Auditorium A**

Chair: Dawson, V. – Australia

Strand – 4 – Student reasoning, scientific thinking and argumentation

28 – Dahmani, H-R., Schneeberger, P., Kramer, I. M. – France
Testing new ways to teach the concept of DNA in secondary school: didactical analysis of the link between graphic activities and verbal interactions in the classroom

121 – Rundgren, C.-J., Hirsch, R., Tibell, L., Rundgren, S-N. C. – Sweden
Help-words -- A creative way of meaning-making via visualizing molecular life science by upper secondary and tertiary students

157 – Zogza, V., Giasemis, H., Ergazaki, M. – Greece
Exploring the "knowledge – attitude" relation in the context of new genetics and biotechnology

9:00 – 10:30 **Auditorium B**

Chair: Ossevoort, M. – The Netherlands

Strand – 5 – Teaching: teaching strategies, teaching environments and educational techno-logy

56 – Härting, J., Pütz, N.– Germany
Learning by natural history museums aspects and goals of formal settings in Germany

82 – Lombard, F. – Switzerland
New opportunities for authenticity in a world of changing biology

122 – Zion, M., Sadeh, I. – Israel
Open inquiry – performances and team spirit

10:30 – 11:00 **Coffee break**

Paper *Session IX*

11:00 – 12:30 **Auditorium A**

Chair: Hammann, M. – Germany

Strand – 4 – Student reasoning, scientific thinking and argumentation

36 – Ergazaki, M., Alexaki, A., Papadopoulou, C., Kalpakiori, M. – Greece
Young children's reasoning about physical family resemblance and its origin

85 – Mackensen-Friedrichs, I. – Germany
How do domain specific learning stimuli influence the student's self-explanations while learning with worked-out examples in biology?

100 – Mnguni, L.E., Abrie, M. – South Africa
Identification of HIV/AIDS knowledge gaps in the Grade 11 South African schools' curriculum

SATURDAY – 17

11:00 – 12:30 **Auditorium B**

Chair: Schneeberger, P. – France

Strand – 5 – Teaching: teaching strategies, teaching environments and educational techno-logy

102 – Moreira, A., Pedrosa-de-Jesus, M.H., Correia, A., Cunha, A. – Portugal
Assessing student's questioning in group-based learning: A study with biology undergraduates

119 – Rixius, J., Neuhaus, B. – Germany
The structure of classroom conversation – a criterion of instructional quality in biology education: Analyses of video tapes

138 –Tapola, A. – Sweden
Human dignity, authenticity and life-science in practice

12:30 – 12:45 **Auditorium A**

Conference closing session

12:45 – 14:00 **Lunch**

SUNDAY – 18

07:00 – 20:40 **After Conference Douro river cruise:**

One-day tour through the Port wine vineyards

ABSTRACTS

KEYNOTE SPEAKER

0 Instruction-assisted development of inquiry: The dual space of philosophy and psychology

Duschl, R.A – Keynote Speaker

College of Education, Penn State University, University Park
USA

The 'naturalized turn' in philosophy of science places cognitive and social frameworks as core elements for understanding scientific inquiry and the growth of scientific knowledge. Science learning and reasoning when viewed generally as the growth of knowledge has many parallels with knowledge building and refining activities and practices in scientific inquiry. The lecture will examine philosophical and cognitive frameworks in the 'naturalistic turn' and then advance an 'enhanced' model of the scientific method that embraces inquiry practices situated in building and refining models and theories. Implications for the design of science curricula, use of authentic science learning models and for teaching and learning scientific knowledge/reasoning and the nature of science will be examined.

SYMPOSIUMS

SYMPOSIUM – 1

181 Approaches for authenticity in biology education: Challenges and benefits of underlying perspectives

Coordinator: van Eijck, M.
Eindhoven University of Technology – **THE NETHERLANDS**
Discussant: Lewis, J.
University of Leeds– **UNITED KINGDOM**

In this symposium we respond directly to the conference theme of the challenges and benefits of authenticity in biology education. We present, compare, and discuss different approaches that aim at bringing in authenticity in biology education. We highlight challenges and benefits of each of the approaches in regard to the underlying theoretical perspectives of authenticity.

Connections between the papers

Authenticity in science education is a fuzzy concept and science educators have contrasting views over exactly what it is. In a recent review study, three perspectives on authentic science education are suggested in order to bring clarity in the diversity of meanings: canonical, youth-centered, and contextual (Buxton, 2006).

The canonical perspective follows from the argument that inquiry tasks commonly used in schools evoke reasoning processes that are qualitatively different from the processes employed in authentic scientific research (e.g., Chinn & Malhotra, 2002). Moreover, school reasoning tasks are suggested to be based on an epistemology that differs from the epistemology of authentic science (ibid.). Buxton (2006) coined this perspective as canonical since it is aligned with both the Western scientific canon and with the recommendations for science education standards in the US (National Research Council [NRC], 1996, 2007), Europe (European Commission, 2006) and elsewhere. The youth-centered perspective draws on the premise that learning is authentic when it takes as its starting point the interests, perspectives, desires, and needs of the students. Such approaches explore ways that science learning can be taken up and negotiated within and against the canonical world of science, but rarely within the setting of school science (e.g., Roth & Barton, 2004; Roth, van Eijck, Hsu & Reis, 2008). A contextual perspective brings together selected aspects of both canonical and youth-centered perspectives. Such approaches attempt to let emerge scientific literacy from a combination of a canonical approach, focusing on the knowledge, skills, and habits of mind of literate individuals, and a sociocultural approach, focusing on language, values, and personal identity that affect an individual's participation in science activities (e.g., Buxton, 2006).

All studies presented in this symposium suggest a particular approach for bringing in higher levels of authenticity in biology education. However, they differ with respect to Buxton's (2006) perspectives on authenticity as illustrated above. Some of the studies depart by and large from a canonical perspective (Willingale-Theune et al), whereas others clearly take a contextual perspective (Jiménez-Aleixandre & Fernandez; Yarden & Gelbart), eventually evolving into an approach that comes very close to a youth-centered perspective (van Eijck). In addition, there is also the question of the teachers' role in relation to the varying levels of students' agency. This role is crucial given that high school students will not practice authentic science on their own. Two studies acknowledge this aspect of authentic science by focusing in more detail on the teacher (Jiménez-Aleixandre & Fernández; Yarden & Gelbart). Together with the discussant, the participants of this symposium will draw connections between the various means to promote the use of authentic scientific practices into high school. Since the studies collectively cover all perspectives of authenticity as outlined above, we expect that the symposium as a whole provides a comprehensive outlook on the challenges and benefits of authentic approaches biology education.

The four authors believe that the joint presentations and discussions that are expected to evolve during the proposed symposium are of great importance for advancing thinking about the means to use authentic scientific practices for science learning at the secondary school level.

182 The meaning of authentic practices: A proposal illustrated by 9th Grade students' generated projects

Jiménez-Aleixandre, M. P.[1] & Fernández-López, L.[2]

1. University of Santiago de Compostela
2. High School Carlos Casares, Viana do Bolo

SPAIN

The first objective is to clarify the meaning of authentic practices and authentic inquiry in science classrooms; the second is to analyze the implementation of research projects designed and carried out by 9th Graders under the guidance of their biology teacher (second author) illustrating our characterization of authentic inquiry. For the notion of authenticity, we draw from the literature about distributed cognition and learning communities (Brown et al., 1993), and about engaging students in scientific inquiry (Duschl & Grandy, 2008) and scientific practices (Reiser, 2009). In particular we frame our proposal in Chinn and Malhotra (2002) theoretical framework to evaluate inquiry tasks, which focuses on: a) cognitive processes in authentic inquiry, such as generating their own research questions; planning investigations; explaining results, or developing interpretations; and b) the epistemology that guides authentic inquiry. Our approach in the RODA project, when designing inquiry-based tasks and teaching sequences involving authentic practices, focuses rather on the cognitive and discursive practices of scientists (Sandoval and Reiser, 2004), as for instance argumentation and modeling, than on the engagement in sophisticated laboratory techniques. In our characterization (Jiménez-Aleixandre, 2008), authentic activities a) constitute problems (as opposed to rhetoric questions); b) are relevant for students' lives; c) require to be solved using inquiry processes; d) are designed in order to produce a diversity of outcomes with different epistemic status.

However, in some ERIDOB papers, authenticity is given the meaning of experiments carried out in an out-of-school laboratory where students perform hands-on experiments, for instance about marker genes (Scharfenberg, Bogner, & Klautke, 2007). Although these experiments may motivate students, they do not necessarily share the cognitive features of inquiry or of authentic problems.

The RODA perspective about authentic inquiry informs the projects designed and implemented by 9th Graders, as a regular part of their coursework. From this work, carried out during the last decade, we analyze here five projects of the term 2007-2008. The participants are 28 students. They generated the questions, carried out the projects and communicated the results in written and oral formats to the classroom, school and town. The projects are analyzed by means of Chinn and Malhotra (2002) framework, showing their alignment with the model, as well as room for improvement. The implication is that the authenticity of practices depends on their purpose, design and scaffolding provided by the teacher, rather than on students' acquaintance with sophisticated equipment and actual out-of-school laboratories.

183 Addressing the dynamics of science in curricular reform for scientific literacy: Towards authentic practices in the case of genomics

van Eijck, M.
Eindhoven University of Technology
THE NETHERLANDS

The aim of this theoretical study is to define scientific literacy Science education reform must anticipate the scientific literacy required by the next generation of citizens. Particularly, this counts for rapidly emerging and evolving scientific disciplines such as genomics. Taking this discipline as a case, such anticipation is becoming increasingly problematic in today's knowledge societies in which the dynamics of the natural sciences is unprecedented. This raises two questions: (1) what are features of the dynamics of a science such as genomics, and, in turn, (2) what notions of scientific literacy appropriate these features? Drawing on a contemporary socio-cultural perspective on the dynamics of science, the scholarly literature on genomics is briefly reviewed. This review yields a model of the features of the dynamics of genomics. Then the science education research literature is reviewed in this respect. This latter review indicates that scientific literacy capture the dynamics of science once defined as an emergent feature of collective activity. This thesis is discussed in regard to the implications for biology education. It is argued that a scientific literacy defined as an emergent feature of collective activity requires authentic forms of science education to which the learners' agency is central.

184 Stimulating critical thinking behind scientific discovery

Willingale-Theune, J., Manaia. A., Gebhardt,P., De Lorenzi, R., Nastasi,T. & Haury, M.

European Molecular Biology Laboratory – EMBL, Heidelberg

GERMANY

An essential part of teaching modern biology is to tutor pupils to develop a "*scientific mind*". It is argued that inquiry-based learning models stimulate this process by recapitulating, in broad terms, the critical steps of a scientific discovery. It also bypasses the limitations of science curricula, which often rely on the plain transmission of facts.

We have explored how bridging the scientific community to the education world can contribute to achieving the goal of increasing scientific literacy in the young population and in schools, on one side, and, on the other, to stimulate the cognition of how scientific reliability can be achieved through dialectics between opponent theories which constitute the base of a peer review process.

Reproducing inquiry-based experiences, which authentically recall specific scientific discoveries, especially with regards to the life sciences, can be challenging in terms of availability of resources and equipment. The European Learning Laboratory for the Life Sciences' (ELLS') mission — to place the advancements of the life sciences within the reach of secondary education -— is achieved through the development of experimental activities. These activities can be performed by teachers and students, and allow the participants to explore the different phases of the process of scientific discovery. Such experiences take place in an authentic research environment, thanks to the fact that ELLS is embedded in one of Europe's best scientific research institutes, the European Molecular Biology Laboratory (EMBL). Through access to Europe's top scientists, the latest techniques and most talked about controversies in the world of biology, ELLS provides the ideal setting to explore the process of scientific discovery — linking researchers to the educational world (Willingale-Theune *et al*., 2009).

ELLS' collaboration with science education researchers is aiming to develop didactical resources, providing long-term support for teacher training activities, and further stimulate the development of long-lasting scientific knowledge among students.

We will present an overview of ELLS' recent activities and examine how joint activities involving researchers and teachers contribute to a better understanding of the scientific methodology in the classroom, and enhance science teaching and curricula.

By confronting science teachers with the real world of science and encouraging direct dialogue between teachers and scientists, we believe that ELLS can contribute to the advancement of life science didactics in schools.

185 Supporting learning of high school genetics using authentic research practices: The teacher's role

Yarden, A. & Gelbart, H.

Weizmann Institute of Science, Rehovot

ISRAEL

In this study we describe the support provided by a biology teacher during learning using a web-based learning environment that make use of authentic research practices in genetics. This environment includes a research simulation that enables learners to take part in an authentic research in genetics, which was developed on the basis of a research paper in which a mutated gene, which causes deafness in an Israeli family, was identified. In the research simulation, the students are introduced to the basic heuristic strategy of comparing between the normal and mutated forms of a certain character and correlating the mutated version of the gene with the phenotype of affected individuals. The study stems from a theoretical perspective that views learning as a combination of the constructivist learning theory namely as a process of knowledge construction. Another theoretical perspective that is at the basis of this study is the views on declarative, procedural and conditional knowledge. The ability to use conditional knowledge is at the hearts of performing authentic scientific research. The overall greater complexity of authentic scientific research requires continuous coordination between declarative and strategic knowledge, as well as between the various intervening events, or various stages of the scientific experiment. Such coordination is not typical to regular school tasks and rarely appears in most learning materials, including textbooks, used in schools. Thus, it is unlikely that students will be able to carryout such coordination without guidance from their teacher. Our research question in this study was what kind of support does a teacher provide during enactment of the research simulation and how does it facilitate students' ability to coordinate between declarative and strategic knowledge? To answer this question, we videotaped and audiotaped one teacher and her students (n=26) during the enactment of the learning environment in class (150 minutes). An iterative teaching cycle composed of three steps which were repeated in all assignments was identified during the analysis of the transcripts: *planning* the research step, *performing* the scientific procedures using scientific tools and methods, and *interpreting* the resultant data in each of the assignments. We found that by guiding students' attention to the research goal and objective and to the research strategies, the teacher apprenticed the students to use their general inquiry thinking skills and prior genetics knowledge in a way that enabled them to recognize the research practices as well as the heuristic strategy of genetics.

SYMPOSIUM – 2

162 Benefits and challenges in teaching and learning about controversial socio-scientific issues in biology classrooms

Coordinator: Saunders, K.

University of Waikato, Hamilton – **NEW ZEALAND**

Discussant: Simonneaux, L.

Toulouse EducAgro, ENFA, Université de Toulouse – **FRANCE**

The ability to make, justify and defend a decision about controversial socio-scientific issues is an important outcome of science education and an indicator of scientific literacy. Students and in many cases, teachers, need to develop the skills to facilitate and make informed and reasoned choices about controversial socio-scientific issues. The aim of this symposium is to explore both the benefits and challenges in teaching and learning about such issues in biology classrooms and in doing so promote the development of dimensions of students scientific literacy.

The first paper reports on a project that developed a pedagogical model for ethical inquiry in to controversial socio-scientific issues. The model shows a progression of stages with appropriate pedagogical strategies displayed in colour coded sidebars. The stage of ethical decision making within the model extends traditional approaches of ethical thinking to propose the inclusion of pluralism as a perspective of multiple identities based on cultural, ethnic, religious and gender perspectives. The initial version of the model was trialled and further co-constructed with a small group of secondary teachers in a professional learning programme. Positive teacher and student outcomes validated the final version of the model as a vehicle supporting biology teachers to improve their practice and confidence as well as supporting the development of students' scientific literacy in terms of thinking ethically about controversial socio-scientific issues.

The second paper further develops the notion of pedagogical approaches for teaching and learning about controversial socio-scientific issues outlined in the first paper and specifically focuses on argumentation strategies. This project involved a small group of teachers, who after participating in a professional learning experience on argumentation, explicitly introduced argumentation skills through the use of writing frames and whole class discussion to their students. This group of students was compared with another group who had not experienced the intervention and it was found that the intervention group showed an improvement in their argumentation skills which contributed to the development of their scientific literacy.

The third paper aims to evaluate the potential of "blogging" about controversial socio-scientific issues in the promotion of students scientific literacy. A biology class was organized into groups, each being responsible for conceiving and maintaining a blog, under the supervision of the teacher/researcher, about a controversial socio-scientific issue. The blogs become a virtual space to collect information and to trigger and support discussion and argumentation and were open to the participation of class members as well as other interested participants. The findings showed that the level of motivation and involvement in the blogs conception was high and contributed to strengthening several dimensions of students scientific literacy.

The final paper in this symposium set explores the challenges of teaching ideas about risk, an important component of scientific literacy, in the context of socio-scientific issues. The project utilises software tools based on contemporary theories of risk so that teachers can express significant issues and concerns related to decision-making in contextual biological dilemmas. In doing so a pedagogy of risk emerges. Initial analysis of the findings indicated that the software tools can identify possibilities of interdisciplinary pedagogy, and that the use of such models promotes for teachers, an awareness of the multi-dimensionality of risk in decision-making through biological dilemmas.

The papers in this symposium set, explore and promote the notion that addressing controversial socio-scientific issues in biology classrooms, develops dimensions of scientific literacy, but that to facilitate this effectively, teachers need professional learning opportunities to increase their confidence and their awareness of a diversity of pedagogical approaches and tools.

163 Argumentation strategies used by teachers to promote argumentation skills about a genetics socio-scientific issues

Dawson, V.[1] & Venville, G.[2]

[1.] Curtin University, Perth

[2.] University of Western Australia, Perth

AUSTRALIA

The ability to justify and defend a decision using a rational and well constructed scientific argument is an important outcome of science education and an indicator of scientific literacy. Students need to develop the skills to participate in reasoned debate and to make informed personal choices about socio-scientific issues (SSI). Since 2006, the authors have conducted six case studies with science teachers in Western Australian high schools. Using a quasi-experimental research design six teachers participated in a professional learning experience on argumentation, decision-making and SSI and then explicitly introduced argumentation skills using SSI as part of a year 9 or 10 genetics topic. The teachers used Toulmin‟s argumentation pattern to explain the structure of an argument. The students then used writing frames to assist in constructing arguments and making decisions about two SSI in the context of genetic testing and genetically modified foods. Students also participated in small group and teacher led whole class discussion about the SSI. In each case the students‟ ability to construct an argument (using claims, data, warrants, backings and qualifiers) and their informal reasoning types (rational, intuitive and emotive) about a „designer baby‟ socio-scientific issue was measured with a pre- and post-test. A comparison group of students from the same school who studied the same genetics course without the argumentation intervention completed the same pre- and post-test. Qualitative data sources included classroom observations, lesson transcripts, teacher and student interviews. The students who were explicitly taught about argumentation improved significantly more in their argumentation skills and ability to use rational reasoning than students who studied the same genetics topic but did not learn about argumentation. It was found that explicit modelling of argumentation skills, the use of writing frames, and whole class discussion contributed to an improvement in students‟ argumentation skills. The significance of the findings for classroom instruction in argumentation will be discussed.

164 Developing a pedagogy of risk in socio-scientific issues

Levinson, R., Kent, P., Pratt,D., Kapadia, R. & Yogui, C.
Institute of Education, University of London
UNITED KINGDOM

The aim of our research is to develop a pedagogy of risk in socio-scientific issues. Risk is prevalent in techno-scientific discourse in late-modern societies but is only slowly becoming integrated into the curriculum for teaching science. It is challenging to teach because of its contested conceptual basis incorporating epistemic and non-epistemic values, its situated nature in addressing socio-scientific issues and its mathematical basis in probability and statistics. In our project – Promoting Teachers" Understanding of Risk in Socio-scientific Issues (TURS) - we have built a set of mature software tools designed through an epistemological analysis of risk and consideration of the teaching and learning of risk, as reflected in discussions with teachers. This software embodying emergent design ideas such as the need to involve the teachers in complex decision-making scenarios, provides teachers with tools that enable them to express what they see as the significant issues and strengths of those concerns, giving feedback that enables the teachers to redraft their models in the light of the ostensible consequence of their decisions. Pairs of science and mathematics teachers have modelled two scenarios, one based on personal decision-making for a surgical intervention, the other on public policy decisions on the risks involved in mass vaccinations. In analysing teachers" construction of knowledge and incorporation of values in decision-making on risk-based socio-scientific issues we have coded dialogue through the modelling process and used synchronous video-flash capture data. This analysis has generated four key findings: teaching risk lends itself to a multi-disciplinary approach; recognition of the multi-dimensional nature of risk can be elicited through engagement with contextualised biological dilemmas; the use of executable models promotes discussion of the complexity of risk as well as awareness of the characterisation of the consequences of the dilemma, and expressive tools can be designed which support coordinated analysis of the multi-dimensional nature of risk.

165 Contributions of "blogging" about controversial socio-scientific issues in the promotion of students' scientific literacy: A case study

Reis, P. R.[1] & Hilário, T.[2]

1. Escola Superior de Educação do Instituto Politécnico de Santarém e Instituto de Educação da Universidade de Lisboa
2. Escola Secundária Manuel Cargaleiro

PORTUGAL

This qualitative investigation, based on a case study centred on a 12th grade biology class (17-18 years old students), aimed to evaluate the potential of "blogging" about controversial socio-scientific issues in the promotion of students" scientific literacy. Data were gathered through content analysis of students" blogs, individual narratives and the transcripts of semi-structured interviews.

During one school year, the class was organized into groups, each being responsible for conceiving and maintaining a blog, under the supervision of the teacher/researcher, about a controversial socio-scientific issue related with "genetic approaches to human infertility", "manipulation of human genetic information" or "genetic engineering". The blogs intended to become a virtual space to collect information and to trigger and support discussion regarding one of these issues. The blogs were open to the participation of everybody (class members or not). The level of motivation and involvement in the blogs" conception was high. However the level of students" participation on each other's blogs varied between groups and individuals. Despite some limitations – such as the time required to maintain the blog and the dissatisfaction of some students about using the computer and the Internet for school tasks – blogging about controversial socio-scientific issues contributed to strengthening several dimensions of students scientific literacy: a) knowledge about the scientific and technological aspects of each issue, the nature and processes of science and the interactions between science, technology and society; and b) skills of information gathering and analysis, communication and argumentation. Another positive aspect of this activity was the development of students" awareness regarding the possible role of their blogs in social action and active citizenship. Based on these results, implications for science education are discussed.

166 A pedagogical model for inquiry into controversial socio-scientific issues in secondary biology classrooms

Saunders, K
University of Waikato – Hamilton
NEW ZEALAND

One aspect of developing scientific literacy in high school biology students requires teaching them to make informed decisions about controversial issues especially those related to the rapid rate of biotechnological progress in society today. However, it appears many biology teachers lack confidence to teach such issues in their classrooms. This paper reports on a project that developed a pedagogical model for inquiry into controversial socio-scientific issues in high schools. The model was informed by the literature, together with data from a survey and interviews carried out previously by the author. It was developed as a coloured, visual representation which showed progression of stages in the process of inquiry as a central feature. Some appropriate pedagogical strategies were displayed in sidebars which were colour coded to link with the relevant stages in the model. The stage of ethical decision making within the model extended traditional approaches of ethical thinking to propose the inclusion of pluralism as a perspective of multiple identities based on cultural, ethnic, religious and gender perspectives.
The initial version of the model was trialled and further co-constructed with a small group of secondary teachers. Positive teacher and student outcomes validated the final version of the model as a vehicle supporting biology teachers to improve their practice and confidence as well as supporting the development of students' scientific literacy in terms of thinking ethically about controversial socio-scientific issues.

SYMPOSIUM – 3

186 **International comparative study on biology, health and environmental education: Teachers' conceptions and textbook analysis in 19 countries**

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Discussant: Yarden, A.

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The European FP6 STREP project BIOHEAD-CITIZEN ("Biology, health and environmental education for better citizenship" CIT2-CT-2004-506015) aims at understanding how Biology, Health and Environmental Education can promote a better citizenship, including their affective and social dimensions, by analysing possible differences in 19 countries, and associating them to controlled parameters, (*e.g.* social context, religion, gender). This project includes 19 countries: 6 EU "old" member states (Portugal, France, Germany, Italy, England and Finland), 7 "new" member states (Cyprus, Estonia, Hungary, Lithuania, Malta, Poland and Romania), and 6 non European Countries (Lebanon, Tunisia, Algeria, Morocco, Mozambique and Senegal). This large East-West and North-South countries distribution was selected to enable a large transnational comparative study, where different social contexts, religions, level of faith and gender can play a major role. We selected 6 main topics to be analysed across the 19 countries:

i) Health Education: explicit and implicit values, nutrition, substance abuse (drugs), biomedical model and health promotion;

ii) Human Reproduction and Sex Education: including related health questions and sexual transmitted diseases (AIDS, other STD, contraception, abortion);

iii) Ecology and Environmental Education (and Sustainable Development): explicit and implicit values, cycles, interactions, pollution, different philosophies on nature and environment;

iv) Human Genetics: genetic determinism of human characters, genetic diseases, interactions between the genome and its environment (epigenesis), genetic engineering, GMO;

v) Human Origin: theories of evolution, with a special emphasis on the origins of humankind;

vi) Human brain: epigenesis, thinking, intelligence, spirit; brain diseases; brain at the command, or brain built by individual/social life.

Two main axes of analyses were carried out:

a) A comparative analysis of the teachers' and future teachers' conceptions (social representations) related to the project selected topics: A questionnaire in the above six topics was constructed in English, (by including questions from previously well tested questionnaires and creating new questions), validated and, after translation to the national languages, it was applied in all countries.

b) A comparative analysis of syllabuses and school textbooks among the 19 countries: For each topic, a specific grid of analysis was constructed to be used by all participating countries in all school levels (Primary and Secondary Schools, i.e. from 6 to 18 years old students).

In this symposium four papers are presented, being two of them ont teachers' and future teachers' conceptions, the third one on textbook analysis and the forth one on both teachers' conceptions and textbooks analysis.

The first paper on "***Health and Sex education: teachers' social representations, conceptions and practices***" puts together the topics "*i – Health education"* and "*ii – Human Reproduction*

and Sex education", joins authors from the French and the Portuguese teams and it reports the results obtained after treating data collected from 15 countries.

The second paper ***"Teachers' conceptions about the Environment and Environmental issues (EE). A comparative study across nine Mediterranean countries"*** concerns topic "*iii – Ecology and Environmental education*" and data from nine Mediterranean countries were worked out by both Italian and the French teams of the BIOHEAD-CITIZEN project.

The third paper on ***"The importance given to environmental factors in the expression of genetic diseases in Portuguese and French textbooks"*** focuses on a comparative approach between textbooks from two countries, Portugal and France, on the topic "*iv – Human genetics"*.

Finally, the French team works the topic *"v – Human origin"* by relating both approaches of teachers' conceptions and textbooks analysis on the fourth paper ***"The origins of humankind: A survey of school textbooks and teachers' conceptions in 14 countries"***.

We expect this symposium can contribute to open a deep discussion about the influence of several parameters (social context, religion, level of faith, gender, etc.) on the teaching of Biology topics.

187 Health and sex education: Teachers' social representations, conceptions and practices

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2. Institute Polytechnic of Guarda and CIFPEC, University of Minho – **PORTUGAL**

Health and Sex Education in school are nowadays an important public health issue. It concerns not only youth prevention and health promotion in school but also interpersonal relationships, psychosocial issues. Therefore school health education and sex education contribute to promote better citizenship. It has been recognized that teachers' conceptions play a crucial role for the effective implementation of school health education. In this communication, we analyse data concerning teachers' and future teachers' conceptions derived from a questionnaire that was constructed and tested during the project BIOHEAD-CITIZEN. We analyze the conceptions and practices of teachers in 15 countries, focusing on their differences and associating them to controlled parameters (e.g. social context, religion, gender, etc.). The questionnaire was completed by 6001 teachers and future teachers. We used statistical multivariate analyses, a method that has become standard for investigating complex data derived from many individuals that needs to be analyzed according to many variables. Results show that the local culture is of major relevance and that the factors that correlate most closely with the teachers' and future teachers' conceptions are religion, the level of belief in God and the level of religious practices. It was also found that the level of teaching (primary versus secondary school) is also correlated with different conceptions on health and sex education. Detailed results will be presented and discussed at the ERIDOB Conference

188 Teachers' conceptions about the Environment and Environmental issues (EE). A comparative study across nine Mediterranean countries

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An important goal of school instruction in general and of environmental education in particular is to relevantly contribute to the construction of basic intellectual tools needed by citizens for conceiving and promoting a sustainable future. Knowledge, system of values, and social practices are integrated in the notion of "conception" proposed by Clément (2006) since their interaction shapes the didactic transposition. Teachers' and prospective teachers' conceptions on several topics of biology teaching and science manuals were the targets of the BIOHEAD-Citizen project. The partners of eighteen countries developed, tested and validated a questionnaire that included a subset of twenty-eight Likert-scale questions focused on nature and environmental problems.

Different aspects involved in the relationship of humans respect to nature and in their approaches to the management of environment were addressed by the EE questions. The religious and political orientation of the individuals, and their active participation in conservation and/or sustainable development were also inquired. Eventual correlations between these personal dimensions and the answers to the EE questions were checked across the data drawn from the samples of interviewed teachers.

We present the results of the multivariate statistical analyses of the data drawn from the EE questions of eight Mediterranean countries (Algeria, Cyprus, France, Italy, Lebanon, Malta, Morocco and Tunisia) and Portugal, a country having strong historical and cultural connections with the other ones. Economical, ecological, religious factors are the source of differences across these countries and they also enabled to attain a deeper understanding of the nature of EE conceptions. The state of the art of Environmental Education has also been considered.

Multiple dimensions seem to feature the conceptions concerning humans' relationships with nature and environment, which have their roots in rational and emotional dimensions. The polarized opposition between anthropomorphism/utilitarism and ecocentrism/conservationism might be a reductive way of modelling this. Anthropocentrism, linked with a sort of optimistic view about the possibility of continuing the exploitation of the planet with the support of science and technology, was found to correlate with faith in God and practice of religion (whichever religion). North African countries seem to concentrate on the side of anthropocentrism, with some difference among them, whilst European countries concentrate on the side characterized by low confidence in scientists and scepticism about GMO.

Differences between pre-service and in-service teachers did not appear, but they emerged between language and biology teachers.

The findings will be discussed also in relation with the results obtained from the science manuals analysis.

190 The origins of humankind: A survey of school textbooks and teachers' conceptions in 14 countries.

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The origins of humankind, is one of the six topics of the European research project BIOHEAD-Citizen. The conceptions related to this topic are analysed with the KVP model (Clément 2006). The research is restricted to the 14 countries where the questionnaire applied to teachers was including a question about the human origin.

In six countries (Algeria, Burkina, Lebanon, Morocco, Portugal and Tunisia), human evolution is not present in the syllabuses. In the 8 other countries (Cyprus, Estonia, Finland, France, Hungary, Italy, Romania, Senegal), the origins of humankind are taught.

When analysing the images of timelines or trees depicting evolution, the 50 schemas illustrating *Homo sapiens* in the eight countries are coming from 18 science textbooks: Cyprus (1), Estonia (2), France (4), Italy (6), Lebanon (1), Portugal (1), Romania (1), Senegal (1), Tunisia (1). *Homo sapiens* is never represented by only a woman. Only two times *Homo sapiens* is represented by a couple, and only 6% of human beings presented in the chapters dealing with Evolution are females. No-one image illustrates ethnic diversity. *Homo sapiens* is nearly always an archetype of a male with white skin, either naked or dressed in occidental clothing. These results show that scientific messages related to the origins of humankind are generally mixed with implicit values

In the 14 countries, 5,706 teachers filled out a long questionnaire. The sample was a balanced set of primary and secondary school teachers who taught biology or the national language. Answering to the question related to *"the importance of God in species evolution"*, the teachers ticking *"great importance"* or *"some importance"* were 8% in France but around 95% or more in Lebanon, Senegal, Tunisia, Morocco and Algeria. Answering to the question related to human origin, 2% to 92% teachers, depending the country, ticked the radical creationist item ("*It is certain that God created humankind"*). Biology teachers' conceptions were more evolutionist than those of their colleagues in only half of the countries surveyed. The longer a teacher trained at a university, the greater the acceptance of evolutionist ideas.

The main results show great differences between countries, and strong interactions KV. We'll discuss the interpretation of these results, proposing correlations between that is taught or not, teachers' conceptions, their degree of practicing religion, the economical level of the country and the teachers' level of training,

189 The importance given to environmental factors in the expression of genetic diseases in Portuguese and French textbooks

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Traditionally, the teaching of genetics has been based on the paradigm of the genetic determinism, in which the great emphasis is given to the role of the genotype upon the expression of the phenotypic characteristics and the environmental influence is not taken into account. In this study, we analyse how genetic diseases are presented in Portuguese and French textbooks, giving special attention to the allusion to the environmental influence or lifestyles in the genetic disease expression.

A total of 13 Portuguese and 18 French textbooks containing the topic Human Genetics for the pupils between 14-15 and 17-18 years old were analyzed. We classified the genetic diseases into three categories – gene diseases, chromosome diseases and multifactorial genetic diseases – the latter depending on the influence of the environment. In addition it was analyzed to what extent the influence of the environment is explicitly referred, with examples, to the phenotypic expression of multifactorial genetic diseases.

The Portuguese textbooks give more emphasis to the gene diseases (haemophilia, colour blindness), whereas the French textbooks refer more often multifactorial genetic diseases (diabetes) than the Portuguese ones. While the French textbooks refer throughout all textbook ages' examples of the effect of the environment in the emergence and development of disease, the Portuguese textbooks give examples just for 16-17 years old textbooks. The Portuguese Psychology textbooks give much more importance (40% of occurrences) to the influence of the environment on the outbreak and development of multifactorial genetic disease than the Biology textbooks (5%), showing the different paradigms underlying the teaching of these two disciplines.

The presentation, in textbooks, of genetic diseases in the narrow view of genetic determinism (*i.e.*, without influence of the environment) gives the negative notion that the person can do nothing to improve his/her health. In contrast, if the influence of the environment on the activation or repression of multifactorial genetic diseases is explained, then the person can develop capacities to improve his/her lifestyle (e.g. stopping smoking) in order to avoid the conditions for the outbreak and development of the disease (e.g. lung cancer outbreak), thus contributing to promote his/her health. We think it is important that textbooks make more explicit the links between biological information (*e.g* causes of genetic diseases) and developing positive attitudes and behaviours in order to improve one's lifestyle, and so contributing for health education and health promotion.

SYMPOSIUM – 4

167 Support and obstacles linked to the teaching of SSIs in familiar and authentic contexts

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Putting things into context is supposed to improve located cognition and enhance scientific learning by giving more meaning to scientific knowledge. Analysing local or global SSI within the framework of environmental teaching and the teaching of sustainability, may encourage an integrated mobilisation of concepts and promote scientific citizenship amongst pupils. Providing context reintroduces the axiological dimension into learning, a dimension which can generate support or create obstacles.

In literature on SSI and particularly on questions related to the environment or sustainable development, diverging results have been observed as to the pertinence of anchoring didactic situations in authentic contexts which pupils are well aquainted with. In short, it emerges that if the context given to the pupils goes against their system of values, their affect-based reponses can hinder critical reasoning, can "blind" them and become an obstacle to decision making based on scientific knowledge; if, on the contrary, the affect allows them to defend socio-cultural stances, it stimulates critical analysis.

The talks given during this symposium concern SSIs which are related to the environment or to Sustainable Development. The teaching devices are all based on authentic, environmental, social and/or professional contexts. The papers question the respective roles of values and knowledge in the negotiations, decision-making and involvement in the action.

This symposium would like to contribute to the identification of didactic modalities which foster both the commintment and the distancing of pupils who are placed in authentic contexts. How can we help pupils to develop their capacity to produce well-argued negotiations, their axiological reflexivity and critical reasoning based on situated and sometimes controversial knowledge?

During this symposium **Grace, Chung Lee, Wallin, Byrne and Asshoff** analysed how 16-17 year-old science students of four different nationalities draw on science and values in decision-making discussions on a familiar socio-scientific issue: whaling. The students discuss this question in small groups in each country, and then each small group makes a presentation which is subtitled and viewed by the students from the other locations.

Within the framework of Sustainable Development Education, **Simonneaux, Léna, Jeunier, Chalmeau & Julien** studied how the different actors in the educational community of a high school (pupils, teachers and technical staff) became actively involved in the setting up of an Agenda 21 school project, which meant forming a partnership with local stakeholders, and how they perceived the process of setting up of this project. Differences were detected between the representations of sustainable development held by the adults and those held by the pupils. The results show that a predominant position is given to values in the conception and running of educational projects concerning sustainable development. They also reveal the necessity to explore, with the pupils, the way in which knowledge / values / action are articulated during the transition from rationality to reason.

A research team in the field of socio-ecology has developed a model of the interactions between the actors and the different elements of a given authentic territory; this model helps to map out the evolution of the territory according to the choices made by the actors. A didactic device was derived from this model. It consists of a role play and a computer simulation. **Vidal & Simonneaux** analyse whether the students' participation in this role play helps in the negotiation

aimed at a community system of management for the given territory, whether it modifies the students' attitude regarding environmental governance and regarding the human and nonhuman elements in the environment. It emerges that the students' attitudes pertaining to their identity are a decisive factor in the negotiation. If the student identifies too strongly with the role, this prevents him from discerning the reasoning of the other actors involved and hinders the negotiation concerning the conservation of biodiversity.

Bravo-Torija & Jiménez-Aleixandre discuss the design of a teaching sequence about a SSI, marine resources management, intended to engage students in authentic practices. They seek to engage students in the authentic practices of argumentation and modelling first about a current controversy about the sustainability of aquaculture, then about an NGO in charge of providing food for a village after a natural disaster.

168 Research-based design of a teaching sequence on marine resources management promoting authentic practices

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Universidade de Santiago de Compostela

SPAIN

We discuss the design of a teaching sequence about marine resources management, intended to engage students in authentic practices. The objectives of the paper are twofold: 1) to discuss a teaching sequence (TS) informed by theoretical approaches and empirical preliminary data; and 2) to document how successive versions of the central task of the sequence evolved in interaction with data of the preliminary studies.

The TS revolves around a problem that the students are asked to solve: How to manage scarce fish resources in a bay in order to feed more people? There are different fishing options for fishes placed in different trophic levels.

The design of the teaching sequence was informed, on the one hand, by theoretical approaches about authentic practices (Berland & Reiser, 2009); argumentation about socio-scientific issues, SSI, (Sadler, 2004) and ecology learning (Carlsson, 2002). Authentic tasks and SSI share features as having social significance, being relevant for the lives of the students. It needs to be noted that they involve science concepts and skills, in this case the model of energy flow and trophic pyramid. We seek to engage students in the authentic practices of argumentation and modeling.

On the other hand, empirical data were collected in preliminary studies carried in three steps: 1) 93 university biology students performed a task about the sustainability of aquaculture of carnivorous fishes; only 16% used the notion of energy flow. 2) An intervention study, involving constructing a concept map, showed improvement. 3) The responses to a task about energy flow in the university entrance exams were examined in a representative sample of 254 students, showing that only 29% used the more complex model. Examples of students' answers are discussed in the full paper.

Taking both the rationale and the empirical data into account, a TS for 10th grade along three weeks, eight sessions is designed, involving students in: constructing concept maps; modeling energy transfer in ecosystems; modeling trophic pyramids, writing a report in small groups about how to manage fish resources in order to feed the population of a village. The problem evolved from engaging in a current controversy about the sustainability of aquaculture, which had too many distractors, to a task about an NGO in charge of providing food for a village after a natural disaster. Implications for identifying and applying design principles are discussed.

169 The science and values that students use in making decisions about a familiar socio-scientific issue: a four nationality comparison

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This study focuses on how 16-17 year old science students of four nationalities draw on science and values in decision-making discussions about the socio-scientific issue of whaling. The students in each location are provided with the same background information (scientific, political, cultural and pro and anti-whaling materials) and after their discussions, each small group makes a presentation which is subtitled and viewed by the students from the other locations. Early findings have already demonstrated that students are able to take part in such decision-making discussions, that student responses are often modified as a result of discussions, and that there are emerging similarities and differences between the national groups. An understanding of how students approach this decision-making task, what science and values they draw upon, and their thoughts about the views of other students around the world, will help curriculum developers design materials and programmes to promote decision-making about familiar global conservation issues. It will also provide a case study and model for teachers who wish to promote among their students an awareness of how their counterparts in other parts of the world feel about and respond to such issues.

170 Attitudes and representations of pupils and adults on sustainability during the setting up of an agenda 21 project.

Simonneaux, J.[1], Lena, J-Y.[2], Jeunier, B.[3], Chalmeau, R.[3] & Julien, M.[3]

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The generalisation of sustainable development education is encouraging schools to organise educational activities of an environmental, social, economic and civic nature. We studied the way in which the different actors in the educational community might perceive and become involved in setting up an "agenda 21" project in a vocational high school.
Setting up sustainable development actions in school constitutes a situation of authenticity as it concerns real local projects. At the same time, sustainable development is a socio-scientific question because it provokes debate and uncertainty from both a social and a scientific point of view. The aim of this research is double. On one hand we want to pinpoint the impeding factors and those that, on the contrary, have a springboard effect on the setting up of such a programme in which environmental actions dominate and on the other hand we want to gain an understanding of the psychological and cognitive aspects which encourage the actors to become involved in this type of project. We are particularly concerned with identifying the values, the attitudes and the representations vis-à-vis sustainable development and the process of setting up an agenda 21 project. We drew up a questionnaire and carried out a survey on the 22 adults - teachers and other adults from the high school -, on the 21 pupils « eco-delegates » involved in the action and on 2 classes (37 pupils) studying for a technological Baccalaureate.
The questionnaire was composed of both open and closed questions concerning the representations and attitudes vis-à-vis sustainable development, the claimed changes in behaviour and the knowledge of the actions undertaken in the school. To complete the questionnaire, we interviewed some of the teachers. The qualitative elements of the questionnaire underwent an intersubjective reclassification by items.
The results highlighted the differences in the representations of sustainable development held by adults and pupils: the notion of long term is much more important for the adults whereas the pupils give priority to the environmental dimensions. The adults focus on the educational and civic dimensions whereas the pupils put the emphasis on "eco-friendly gestures". We also highlighted the differences in the representations linked to gender but also those specific to the "eco-delegates". To the latter their involvement in the action is a priority whereas the other pupils have a wider vision of sustainability.

171 **The use of companion modelling in "territories" of socio-environmental authenticity in the teaching of biodiversity**

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A research concerning the didactic value of companion modelling in teaching biodiversity has been carried out. These models, invented by the consultative group "ComMod" from the French National Institute for Agricultural Research (INRA), are rooted in the Multi Agent Systems theory (Ferber 1995). Multi agent systems are composed of computer processes simulating agents or "actors" capable of perceptions, representations and actions, interacting with each other and sharing common resources. When adapted to the representation of dynamic complex authentic systems, the simulation tool which the multi agent system represents, led the ComMod team to combine it with the Geographical Information Systems and with role playing in order to create a model and to simulate the dynamics of eco-socio systems, that is to say the ways different stakeholders manage the resources and elements which form the heritage of a given territory. The aim of introducing companion modelling into teaching is to develop an "eco-citizen" attitude. According to its advocates, it should lead to the identification and analysis of the rationale of the local stakeholders, to the development of a line of argument on a given issue, to a negotiation. In addition, it should foster a respectful attitude towards others and a respect for local heritage and natural resources. Our research questions are: Does companion modelling enable students to analyse and negotiate the reasoning of local stakeholders in a given territory? More specifically, does their participation in the role play help them develop a respectful attitude towards other human beings or other nonhuman elements in the environment and a respect for local cultural heritage and natural resources?

The model observed simulates the dynamics of conifer planting in the "Causse", the limestone plateau in central and southern France. Students in second year university level on a Wildlife Management and Conservation course were actors in a role play. Different activities can be carried out according to the actors concerned: pathway management, deforestation, conservation, maintenance, restoration or creation of natural habitats.

We used a qualitative questionnaire, before and after carrying out the activity, to analyse the student's attitudes towards environmental governance. Role plays were recorded and filmed. Four students took part in subsequent interviews to understand how the person defends his attitude during the game and to identify the attitude of the person regarding his relationship with the human and the nonhuman. The triptyque "issue of the role play – role attributed – attitude pertaining to identity" may either foster or get in the way of learning. For the role play to be educational, the role must be at a suitable affective and cognitive distance from the player so as to be adopted by him without sparking off the identification process. If he identifies too strongly with the role this prevents him from discerning the reasoning of the other actors involved and hinders negotiation concerning the conservation of biodiversity.

SYMPOSIUM – 5

172 **Use of evidence and argumentation in science learning**

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Discussant: Boersma, K. T.– THE NETHERLANDS

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Argumentation promotes scientific literacy, considered not just as the capacity to read and to write science, but also to communicate scientific knowledge. Research is showing the relevance of argumentation for a meaningful science learning.

One of the central features of argumentation is the use of evidence (Jiménez-Aleixandre, 2008), a scientific competency that needs to be developed through specific tasks where students are protagonists of the construction of knowledge. Scientific argumentation reflects students'understanding and reasoning about science: about what is a scientific fact, what makes a claim scientific, which criteria do they consider for a quality inquiry or which questions can be answered by science (PISA, 2006). Argumentation is a social process and it provides a context where students make explicit their views about scientifics issues. There are different contexts in the clasroom where students can get involved in argumentation (Kolstø, 2006). In this symposium we present four works in which scientific argumentation takes place in two different contexts: notions about evidence in arguments (Van der Jagt & Schalk; Puig & Jiménez) and argumentation about socio-scientific issues (Molinatti; Chouchane & Simonneaux). The goal is to improve the knowledge about argumentation as a scientific practice that help students to develop the skills for being competent in a science context.

173 Argumentation, norms and normativity: discourses analysis concerning human embryonic stem cells

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Human embryonic stem cell (hESC) uses are part of French bioethic laws revision planned for 2010. In this context, plurality of actors expresses their voices.
Didactics of controversial socioscientific issues are the main theoretical framework used in this study, to focus on relationship between scientific knowledge and socioscientific argumentation. I also used communication sciences theoretical framework of sciences « sociodiffusion » proposed by Jacobi (1999), which focus on scientific concept rewording during their social circulation.
I did a comparative sociolinguistic analysis of the discourses of the researchers, the Christian and Church and medias concerning hESC uses. I first focussed on argumentation and on the scientific and social norms used. The French epistemologist G. Canguilhem (1994) offered to consider sciences in societies by paying attention to the scientific and social norm interconnections and to their normativity process, meaning what institutes norms.
I observed that the researchers (n=7) who participated in the analysed debates did not clarify their own opinions on embryo's status. However, rewording processes reducing the human embryo to his / its cell dimension occur in their communication discourses. Their implicit purpose is to present the embryo as an object more than a subject and so to legitimate its / his use for research. Scientific norms, especially concerning the nervous system ontogenesis, are also clarified. Nevertheless, the researchers used "framing arguments" (e.g. the embryo is frozen and not to be used for a parental project) but did not explain their own opinions.
Christian and apostolic church instructions (*Donum Vitae* and *Dignitas Personae*) express social norms concerning human embryo's status. The embryo is at the same time human and divine, that is why he cannot be used as research material. The argumentative strategy of these theological discourses consists in picking some scientific norms or debates in order to disqualify hESC uses. The argumentation concerning embryo's protection is mainly based on embryo's personification.
The work concerning media report analysis is in progress. Press articles introduce several actors' discourses but rarely clarify the scientific and social norms involved in the debates.
This research should help science educators to conduct a reflexive work on their own scientific and social norms and so to limit risks of influence when leading debate with students.

174 Students' understanding about evidence for evolution

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Increasing attention is being placed on argumentation in science learning, considering the use of evidence as one of the three dimensions in the scientific competencies (PISA, 2006). There is a body of research in science education showing the relevance of argumentation for a meaningful learning. However, argumentation is not frequently implemented in the classrooms.
This paper reports on a study examining secondary students' use of evidence and argumentation about evolution. The objectives are to examine: a) the capacity of students to construct arguments about evolution using appropriate evidence and, b) their epistemological commitments about what is evidence.
The study is framed in the literature about argumentation (Erduran & Jiménez-Aleixandre, 2008; Sandoval & Reiser, 2004) and evolution learning (Jiménez-Aleixandre, 1992; Kampourakis & Zogza, 2009). The participants are five groups of 10 and 11 graders, 15-17 years old, and their biology teacher. The task requires from students to convince someone that evolution has taken place by choosing different pieces of data as appropriate evidence to support it. Data collected include individual written responses and recordings in video and audio of students' discussion in small groups. In the second part of the task, the open discussion, each group had to justify their election and construct an explanation about why do they think that evolution occurs.
Data from transcriptions and questionnaires were interpreted in terms of their use of evidence. In particular we look at: a) the quality of students' arguments and explanations (e.g. presence of warrants); b) what do students identify as evidence and why.
The written results show that students have some difficulties in using evidence for supporting their conclusions about evolution. The fact that 14% consider that the increase in human height is evidence for evolution related to an adaptation to the environment, reveals their problems to interpret the theory and the persistence of Lamarckist ideas. The oral debate shows some changes in students' views. This points to the relevance of oral argumentation in the science class as a way of promoting collaborative learning and knowledge construction between students. Implications about the use of evidence as a contributing factor for learning evolution are outlined.

175 The reasoned arguments of a group of future biotechnology technicians on a controversial scientific issue: human gene therapies.

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We tried to determine the reasoning behind the positions taken by a group of students on the unsettled and controversial issue of the feasibility and acceptability of human gene therapy. The students were 19 to 21 years old and in training at a biotechnology institute. The current state of conceptualization of certain concepts relating to gene therapy and the students' positions on the subject were recorded before and after debates. These debates were punctuated by phases of epistemological "disturbances".

We used several analytical tools: Gauthier (2005) to measure the intensity of the line of argument in relation to the opinion and to determine its origins, Mercer (1995) to analyse the form of argumentation, Habermas's (1987) theory of communicational action to identify the different kinds of "action" used by the students.

In the pre-test and first phase of discussion, the students justified their stances primarily on the basis of Crick's dogma (considered to be true and conclusive) and ideas related, broadly speaking, to their own personal vision of genetic technology, scientists and science. Students were encouraged to reconsider Crick's model so that, based on recent results in molecular genetics and in genomics, they could grasp the integrated complexity of the way genes function. During the different phases of epistemological "disturbances", discussions were organised in small groups using a variety of resources and linking gene therapy already undertaken and gene therapy in progress in authentic situations. New arguments and the construction of new knowledge were recorded during the course of the different debates and in the post test. However, certain students continued to refer to Crick's dogma in their line of argument and very rarely mobilised current data in the field of molecular biology to back up their reasoning.

176 Teachers and students' use of concepts of evidence in assessing the quality of an in inquiry

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Learning to inquire in biology, chemistry and physics in secondary school includes learning how to ensure the quality of scientific research. Therefore it is important that students have some procedural understanding about the use of evidence in reasoning. To enlarge this procedural understanding students can make use of concepts of evidence (CoE) that help them to control the accuracy, reliability and validity of an inquiry. A complicating factor for students in this is the slightly different meaning of accuracy, reliability and validity in the different research contexts of the science disciplines.
In this explorative study we tried to gain insight in the criteria science teachers and students from upper secondary school use when they assess the quality of a students' research article and to what extent they use CoE. We also used this study to figure out which differences in the use of accuracy, reliability and validity can be observed between teachers from the different science disciplines.
The methodology involved a think-aloud task, interviews and a questionnaire. First, the teachers (n=6) and students (n=6) assessed the research article by thinking aloud. Afterwards they were interviewed to elucidate their statements. The students and teachers also answered questions about their knowledge of the concepts accuracy, reliability and validity in the research contexts of the science disciplines. A questionnaire, filled in by students from upper secondary school (n=42), was used to gain more insight in students' understanding of the application of accuracy, reliability and validity of an inquiry.
Results of the think-aloud task show that students scarcely use CoE while assessing the research article. However, from the interviews and the questionnaires it looks like they have knowledge about the CoE that give support to empirical argumentation. Three of the teachers looked at the empirical argumentation while assessing the article. The others concentrated on the quality of the different parts of the research instead of assessing the reasoning in the whole article. Overall, no major differences in assessing the quality of research were observed between teachers from different science disciplines. The findings of this explorative study will be used for the design of interventions that help students to learn to reason about evidence in the different science disciplines.

ORAL COMMUNICATIONS

4 The benefits of residential fieldwork: Insights from ecological and environmental experiences during a 4-year Initiative for inner-city students in the UK

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Over the past few decades there has been a great deal of interest in many countries in the worth of residential fieldwork for school students. In the UK, pressures on curriculum time, rising costs and allegedly heightened concern over students' safety seem to be curtailing teachers' ability and willingness to lead residential experiences. Collaboration between several of the main fieldwork providers across the UK created an extensive programme of residential courses for 11-14 year olds (Years 7 to 9) in London schools during 2004-2008. Some 33,000 students from 849 schools took part. The courses were designed as interventions to promote learning science or physical challenge, and to take students to a rural setting; the participants would not necessarily have such opportunities in school.

The focus of this paper is our evaluation of the programme in terms of the potential learning gains that were expected and achieved during a series of ecology and eco-adventure fieldwork courses from within the programme. Data from several 'case studies' are presented and explored using a theoretical framework of learning domains: cognitive, affective, social and behavioural. The interrelationship of the learning domains is explored in an attempt to illuminate potential pathways to learning ecological / environmental ideas.

Data were gathered using pre- and post-course questionnaire and interviews with students, teachers and parents / carers. In addition, observational visits were made to a number of fieldwork courses so that field notes, photographs and video recordings could be made. In all, 77 courses formed the evaluation sample.

The evaluation revealed that students gained self confidence and a greater sense of independence amongst other affective impacts. The challenges of measuring meaningful cognitive gains for students are highlighted. Evidence was gathered which showed students building understanding of an ecological and environmental nature. A small number of longitudinal measurements were made which revealed potential for long-lasting cognitive gains (6-month and 12-month post course). As the programme developed, courses which combined adventure activities with curriculum foci proved to be popular with students and teachers, and opened up opportunities for learning science in ways not usually accessible in their urban school environments. Further programmes have been implemented in other parts of the UK as a result of the London experience.

79 Teaching about behaviour as an explanatory framework for biology

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This paper reports on the development and implementation of a teaching sequence designed to extend lower secondary school students' understanding of behaviour from the basic concept of a response to an external stimulus to a coherent conceptual framework which could be used to explain a range of biological contexts. A conceptual analysis of the topic identified the key ideas on which a coherent conceptual framework could be built, diagnostic questions designed to probe students existing ideas provided information on students' likely starting points and a comparison of the two informed the design of the teaching sequence. The sequence was initially implemented with one class of 28 14-15 year olds of middling ability. A pre/post test, combined with a teacher interview, showed that the sequence was effective in supporting the development of a more coherent conceptual framework which students could apply to a range of biological contexts. Further implementation and evaluation is in progress.

12 Who does and who does not? The decision of German adolescents concerning post-mortem organ donation

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In Germany there is a big discrepancy between the amount of post-mortem donor organs needed and the amount of potential organ donors (DSO, 2009). Although the majority of German adolescents (85 %) reports a positive attitude towards organ donation only 11 % of them possess an organ donor card (Forsa survey, 2003). Furthermore, only 26 % of the decisions for or against a post-mortem organ removal in 2008 have been made by the deceased themselves (DSO, 2009).
Based on the integrated model of the individual attitude towards organ donation and its practicability (Gold et al., 2001) we surveyed 468 German pupils of 11th grade by means of a pre- and post-questionnaire. Between the points of measurement different groups of pupils took part in one or more different treatments (PowerPoint presentation about facts; expert talks (ethician, surgeon, organ recipient); provision of organ donor cards). In the questionnaire we asked for the pupils' knowledge and beliefs (pro- and antidonation), their attitude, their involvement with the topic and their decision concerning post-mortem organ donation. All pupils stated whether they possessed an organ donor card or not. Those who had a donor card could report whether they were going to donate organs or not. Those who did not possess a donor card could explain why not. In the post-test the pupils could also evaluate the interventions (PowerPoint presentation, experts) they attended.
By means of logistic regressions we tried to answer the questions: 1) Who signs an organ donor card and who does not? 2) In those who do, who agrees and who disagrees to an organ removal? 3) What are the reasons for those who do not sign? Can we forecast from the pupils' knowledge, pro- and antidonation beliefs, attitude and involvement how they are probably going to decide?
Concerning question 1) we can e.g. show that we can forecast the decision for or against signing an organ donor card by the pupils' attitude and their involvement, but not by their pro- and antidonation beliefs and knowledge. It is crucial for the decision whether a pupil attended one or more expert talks or was provided with donor cards, but not whether he attended the PowerPoint presentation about facts. These results are not consistent with Gold et al. (2001)'s model.

13 Characterizing three levels of systems thinking amongst 10th grade students while studying human biology

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This study aims to assess the extent of students' understanding of the body as a system, under the assumption that systems thinking is a prerequisite to the comprehension of various singular phenomena. The study involved 120 tenth-grade students from 3 different high-schools who had completed the first stage of studying systems in the human body. This presentation emphasizes two of the several research tools employed in the data analysis – Repertory Grid and Word Association. Our data suggested that the students had difficulty progressing beyond a basic comprehension of system components and processes, largely failing to recognize their interrelationship. Moreover, the interrelations they did express remained chiefly on the macroscopic level, rarely acknowledging relations with microscopic elements. This latter is particularly important because interrelations between micro and macro are central to the comprehension of homeostasis. Furthermore, of the three patterns of the body as a system (hierarchy, homeostasis and dynamism), the students almost exclusively acknowledged only the first, an indication that their understanding of the human body as a system is limited. We hold that these limitations may be due in part to the lack of a supportive learning environment, focused on the development of systems thinking skills.

15 Rethinking the introduction of systems thinking in biology education

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The discrepancy between the results of the studies of Assaraf & Orion (2005), Sommer (2005) and Evagorou et al. (2009) showing that lower secondary and primary school students attained systems skills or competencies to some extent, and the study of Verhoeff (2003) and others, showing that the introduction of systems thinking in upper secondary education is not without difficulties, could be explained. Our analysis shows that the three studies measured a number of skills/competencies that students developed before the introduction of systems thinking. Furthermore it shows that a number of basic concepts could be recognised in the systems characteristics and that most of these basic concepts could also be recognised in the conceptualizations of systems thinking in the three studies. Literature shows that children develop these basic concepts to some extent innate or in early childhood. As a preparation on the introduction of the model of the General Systems Theory it is proposed to develop and model these basics concepts explicitly. A cybernetic and a dynamic systems model may be introduced in a second and a third step.

This line of argumentation implies that our learning and teaching strategy developed earlier requires some adaptations. Maybe the most important adaptation is that it should not be aimed to develop a general, biological systems model in one single step. From the perspective of the students the development of a general model can only make sense when they were previously engaged in modelling structures and processes on different levels of biological organisation. A general model should be reinvented. The second adaptation would be that, if we define the introduction of a first systems model as the integration of models of the four basic concepts, all four components should be previously available.

28 Testing new ways to teach the concept of DNA in Secondary school: didactical analysis of the link between graphic activities and verbal interactions in the classroom

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This study focuses on the construction of knowledge in the field of molecular biology by pupils attending secondary school. In particular, it analyses the impact of graphic and discursive activities on learning. Images are an important "*means of expression that guide the cognitive activity of pupils*" (Vezin 1987). Not only that, with respect to the world of the unseen which is molecular biology, images play an essential role "*as an intersemiotic medium in between the object and the experimental data, both of which are neither visible nor comprehensible by the unaided eye*" (Dahmani & Schneeberger, Kramer 2009).

So, how can we use images of molecules as a way of learning?

Our learning topic is DNA. Historically, the breakthrough in the understanding of the structure and function of DNA emanated from modelling activities, not scientific experiments (Watson et al. 2003). The proposal of a double helix structure was based on the idea that this arrangement of DNA was likely to satisfy the following two basic functions, acting as two conceptual constraints: carrying the genetic code and transmitting it to the next generation. From groundwork we had learned that both the activities proposed by the official French curriculum ("*extraction and identification of DNA, analysis of real and virtual models*") and the way teachers deal with the subject did not result in a meaningful comprehension of DNA.

30 Evaluation of a diagnostic inventory to determine students' conceptions of vision and perception

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The aim of this research project is to develop and to evaluate an inventory of tasks to determine students' conceptions of vision and perception. If teachers have the possibility to gain access to their students' conceptions more easily, they could consider them in class more frequently. The designed inventory is a computer programme which consists of 17 tasks with closed items. The programme generates an overview of 26 individual student's notions.
The theoretical framework is the Model of Educational Reconstruction (Kattmann 2007).
This paper focuses on the results of the validation of the developed items. To test their validity, the conceptions diagnosed by the inventory are compared with students' statements in problem-centred, semi-structured single interviews. The interviews are analysed by Qualitative Content Analysis (Mayring 2003, Gropengießer 2005). Patterns of conceptions and interrelations between specific notions are identified by cluster and factor analyses.
The computer programme was answered by 259 8th, 9th, and 10th grade students of secondary and comprehensive schools. In addition, 32 students were selected according to their outcome and interviewed about one week later so that each of the 26 notions was scrutinised three times.
The comparison of the programme results and the retrospective interviews shows that students reproduce their diagnosed notions to a large extent. In the computer programme, each notion is presented in several tasks using different contexts. This allows a division in decided and undecided students for each notion. Decided students chose the same notion in most task contexts. All decided students described this notion in their interviews. However, even undecided students, who chose different notions in different task contexts, described these multiple notions in their interviews. Only four students expressed differing notions and explained these with learning processes, which took place in the meantime, or with "just guessing". The results show that the developed items can be used to identify students' conceptions in most cases.
Different patterns of conceptions, e.g. interrelations between the notions "Light isn't necessary to see." and "My eye emits something that hits an object and gets back into my eye." were found. If light is not mentioned to be obligatory, students tend to think that eyes emit something to make seeing possible. For them, it is much more difficult to consider the scientific notion as plausible alternative. The different task contexts provide clues about such specific patterns. The results could indicate advisable sequences of the topics in class.

35 Working with socio scientific issues in secondary school: Students' learning in a case about global warming

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In this study we report about secondary school (age 14- 15) students' learning when working with a socio-scientific case - *Me, my family and global warming*. 27 students in five groups answered a test after 9 hours of teaching. The test included four questions about conceptual understanding, one question about applying knowledge, two questions about asking questions to one researcher and one politician and one question about resources' trustworthiness. We also audio recorded the students' poster presentations and performed three focus group interviews after the work. The students were presented an advertisement for a green car as a starting point for the discussion.
In the data we identified the students' conceptual understanding. We then used four aspects in competence for SSI defined by Sadler et al. (2007): Recognizing the complexity of SSI, examining issues from multiple perspectives, appreciating that SSI are subject to ongoing inquiry and exhibiting skepticism when presented potentially biased information. Then we constructed a matrix to define three levels of these aspects.
The students worked with the simple questions in the case, e.g. comparing how their families travel. Most groups however, did not carefully examine the issue, i.e. they failed to identify it as a SSI-case with complexity and different levels of conflicts. The test results showed that the students know that emissions from a car have weight and they all know that carbon dioxide is released when a car drives and when oil is combusted, but they did not seem to have the basic conceptual understanding of the chemical reaction. Three of the five groups did recognize a need for inquiry but they did not use the information they got to make any decision. The students showed no skepticism to the information they found. Neither were they prepared to ask questions with a high degree of complexity. Most questions were on a personal level. To conclude, the students increase their scientific content knowledge somewhat during the work with the case but the outcome of the case is not very encouraging when it comes to cover aspects of nature of science in the curriculum.

36 Young children's reasoning about physical family resemblance and its origin

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This paper is part of a larger study that aims at shedding more light on preschoolers' intuitive reasoning about several aspects of physical family resemblance, in order to subsequently develop a learning environment that could possibly support them to gain a better understanding of inheritance. Our focus here is set on what preschoolers think about whether and why physical resemblance runs into families. In other words, this paper is particularly concerned with ascertaining whether preschoolers recognize that children share common physical traits with their parents, as well as whether they are able to explain 'why' is that, by drawing upon the biological phenomenon of birth rather than the psychological phenomenon of parents' or children's intention.

90 preschoolers (age 4.5-5.5) gave us individual, semi-structured, 20-50 minute interviews. The interview protocol was structured in six parts, two of which concern us here. In the first one, children were engaged in a modified version of Springer's 'functionality task' (Springer, 1995), which included five different cases. In each case, the participants were required to predict whether a child would resemble its parents in regard with a specific, *unusual* physical trait of theirs, or it would resemble *all* the other human beings who did not have this unusual parental trait but the usual trait of the species. In the second part, the participants were engaged in a modified version of the 'wish fulfilment task' of Schroeder et al (2007), which included three different cases regarding the role of parents' intention in family resemblance. In each case, the participants were required to make a *justified* prediction about whether a child would have a specific *inborn* physical trait of its parents or the one that they deeply *wished* it would have.

The analysis of the 90 interviews within the environment of the qualitative analysis software 'NVivo' showed that most of the times they were asked, the participants predicted that children would *have* the physical traits of their parents, although these traits were supposed to be non-typical of the human species. The most popular criterion for justifying this prediction was the idea of 'family resemblance' *('kids have to look like their parents').* Moreover, the criterion of 'birth' *('the child is born by them')* was used *at least* once by almost 27% of the informants, while 6.7% used it consistently in *all* five cases they dealt with. Finally, most of the times they were asked, the participants claimed an 'intention-free' character of inheritance, drawing upon the criterion of 'family resemblance' rather than the criterion of 'parents' intention' for predicting a child's physical trait: 52.2% of the participants used the former consistently in *all* three cases they dealt with.

49 Science meets society: an exhibition on evolution at IKEA

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Evolution is a central biological topic but its teaching is very challenging: aside from creationist movements, the biological topic is complex and everyday conceptions which are not in accordance with scientific conceptions are widely spread. Educational programs and exhibitions on evolution have been organized in out-of-school learning environments to foster the dialogue between science and society. Nevertheless, empirical studies show that their educational impact is often rather marginal. We assume that these difficulties are due to the educational implementation: These programs and exhibitions do not – or at least not at a reasonable level – consider the learners' ideas and conceptions of the biological topic. Even though, everyday conceptions are essential premises for successful learning. Furthermore, informal learning environments provide a different form of accommodation for learning than formal environments, schools, can provide. Visitors rarely attend with learning as their main objective. Therefore it is crucial to catch their attention and awaken their interest to render them open to accommodate new knowledge.

The goal of our project is to engage learners' interests and to encourage evolutionary biology learning for a wider public. We therefore designed an exhibition that introduces evolution to the visitors in the context of everyday life: at an IKEA store. The exhibition's concept is based on the results of various empirical studies. These concern the analysis of scientific and alternative conceptions of the theory of evolution and interest development in out-of-school learning environments.

Evaluation studies have been conducted during the planning and construction of the exhibition to make sure that the learners' individual needs and preferences are met, while also looking for any problems that might arise during the interaction between learners and the exhibits. Quantitative (questionnaires, n=220) and qualitative (interviews, n=53) studies were conducted during the exhibition period on the development of interest and the educational impact of the exhibition. The results show on the one hand that our goals could be attained to awaken the visitor's interest, to clarify misunderstandings about the theory of evolution and to foster the dialogue between science and society. On the other hand these results reveal learning boundaries in informal environments concerning the theory of evolution. Even though everyday conceptions are questioned, some of the exhibits are still too complex and even very short explaining texts are not read. Therefore, our results hint at how educational programs on evolution should be designed to overcome existing teaching difficulties in informal learning environments.

54 Situational interest in evolutionary topics, contexts and activities

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We investigated which evolutionary topics, contexts and activities meet the students' situational interest. The following evolutionary topics were investigated: evolution of HIV, avian flue, antibiotics resistance, impact of trophy hunting on elephants and bighorn sheep, impact of size-selective harvesting on cod, evolution of lactose tolerance and adaptation to high altitudes in human beings. Students of grades 9-10 (age 14-15, n = 263) and grades 11-13 (age 16-18, n= 153) were asked to fill in a questionnaire with 4-point Likert scale items. Construction of the questionnaire took into account that situational interest in biological topics depends upon the context, in which the topic is placed and the activity the students are asked to do. Thus, in the questionnaire, we systematically paired evolutionary topics with contexts (history of the phenomenon, relevance for human beings, responsibility of human beings, reasons for evolution, application of evolutionary knowledge in medicine and science, methods of scientific inquiry, relevance for one's own life, relevance for the environment and the ecosystem) and activities (doing a computer simulation, watching an interview with a scientist, discussing, doing internet research and presenting the research, working with texts, watching a film, analysing data, making comparisons). The study provides information on topics, contexts and activities that attract the students' situational interest and provides the basis on which we developed educational materials for the Darwin year 2009 (see proposal by Jördens for ERIDOB 2010), which are going to be published online in December 2009 at www.evolution-of-life.com. The study revealed that students show the highest situational interest in evolutionary phenomena that relate to human beings (evolution of HIV, evolution of avian flue, evolution of antibiotics resistance, evolution of lactose tolerance and evolution of adaptation to high altitudes). In this group of topics, however, the four topics of evolution of HIV, avian flue, antibiotics resistance and lactose tolerance proved more interesting than the evolution of adaptation to high altitudes, which can be interpreted as situational interest in evolutionary phenomena that affect human health and are widely discussed in the media. Concerning the contexts, the students showed the highest situational interest in the reasons for evolution and the application of evolutionary knowledge in medicine and science. Concerning the activities, the student indicated that they have the highest situational interest in watching films, doing computer simulations and making comparisons. The educational implications of these findings are discussed and we show examples of how the findings can be used for the development of new teaching materials.

56 Learning by natural history museums aspects and goals of formal settings in Germany

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Guided tours are known as the traditional method to convey knowledge to visitors in museums throughout Germany. But how much do people, especially students, really learn when they participate in a tour and what aspects impact the learning outcome? Therefore, it is the aim of the project to identify the impact of guided tours on visitors' learning outcome. Here we show the status quo of learning aspects during a guided tour.
Our study is based on the Contextual Model of Learning (CMoL) by Falk and Dierking (*1992,* 2000*; cf. Falk & Storcksdieks, 2005a, 2005b)*. With these model aspects influencing the compulsory and informal museum learning process can be estimated. Whether these aspects are also of relevance and practice in museum guided tours, which could be defined as a more formal setting, was the question of the first study. The second study was aimed to specify factors of learning from the guides' perspective based upon the previous results.
To answer the first question an interview study has been conducted. Museum guides from 14 natural history museums in Germany where questioned about their modalities to conduct tours (1st study). Several aspects which suit the CMoL and are also minded in guided tours could have been identified. Those aspects have been used for the second study: Via an online questionnaire a factor-analysis has been carried out to get the aspects of learning defined by the museum guides (2nd study). The results of both studies are used to create an evaluation tool for guided museum tours. By this, potential correlations between the learning outcome and the quality of guided tours are to be detected. Therefore, the tool should be applicable to measure three different perspectives: the guides, students and teachers view on the guided tour. To achieve a high validation of the tool, several tests were carried out in a natural history museum in Germany.
The results of both studies, as well as a first outline of the evaluation tool are to be presented. First results show that almost all aspects identified to impact learning in museums are applied in a formal guided tour setting.

160 Conceptualising the transfer of learning in "21st century" terms

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This presentation highlights an area of potential attention for researchers interested in ideas of 21st century education, and associated concepts such as learning to learn and key competencies. Such "21st century" ideas have a *participatory* ethos. Students are expected to show how they *use* their learning in meaningful ways, to transfer and apply it in new (often claimed as authentic) contexts. This begs some interesting questions about relationships between knowledge and action. When national curricula claim that learning science/biology will lead to students using scientific knowledge and skills to make informed decisions about matters of importance to them and the nation, there is a leap of faith in assuming these outcomes will be achieved provided that students demonstrate what they know and can do in traditional assessment tasks.

By contrast, the current emphasis on "competence" is most appropriately located in a sociocultural framing of learning where transfer is described as the ability to adapt existing competencies to new contexts of use (as for example in the OECD's DeSeCo project). This framing highlights the *situated* nature of learning, with associated teaching implications for orchestrating *opportunities to learn.* Fostering i*ntercontextuality* is one way to create opportunities for transfer. The teacher helps students link two or more contexts in ways that connect learning-in-action across them. The learning context and potential new contexts are framed to highlight features salient to transfer, in terms of both their similarities and differences. However, doing this requires the teacher to gain good insights into students' thinking and decision-making, so that they can shape appropriate responses.

Drawing on recent research findings from a project called Assessment Resources For Classroom Teachers (ARCT) the presentation illustrates one possible way of reframing a traditional biological classification task with key competencies in mind. ARCT item analysis challenges researchers to understand the thinking behind the responses made the students (in this case 340 year 6 and 8 students from a range of schools) in order to provide advice to teachers about likely response patterns. Changing an observation task called "What makes a reptile a reptile?" to include an "I cannot tell" category highlighted what children brought to the task from other contexts, and also what they might take from this task into further contexts. These findings generated insights the teacher could potentially use to foster conditions of intercontextuality, but they also highlight areas for further debate and research.

64 Interactions between student conceptions and teaching materials on evolution of life

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Building on constructivist approaches to teach evolution and theories of conceptual change [7], we developed teaching materials in order to analyze more closely how particular learning opportunities affect students' conceptions – and how they contribute or fail to contribute – to conceptual change/growth. This focus was chosen because little is known about the actual learning processes that occur when teachers give students materials that are intended to confront and restructure student conceptions. We thus focus on the interactions between student conceptions and teaching materials in order to characterize different types of interactions between teaching materials and student conceptions – an innovative approach which allows for describing particular problems students encounter when they restructure their conceptions and proposing ways to render the teaching of evolutionary biology more effectively. Thus, the research we describe here is a reaction to prior research which showed that it is difficult to affect conceptual change or conceptual growth in evolutionary biology [8]. We also investigated which examples are effective for triggering cognitive conflict and assessed the students' interest in evolutionary topics, because we assume that conceptual change/growth is difficult to affect if the materials do not catch and hold the students' situational interest.

66 « Me and the environmental challenges »: A survey of French students' environmental attitudes (ROSE). The case of secondary school of Paris and Créteil

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This paper presents some of the results of the questionnaire-based Relevance of Science Education project (ROSE), carried out in France in the last half of 2008 as part of an international comparative study based at the University of Oslo. Data is drawn from 2395 students (13 to 16 years old), from 61 secondary school in Paris and 53 in Créteil. Paris and Créteil are too main area (1/10 of all school of France). We have 30 geographical areas who are placed under the responsibility of the *Recteurs* which decline the educational policy according to the local context and in partnership with the local government agencies.
The focus of the paper is the students' environmental attitudes. The study does seek to show how these might influence the students' understanding of environmental problems and the influence of the local context, the gender and the diversity of the students
The ROSE questionnaire has 10 sections (with more than 240 statements). 18 statements were explicitly relating to the environmental challenges. But some of the other statements concern also plants, nature, agriculture, farming…About 48 items (1/5) are linked to the protection of environment, respect of the biological and natural label, familiarisation with nature, practises vegetable culture, impact of science on the environmental problems, perspective of a trade in relation to the environment, role of the school in awakening of the role of nature. The students are requested to give their response by choosing the appropriate box in four-point Likert scale (Disagree—Agree or Very Interested—Not Interested).
The results show that when students are pessimistic, "environmental problems make the future of the world look bleak", they feel concerned like optimistic students and can be interventionist. Even, optimistic or pessimistic students can not be interventionist because the problems are badly identified, the action must comes from outside. They idealized nature and saw action of man like harmful. They have great faith in science and in the progress which can solve all the problems.

78 Using a teaching-learning sequence (TLS), based on a physical model, to develop students' understanding of the process of self-assembly

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Self-assembly is a biological process in which free subunits combine to form molecular complexes. Although self-assembly is considered to be one of the 'big ideas' in molecular life science, very little science education research has been done in this area. The primary objectives of this study are to investigate the development of student understanding of the underlying principles and concepts of self-assembly during a teaching-learning sequence (TLS) that includes a tutorial exercise with a physical model of a poliovirus capsid. The study was performed on 20 third-year biochemistry students registered for a course in protein structure and function at a university in South Africa. A mixed methods approach was employed to collect both qualitative and quantitative data from written pre- and post-tests, audio recorded group discussions and interviews, drawing questions, and a written assignment. The qualitative data was analyzed by inductive analysis, while quantitative analysis was performed using paired-samples t-tests. Results show that the students significantly improved their understanding of self-assembly during the TLS and greatly benefited from their interactions with the physical model. In particular, it was found that students gained an improved understanding of the random nature of the process. Some conceptual and visualization difficulties were also found. For example, this included problems in understanding the reversible nature of the interaction between correctly bound subunits, and the effect of an increase of temperature with respect to (i) the stability of complexes, (ii) the rate of the assembly process, and (iii) the amount of incorrect structures. Further research is required to fully establish the nature of the difficulties so that improvements can be made to the TLS to prevent and/or remediate such difficulties. This will include more fully investigating the educational benefits of incorporating physical models in teaching and learning sequences.

82 New opportunities for authenticity in a world of changing biology.

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Biology now produces massive genomic and other biological data, whose processing by information technology (IT) expands how knowledge is created.
New ways of building knowledge in research rely ever more on information processing, which alone often qualifies as research.
A side effect is that vast amounts of authentic data and tools are now available to schools. Therefore biological data such as sequences and tools such as Blast and multiple alignements widely accessible via internet in school should qualify as authentic. New opportunities to explore, test and validate hypotheses in numerous chapters of biology allow students the same cognitive processes as hands-on biology.
We have used design-based research during seven years to explore the educational potential of these new forms of authenticity. Analysis of a few designs will allow discussing their effect on knowledge building.
Framing authenticity in terms of resources and students activities, we have refined designs for building scientific knowledge.
We will discuss designs in high school and continued training for the effects of this new authenticity. The most well-documented design, for high-school students majoring in biology produced data from over seven years in a Wiki-supported Inquiry-Based Learning, Using IT as a cognitive tool, it attempts to develop authentic knowledge building strategies in information-dense environments of various degrees of authenticity.
Successive versions of the same wiki document were analyzed, yearlong progression was sought and design iterations (2002-2009) allowed longitudinal analysis. Text is judged for epistemic complexity and type of resource used.
The effects of authenticity on knowledge building will be discussed. The use of resources will be analyzed and related to the development of efficient strategies and self-regulation. Effects of authentic processes on insecurity and links to autonomy and validating information will be explored.
Results include an increase in epistemic complexity of student-produced text, a shift towards using resources of increasing authenticity and autonomy in validating information. The use of a wiki as a conceptual artifact will be discussed.
Designs relying on authentic resources raise quite a few issues that will be discussed, such as the possible effects of generalizing such designs when applied by inexperienced teachers.
We will discuss generalizabilty of some authenticity-linked design features with data from other designs, and will finally discuss the possibility of including these new authentic approaches in various chapters of biology.

85 How do domain specific learning stimuli influence the student's self-explanations while learning with worked-out examples in biology?

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Previous studies have shown that the effectiveness of learning from worked-out examples (tasks with a step by step well elaborated solution) depends on the quality and quantity of self-explaining. On the one hand, many studies indicate that it is easy to influence the quantity and quality of the student's self-explanations. On the other hand, it is not known, now, how the treatment, in form of learning stimuli for example, effects the level of the self-explanations. So the goal of this study is to analyse, how domain specific learning stimuli taking the student's prior knowledge into account influence the self-explanation in detail.
For this study, 47 ninth graders (15 years old) from 8 different gymnasiums (German high school) were chosen based on the results of a test interrogating their domain specific prior-knowledge in biology. Two groups consisting of 24 students with high pre-knowledge in biology ("experts") and 23 students with low pre-knowledge in biology ("novices"), respectively, were formed. During five learning sessions all the participants learned with 10 worked-out examples about ecological themes on parasitism. Stimuli, which were intended to stimulate specific self-explanations, were integrated into these worked-out-examples. These learning stimuli should evoke self-explanation like "using prior-knowledge" or "initiating conclusions", which are known to be effective for learning in dependency on the student's prior-knowledge. This special kind of learning stimuli should improve both the quality of self-explaining and the learning outcome.
The methodology involved recording "thinking aloud protocols" of every single student while learning with the worked-examples. After the learning session the students were tested in their learning outcomes. The thinking aloud protocols were analysed in detail by using a special system of self-explanation categories.
The results indicate that the special learning stimuli evoke the desired self-explanations and, in addition, other effective self-explanations, too. So the learning stimuli have a positive influence on the quality of self-explanation and therefore to the learning-outcomes.

90 Improving student images of molecular mechanisms in chromosome segregation.

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To relate the secondary school biology education to the increasing insight in the complexity of cellular processes, students need a better understanding of cellular processes, from a molecular perspective. To create a better understanding of cellular processes, mental images are very useful.

To investigate whether it is possible to enable students to create such mental images, two interventions were designed. The criteria by which these interventions were designed were based on three strategies: systems thinking, learning by designing and the perspective of form and function. The first intervention consisted of assignments that students in the 11th (age 16-17) grade of pre- university education worked on in focus groups. Based on the results of these interventions, a second intervention was designed. This intervention consisted of a single lesson for three groups of students in the 12th grade (age 17-18) of pre-university education. The lesson dealt with mitosis: a process familiar to the students. The interventions were videotaped and selected students participated in stimulated recall sessions, in which parts of the preceding lessons were further discussed.

All recordings, drawings and completed assignments were analysed to find an answer to the research question:

How can secondary school students form mental images of molecular mechanisms to create a better understanding of cellular processes?

The results from the first intervention indicated that students did not easily relate cellular structures to cellular processes and did not descend to the molecular level on their own accord. This intervention also showed that students rarely asked questions that reached beyond the level of factual knowledge.

Results from the second intervention show that most students were able to descend to a molecular level when designing a mechanism for a relatively simple cellular process, such as the binding of microtubules to chromatides. Fewer students retained this ability when the posed problem was more complex. However, from the recall sessions it can be concluded that students did create or alter mental images of a cellular process during the lesson. This research indicates that educational activities based on the three strategies mentioned above have the potential to enable students to create mental images of molecular mechanisms underlying cellular processes.

96 What influences young peoples' commitment to protect biodiversity in Chile and Germany?

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Fostering young people's commitment to protect biodiversity is an important goal of Education for Sustainable Development. However, little empirical evidence exists to describe factors that influence commitments to protect biodiversity. Besides this, there are no empirical studies that explicitly compare the perspectives of young people who live at designated biodiversity hotspots to those who live in an industrial country. In order to fill this gap in research, we investigated 15 to 19-year-old Chilean and German pupils' commitment to protect biodiversity.

Even though there are no theories that focus explicitly on explaining commitments to protect biodiversity, various theories are available to explain environmentally friendly behaviour. For example, the Value-Belief-Norm (VBN) theory (e.g. Stern, 2000) has successfully been used to predict pro-environmental behaviour in different contexts. The VBN theory presumes values, beliefs and personal norms to be influential on a commitment to pro-environmental behaviour. As yet, however, the theory has not been used with adolescent samples or in the context of biodiversity.

In order to investigate Chilean and German adolescents' commitment to protect biodiversity, we adopted the VBN-theory to the context of biodiversity. Correspondingly, our questionnaire embraced scales that measure values, beliefs (e.g. the New Ecological Paradigm (NEP), Dunlap et al., 2000), personal norms and four different forms of commitments to protect biodiversity (after Stern, 2000). In order to measure general aspects of personality approved scales were available (e.g. a questionnaire to measure values (Schwartz, 2005) or the NEP). All other scales were constructed after templates from literature so that they reflected the context of biodiversity and the environment of young people.

The questionnaire was completed by n=446 Chilean and n=441 German students in secondary education. Comparisons (based on independent group t-tests) revealed that Chilean adolescents showed higher personal norms and commitments to protect biodiversity. Regression analysis showed that within both samples, the value universalism was an important predictor for all kinds of behavioural commitment measured. Regarding beliefs, in both samples, an 'ascription of responsibility', 'perceived ability to reduce threat' and the NEP proved to be important predictors. Above all, 'personal norms' were positive predictors in both samples, for all commitments measured.

Biodiversity education should, therefore, strengthen the value universalism. As values develop early in childhood, values such as the beauty of nature or empathy with nature should be developed from pre-school programmes on. For adolescents, educational interventions should focus on offering real behavioural options to young people.

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How does pupils' choice in Biology lessons influence Intrinsic motivation?

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Self-regulated learning, like for instance the opportunity to choose topic and method of a biology lesson, is considered to support intrinsic motivation (cf. Deci & Ryan 2000). Accordingly, the intention of this study was to find out whether the actual realization of the individual (content related) pupil's choice or the participation in a collective decision and therefore the perceived autonomy was more relevant for the pupils' intrinsic motivation. The pupils in this study were supposedly given the possibility to choose the topic for future biology lessons for themselves. Supposedly means that they were asked to vote for a topic, but regardless of their choice the topic of the lessons was chosen beforehand while they have merely been told that this was their choice.
118 5th graders of five classes from Germany participated in this quasi experimental pre/posttest study. The experimental group (N = 73) was given the opportunity to vote for the content and method of the next biology lesson; the control group (N = 45) did not get to vote. One class of the experimental group did choose this topic, so that the comparison of the class whose democratic choice was realized and the classes whose choices were not realized was made possible. A questionnaire regarding the intrinsic motivation (KIM: Kurzskala intrinsischer Motivation = short scale of intrinsic motivation, Wilde et al. 2009) was conducted. For the sub-scales of intrinsic motivation no normal distribution was given, therefore, non-parametric methods were used.

Results: The pupils of the experimental group indeed showed higher intrinsic motivation. Also, no significant differences between the pupils whose choices were realized and the pupils whose choices were not realized could be ascertained. We concluded that the participation in the decision process and the feelings of autonomy it created alone was more important than the realization of the individuals' choices.

100 Identification of HIV/AIDS knowledge gaps in the Grade 11 South African schools' curriculum

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Attempts continue to be made to reduce the rate of HIV/AIDS infection in South Africa, yet some scholars argue that these attempts lack effectiveness. Researchers report that youths are amongst the most infected in the population. One reason behind this problem is lack of adequate information and deleterious behaviours. The theory of planned behaviour suggests that to transform behaviour; attitudes, subjective norms and perceived behavioural control would have to be transformed first. In this context, scholars argue that knowledge can be used to change these factors. Given this, the current study was conducted with the aim comparing what learners currently learn with what they ought to learn. Document analysis was performed on the Life Sciences curriculum and textbooks using a specific framework. Thereafter, experts (n=19) were asked to respond to an open questionnaire in which they were asked to suggest HIV/AIDS related topics that they believe should be taught to learners. All data were analysed inductively. Findings revealed that there are specific skills that Grade 11 learners are expected to acquire through Life Sciences, which are categorized as scientific enquiry and problem-solving skills as well as construction and application of scientific knowledge. With respect to content knowledge, it was found that general micro-organisms' structure and characteristics are learnt. In this instance, HIV is used as a model example. The immune system is also covered. However, there are several topics that are not dealt with which, according to experts, should be taught. In this instance, some experts felt that due to the epidemic nature of HIV/AIDS, a Health Sciences module dedicated to issues such as HIV/AIDS, how medical assistance work, how micro-organisms develop resistance to drugs and factors related to the malfunctioning of the immune system. It must be emphasized that these topics are currently not included in the schools' curriculum in South Africa. Also not included and recommended by experts is that learners be thoroughly taught about the nature of HIV, (including the multiple strains, structure and function). These findings suggest that there is a gap between what is currently taught and what experts think should be taught. However, further research is required to determine whether certain knowledge, such as that recommended by experts, would transform learners' behaviour.

101 Exploring qualitative levels of scientific inquiry competence: A longitudinal study on the development of scientific inquiry competence of biology students from grade 5 to 10

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The detailed developmental processes of scientific inquiry competence within the school environment have so far been studied only unsystematically. Especially focusing on a thorough exploration of competence development in the four central subskills “formulating questions”, “generating hypotheses”, “investigation planning”, and “interpreting data” seems to be expedient in order to provide adequate promotion in school. In this study we used five qualitative levels of inquiry competence in the four central skills which differ in complexity and are graded according to problem-solving processes. Using these levels, we analysed a longitudinal test investigating the development of over 1000 German highschool students’ (age 10-16) scientific inquiry skills over one school year. We found that the increase of inquiry competence within one school year is due to a significant qualitative increase within the skill levels. However, detailed analyses reveal that students’ performance development differs significantly within the investigated grades and within the four mentioned subskills. Overall, the results support a qualitative grading of each of the four skills according to scientific problem-solving processes and provide a more precise information about the qualitative development within the skills. The described threshold values for each competence level permit and facilitate a targeted choice of test items. Our study can thus help providing a valuable assessment tool for individual promotion of scientific inquiry skills, as well as enable the science teacher to provide accordant feedback, and distribute adequate exercise units.

102 Assessing student's questioning in group-based learning: A study with biology undergraduates

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Current reforms in Science Education, particularly in higher education, are asking for situated learning in real-world phenomena. These approaches enable students to construct knowledge, promoting higher-order thinking skills. Group-based education has been of great interest as an alternative route for students' learning, particularly through problem-based strategies. Furthermore, questioning by students plays a central role in these kind of practices, since problem oriented approaches involve the formulation of relevant and critical questions towards the addressed problem.

This study was conducted during the academic year 2007/2008, with biology undergraduates, at the University of Aveiro, Portugal. One of our aims was to develop and adopt two group-learning strategies: "Incentive for Study in Group" (ISG) and "Cases for Learning in Group" (CLG), in Microbiology and Genetics, courses running during the first and second semesters, respectively. The main purpose was to stimulate and consider students' questions as an integral part of group learning, to characterize the type of questions and to relate them to the contexts referred. Those two strategies were also considered as means for alternative students' assessment. The main sources of data for analysis were students' productions from both group-learning activities, specifically in what concerns student questioning. Students' written questions were characterized according to the following categories: *i) Acquisition, ii) Specialization, iii) Integrative, iv) Organisational, and v) Reflective questions* (Pedrosa de Jesus, Almeida and Watts, 2004).

A questionnaire was also addressed to all students, nine of them being selected for interviewing at the end of the year. The main purpose was to identify students' perceptions about their questioning behaviour and to know their opinion about the adopted group-learning strategies.

Forty two students' written questions resulted from the ISG strategy, generally formulated with an emphasis on meaning-oriented type (acquisition and specialization). In CLG strategy, the nature of the two problem-based cases presented to students appears to have influenced the types of generated questions (251). This will be an issue for further exploration during presentation. Both strategies were considered very positive by students. It was also emphasized the importance of group-learning activities and the value of questioning in these contexts. Some implications for practice will be discussed.

105 *"It is not the CO_2 itself, it's the imbalance!"* Conceptual reconstruction on the global carbon cycle in global warming

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Global warming is one of the greatest challenges facing humankind in the 21st century. Translating public concern for global warming into effective every-day action requires knowledge about the causes of climate change. An analysis of students' conceptions on global warming shows that they often differ from scientists' conceptions even after instruction.
The aim of our study is an evidence-based and theory-guided development of learning environments on a key issue of global warming, i.e. the global carbon cycle and the human impacts on it.
We collected conceptions of students (18 yrs., 18 female, 22 male) in an interview study (n=16) and stages of teaching experiments (n=24). Based on students' conceptions we developed and evaluated different learning environments using the model of educational reconstruction. The data were gathered with video (teaching experiments) and audio (interviews), transcribed and investigated by qualitative content analysis and metaphor analysis.
Guided by Lakoff's experientialist view we found three thinking patterns of the causes of global warming: Global warming caused by (1) *a man-made imbalance in carbon cycle*, (2) *exclusively man-made CO_2* and (3) *man-made CO_2 additional to natural CO_2*. The analysis shows that all students – as well as scientists – refer to a container-flow schema. Students and scientists alike discern natural and man-made carbon to explain global warming. They differ in what objects and events are meant to be man-made.
Our teaching sequences on global warming aimed at a conceptual reconstruction based on students' schemata. Vosniadou describes learning as difficult, when both specific theories (i.e. *carbon flows*) and framework theories (i.e. *container-schema*) have to be changed.
In our study experientialism provides a useful tool to gain insight in the experience based framework theories (i.e. *container schema*) and to explain abstract specific theories (i.e. *greenhouse effect*). By uncovering the – mostly unconsciously – employed framework theories, we gave students access to their conceptions and let them work on their mental models. By discussing the consequences of their domain specific use of the schema they reconstructed their everyday-conceptions i. e. *Man-made and natural CO_2* to scientific concepts, i. e. *Man made and natural cause of carbon flow* by reflecting on their mental model.
In the context of global warming our approach proved to be appropriate for the reconstruction of every-day conceptions to more scientific concepts.

107 Exploring argumentation patterns in the classroom: towards an interlanguage of talking science

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The most frequent applications of the notion 'authenticity' in science education are done with reference to ways that science is performed by practicing scientists, often articulated as 'doing science'. In this paper we wish to explore the notion of authenticity in relation to the use of language which is an aspect of doing science closely connected to school science, since learning science involves mastering the language of science. Furthermore, several researchers that depict argumentation as an important feature in 'real science' also advocate for introducing an argumentative practice in schools (cf. Jiménez-Aleixandre & Erduran, 2008).

The aim of this paper is to explore argumentative practice in the classroom, specifically the relations between content oriented aspects and more generic patterns; the content concern biological evolution and the generic patterns are related to social languages (colloquial, inter-, and school scientific language). The analysis focuses peer group discussions, among 17 year old Swedish upper secondary students, concerning the origin of biological variation. The analysis deals with the notions/words that the students negotiate meaning of, and the argumentative structure of the thematic patterns that the students use when explaining.

There are three prominent conceptual notions in the students' discussion: need, randomness and development, and these notions are articulated in three social languages: colloquial, inter-, and school scientific language. The students interconnect and shift between the three types of social languages when co-constructing explanations. Explanations which often show sound scientific quality and the thematic pattern become more and more in line with scientific argumentation. Furthermore, colloquial expressions are used as theoretical and argumentative leverage and resource.

The fact that the students incorporate colloquial expressions as an intellectual resource in argumentation points at a continuity between colloquial and scientific accounts. The idea of continuity challenges the framework of conceptual change. A framework in which colloquial and scientific accounts are depicted as discontinuous; even in conflict with each other and a hinder for learning. In this study, colloquial expressions are not a hinder - on the contrary - the students demonstrate what Lemke (1990) calls an 'interlanguage, a sort of hybrid between colloquial and technical register'. We understand this to rely on the establishment of an arena for learning where technical terms and scientific models may be introduced, negotiated, and made sense of, in particular in relation to personal and everyday experiences, resulting in an interlanguge of talking science.

108 A lesson in scientific argumentation: experience with research articles by undergraduate life science students.

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Written communication among scientists in the form of research articles contains an argumentative structure, whereby conclusions with supporting evidence are presented, unlike textbooks used in an educational setting, where scientific information is given as facts. The ability to successfully read research article, so-called primary literature, has to be mastered by every life science student in higher education. Educational research into effective ways to teach students how to unravel the argumentative structure in primary literature is scarce. That is why we developed a 10-weeks research-based teaching strategy for first year undergraduate life science students that aimed to improve their ability to read primary literature. Besides learning content knowledge, students were made familiar with the argumentative structure of authentic research articles in tutor-led groups. With argumentative structure we aim at the conclusion (claim) and justifications the author presents in the research article. The conceptual framework that underlies our teaching strategy is cognitive apprenticeship. In this paper, we present data from assignments made by students in week 3 and 5 of the course. We present how well these students are able to distil the conclusions and justifications of an authentic research article by comparing their answers with experts' answers. The subject of the research articles were related to pharmacology and physiology. In week 3, students individually made an assignment, whereby they had to identify the conclusion made by the author in an authentic research paper. In week 5, they had to identify the conclusion and the justification of another authentic research paper. One of the lecturers of the course also made the same assignments. All written assignments were collected and analyzed quantitatively and qualitatively. Our results suggest that the students did have difficulties with identifying conclusions and link the justifications with corresponding conclusions compared with the experts' answers. Confusion of the terminology used is maybe the cause of this result. Our findings are used to refine the teaching strategy to be used in next years' curriculum.

7 Study of evolution theory teaching: students' conceptual ecologies and teachers' perceptions

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This paper reports data and findings, part from a wider study about the evolution theory (E.T.) teaching in Greece. Particularly, we aimed to explore, using conceptual ecology for biological evolution as a theoretical frame: a) the factors related to students' acceptance of evolutionary theory (students' study) and b) Biology teachers' conceptions and attitudes concerning evolution theory and their teaching (teachers' study).
Specifically, relating to students' study, we aimed to look into the understanding and the acceptance of E.T. among students. Moreover we aimed to look into the relationship of the acceptance and understanding of E.T. with their parents' educational level and students' and their family's religiosity. A total of 168 students, future teachers in Early Childhood Education, participated in a survey carried out by the use of a questionnaire. In our findings, students/preservice preschool education teachers' restricted understanding of evolutionary theory is positively correlated with moderate acceptance of evolutionary theory and negatively related with students' religiosity. We did not find any significant correlation between parents' educational level and religiosity and students acceptance of evolution. Our findings indicate the necessity to develop the teaching and learning evolution theory in secondary education and the enrichment of this teaching with focus in the nature of science. Our findings also indicate the necessity to investigate other factors of conceptual ecology in Greek cultural frame.
At regard of teachers' study, it was conducted by semi-structured interviews with 10 in service secondary biology teachers in order to investigate the knowledge related to evolution theory, the acceptance, social impact and other issues related to their every day teaching experience. Of the most interesting findings is that, in most cases, evolution theory teaching does, almost, not exist in Greek secondary schools due mainly to time deficiency. Teachers assert knowledge shortages about evolution issues and they do not report social pressure against evolution teaching. Our findings indicate the necessity to enhance the teaching of evolution theory in Greek Universities, even in Biology departments and improve teachers training in pedagogical content knowledge concerning E.T.

52 Charismatic threatened plant VS road development: Value driven decision-making through computer-based, scaffolded learning activities

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This paper reports data from the evaluation of a learning intervention aiming to the development of student's decision making skills and argumentation for the conservation of threatened plants. The study addresses the role that children's value-based arguments play in the formation of a decision by applying the optimization strategy. Computer based, scaffolded learning activities were designed challenging students in solving an authentic local problem. The problem was related to the conflicts among the inhabitants of a village derived from the need of a new road development. Four options were presented; two of which causing direct and indirect impacts on the ecosystem of a threatened plant population and other two affecting directly or indirectly the inhabitants of the village. The learning environment provided necessary scientific information through digital learning objects for the consideration of the multiple aspects of the problem, the study of the effects of the possible options and the formulation and balancing of criteria before selecting the best compromise. Children were asked to come up with concrete decision, in order to help inhabitants with the problem.
The research is aiming to answer three main questions: 1.Which are the substantive arguments and the decisive values driving student's decision? 2. Are there any patterns among the decision-makers? 3. Can a computer-based, scaffolded learning environment deal effectively with the complex topic of biological conservation?
Findings highlight that even though children incorporate several criteria in the decision making process, however, what is finally driving their decisions are some substantive arguments which are based on decisive values.
The results exhibited three value-driven patterns of decision-makers: Ecocentric, Weak anthropocentric and Strong anthropocentric. Transmission of decision-maker patterns from strong anthropocentric towards weak anthropocentric and ecocentric, by increasing quality of ecological reasoning, was revealed after the learning intervention.
That transmission in patterns implies that integrated learning strategies of placing threatened organisms in the frames of the complex system of ecological and societal components, through computer based-scaffolded learning activities, were proved to challenge children develop values, skills and action competence needed to face complex situations and act on critical decisions regarding the conservation of organisms in danger.
Such integration in teaching strategies effectively engage students with the complex topic of biological conservation; not just in terms of science content, but also in terms of preparing citizens for competent participation in environmental decision making and facilitate the issues as future stakeholders, managers or policy makers.

118 How can the quality of students' argumentations and their conceptual development be interrelated?

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Research rarely explicitly addresses (details of) the interrelationship between argumentation (learning *about* science) and conceptual understanding (learning *of* science). Therefore, research reported in this paper aims to investigate how the quality of students' argumentation depends on their conceptual understanding and vice versa. Data analysis is based upon two different theoretical frameworks: A refined version of Toulmin´s argument patterns is used to describe the processes of argumentation and its quality. Students' conceptual understanding is investigated with a coding schema distinguishing between exploration, intuitive rule-based understanding and explicit rule-based understanding. Video data from students of different age (grade 8 and grade 11) working in groups on biology (blood pressure) and physics instruction were analyzed with these two frameworks. Results demonstrate that each single argumentation typically contains only few different elements, and elements that are regarded to be of "higher quality" are rare. Furthermore, we found high variances of individual contributions to an argumentation and of individual frequency of conceptual knowledge, even within the same grade. Our analyses of conceptual development show that students mainly construct knowledge which is explorative or intuitive rule-based in nature, independently from the topic of the learning sequence. Argumentations that consist of high structural *and* high conceptual quality occurred when students were able to utilize everyday-experiences or specific experiences they made during the learning sequences. Implications for research and teaching of argumentation are discussed.

119 The structure of classroom conversation – a criterion of instructional quality in Biology Education: Analyses of video tapes

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As classroom conversation induces the content structure of a lesson and introduces biological concepts, it is one important criterion of instructional quality (cf. Scott & Ametller, 2007). Therefore, the question arises how classroom conversation is sequenced and how the sequences influence the learners' achievement. Structuring conversation through sequences refers to the formation of successive utterances to larger units, the duration of those formations, and their chronology. So far, science-specific quality criteria have mostly been analyzed either through time-based coding (e.g. Stigler et al., 1999) and final ratings of videotapes (Rakoczy, K. & Pauli, C., 2006) or through discourse analysis based on case studies using transcripts (Viiri, 2006).

In order to analyze the deeper structure of classroom conversation in biology lessons, we combined video coding and transcripts using utterances as coding events. Up to now, we evaluated 15 of 50 videotaped 9th grade grammar school biology lessons on the topic "blood and blood circulation" by assigning the occurred utterances to categories and determining their structure by sequencing them. The following utterance categories were applied: teacher-task, teacher-feedback, teacher-information, pupil-argument and pupil-question. We do not only analyze the frequency of the different utterances, but also search for typical sequences of utterances in conversation and correlated both with pupils' achievement.

We found that the coding scheme provides a reliable instrument for analyzing classroom conversations in biology lessons. Looking at the deeper structure, different formations within the conversation could be identified. First results indicate that the frequencies of utterances and sequences are interrelated to the learning process of the class. Thus, a helpful instrument could be developed to analyze and reflect conversations in biology lessons.

120 Conceptualization of in-service biology teachers' pedagogical content knowledge (PCK) at the initiation of a long term professional development program

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ISRAEL

It is well known that Pedagogical Content Knowledge (PCK) is acquired during a teaching career. This unique type of knowledge is structured and "reconstructed" in an individual teacher's mind during his or her teaching experience and may guide the teacher's actions in teaching a specific content. Researchers agree upon the nature of PCK as an integrated knowledge and beliefs, acquired throughout teaching, and used in the context of teaching a specific content. Despite numerous efforts to conceptualize it, PCK is still a very broad conception and its precise definition is controversial. Furthermore, examining teachers' PCK is very complex because of the multiplicity of its components. Here we attempted to analyze the PCK of five in-service experienced biology teachers during a long term constructivist based professional development course. This course, entitled "Initiatives course", is part of a long term professional development program that is aimed at developing teaching initiatives by the participating teachers themselves in order to improve science teaching and learning in Israel. Biology teachers' conversations about their teaching needs, teaching "dreams" and teaching goals have been analyzed in order to capture the teachers' PCK. Fifteen categories of PCK emerged during the analysis and they were subsequently classified to three main categories: the teachers' domain, the students' domain and the outdoor domain. The teachers' domain describes concerns about teaching; the students' domain include the teachers' concerns about students' learning; and the outdoor domain includes new teaching strategies and new contents that teachers were exposed to. Using this categorization we found that four out of the five teachers refer to the "student's world" more than to the "teacher's world". Only one less experienced teacher referred more to the "teacher's world" than to the "student's world". This may stem from the fact that beginning teachers do not usually consider students' needs and knowledge extensively in their teaching practices. In addition, four out of the five teachers hardly referred to the "outdoor world". The one teacher that did refer to the "outdoor world" is the only teacher that came to the initiatives program with a ready made initiative. We suggest that looking at teachers' PCK using the suggested general formation of the three domains may enable to characterize unique patterns of in-service experienced teachers' PCK.

121 Help-words – A creative way of meaning-making via visualizing molecular life science by upper secondary and tertiary students

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Science communication has become an emergent research topic in science education to develop a better way to convey and make learners understand scientific concepts. Also, it is important to explore learners' thinking through science communication. When confronted with the representations and terms of science, students make meaning by using the knowledge and language they possess. They not only make frequent use of conventional and spontaneous metaphors, but they also use words that seemingly have no conventional meaning, here labelled *help-words*. The purpose of this paper is to present the verbal resources upper secondary school students use to make meaning of molecular life science through visualization materials. Hopefully, from the results of this study, science educators can understand and pay more attention to the language students actually use in science lessons. This paper gives a description of the phenomenon of help-words, based on a study of 20 upper secondary and 35 tertiary students. The main result of this study was that students not only use scientific terms (which is expected), everyday expressions and metaphors (which is known), but also words that may seem to convey no meaning at all, such as *plupp* and *flopp*, which are omitted from the standard Swedish dictionaries. Furthermore, students can express an understanding of a scientific content without using scientific terminology. Our results indicate that help-words exist and are meaningful for students in learning situations, especially in abstract disciplines such as molecular life science. As science educators, we need to understand the role of these "nonsense-words", which we call *help-words,* in the creation of meaning during the process of learning science.

127 Modelling Students' Competencies in the Area of Heredity

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In order to foster students' learning of biological ideas, it is necessary to have knowledge about their actual competencies. The focus of our study is the development of an empirically tested model to describe students' competencies in the area of heredity. Starting with the first findings in this field by Gregor Mendel, the idea of heredity has been of enormous interest for researchers in Biology as well as for those in Biology education.
Based on typical conceptions, well-known misconceptions and findings from think-aloud protocols, we postulate levels of understanding of heredity as one dimension of our model. In addition, we take the enormous importance of terminology in this context into account and suggest that this forms a second dimension.
To validate this model we developed multiple choice test items for an achievement test based on both dimensions of the theoretical model.
About 3000 students of different class levels took part in this test. A one parameter Rasch model was used for the parameter estimation, ANOVA and a multiple regression analysis for the verification of the model.
Based on the empirical findings, we had been able to confirm our hypothetical model in part and established a new, combined model containing six levels of competency. This gives a deeper insight into students' competencies of heredity and provides helpful suggestions for Biology education.

9 Can primary school students achieve a basic understanding of scientific concepts of the cycling of matter?

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There is still a controversial debate, which aspects and contents are necessary for a basic ecological education. Beside the question about the contents, there is also the question about student's concepts, because they are the initial point for any restructuring of concepts. Results of previous studies show, that children in Primary school attribute ecological processes to very simple cause-and-effect chains and usually don't recognize biological cycle. For this reason, the research project focused mainly on the principle of the biological cycle of matter.
Interviews conduced with the students of four different third grade classes showed, that the student's explanations of the process of decay are incommensurable to scientific concepts. Two of those classes were undertaken an experimental classroom study. They had the opportunity, to watch the process of decay in a compost case with window. This was possible in a learning environment, which was based on discovery learning by hands-on experiences with authentic materials and allowed the students conceptual reconstructing in classroom discourse. The two other classes (control-classes) did not get any lessons about the cycling of matter.
Interviews conduced with the students from all classes later showed, that the students from the experimental classes restructured their concepts about the process of decay to cycling processes. The students of the control classes did not show any conceptual change.

135 The analysis of the efficiency of applying problem-based learning to biology instruction in terms of elementary school ecology curriculum

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In this paper a comparison is made between the level of efficiency obtained when using the problem-based and the informative-illustrative biology teaching models in terms of the ecological curriculum for the seventh grade of elementary school. In order to accomplish the tasks of this paper, the model of a pedagogical experiment with parallel groups [experimental (E) and control (C)] was applied, involving 177 students from four elementary schools in the municipality of Valjevo (western Serbia). The aim was to identify and measure this difference, as well as compare the efficiency of these two models of teaching. Both groups were made uniform at the beginning of the experiment, according to number of students, gender, and the general knowledge of ecology by distributing the pre-test of knowledge. Afterwards, the E group realised the ecological syllabus by applying the problem-based teaching, while C group were applying the traditional teaching model. The implementation of problem-based biology instruction in the E group took place in several stages (setting problems, finding solutions, analysis of the problem, the process of solving problems and making conclusions). By solving given problem questions, students successively passed through all stages of the problem-based instruction in terms of ecological programme content. The implementation of informative-illustrative teaching model (traditional approach) in C group was performed by presenting the above mentioned teaching content by classic teaching methods: oral presentations, discussions, illustrations and demonstrations. In order to check the acquired knowledge of students using the both above mentioned models of biology teaching, we applied the post-test of knowledge. For this research, apart from the pre- and post-tests, other things were used: school documentation, teaching sheets, adequate text materials and drawings. Data and results processing was performed by applying descriptive statistics and t-test for testing differences. The results show that E group performed better on the post-test of knowledge in comparison with the C group. The high level of statistically significant difference is especially noticeable between the groups (in favour of E group) in the application of knowledge in the given teaching field. By using this experimental design we determined that the problem-based biology teaching was more efficient in terms of quality and quantity of knowledge acquired in the examined teaching field. Modern biology teaching process, especially in terms of ecological curricula, should involve the model of problem-based teaching.

136 Being able to see the wood for the trees: Expert teachers' observational skills in complex environments explained by a neurocognitive model of learning.

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SWEDEN

This paper aims to provide a broader picture on 'knowledge' and 'understanding' by introducing a dual memory system, which has been applied from the field of neuro-cognitive research. Traditionally, knowledge is viewed as explicit or declarative, based on the spoken or written word. In contrast, this paper focus on implicit or non-declarative memory, identified as being the basis for procedural and observational skills. These two memory systems are anatomically separated in the brain. Acquiring implicit memories is time-consuming and requires sensory-based experiences. The implicit memory system can help humans handle complex situations where the explicit memory system would otherwise be cognitively 'overloaded'. This explains how an expert can handle a complex situation, e.g. an experienced teacher performing tasks in a multifaceted classroom. Using nature as a classroom is even more complex since it calls upon knowledge for reading nature and the appropriate strategies to teach this to students. This paper highlights the implicit part of the biological knowledge as well as the teaching skills. By following two experienced biology teachers and their students on an excursion, we intend to use the implicit memory model as a way to explain teachers' observational skills and teaching strategies. Data was collected using video and audio recording, complemented with photographs and field notes. The teachers were interviewed as part of a stimulated recall session. Two main findings are presented. Firstly, the teachers have several types of observational skills: being able to see large and abstract structures; being able to discern the relevant details; and being able to see (or perceive) what is 'missing' in a situation. Secondly, two different teaching strategies of reading nature were identified. The first builds on declarative knowledge and rational verbal explanations. The second strategy offers the students sensory-based experiences which are directed towards exploiting the implicit memory system, e.g. actually feeling the peat bog tottering beneath one's feet. Our results intend to support the hypothesis that not all knowledge is possible to verbalize. Consequently, we suggest that both strategies are important in learning about nature. Furthermore, we are of the view that the implicit memory system is the only way to handle such a complex context.

137 Development and employment of the FiNE Model for Learning in Nature

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ISRAEL

Field trips in natural environments are popular worldwide, and a great number of school field trips are carried out in nature, facilitated by nature guides. In this study, we followed up previous studies of Michael Brody (2005) and Martin Storksdieck (2006) who respectively suggested schemes for understanding learning in nature and an assessment means for evaluating field trips in environmental education. We point out the deficiencies of these studies, claiming they do not provide a working model that enables capturing multiple perspectives of a variety of field trips. In the study, we developed the circle shape Field trip in Natural Environment (FiNE) Model, which consists of four rings: planning, pedagogy, activity and outcomes. The first two rings are assessed by the expert-researcher, the outcomes are reported by the students, and the activity is reflected by the students and the researcher. We developed a detailed assessment rubric that enabled the researchers to consistently grade each component of the model. Altogether, we observed 22 field trips of 4-6th graders who participated in field trips in nature parks in Israel in 2006-2008. In addition, we had in depth pre/post interviews with 41 students from seven schools and we carried out short, informal interviews with nature guides and teachers regarding the coordination and preparation for the field trip. Our findings indicate limited preparation in school and almost no communication between the teachers and the facilitators from the environmental organization. In the pedagogy ring, we found limited deliberately-enhanced social interactions, almost no discussion of goals with the students, reasonable reference to the actual environment and overall attentive facilitators. The activity ring indicated alignment between the students' and the researchers' perception indicating medium to high activity levels in the learning and the physical dimension. It is important to note, however that we found inadequate special guide-enhanced activity. Overall, the FiNE model was found to be a coherent framework and a clear grading rubric, which is based on general principles and allows assessing field trips that are carried out in different settings by different facilitators. It allows comparison and discussion of pedagogical principles and their impact on learning outcomes.

138 Human dignity, authenticity and life-science in practice

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Protection of human dignity is supposed to be a central task in all democratic school systems. Therefore, it is assumed that preservice teachers during their initial education have some training on how to maintain and protect human dignity. Previous studies show that Discourse of Human Dignity within teacher education to a high degree is permeated by themes and arguments that are related to life-science subject matter, for example, anatomy, physiology, early human ontogenesis, etc. This study aims to analyze and clarify how Discourse of Human Dignity within teacher education is related to the notion of human dignity in life-science research practice. Three different categories data are scrutinized in this critical discourse analysis: theses (at bachelor or master level) written by students of life-science and health care, and where they relate to human dignity; life-scientific articles published (2000–2009) in peer-reviewed journals that relate to human dignity; various documents, conventions and other texts related to human dignity in life-science research practice. The thematic patterns of the discourse within teacher education reappear in the life-scientific articles; it is obviously relevant to discuss human dignity in relation to life-science subject matter. However, there is a significant difference. Ethicists and legal experts discuss human dignity in terms of human rights, which is highly unusual in the Discourse of Human Dignity within teacher education. However, professional scholars of life-science rarely publish articles that jointly concern life-science subject matter and human dignity. Finally, it is suggested that the modest number of contributions from life-science research practice can be explained by lack of Critical Socio-Historical Literacy, which is a new concept that will be further clarified at the conference.

146 A model of expert thinking for developing molecular biology education

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Several studies in science education have shown that students and teachers in upper-secondary education have problems relating molecular concepts such as DNA, RNA and protein to the living cell functioning as a system. They do have declarative knowledge of molecular concepts, and know about the different structures in the cell and the processes occurring in or conducted by the cell. However, it is not evident to them that these structures and processes have a molecular basis and can be explained in terms of molecular interactions. The consequence is that concepts at the molecular level, such as gene and protein, remain separate entities without functional characteristics that relate to the cell, which prevents meaningful learning in molecular and cellular biology.

In this paper model of expert thinking is proposed, that can inform biology education to overcome this problem. The model focuses on the strategies experts use to relate the molecular level in biology with the cellular level and higher levels of organisation in biology.

To construct this model we deduced common characteristics in expert thinking from recent reviews and opinion articles in influential scientific journals on the upcoming field of molecular systems biology. The proposed model was validated by analysing whether and how these levels were used in different high impact reviews on two specific cellular processes.

Until now, levels of organisation in biology consider the molecular level as one level. The model presented in this article shows that in practice, many levels are needed to relate molecular components to cellular processes. We suggest the term ‘molecular systems thinking’, to indicate the competence of using these levels. A learning and teaching strategy based on molecular systems thinking might improve relating molecular concepts to regulated cellular processes. Designing and testing such a strategy will be the next step in our research project.

155 Darwin's mental Landscape: Mapping students' learning trajectories in evolution theory

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The paper reports data from a naturalistic study about a learning progression of 13-year-old students in evolution theory. Our aim was to improve learning in this domain by exploring and modelling the process of conceptual reconstruction under actual classroom conditions and with a large sample size that is unusual for qualitative studies.
The methodology was based on the analysis of student texts. A group of 107 learners followed a teaching unit on Darwin's Theory of Natural Selection. At the beginning and end of the teaching sequence, the students wrote texts that explained an evolutionary phenomenon. Students' explanations for evolutionary change were analyzed and categorized into nine different patterns. Contrasting these explanation patterns with the corresponding scientific conceptions resulted in five conceptual frontiers, each of them marking one major learning task. The conceptual development of all 107 participants was then assessed by using longitudinal data. Thereby, the actual learning progression of the sample group could be visualized as learning trajectories on a conceptual landscape. This landscape model reflects students' conceptions on evolution and their pre- and post-instructional distribution in the sample group. Our findings indicate that learning to explain evolution is actually a very individual process where the students depart from several distinct ideas and take different trajectories. Furthermore, the effects of teaching strategies, e.g. cognitive conflict, on the students' conceptual development could be retraced on the map. Our data suggest that this method of mapping a content-specific learning progression within a mental landscape is advantageous for other domains of science teaching, too, as it allows more detailed insight into the process of conceptual reconstruction.

122 Open inquiry – performances and team spirit

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Zion et al. (2004b) characterized open inquiry as a dynamic process, whereby learning is a process of continuous and renewed thinking. They grouped the categories of dynamic inquiry into four main criteria: changes occurring during inquiry; learning as a process; procedural understanding; and affective points of view. The Israeli Biology Syllabus for high school students studying toward matriculation in biology includes an open inquiry project (Israeli Ministry of Education, 2006). Students can perform the inquiry as individuals, pair or a group of three. Some teachers are afraid that working as three won't contribute to the group (Sadeh, 2007) and this concern raised the research questions: What are the relative frequencies of the different dynamic open inquiry categories that are expressed during open inquiry? (The current research focuses on '**changes occurring during inquiry**' and '**procedural understanding**') and how does cooperative learning contribute to dynamic inquiry performances in open inquiry learning? 73 open inquiry projects of 153 biology high school students were examined. Twenty of the projects were performed by three students, 41 by two students, and 12 by students working individually. Data sources included students' logbooks, inquiry summary reports and interviews. The accumulated data contained evidence indicating diversions of the inquiry project from its original plans submitted by the students. Every instance of such diversion is termed '**performance**'. We used parametric Kruskal–Wallis analyses to examine whether the number of performances for each criteria depended on the team size and a Spearmans' correlation was calculated for examining the link between the team size and the type of performances. Statistically significant differences by the number of students were found in each team according to both criteria: The greater the number of students, the higher the number of performances. A positive correlation was found between the number of students in teams and the number of performances concerning 'procedural understanding' and 'changes occurring during inquiry'. A quality analysis of students' interviews revealed that most of them praised the benefits of teamwork. Teachers who often discourage students from working in groups in order to prevent situations in which one student could end up being a 'parasite', can see that the findings of this research dispel these concerns. A third student contributes to the team and the inquiry project. From a pedagogical viewpoint, this creates a student discourse, and more intensive metacognitive thinking, which occurs in a team setting, compared to individual work.

157 Exploring the "knowledge – attitude" relation in the context of new genetics and biotechnology

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GREECE

This paper presents data concerning knowledge and attitudes about genetics and contemporary biotechnology applications of students of upper secondary education level from various parts of Greece. It is a survey study, descriptive and correlational, using a 45-item research instrument designed on the basis of previous research and our research questions to measure knowledge and attitudes. Our focus is set on exploring whether graduate students of upper high school in Greece are well equipped with relevant knowledge of new genetics and molecular biology, as well as whether and how they use this knowledge in expressing an informed opinion on current issues of biotechnological applications. Lastly, we attempt to explore the relationship between students' knowledge and attitudes regarding biotechnology applications.

The methodology included the selection of the sample (1019 students) in order to represent cities and towns of various parts of Greece, the design of the research instrument and its reliability test, the analysis of gathered questionnaires using SPPS and the correlation of knowledge and attitudes with factors such as, geographical area, gender, parents' educational level, and finally the correlation of knowledge level to positive or negative attitudes towards biotechnology applications.

The results show that the students' knowledge of genetics and biotechnology is moderate and presents similar defects as known from previous studies. Students' attitudes are either positive or negative depending on the specific biotechnology application in question. Positive attitudes in general are expressed towards biotechnology applications that are thought as having a beneficial effect on human health, according to students. Negative attitudes are expressed towards applications that are thought as possibly having a negative influence on either human health or the environment, or as raising ethical considerations. Correlation of students' knowledge level and attitudes was found to be statistically significant.

POSTERS

1 Exploring Podcasting in biology teaching

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Podcasts are digital files that are becoming very popular in several areas such as education. In higher education in particular, these audio files have been explored in amultitude of ways to support teaching and learning contexts.
The study here described integrates a research project conducted at University of Minho during the years 2007/ 2008 and 2008/ 2009, to investigate the impact of podcasts in blended-learning. The present paper focuses the integration of podcasts in the course of Heredity and Evolution, from Graduation in Biology and Geology, during the 1st semester of 2008/ 2009. The study aimed to introduce podcasts in teaching/ learning context, exploring different characteristics of these audio files, and to evaluate students´ acceptance and receptiveness to the pedagogical use of podcasts.
A total of eight audiocasts, five informative and three with feedback, were produced and delivered in the e-learning platform. All the students listened to the podcasts and considered the episodes listened audible and clear. Although 53% of the students stated they would prefer to have had podcasts content in a written format, results showed that students considered extremely valuable the integration of this technology in learning. Students are also receptive to podcasting in other courses, their preferences going to episodes with summaries, guidelines or contents and to short or moderate episodes.
Curiously, in spite of owning MP3 or MP4 players, students did not use mobile devices to listen to podcasts, preferring to use their personal computers.

21 Laboratory work and fieldwork in biology: promoting students' questioning competence

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PORTUGAL

This poster reports data from an ongoing research project about the enhancement of the questioning competence through the development of both laboratory work and fieldwork in grade 8 Biology. The study is being conducted with a sample of 75 students and their teacher, at a Portuguese Secondary School, in Portugal. A Botanic university teacher and an educational researcher are providing support to this research.

The focus of this poster is the design of specific laboratory work and fieldwork teaching and learning strategies to engage students in learning biology, and to foster learners' questions. These strategies are being developed in the field of nature protection and conservation, and bearing in mind the biology curriculum for grade 8.

The methodology involves recording selected classes along one year (from September 2009 to June 2010), keeping field notes, collecting students' productions and written responses to questionnaires. Students' oral and written questions are being collected: oral questions are being collected during classes; written questions are being collected through an online platform.

This is an ongoing research project and data are still being collected. However, it was already possible to register students' enthusiasm and involvement with the laboratory work and fieldwork strategies designed and implemented so far.

3 Localizing a teaching sequence about photosynthesis in Saudi high schools

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International literature in science education provides considerable evidence that students' scientific understanding can be enhanced by using pedagogies derived from social constructivist perspectives on teaching and learning. However, little attention is directed specifically to the issues involved in implementing such pedagogies when these differ significantly from local interpretations of what counts as 'good science teaching'. The purpose of this paper is to examine these issues through a study of how Saudi pupils aged 15-16 responded to a teaching sequence (TS) about photosynthesis. The TS was designed to tackle the documented conceptual difficulties in understanding the source of plant food and extra biomass when developing the scientific view. Quantitative findings based on a post test show that while the TS was effective in developing the pupils' factual knowledge and understanding of what plant food is, it was less effective in enabling them to explain the source of biomass. In addition, qualitative data based on student interviews suggest that despite unfamiliarity with the pedagogical approaches, pupils found them useful in making their learning more meaningful.

38 Primary school children conception's about body and about sexual/gender identity

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Body growth and sexual and gender identity are topics to be approach in sex education, since primary school according to sex education guidelines for Portuguese schools (CCPES *et al*., 2000; GTES, 2005; 2007).

The aim of this research was to identify primary school children conceptions about body and about sexual / gender identity, as well as some influent factors in these conceptions.

We developed a qualitative research, following a transversal study, in three primary schools of rural milieu in the northern region of Portugal.

A questionnaire was carried out, based on literature review (Jowett, 1994; Brown, 1995). It was constructed and validated specifically to attend the propose of this research and it used the "draw-and-write" technique, then this is one of the most appropriate to primary school children and has been used to evaluate conceptions about body (ex: Clément, 2003). The questionnaire included two parts, being the first related to conceptions about body and the second related to conceptions about sexual / gender identity. The factors we considered were: gender; school year; father's job; mother's job; number of brothers and sisters and the age of them. The instrument included open questions, where children were asked to draw and to write some words, and closed questions with multiple response options. To validate, a pilot test was done with 16 pupils. The large sample included 177 children of the four years of the primary school. To analyse data we used the statistics program SPSS and categories of responses was constructed to open questions. The *X*-square test was applied.

In order to conceptions about body, children revealed some stereotypes associated to external characteristics, namely hair length and wear. Results show only one category to the representation of the boy, three categories to the representation of the girl, three categories to the self representation and four categories to the body representation when to go into bath. Some inhibitions about body were expressed. In terms of resemblance with parents, children identified essentially with the same sex progenitor and the body parts they consider looking like were "head/face". Concerning sexual / gender identity, children expressed strong stereotypes about femininity and masculinity and the sexual identity appear very connected to gender identity and roles, with activities, wear, personal characteristics, jobs and tasks separated for females and males.

6 Assessing students' attitudes and interests towards evolution – a methodological approach and survey

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In this study we assessed creationist/scientific beliefs of presently 118 students (sample size will be increased to 2500 by January 2010) with two different instruments: a reliable 16- item scale questionnaire and a match-the-opinion item. Both instruments revealed as precise tools to measure students beliefs and the test results were highly correlated. The majority of the surveyed students (54%) showed scientific beliefs and none of them showed creationist beliefs However, one third of the students' beliefs were classified as intelligent-design beliefs of different grades. Male students revealed significant higher scientific beliefs than female students.

Moreover, we evaluated the interest of students towards different up-to-date evolutionary topics (e.g. evolution of HI virus). Surprisingly, and contrarily to our assumption, we did not find a correlation between the interest towards these topics and creationist or scientific beliefs. We assumed that students with higher scientific beliefs show more interest in evolutionary issues than students with more creationist beliefs – but that was not the case. This means that beliefs are not necessarily a predictor for interest in evolutionary biology and emphasize the importance to clarify to students that biology and theology are two different modes to encounter and explain the world.

178 Children's understanding of animals in Finland and in Iceland

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In this study we describe results from a pilot study on children's knowledge of animals in two Nordic countries, Finland and Iceland. In Finland the focus was on which animals they have seen in their neighbourhood while in Iceland they were asked more generally about their knowledge. Twenty seven children (9 in each age class) between ages from 6 to 10 years old were interviewed in Finland and 36 children in Iceland (from age 6-15) according to the interview schedule agreed in the research group. In both countries the children had a wide knowledge of animal species. Nine children mentioned 87 animals in Finland in age group of 6 to 7 years and 53 animals in age group of 9 to 10. In Iceland the numbers of animals were 54 in age group 6-7 and 70 in age group 9-10. In all age groups and in both countries the children mentioned lots of mammals, but also birds and fishes. In Finland big mammals, wild animals and pets were mentioned systematically. In Iceland birds and fishes were mentioned more frequently than in Finland. The places where children come across animals were around their homes, in natural settings or with friends and relatives. This seems to indicate that children in Nordic countries gain their knowledge from the locality as a result of spending a lot of their time outside or from their homes. However, it is interesting to note that the media also seems to play an important role as a source of information.

8 Several CASE lessons have a positive long-term effect on students' control of variables reasoning scheme ability

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One major aim of the science curriculum is the promotion of scientific reasoning, in which the control of variables reasoning scheme plays a role. This reasoning scheme is important to the ability to draw conclusions and design experiments, yet difficulties related to the use of this scheme have been observed in numerous studies with school children. Here we address these difficulties through short intervention of three sessions taken directly from the CASE program (Cognitive Acceleration through Science Education). The full CASE program of 30 lessons is known to accelerate students' cognitive development and to have a long-lasting positive effect on their academic achievements. We explored whether a short intervention that focuses on the control of variables reasoning scheme would have a long-term effect on ninth graders' ability to apply this scheme in problems related to the biology curriculum.

Taking part in the study were 124 ninth graders from four classes. Two classes were randomly chosen to serve as an intervention group and the other two as a control group. In the control group the control of variables reasoning scheme was taught in a traditional way for the same amount of time as in the intervention group. A posttest was administered 2 months post-intervention and a delayed posttest took place 2 months later. Both tests were in biology and included biology content knowledge questions and biology-content related questions assessing the ability to use the control of variables reasoning scheme properly.

Overall, the results indicated that the short CASE intervention had a significant positive effect on students' ability to properly use the control of variable reasoning scheme both in the posttest and in the delayed posttest. Further analysis revealed that in the Piagetian concrete developmental stage the intervention was significant in the posttest only, while in the transition stage from concrete to formal operations levels significant positive effects were observed in both tests. The results did not reveal a significant benefit of the intervention in the Piagetian formal operations level. Students in this developmental stage in both groups and both tests had high scores.

The study shows that the short CASE intervention has a positive effect for the vast majority of students, as more than 80% of them were below the formal operations level, in line with previous findings. In addition, it indicates that science educators should consider the cognitive levels of students when addressing scientific reasoning.

10 Students' scientific reasoning and thinking in authentic learning environments

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AUSTRIA

This paper reports data from an authentic learning environment for problem based learning. Six students from tenth grade elective course in biology participate in this study. It is part of a two years study of a Research Education Cooperation project, *Kids Participation in Educational Research* (http://aeccbio.univie.ac.at/kip).
Neurobiologists invite students into their laboratories to work and experiment with the model organism of the hunting spider *Cupiennius salei*.
This paper explores models and argumentation used by students in discussions between each other and with biology scientists. They develop research questions, in preparations for a neuro-visual experiment with the model organism and discuss the interpretations of the resulting data.
Focus of research

- Development of student's argumentation during the process
- Models and arguments used by students
  - in discussions with researchers about problems and research questions
  - in discussions about (neuro-) biological data
- Models and arguments used by researchers in discussions with students

The methodology contains audio documentation from students' discussions and students' interviews as well as students' field notes and research diaries. Transcribed audio and other resulting text files get analyzed following the method of qualitative content analysis using deductive and inductive codes for argumentation and students' concepts of models.
Results
First results are coming from a pilot project. Data indicates, like shown in other studies as well, that students take their inspirations for argumentation from their everyday live experiences. This is documented by argumentations from 10 year old students about their question "can bees get twins?"
- I don't think so. Because, why should they get twins, they have so much cocoons.
- They can't get twins, because one bee comes out of only one egg.
- I do think they can, but they seldom do, because chicken do it too, last Sunday I had an egg with two yolks!
First results of this project will be presented at the conference.

14 Students´ argumentation in biotechnology issues: An action research study in lower secondary school

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SWEDEN

This paper reports data from students' argumentation in socio-scientific issues connected to biotechnology in lower secondary school. A group of 20 students (14-15 years of age) was studied during four weeks of teaching where I was both the teacher and the researcher.
The focus of the paper is the process of students´ argumentation when they are taught biotechnology as well as argumentation skills. Particular attention is given to the students´ argumentation in small groups.
The research method involved keeping field notes, collecting students´ written texts and collecting students own video recordings from conversations in small groups.
Data from students´ individually written texts and video recordings will be analyzed with a tool for evaluating the content of arguments before, during and after the small group discussions. The data will also be analyzed with a tool for evaluating the progress in the students´ argumentation during the four weeks studied.
Results are not yet available, but in time for the conference they will be.

17 Education for sustainable development one in two teachers believe they lack the necessary knowledge

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SWEDEN

The purpose of this study is to investigate upper secondary school teachers' understanding of the concept of sustainable development, their attitudes towards it and their views on appropriate teaching methods. Our goal is to identify opportunities for, and barriers to, education for sustainable development. The concept of sustainable development is complex, and previous research shows that teachers have difficulties in understanding the meaning of the concept. Because the Swedish curriculum states that every subject should include sustainable development issues, it is important to investigate teachers' understanding of the concept, and if this differs depending on which subjects they teach. To date, little information exists on how education for sustainable development is understood and taught by teachers representing all subject areas. Upper secondary school teachers, (N=10 000, in 300 geographically distributed schools in Sweden) will be surveyed by online questionnaire with multiple choice questions. A pilot study was conducted at four upper secondary schools, N=138. The results from our pilot study show that 45 % of the teachers believe the biggest difficulties in including sustainable development within their teaching is that they lack the necessary subject knowledge. Only 33% teach according to pluralistic environmental education, which is also called "education for sustainable development. It also shows that many teachers lack a holistic perspective of the concept and 75 % of the teacher's state that they have a desire for further education. Teacher's positive attitude towards sustainable development and their desire for further education promises to help achieve successful implementation of the UN call concerning education for sustainable development.

71 Indonesian biology teacher and agronomy students' perception of commons dilemmas

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Indonesia's Central Sulawesi province harbours core ecosystems of the global Wallacea biodiversity 'hotspot'. Largely consisting of common pool or open access forest resources, it is heavily threatened by intensive resource appropriation such as rattan extraction and forest conversion into agricultural plots. To improve prospects for conservation and sustainable long-term development, a set of socio-ecological 'commons dilemmas' need to be solved. This requires local actors who command knowledge on the social, economic, institutional, and ecological aspects of forest resource utilisation. In the spirit of the Agenda 21 or the Convention on Biological Diversity (CBD 1992), fostering such knowledge should be a prime task of international environmental education. While Indonesia strives to include environmental education in its school curricula, we report on results of a study that systematically investigates the pre-concepts of environmental problems and its impact on human livelihoods as well as the perception of commons dilemmas that future teachers and agricultural advisors bring to local resource conservation issues in Central Sulawesi.

Based on the 'Protection Motivation Theory', we abstracted our results from 19 qualitative in-depth interviews including interventions on the intensive rattan utilisation in and around Central Sulawesi's Lore Lindu National Park with agronomy and biology teacher students from UNTAD University, Palu, i.e. from potential key communicators on resource use dilemmas. Students' perceptions of commons dilemmas are fundamental for teaching or giving advice about resource management problems and potential solution strategies.

The results of our qualitative study show that university students' pre-concepts – before providing them with interventions on rattan utilisation – are limited to ecosystem interrelations such as landslides or flooding as a result of deforestation. However, socio-economic impacts on living conditions of the local population – depending highly on forest resources for their livelihoods – were not emphasised. Thus, most interviewees readily recognised ecological aspects of the exploitation of forest resources, and frequently called for state regulations. While emphasising e.g. the time tap of over-exploitation of natural resources, the core of the commons dilemmas, i.e., the need to institutionally balance short-term individual exploitation profits with long-term and community interests was not recognised in any detail, however. Concerning courses of action to improve the implementation of environmental education, the respondents highlight the claim to integrate 'practical learning' into university and school curricula to foster sustainable resource management. The results of our study give suggestions for the improvement of university education through adapted university curricula development in Indonesia.

18 The assessment of didactic activities from a hierarchical proposal

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Discussions on Epistemology of Biology are barely seen on Biology books. However, the understanding of biological knowledge organization is essential for teachers' training. Such comprehension can be developed through the insertion in scientific research context. In this way, the research group on Epistemology of Biology has evolved in its activities. That group has been formed by both graduating and pos-graduating students, university teachers and it has discussed questions concerning the Biology characterization as a distinct scientific area, unifying concepts of Biological knowledge and the contribution of those discussions on Epistemology of Biology inside the Biology teaching. Based on Salthe's hierarchical model (1985-2001), it was proposed a didactic and epistemological model in sake of the biological concepts organization to be done during the discussion and group activities. The settled model proposed the organism as the focal level, the external ambient as the superior level and the internal ambient as the inferior level, having the following relation among the hierarchical levels: [external ambient (ecological/evolutionary) [organism [internal ambient (genetic/molecular)]]]. The aim of the current paper was to assess how students from Biology course, who are members of the research group on Epistemology of Biology, translated the epistemological constructions proposed in didactical methodology when they were asked to elaborate didactical sequences for the biology teaching aiming high school level. Such activity was realized during the first semester of 2009, and it has as its components 12 students divided into 4 groups. The data were assessed according to a qualitative approach featured by one purposeful sampling and one inductive analysis from the produced work made by the students, from which it was elaborated one creative synthesis. It was possible to realize distinctions among the sequences didactic constructions elaborated by the students. Two groups were able to articulate that knowledge inside the three proposed level range by making use of concepts which enabled the integration among them. The remaining two groups showed hindrances in their constructions and they did not explore concepts through the three proposed level range. In this way, it is possible to consider that the discussions of such group can be realized by the students in different levels of deepness, that lead it towards different didactical proposals from which the most coherent ones were those that didn't lose the threat of biological concepts in an integrating way.

179 Children's understanding of animals in their everyday life in the UK and USA

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This paper is one of three inter-connected papers that explore children's ideas about animals in their everyday lives as this is an area that is under represented in the literature. The specific aim of the research presented in this paper is to discover what children intuitively thought of as an animal, where that source of knowledge was acquired and what if any socio-cultural influences affected their ideas.

The research took place in main stream schools in the UK and the USA; two countries that might be considered to have similar socio-cultural influences affecting children's ideas. Participants were children in main stream schools that had similar school environments in both countries. Nine children in both countries , aged 4 years, 8 years, 10 years, 13 - 14 years and 15- 16 years respectively that represented the range of attainment, were interviewed separately. They were asked to name as many animals as they could in one minute and then to say where or how they had found out about them.

Data reveals some similarities in children's ideas in both countries but also a number of differences that are thought to result from specific cultural differences.

5 Brazilian teachers' conceptions about creationism and evolution

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The assessment of teachers' conceptions on evolution is important because it allows to understand, for example, how they cope inside the classroom with issues related to the confront creationism *versus* evolution. This paper takes into account the European project Biohead-Citizen "Biology, Health and Environmental Education for better Citizenship" (Carvalho, 2004; Carvalho & Clément, 2007), aiming to improve understanding of how different aspects of citizenship are promoted or may possibly be promoted through Biology, Health and Environmental Education. This project takes into account not only that scientific knowledge on these topics develops fast but also that teachers' attitudes and values can influence these topics practices. A questionnaire was constructed, translated and validated to be applied in the 19 countries with geographic, historical, cultural, social, religious and political contrasts: European, African and Middle East countries. This current paper extends the Biohead-Citizen project to a South American country, Brazil, aiming to assess the conceptions of six groups of teachers from São Paulo countryside about the topic evolution, in particular about their evolutionist and creationist conceptions. The Biohead-Citizen questionnaire was applied to six groups of S. Paulo countryside teachers: 50 Biology teachers, 50 Portuguese language teachers, 50 Primary school teachers, 50 Biology students, 50 Portuguese language students and 50 Pedagogy students. For this work, five questions were used. The software package SPSS statistic for Windows, version 17 was used for the teachers' answers analysis. The majority of Primary school teachers, Pedagogy students, Portuguese language teachers and Portuguese language students have creationist conceptions. Nearly half of the Biology teachers and Biology students have creationist conceptions. Almost all Biology teachers and Biology students give great importance to the process of natural selection concerning the evolution of species while only 30 to 40% of Primary school teachers and Pedagogy students, respectively, give great importance to this process. It ranges from 50% to 70% the amount of Portuguese language teachers and Portuguese language students, respectively, who give great importance to natural selection. These results agree with previous ones concerning 12 countries (Quessada et al, 2007), as far as the Biology teachers and future Biology teachers give more importance to the natural selection and the evolution process, however the total Brazilian sample shows a higher percentage of creationist conceptions.

20 Media analyses in biology class! A case study of how media framing activities can improve upper secondary school students' understanding of gene-environment interaction

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NORWAY

This case study illustrates the learning gains of raising students' awareness of the different ways the gene concept may be understood. As a supplement to their normal genetics module in the biology curriculum, 38 year-13 students in an upper secondary school in Norway are taught how to identify five different ways of presenting the gene concept in newspaper articles about cancer, with the objective of deepening their understanding of the way genes and environmental factors interact.

The study attempts to reconstruct predominantly deterministic ideas of genes in relation to health and disease. A pre- and posttest with a series of open and closed questions pertaining to genes and disease are given directly before and after the intervention, with a follow-up posttest 2 months later. For the intervention students are taught how to analyze newspaper texts using a previously established framing scheme. A group of the students also participate in a focus group discussion about genes and disease before and after the intervention, which is recorded.

Their written answers in the pre-and posttests, as well as the oral discussions in the focus groups, are analyzed using qualitative frame analysis: key words and phrases in their answers are identified and categorized into one of five previously established gene frames (Carver et al. 2008). The frequency of each frame used in the pre- and posttests are compared, and used as a measure of conceptual growth and/or change. The focus group material provides additional information on their understandings of genes and disease.

The results from a pilot study (n=22) with a similar design indicate that students refer to the evolutionary frame more often in posttest answers, and show more reflection about gene-environment interaction when answering open questions such as "why do some people live to they are 100?".

23 Upper secondary students' use of scientific knowledge in arguing socioscientific issues

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The ability of argumentation has been stressed in school education and science education during the past decades. But how much students could use scientific knowledge into their argumentation is still unclear. The purpose of this study is to investigate 80 upper secondary students' resources of supporting reasons while making written arguments on four socioscientific issues (SSIs) related to sustainable development issues, and to explore how much scientific knowledge students could use. Also, we would like to know whether there were any alternative conceptions found in students' argumentation. Besides, the differences among science and non-science majors are disclosed. We invited 40 upper secondary students with focus on science and 40 students focused on social science at the end of their education (18-19 years of age, grade 12) to participate in the study. All the students were asked to express their opinion on a SSI individually via a written report– they could choose one out of four, and formulate arguments to support their standpoints. The SSIs addressed in this research are global warming, GMO, nuclear power and consumption. The analysis was made with focus on what resources could be found in students supporting reasons and also the scientific knowledge (and alternative conceptions) used by the students. The preliminary results show that students used value in a greater extent than scientific knowledge when supporting their claims, and interestingly, non-science major students used slightly more scientific knowledge than the science major students. Some alternative conceptions were also found. The implication to research and education will be discussed.

25 Flows of energy and matter cycles in the ecosystems: A conceptual tool to deal with issues of global sustainability

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This paper looks at one of the central concepts in biology and biology education – energy flows and matter cycles – as a tool for addressing issues of environmental sustainability. Such issues are by nature trans-disciplinary and they call for a reformulation of traditional knowledge categories in the sciences. Equally, sustainability issues arise from a complex interrelation between facts and values and the interplay of different types of knowledge: both scientific and global and local and experiential, which are constituted by people's experience of everyday life settings.

As never before, concepts of energy and matter have become key pointers in the debates surrounding the representation of nature and the complex interactions between human societies and nature's services. Arguably, recovering the cultural role of biology education and bringing school science learning to contribute to important matters of personal and public life is an important aim for science education. In this paper, we report the learning experience of a course on energy flows and matter cycles offered to post-graduate students from different scientific backgrounds enrolled in a teacher education programme in Italy. Interdisciplinary and participatory activities were used to stimulate students to think across levels and across boundaries in order to acquire the competence of using the concept of energy flows and matter cycles as a tool for understanding the critical interface between human beings and nature. Data were collected in the course of classroom observations and from students' own products. The analysis illustrates a process of reconfiguration of established meanings and terms which is sustained by the dual processes of discussion and explicit use of conceptual tools which the students experience for the entire duration of the course. Such data suggest that energy flows and mater cycles can be proposed as a tool for reading socio-ecosystems' dynamic transformations. The data describe a shift of perception, from looking at objects to appreciating relationships which can occur within a learning environment that stimulates engagement with alternative interpretations and multiple knowledge perspectives.

26 Biomedical students as teachers and science communicators; developing a training program for the mobile DNA labs

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This presentation describes the development of a course for students in Life Sciences in which students are trained in communication on current genomics topics and their implications for society. As a main part of this course, these students assist a mobile DNA lab and visit schools twice a week. The construction of this course is an ongoing process in which student learning, student satisfaction and performance in the classroom are monitored and used for improving the course. The permanent research question in this process is:
Which training design prepares assistant teachers effectively for science communication through mobile DNA labs?
Student learning is monitored through a personal dossier, in which the student notes his or her personal learning goals and learning results. These are discussed with the course coordinator.
Students evaluate their practice with colleague students in a process called intervision.
Student satisfaction is measured with a written inquiry, consisting of Likert items and open questions.
The training program can be considered very successful. The Likert item 'I think the course 'Communicating trough the DNA-lab' is a useful addition to my curriculum', receives a mean of 4.8 out of 5. Students report personal growth and a deepened insight in the specific characteristics of genomics research and the resulting societal and personal issues.
Teacher and student satisfaction in the receiving schools is very high.
Results show that the combination of a science communication course with a training in assisting mobile DNA labs cuts both ways; students in life sciences are prepared for societal communication about their work, and secondary school students are prepared for societal implications related to genomics. Moreover, the reflection process stimulates also the constant revision of both the DNA lab and the science communication course. This model can be instructive for other situations in which authentic practices are introduced in school curricula.

33 Subject-matter related diagnostic competence: A four year longitudinal study to examine the structure and development of diagnostic competence of prospective sScience teachers

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Our project aims to promote and evaluate prospective science teachers´ subject-matter related diagnostic competence. The project has an interdisciplinary approach, including biology-, physics and mathematics education, as well as the pedagogical psychology. The project has started in October 2008 and will last four years.

The part of the study presented here concentrates on prospective biology teachers and examines the structure, the development, and assumed predictors of their diagnostic competence with a focus on scientific inquiry.

In order to examine and evaluate the above mentioned diagnostic competence, we have developed a model of its structure which serves as a frame of reference for the entire project. The model is applied specifically to the university part of teacher education. Two cohorts of prospective biology teachers are monitored through their university education. Methods used in both cohorts include summative and formative instruments such as paper and pencil tasks, questionnaires and (learning) journals. Relating the here collected data to data gathered in pedagogical psychology on students´ general attitudes and beliefs will help to identify the impact of specific predictors on prospective teachers´ competences. The data collected in the study will not only serve as a means to assess students´ competences but also to evaluate university instruction developed in the project. Thus, results will be integrated continuously into revisions of the university curriculum. The focus of the project is therefore twofold: in one way the study provides empirical data on prospective teachers´ diagnostic competence structure and its development while being educated at university level. On the other hand a curriculum is trialed, to improve prospective teachers´ knowledge on methods and on interpreting results of assessment.

First findings from cohort 1 indicate, that at the beginning of their university instruction prospective teachers differ in terms of their understanding of scientific inquiry. No significant differences were found on gender and type of highschool they are trained for. First results from instruments that measure students´ beliefs about the nature of science indicate a partly underdeveloped understanding.

Further research has to show, what kind of effects these results have on the development of subject-matter related diagnostic competence of the prospective biology teachers.

48 Students' ideas about the human body and health in school settings in Sweden and South Africa

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The importance of living a healthy life is promoted in schools and in society. The discussions often focus on different kinds of food. In this paper the focus is on how students' ideas about the human body are structured and how this is related to their thoughts about some health questions. The study surveyed 9th grade students: 88 in one Swedish school, and 161 students in five different schools in South Africa. The study methods utilised drawings and written questions, both open and multiple-choice, and interviews with students in both countries. In both countries issues about body and health are discussed in several different subjects in school. Most of the students (~75% in Sweden and ~ 60% in South Africa), showed basic knowledge of the digestive system, congruent with goals in the Swedish and the South African curriculums. In the South African sample some students had ideas that a sandwich went through the throat to the lungs and then to the stomach. The same pattern was also seen for the water pathway. The students were asked what happens in the body when you drink water. It was revealed that one group of students had an idea about an alternative system for fluids. These students drew a tube from the mouth connected directly to the kidneys. They struggled to explain the function of the kidney, and had simplistic explanations of why humans sweat. Nearly all of the students in the study had difficulties explaining the connection between the digestive system, the blood circulation system, and the kidneys. Slightly more South African students than Swedish students knew that the kidney is involved in the excretion system. In both countries, some students claimed that water contains nutrients and gives energy to the body. There were also a few students who had the idea that you have to drink water to fight off bacteria or diseases. The students with a more advanced understanding of a painkiller's way through the body were those who believed that pills primarily could be replaced by pain-relieving creams. This group spontaneously gave fewer alternatives to painkillers than other students in the Swedish sample. The pattern was different in South Africa where all the students willingly considered alternatives.

180 Portuguese and Brazilian children's understanding of animals in specific habitat niches

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The aim of this work is to compare children's knowledge about animals from two countries, Portugal and Brazil, with geographic differences: the former a European/Mediterranean country and the later a South American/Tropical country. These two countries share the same language and some common historical and cultural background, since Brazil was a former Portuguese colony.

In Portugal 12 pupils per age group (6-7, 8-10, 15-16 and 17-18 years old) were interviewed, being 4 weak, 4 regular and 4 gifted pupils. Half were girls and half were boys, making a total of 48 children. In Brazil, 9 children per age group as above were interviewed, being 3 weak, 3 regular and 3 gifted pupils, making a total of 36 children.

In this specific Luso-Brazilian piece of work we gathered preliminary data of small samples which, even so, give interesting contrasting differences clearly associated to geographic and socio-cultural country specificities.

Both Brazilian (BR) and Portuguese (Pt) children named the 18 displayed animals but a different trend in the animals' selection was found: the Portuguese sample stressed "duck" (97 occurrences) "dog" (91), "butterfly" (88) and "cat" (87) whereas the Brazilian group emphasised "earthworm" (8), "birds" (4), "hawk" (4) and "mouse" (4). When asking "*Where did you find out about/How did you know about this animals?*" children's answers distributed in several categories, being "home" (135 Pt; 87 BR), "TV" (64 Pt; 87BR) and "farm" (27Pt; 9BR) the most expressive ones, common to both samples. In contrast, "street" (76 Pt; 0 BR), "garden" (43 Pt; 3 BR), "grandmother's home" and "lake" (18 Pt; 0 BR) were conveyed mainly by Portuguese children whereas "Zoo" (16 Pt; 89 BR), "internet" (8 Pt; 17 BR), Film/DVD" (0 Pt; 14 BR) and "school (near)" (0 Pt; 11 BR) by Brazilian children. The distribution of these answers are by age groups of Portuguese and Brazilian children. One can see that "street" is gradually more expressed from 6-7 years old children up to 17-18 years old in the Portuguese sample. In contrast "TV" and "Internet" are home activities showing an increase with age among the Brazilian sample. These results seem to be associated to differences in Portuguese and Brazilian young people's lifestyles, the former spending more time on the street in the open air.

39 Children's attitudes towards animals: Evidence from a primary school context in Portugal

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PORTUGAL

The use of animals in education has become a popular strategy to engage students with Science, enhance their motivation, and promote important values such as respect, tolerance, and empathy for all living beings. Although the beneficial outcomes of these educational programs are widely acknowledged, reliable indicators of their efficiency have not yet been provided. Therefore, it is essential to increase and broaden the studies concerning the effectiveness of the use of animals in education. In this regard, it becomes necessary to understand the students' attitudes towards animals.

This communication presents data on the attitudes of primary school children towards the humane treatment of animals and reverence to animal life. The work was carried out within the scope of the RODENTIA project (http://www.rodentia.ibmc.up.pt/), a longitudinal project based on the concept of classroom pet aimed at fostering the development of scientific reasoning competencies and positive attitudes towards animals in primary school. To assess the efficacy of this project, a methodology combining quantitative and qualitative assessment approaches was outlined. This study focuses on the results of the diagnostic survey conducted to depict the students' constitutive attitudes towards animals. The study involved 48 students (aged 9 to 10) from two 4th grade classes of the same school. Following a pre-test design, a 43 item questionnaire was specifically developed and administered to assess the children's attitudes towards pets, livestock, wild and laboratory animals, and animal sentience. Our results reveal that children hold intrinsically positive attitudes towards animals. Interestingly, their attitudes do not seem to be linked to their degree of familiarity with pets or other animals in general. Furthermore, although overall no major differences can be attributed to gender, girls show more concerns about the welfare of livestock and laboratory animals. This study provides useful information for the development and implementation of humane educational programs.

45 Model-based innovation in science curriculum: the case of teaching and learning the nervous system

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In this work we describe the development of a proposal for teaching and learning about the nervous system based on models and modeling. It recovers scholarly science education proposal which affirms that one of the basic students' activities is the construction of theoretical school models.
Models are understood as plots of ideas that allow students to explain theoretically a phenomenon; these explanations adjust highly to the experimental, discursive interventions and representational students' ideas about the world.
The focus of this study is present a methodology of curriculum development, our curricular proposal is based on the creation of a progression hypothesis for model development. Such hypothesis is based in theoretical contributions of the area, and considers a target model and five intermediate models. Every intermediate model is associated to school years, including pre-school, primary and secondary education. From the initial progression hypothesis, we designed a series of Teaching Learning Sequences (TLS) for every intermediate model. The TLS for pre-school and primary education were discussed with ten pre-school and primary school teachers and taken to the classroom in natural conditions. In every TLS the conversations were recorded, students' productions were gathered and every teacher took a diary. With this information a qualitative analysis was made to identify the explanations constructed by the students. With the obtained results, the progression hypothesis was reconstructed. Theoretical contributions allowed generating the first hypothesis of progression in the development of the model which established the bases for the discussion with the teachers. Later, the feedback with teachers and the analysis of the explanations generated by the students allowed us to refine the ideas to develop in every intermediary model and integrate the target model.
We consider that this methodology of curricular development based on modeling, in which theory and practice feedback each other, allowed us to generate new curriculum proposals for more authentic school models, which do not consider only the scientific erudite models, but the contributions of the teachers' expertise and messages coming from classroom practice.

50 Model competence in biology education – Validation of a theoretical model of model competence using open- ended Items

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Various empirical studies have identified that students reflect little on their handling of models and that they are not aware of the role models play in an epistemological process (e.g. Grosslight et al. 1991, Mikelskis-Seifert & Leisner 2004, Trier & Upmeier zu Belzen subm.). A reflective handling of models functions as a "door-opener" for an elaborated understanding of the nature of science, leading to advanced levels of scientific thinking and problem solving (Leisner 2005). The relevance of models is also noticed by the Standing Conference of the Ministers of Education and Cultural Affairs who require a reflective handling of models in five out of thirteen educational standards (E9-E13) in biology (Kultusministerkonferenz 2005). To foster students' competence specifically, a diagnostic instrument has to be designed. The precondition for designing a diagnostic instrument is an empirically tested theoretical model of model competence. Krüger and Upmeier zu Belzen (2009) have developed a theoretical model of model competence with two dimensions *knowledge about models* and *modelling*, which are both further subdivided into three qualities. However, an empirical validation of the theoretical model is needed.

The aims of this research project are to operationalize and validate the theoretical model of model competence with open-ended items. Based on the theoretical model, 25 open-ended items were designed. The pretest was conducted with 510 students at grades 7 (Realschule, age 12-14) and 10 (Gymnasium, age 15-17). The items were tested for understandability and consistency with the theoretical model of model competence. The data was analyzed by Qualitative Content Analysis (Mayring 2003). 1019 student answers in the dimension *knowledge about models* could be categorized within the theoretical model. The student answers in this dimension are consistent with the theoretical model. Additionally, the data of the dimension *modelling* will be analyzed and presented at the conference.

In the subsequent step, the optimized open-ended items in the dimension *modelling* will be validated. For that purpose, students (grades 7 to 10, Realschule and Gymnasium) will answer a paper-pencil test with the optimized open-ended (Grünkorn et al. 2009) and multiple-choice items (Terzer et al. 2009). Each student answer will be assigned to a specific quality of the theoretical model. This achieved quality will be compared with the quality they show in their hands-on performances.

The poster focuses on the findings of the pretest. The generated categories will be presented and illustrated with prominent student answers.

51 The city as an urban ecosystem: A pathway to a causal thinking

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The paper presents preliminary results from a research about causal thinking and decision-making in the context of the study of the city as a socio-ecological system.

The focus of the paper is the exploration of an adequate evaluation instrument that allows us to explore students' model of a city, with the aim to address teaching-learning processes towards transforming action and decision-making, as well as the learning of strategies in order to act in the environment and to develop a critic, active and responsible citizenship.

The aim of the research is to move forward into the design of didactic materials that favour the processes of teaching and learning sciences that incorporate the principles of Complexity, focusing in the evaluation of the adequacy of a didactic material that can favour the students' developing of causal thinking from a complex perspective.

Data was collected from a group of 100 students in the second year of Secondary School (14 years of age) working in groups a didactic unit about their city. The students were asked to write an action proposal to improve the environmental quality of the city. The proposal was finally communicated with graffiti painted by the students and a text justifying it.

Methodology involved recording classroom sessions, taking field notes and collecting the students' production (graffiti and texts). Data analysis focuses on the description of causality in the students' productions by the establishment of indicators to evaluate the presence of causality. In this paper is discussed the preliminary version of the evaluating instrument.
Preliminary results let us assert that the evaluation instrument must be conceived as a net and must be able to perceive a gradient of causality. Moreover the indicators must allow identifying and describing the different kind of causal relations according to the categories and the model proposed by the theory.

To continue with the research we are working on the establishment of the students' causal thinking patterns, with the aim to go forward on the evaluation and promotion of the causality in the school science.

53 Ecosystem knowledge and system-thinking skills of K12 biology students

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The significance of ecosystem has central role in the sciences of ecology, biology and environmental education and gain particular attention in the national standards and the curriculums internationally. Particularly the recent decades, which are characterized by rapid and intensive environmental changes, students need to acquire the essential knowledge for the ecosystems so that they can comprehend the human position in the ecosystems and that several human activities can, intentionally or unintentionally, change the flux of ecosystems. However, students appear to have difficulties in understanding concepts related to ecosystems while seem to have low level of systems thinking skills.

The research aims to study the knowledge for the concept of ecosystem and the systems thinking skills of K-12 students as well as the possible correlation between knowledge and systems thinking skills. The research is trying to answer the following questions: 1. Which is the level of the students' knowledge regarding ecosystem? 2. Which systems thinking skills and in which degree are held by the students? 3. Which is the correlation between ecosystem knowledge and systems thinking skills?

The participants of this study were 16 students of K12, from an urban lyceum equally represented by boys and girls. Data were collected by two open-ended questionnaires: (a) for knowledge (Q1) and (b) for skills (Q2). Data were analysed both qualitatively by content analysis and quantitavely by the evaluation of questions.

Weakness on students reasoning to conclude to generalisations regarding ecosystems was obvious, while basic ecological reasoning was absent. This may due to the fact that in Cyprus curriculum focus is given to the structure of ecosystems and therefore processes and relationships are not taught, while there is an entire absence of laboratory and field experimentation.

The results highlight the need of integration of learning strategies related to ecosystems. Computer- based scaffolded learning activities could engage students with the complex topic of ecosystem. Additionally, curriculum should be restructured and enriched with basic ecological concepts focusing on the functions and relationships (e.g. decomposers and nutrient recycling, population dynamics, food webs) within the ecosystem in order to help students to be able to come to generalizations. Skills related to the cycling nature of ecosystem, to the difficulty to foresee the result of a change or designate the limits between all ecosystems should be developed and enhanced by students.

55 Cross-curricular teaching of origins of life: Opportunity or threat?

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The research reported here explores the teaching of origins of life in science and religious education (RE) in secondary schools in England. The experiences, attitudes and beliefs of teachers and 14-16 year old students were investigated, primarily through questionnaires, interviews and small focus groups.

This paper considers what is currently being taught about origins of life in science and RE. The approach of the two disciplines to the topic is compared and contrasted from both teacher and student viewpoints. The amount of, and attitudes to, cross-curricular collaboration is assessed, and there is a particular focus on opinions about whether religious beliefs should be covered in the science classroom.

The study involved a self-completion survey of a small sample of science and RE teachers across England. This was supplemented by richer data collected in four case schools: interviews with the heads of science and RE departments, questionnaires and focus groups with students (aged 14-16), and a small number of lesson observations. These schools illustrated three different contexts: Christian faith school; non-faith school with a catchment of mainly Muslim families; and non-faith school with pupils drawn from no particular religious background. Data were analysed using grounded theory or descriptive statistics, as appropriate.

Most science teachers claim to mention religious beliefs when they cover this topic, and the majority of RE teachers say they mention scientific theories. However, the findings suggest that there is currently little collaboration between science and RE departments, even though this could be beneficial to both teachers and students. It seems that some science teachers, for instance, could profit from RE teachers' experience in handling controversial subjects, encouraging students to express their opinions and promoting discussion. From science teachers, RE teachers could discover whether or not their confidence in teaching the scientific angle is justified. In view of the prevalence of student misconceptions about evolution, and in the absence of universal acceptance of the theory, it is important that all teachers who cover it in their lessons – be they from the science department, RE, or elsewhere - get it right. This raises the issue of how to encourage cross-curricular endeavours in face of time and work pressures, and the automatic defensiveness of many teachers in respect of their own subject.

57 Subject meets subject - a study about teachers interchange in education for sustainable development

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Environmental education has been a topic for biology teachers in Sweden, as well as in many other countries, since the 1970th (Björneloo, 2007; Öhman, 2006). However as a requirement due to the goals of Education for Sustainable Development (ESD), environmental education has broadened up to embrace other subjects as well.

ESD seeks to integrate ecological, social and economic perspectives into the education. Facts, values, democracy and action competence are important aspects (UNESCO, 1995). To educate for sustainable development is indeed a challenge and a way to put the education into authentic problems of the world.

The aim of this study is to investigate how interdisciplinary group meetings can broaden teachers' understanding of ESD. This first study of my thesis investigates what perspectives of sustainable development that are emphasized, when teachers from different disciplines meet in a joint discussion. Research questions: What aspects are emphasized by teachers in an interdisciplinary discussion about sustainable development? What do different teachers consider as important aspects of sustainable development after an interdisciplinary discussion?

This case study is based on a discussion between teachers at a literature seminar. The target group was chosen from teachers taking an in-service course at Malmö University. This course is one of the components included in the RCE-project "Food & ESD" running at Malmö University.

The teachers normally work in public schools in Malmö with pupils age 13-15. The teachers represent different subjects as for example: natural science, social science, language, mathematics and home economics. The course given had an interdisciplinary approach dealing with the consequences of our food production and consumption in the frame of sustainable development. A socio cultural perspective is used as a starting point for this study. In this research design I have my starting point from the teachers' discussion. A literature seminar was videotaped and semi-structured interviews were used after the discussion. The transcripts from the seminar and the interviews are now the subject of analysis and the results will emerge during this winter and spring. The very first indications show that the mutual discussion brings about topics from as well ecological, social as economic dimensions. The different perspectives continue through the conversation despite which school subject the talking person represent, however, it seems to be a qualitative difference of how the subject is treated.

63 Changes in student's understanding of evolution: Teaching evolution on the case of the Galápagos finches

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AUSTRIA

This paper reports data from a case study on teacher knowledge of planning lessons concerning Galápagos finches of 4th grade students. The teacher is guided by several blocks of Educational coaching to plan the biological lessons and reflect the effectiveness of the learning environment. Proceedings in the development of teacher's expertise were ascertained by interviews, video-tape of the lessons and also by changes in the student understanding.

The aim of this survey is to guide the teacher how to reflect on the design of learning environments. For the improvement of the teacher's expertise we used Educational Coaching. The subject-related educational reflection is part of the Model of Educational Reconstruction. Understanding of teacher's knowledge and beliefs about content and teaching, process consultation and consultation about the issue of teaching – learning processes are emphasized. The analyses of teacher knowledge and beliefs are oriented on some components of Content Knowledge, Pedagogical Content Knowledge and Pedagogical Knowledge. In this paper some results from the first block of the Educational Coaching to Subject matter Knowledge and changes in planning a lesson, and Pedagogical Knowledge and their changes caused by Educational Coaching are presented.

Teacher beliefs and knowledge are investigated by problem centered interview and videotaping of selected lessons. The level of students' understanding will be ascertained by videotaping selected lessons and teaching materials filled out by the students. The data are interpreted by qualitative content analysis. The analyses of the teacher's knowledge and beliefs are oriented also on the domains of teacher knowledge.

The first results of the case study show that better understanding of students' conceptions and their conceptual reconstruction can improve the effectivity of the lessons, at first in the Pedagogical Knowledge domain. With help of students' conceptions, we hope to structure the lesson blocks more meaningful in order to enable the students to gain a deeper insight in selection, and evolution.

65 Professional knowledge of biology teachers - Development of measurement instruments for biology teachers' pedagogical content knowledge and content knowledge

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One important consideration of an optimal teacher education is dealing with criteria of the quality of instruction in biology education. Thus, research on teachers' professional development is essential.

Shulman (1987) differentiates seven categories of the professionalization, whereof three are important for research on teachers' professionalism in Germany (Bromme, 1997): pedagogical knowledge (PK), pedagogical content knowledge (PCK) and content knowledge (CK). According to the *COACTIV*study (Baumert et al., 2003), the presented project (*ProwiN*) exposes all these three dimensions of *science teachers* in Bavaria and North Rhine-Westphalia. In the following, we will focus on the biological knowledge.

The developed reliable and valid instruments will be used to analyze the relatedness between PCK, CK and PK of biology teachers in Bavaria and North Rhine-Westphalia, as well as between biology teachers of *Hauptschule* and *Gymnasium*.

The study will be realized in four steps. First, the curricula will be analyzed and compared to each other, concerning the two federal states and concerning the two types of school. Topical overlapping of the federal states as well as of the types of school should be identified for setting a focal point. In a second step, the CK and PCK paper and pencil tests will be developed accordingly to the chosen topic.

In a third step, a pupils' achievement test and a coding system for a video based lesson analysis will be developed. In the fourth step the coherence between teachers' professionalization and pupils' learning achievement should be demonstrated by videotaping the participants' lessons (N = 80 biology teachers).

Currently, in biology, two topics were identified (neurobiology and immunbiology; 9th and 8th grade) as an intersection of the types of school and the two federal states. In July 2009 the first pilot study of the pupils' achievement test took place (N = 110). Open-ended items were given to students in Bavaria to analyze typical errors. The identified errors were categorized and used for developing items of the teachers' PCK test. Furthermore, pilot studies and improvements of the tests will be done, before the main study will start in October 2010. By taking the two federal states, the variance of the sample should be guaranteed for the main study (N = 300 biology teachers).The results will be analyzed by using the item response theory.

Findings are to be applied by universities for teacher education and for in-service teacher training to improve the quality of teacher education and of instruction.

67 Context based education in the zoo

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Zoos offer educational tools for visiting students. Generally these "lessons in the zoo" are not systematically designed and tested. Also, teachers seldom incorporate them in the curriculum. Therefore it is uncertain what students learn from them.
In this research a lesson unit for use in the zoo as part of the biology curriculum is designed, tested, and evaluated with regard to promoting or hindering the learning of biological key concepts by students in secondary education. The design principles used are the Contextual Model of Learning, CML (Falk & Dierking, 2000), and a form of context based education, the Concept Context Approach, CCA.
The CML, a theoretical construct on learning within a free-choice setting, is useful for understanding complex combinations of factors influencing the learning of the visitor. In this research we chose to focus on 9 of the12 key factors. For example: motivation and expectations; prior knowledge; choice and control; orientation to the physical space.
In CCA contexts are defined as social (scientific, professional and life-world) practices. Incorporating a typical CCA-context in lessons confronts students with authentic materials and activities in which biological knowledge is used. These lessons provide opportunities to learn key concepts, and to increase conceptual coherence. The lesson unit stimulates active learning and enhances motivation by providing opportunities for free choice.
The research question is: What characteristics of a lesson unit for use in the zoo contribute to an increase in various types of coherence in the thinking of students in secondary education?
Data were the lesson unit, observations of and interviews with 7 teachers and 165 pupils of 6 classes, pre-and post-tests, products and school test results of students. In a complete sequence of sentences a student says that she sees something, tells how she interprets it and then argues aloud about this interpretation.
Analysis of 500 sequences indicates that students generally use biological concepts accurately. The emotional expressions of students were regularly positive. Students were often able to take a scientific look at the zoo animals. They were intrinsically motivated; motivators were the authenticity of the assignment, the freedom during the visit and the free choice of an animal for the assignment.
Conclusion: the lesson unit is very useful and strongly enhances the motivation and the biological thinking of students. The combination of the CML and the CCA offers a firm foundation for educational design research in a learning environment outside school.

68 Developing a competence test in biology

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The presentation aims to give insight into the quality assurance process of developing items for a competence test in Biology. The data base of 3326 German 10th grade-students in 158 classes will be analyzed regarding the testability of the items which goes along with presenting the 'good' and 'bad' items and the dimensionality of the construct.
Since recent results from international large scale assessment studies, a paradigm shift to competence-orientated learning and instruction can be observed in Germany. As a consequence, Educational Standards for the school subjects Physics, Chemistry and Biology have been publicized. Furthermore, research and theoretical discussion aims to define the components of competence in Biology. The Educational Standards divide competence in Science – and thus also in Biology – into the four sub-dimensions 'content knowledge', 'acquirement of knowledge', 'evaluation & judgement' and 'communication'. The differentiation between "content knowledge" and "acquirement of knowledge" goes along with the classification of knowledge into declarative and process knowledge in Educational Psychology.
The test items for the Educational Standards are being developed by the German Institute for Educational Progress (IQB). A thorough description of the quality assurance process of developing the test instruments will be presented. The items constructed during the first phase of the project (147 items on 'content knowledge', 121 items on 'acquirement of knowledge') have been piloted in autumn 2009. Using the data of 3326 10th grade students enrolled in 158 schools in Germany, IRT-analysis will reveal 'good' and 'bad' items regarding the competence test. Some example items will be shown in order to explain the difficulties and the chances for improvement.
To come full circle, a structural equation model in order to survey the dimensionality will be applied. It will be shown whether competence in Biology can be seen as two-dimensional, the sub-dimensions being 'content knowledge' and 'acquirement of knowledge', or one-dimensional. Explorative analyses on an adult sample showed first evidence for a two-dimensional model.

69 What can teachers learn in an open enquiry-based learning environment? The development of pedagogicalcontent knowledge (PCK) through "Lernwerkstätten" in science teaching.

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Interviews with teachers and teacher trainers in specially adopted learning environments for enquiry-based learning - the so called Lernwerkstätten - at universities and schools in Austria, Germany and Switzerland are carried out. The here presented data from the interviews focus on Professional Development aspects that can be obtained through working in such a setting. This investigation is the first part of a bigger project in which evidence based teacher training models, with an enquiry-based learning setting (Lernwerkstätten), for science classes are developed.
The intention of this paper is to show the potentials of professional development for teachers in open, self directed enquiry-based learning environments (Lernwerkstätten). We analyse the data reported by teacher trainers and teachers regarding their experiences with the learning options in such a setting. Because many Lernwerkstätten are situated in primary schools or in primary school teacher education they are not focused specially on science. In a second analysis step we therefore will focus now on the findings that can be specially related to science (biology, chemistry or physics) teaching.
In our research we follow the concept of Pedagogical Content Knowledge (PCK) from Park & Oliver (2008).
Experts from Lernwerkstätten in eight different universities and four schools in Austria, Germany and Switzerland have been interviewed
The collected data are audiotaped, transliterated and analysed via the Qualitative Content Analysis (MAYRING 2003) using, among others, the PCK domains as deductive categories.
Results will be outlined in a case study (Yin 2003).
First findings show that the work in Lernwerkstätten provide different Professional Development options for teachers. Although the domains for the development of Pedagogical Content Knowledge can be found in the interviews and often are described as important learning options, little data can be explicitly related to science learning.
To make these ties towards the content more visible we are now going to analyse triangulation data and carry out further interviews.

70 Slowmation animation: Highlighting pre-service biology teacher conceptual change

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This paper is an exploration of conceptual change. It reports on a project which explores the unique contribution of *Slowmation Animation* in the conceptual learning of pre-service biology teachers. 10 short animations were created by 35 participants in a single two hour class lesson as a part of their methods training.

The focus of the paper is the conceptual change that was found to occur in all groups when the animation topic challenged the understandings of the processes within the biological concept. A digital recorder was placed in the centre of the work space for each group in order to record the conversations as they created their animations. These recordings were later transcribed for analysis. Additional data collected was in the form of planning artefacts and a completed video from each group, and a video recording of each group's verbal explanation of their video to the class.

The results show that the pre-service biology teachers were enthusiastic for *Slowmation Animation* as a method for learning how to learn, as well as for highlighting what they thought they knew, but didn't really know. Conceptual change was evident when the pre-service biology teacher becomes dissatisfied with their conception and representation of a concept. Indicators of dissatisfaction were found to be intelligibility, plausibility, and fruitfulness. The dissatisfaction led to conceptual change sufficient to build enough confidence to take over a class and present the topic without any planning. On the other hand, dissatisfaction may in fact highlight further gaps in the pre-service teacher's knowledge preventing them from achieving a level of confidence sufficient to teach the topic. Further research is needed to assist pre-service biology teachers to recognise dissatisfaction and cope with conceptual change in order to reduce the impact of gaps in their knowledge. Further research is also needed in supporting pre-service "to critically evaluate and communicate their scientific ideas with others" (Songer, 2007, p.464) during the use of ICT's.

72 Comprehending species interactions through computer simulations

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Students' reasoning about species interactions is characterized by a simplistic understanding of causality and of the systemic nature of interactions taking place within complex systems such as food webs. Students cannot grasp complex interactions, as the effect of a disturbance through different branches of a food web, or the feedback effects taking place in interactions between populations. Within the present study we evaluated the effectiveness of computer simulations in improving students' comprehension of the nature of species interactions. The sample consisted of 57 students of the Department of Educational Studies, University of Cyprus. The learning material included eight activities on species interactions from the software "*Logal Express: Biology Explorer*". The specific software follows the principles of guiding inquiry allowing students to make hypotheses, to run simulations and to reflect on their findings. Data were collected through the use of tests completed by the students before and after the learning intervention. The test included three tasks asking from students to predict the consequences of population changes in different foodwebs. The correct answers to the tasks should, in all cases, be based on the comprehension of the feedback mechanisms that characterize species interactions and result, after the end of a disturbance, in the establishment of a balanced situation between the interacting species. Results showed that students' comprehension of the nature of species interactions increased after the implementation of the learning activities. an important percentage of students were able, after the implementation of the learning activities, to describe effectively the feedback mechanisms and their regulation effect. Despite the improvement recorded, an important part of the participating students continue to give rather simplistic answers after the learning activities. However, we believe that the proposed learning procedure could be regarded as a pilot study of the possible validity of computer simulations on improving students' comprehension of species interactions and of ecological processes in general.

73 Inquiry based biology teaching in ecology

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This paper will present and discuss experiences from Inquiry Based Biology Teaching(IBBT) methods used in ecology in a Swedish upper secondary school during the spring 2008.14 students aged 17-19 participated in the 8 week long project. A senior secondary teacher is followed as she initiates using IBBT methods. The teacher taught the same topics in a parallel class using Direct Biology Teaching (DBT) methods to serve as a control group.
Each IBBT lesson was a complete unit on an ecological topic. In every unit, did groups of students construct and carry out authentic experiment- and observation-studies; to find evidence that could support a claim in context to the ecological topic studied. All lessons were mainly carried out outdoor whereas some analysis of data and experiments were completed indoor. In the end did the students interpret and discuss their findings in context to some environmental problems.
The focus of the paper is benefits and challenges for teachers using IBBT including students understanding of ecology and their motivation.
The teacher's field notes of student activities and her own experiences during planning and conducting the project were interpreted to evaluate her experiences from conducting IBBT. A subject based test was administered to investigate student learning gains. A questionnaire based on Intrinsic Motivation Inventory (IMI) including open comments, was administered to assess participants' subjective experience from the teaching method.
The teachers' field notes showed that IBBT allowed her to spend more time on being a guide instead of lecturing. This also allowed her to differentiate her teaching to each student individual needs. A challenge for the teacher was the increased time needed for planning and practical preparing before each lesson compared to DBT. The results from the subject test showed similar learning gains from IBBT methods compared to DBT methods. Results from the IMI indicated a positive effect from IBBT on motivation and interest in biology, a finding also supported from the open comments by students.
The results from this study indicate that IBBT has a positive affect on students' biology understanding and students' attitudes to and interest in biology. The conclusion based on the teachers evaluation is that it is realistic for teachers to do IBBT and that benefits outweigh the possible challenges. The overall conclusion is that IBBT is a successful teaching method to provide students with scientific competences including elements in knowledge and skills, all of which are needed for lifelong learning.

75 Elementary school pupils knowledge and attitudes toward butterflies and mosquitoes

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The purpose of this study is to compare attitudes and knowledge about the mosquito and the butterfly among elementary school pupils from Slovakia and the Czech Republic. In this study a mosquito is considered to be an unpopular / unsympathetic animal and a butterfly is considered to be a popular or sympathetic animal among people. The number of similar studies is constantly increasing.

Mosquitoes and butterflies are common animals occurring in the area of human habitations. Mosquitoes are generally considered to be harmful animals, which suck blood and leave itchy red bumps. Most people do not see any importance in this kind of animal, as they always kill them without thinking about the

mosquitos' significance. On the other hand, there is another group of animals called butterflies. People are evaluating these animals as more positive in comparison with mosquitoes. This is probably caused by the more colored wings of butterflies. Due to this attribute butterflies are caught by collectors. This activity has caused some species to be endangered and some have disappeared from Slovakia and the Czech Republic.

We were interested in knowledge and attitudes of butterflies and mosquitoes among elementary school pupils. We focused on finding differences between gender and residence of respondents. In total, we received filled questionnaires from 614 elementary school pupils from all grades of lower secondary basic education (according to ISCED). The age of pupils was between 10 of 15 ($x = 12.62$; $SD = 1.39$). More respondents were from towns ($n = 423$) and the proportion between girls and boys was similar. Boys created 51.47 % ($n = 316$) and girls created rest of sample ($n = 298$).

We used a Butterfly-Mosquito Attitude Questionnaire (BMAQ), which contained 78 Likert type items, 39 for butterfly and 39 for mosquito. On the statistical evaluation, factor analysis was used which divided items in to three dimensions for each animal. Paired t-test was used next, for finding differences between children's attitudes and knowledge toward butterfly and mosquito.

By use of paired t-test we found pupils had better knowledge and attitudes toward butterflies in comparison with mosquitoes.

77 Learning about adaptations of animals at the zoo - results of an empirical study

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The aim of the study was to evaluate cognitive achievement and emotional variables of different forms of instruction by using self-report questionnaires and paper-pencil-tests in the zoological garden of Bernburg (Germany, Saxony-Anhalt).
It examines the following forms of instruction:

- Group-based work (learner-centred) with the evaluation by pupils (peer-tutoring)
- Group-based work (learner-centred) with the evaluation by teacher and pupils
- Presentation of learning content by teacher (teacher-centred) in the form of a tour through the zoo.

750 pupils of the fifth and sixth grade (10 to 13 years of age) participated in this study (375 pupils of secondary school and 375 pupils of secondary modern school).
The focus of the paper is the question whether a teacher-centred "tour through the zoo" is more effective in terms of learning and retention than a learner-centred, group-based work following the self-determination theory Deci & Ryan (1985). So far there are no surveys on the short-term and long-term success of these cognitive forms of education at the zoo. In addition, two forms of learner-based instructions were tested: group-based work followed by peer-tutoring and group-based work followed by a teacher-centred instructional part.
The assignment of the classes to the different treatments was randomized. The pupils work in groups and they are dealing with the following worksheets: vervet monkey as a representative of mammals, mallard as a representative of birds and chameleon as a representative of reptiles. The choice of the animals was based on the optimal observation possibilities and of their adequacy to their habitat. The division of groups within a class was also randomized.
The data were collected using paper and pencil test. The cognitive evaluation divided into pretest, posttest and follow-up test. Emotional factors, such as interest, physical well-being and boredom will be based on a state questionnaire with multiple choice items and open items (situational emotions).
The study was completed in November 2009. In January 2010 the first results of the empirical study are available.
This empirical study contributes to the teaching at zoo as a place of learning more effective.
The results of the study will be exerting influence in the design of teaching at zoo as a place of learning.

References

Deci, E. L., & Ryan, R. M. (1985). Intrinsic motivation and self-determination in human behavior. New York: Plenum.

87 HIV/AIDS education in Malawian secondary schools: are the pupils' needs being addressed?

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HIV/AIDS education was introduced in Malawian secondary schools through Life Skills education in order to provide for open discussions among teachers and provide an environment for the development of social skills which would help pupils to avoid being infected by and spreading HIV. There was therefore a need to examine the extent to which the pupils felt and believed that their needs were being met through classroom teaching activities.

There was concern among secondary school adolescents regarding lack of openness in the teachers of HIV/AIDS education and among themselves, and the irresponsible approach to discussing sensitive issues surrounding HIV/AIDS among peers. Pupils felt that were not HIV/AIDS issues were not being discussed openly. According to them, teachers were not opening up issues to do with HIV/AIDS transmission, prevention, and care of the HIV/AIDS victims. In some cases teachers felt compelled to maintain the cultural norm which restrained them from tackling what were considered culturally sensitive issues. In others, school specific policies and the unwritten but understood policy from the Ministry of Education that prevented them from tackling issues of a sensitive nature, particularly the use of a condom. Although most pupils felt that this lack of openness among themselves being accentuated by the deficiency of the same in their teachers, classroom observation and interviews with both teachers and pupils seemed also to implicate the absence ground rules to ensure open classroom discussions.

These findings suggest that there is need to identify HIV/AIDS education teachers that are willing and able to rise above cultural constraints. Further it appears appropriate for the Ministry to make its policy on the use of the condom, or discussions on the same in the classrooms explicit. There is also need to have HIV/AIDS education specific ground rules in order to facilitate open classroom discussions. Further the Ministry should consider appropriate policies which should be put in place on how best schools to can link up and use referral services where pupils can obtain additional help.

80 How to help pupils to change their questioning to build up biological problems?

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The data of our research were collected in a class of 11-12-year-old pupils (grade 6) and a class of 15-16-year-old pupils (grade 10) whose teachers are associated to the researches conducted by our teams. Our reasearch try to understand how change the questioning of pupils (Schneeberger & Dhouibi, 2006; Lhoste, 2008) in session which plan moment classroom-debate in science. For the class of grade 6, the collection of data took place during a sequence involving 23 pupils (from January till March 2009). For the fifth year of high school, data concern several sessions (from March till June 2009) of practical class in half group (15 pupils) and course in whole class (30 pupils).

The various sessions of two sequences which we observed were recorded and retranscribed. The analysis of the contents of the linguistic interactions during these sessions shows how linguistic displacements take place, from successive reformulations of pupils and the teacher. It also allows to locate the role of the teacher in the orientation of the exchanges, the teachers' speech acts which are analysed in terms of "inductor of problem building" (according to the propositions of Fabre and Musquer, on 2009). The hole corpus is more important than the one we are going to exploit in a systematic way for this communication. We also use teachers' interviews to make them clarify their intentions during the interventions.

Following the studies conducted by Schneeberger *et al.* (2007) and Rebière, Schneeberger & Jaubert (2009), this contribution aims to understand how and in which conditions teachers' speech acts can help pupils to change their questioning showing their involvement in a problem building.

From examples observed in classes of various levels on different biological topics (recycling organic matter in the ecosystems in a class of 11-12-year-old; supply of dioxygene in the body in a class of 15-16-year-old), we will examine how the teacher use the confrontation of pupils' proposals to change their questioning and modify their biological points of view.

To test Fabre's and Musquer's hypothesis, we could study the fruitfulness of the idea of "inductor of problem building". We highlighted a variability in teachers' speech acts according to the level of the class and the moment of the lesson. That enables us to modify our questions concerning the process of problem defining in biology class, for example: to change their problematic, to increase the level in abstraction which characterizes any activity of scientific knowledge's construction.

81 Teaching time, and approaches to teaching and learning; The post 16 Nuffield Biology and Salters Nuffield Advanced Biology experience

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UNITED KINGDOM

Two questionnaire surveys were completed by teachers responsible for teaching biology to academically able 16-19 year olds studying innovative advanced level biology curricula; Nuffield A-level Biology (Nf) and Salters Nuffield Advanced Biology (SNAB). The research questions addressed issues of curriculum teaching time and approaches to teaching and learning in the two courses. The SNAB course replaced the Nf course in 2000 and from September 2008 was itself combined with a more traditional curriculum. The surveys were carried out, using identical questionnaires, in the final years of the independent existence of the curricula; Nf in 1997, SNAB in 2008. This paper reports on the findings arising from these studies which suggest that time for teaching advanced level courses has reduced and that teaching groups are larger. The balance in time spent on teaching theory and practical work is very different for the two courses with the SNAB course showing a pattern similar to that of traditional courses surveyed in 1997. Fieldwork opportunities were less frequently offered by SNAB teachers but they made more use of technology in their teaching.

27 "Questions in Biology" – A strategy designed to promote students questioning

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This paper reports data from an online discussion forum carried out in the context of a curricular unit about *Evolution* taught to eighty biology undergraduate students at the Biology Department of the University of Aveiro. The "Questions in Biology" strategy, was developed and implemented in collaboration with one Biology teacher during the second semester of two schoolyears, 2007/2008 and 2008/2009. The main aim of this student-centered strategy was the promotion of undergraduates' questioning practices, since a true spirit of inquiry can improve the quality of teaching and learning (Chin & Osborne, 2008).

The first part of this report describes the strategy design in particular the definition of students' questioning assessment criteria.

Besides collecting all questions formulated in the online forum, data was gathered by: i) observation (non-participant) and audio-taping all curricular unit lessons and ii) interviewing some student in each schoolyear (semi-structured interviews).

Empirical data will be discussed considering the main characteristics of students' questions, throughout each semester, in the "Questions in Biology" learning contexts. Particular relevance will be given to: (1) students' questions (and other practices) leading to changes of the strategy design at the beginning of the second year (2008/2009) and (2) quality improvement indicators of students' questions. Alignment between teaching-learning strategies and kind of assessment will also be taken into account.

The analysis of all students' questions is still being undertaken. However, some indicators have already been identified pointing clear benefits of this strategy in the present context of Higher Education, based on the acquisition of competences by students.

86 On the methods of teaching integrated science in the middle school years

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GEORGIA

We report on the advantage of integrating teaching of biology and physics as compared to the teaching physics and biology as discrete units in the middle school. Experimental group (EG) had a lesson integrating knowledge of physics and biology, while control group (CG) had discrete lessons in physics and biology, referring each to their specific topics The competence of the EG and CG in finding connections between the physical and biological phenomena has been measured by the use of school standard rating system.

The study was aimed at finding out if integrated teaching of physics and biology in the 7-th grade helps pupils in better understanding of interconnections between physical forces and structure of animal body as compared to the teaching of physics and biology as discrete units. The topic under class discussion was an adaptation of animals to the earth gravity. EG observed the feet of elephant and blue heron, as well as a hoof of a camel. EG was informed, that heron has a small mass and elephant has a large foot and this keeps them from sinking in the mud, while large hoof of a camel keeps it from sinking in the sand. At the same lesson, EG conducted experiments to find out how things of different mass and surface area are sinking in the flour and analyzed data in terms of the gravity, mass and weight.

CG was involved in the same activity. However at the biology lesson pupils observed the feet and a hoof of animals and have been informed about adaptation to the walk in the mud and sand, while gravitation experiments were conducted at the lesson of physics and appropriate data analysis in terms of gravity, mass and weight was provided.

In the final stage of the research, EG and CG were requested to write an assay to explain the way gravitation, mass and weight influence the formation of a structure of animal body. Answers were assessed by standard grading system ranging from Fail (bellow 50) to A (94 - 100). EG predominated over the control group in the precise interpretation of adaptation of animals to walk in the mud and sand. Presumably, integrated teaching of physics and biology helped pupils in better understanding of interconnections between physical forces and formation of the structure of living things.

88 Students' attitudes towards science while studying biology: The incidence of the behavioural component.

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Attitudes towards science and science class has been a broad research field since its emergence during the 60' (Simpson, Koballa, Oliver, & Crawley, 1994) and has become a crucial field since the current lack of vocational scientific studies (European Commission, 2004).
Attitudes are defined by many as including the three components: a knowledge about the object, the beliefs, ideas component (Cognitive); a feeling about the object, like or dislike component (Affective); and a tendency-towards-action, the objective component (Behavioural).
Our research focuses on the impact of both the behavioural and the cognitive component (while studying human biology and their intention of studying science in the future, respectively) on the affective component. In detail, our research questions are the following:
- Which are 15 years-old students' attitudes toward science while studying biology?
- In which affective component aspects do the behavioural and the cognitive components influence?
- In which way the behavioural component is affected by de cognitive component?
Data were drawn from 358 students (160 girls and 198 boys) from 10 Secondary School from Barcelona using a part of the ROSE questionnaire (Schreiner & Sjøberg, 2004). Data were statistically analyzed using ANOVA ($p \leq 0, 05$).
Briefly, results show:
- Students' attitude towards science class while studying human biology are in general, more positive than others obtained with the same instrument while opinions regarding the importance of Science and Technology in the society and their professional future aspiration are the expected (Schreiner, 2006). Thus, the cognitive component has a different impact on the specifically affective component aspects.
- Depending on the behavioural component, affective component differences were detected especially towards science class, but not towards the importance of Science and Technology in the society and their professional future aspiration.
- Behavioural component has a different impact depending on the cognitive component. Comparing these data with other obtained with students studying other scientific disciplines (Marbà-Tallada & Márquez, in press) it is described a different effect: only few affective component differences are detected between the behavioural component while studying physics or chemistry, while a huge impact is described while studying human biology.

91 What do Greek students think about biology?

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Interest, goals and motives have been assigned as major factors that influence learning and academic performance. However, many consider science as boring, difficult and irrelevant to everyday life. Today, there is an adequate amount of literature concerning attitudes towards physics and chemistry but very few studies concerning biology and none concerning Greek students. The key objective of our study is to reveal what Greek students think about biology. For the purpose of our study we conducted a questionnaire of 31 5point Likert-type statements measuring students' views about biology. We grouped the 31 statements as following: a. students' interest for biology (16 items), b. importance of biology in their life (6 items), c. how difficult they find biology courses (9 items).
After a pilot study of the questionnaire that revealed a high degree of reliability of the test scores (Cronbach's alpha= 0,885), it was administered to 258 Greek students: 140 students from the 8th grade (2^{nd} year in the Greek secondary education system) and 118 from the 12^{th} grade (3^{rd} year in the Greek High school). The results revealed that Greek students have a medium to slightly positive opinion for biology. They are neither interested nor indifferent for the course, they find it slightly difficult and tend to think it important for their lives. Independent samples t-test revealed no statistical significant differences ($p>0,05$) among male and female students. The same method was used for all the demographic data from our sample. Measuring students' views regarding biology could help teachers organize better teaching strategies in order to reinforce students' interest to biology as also to help us get a better picture of what students think: a. about biology as a subject, b. biology teaching and learning and c. other dimensions such as the degree to which it affects their decisions for future enrollment in the field.

92 Initial models for elementary students on dental caries

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In this study we have explored the initial models of students from second year of primary school on dental caries and the recognition that the bacteria which interact in this process are living beings. We conducted a didactic sequence of four lessons with a group of 25 students aged between 7 and 8 years old.
The study is aimed at understanding the data explored in the first and last sessions of the didactic unit, where in the first we studied the development of caries and the elements that are related to it and in the last we recapitulated all that has been studied besides comparing two organisms, bacteria and rabbit, based on systemic networks. The material analyzed is mainly based on drawings and texts made by students to find out what information and connections are identified in the process of appearance and development of caries, in addition to examining changes in the initial model starts in a didactic intervention.
The methodology applied in this study is based on the collection of student productions in the audio recordings of conversations and a KPSI questionnaire beginning and ending the entire unit in order to obtain the initial models and ideas that are not explicit in the productions, as well as identify the possible conceptual advances in knowledge construction.
The results show how students are able to identify a variety of elements related to caries such as candy and bacteria even though they at first called them "bug", as well as external agents such as a visit to a dentist and the financial factor involved. The students also present in their drawings some process of connection such as the sweet starting the onset of caries and bacteria by destroying the tooth. At the end of the teaching unit the students understand and demonstrate that the bacterium is a living being and performs the same functions as any other living being but in different way and that the bacterium is constituted by one cell.

93 Connecting school and work placement: An educational design for learning about animal reproduction

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This paper reports on the research-informed design and field test of learning and supervising strategy which aims at connecting learning about animal reproduction in school and work placement. The strategy should effectively address pedagogic problems of work placement identified in a previous study (Mazereeuw et al., forthcoming). An in-depth analysis of these problems based on a theoretical framework resulted first of all in characterizing the intended learning process:

- experiencing a need to know and a sense of direction while engaging in the workplace, i.e., being aware of what ultimately counts in the workplace (e.g. farm profits);
- reflecting on the relation between the workplace and prior experiences, on actions engaged in, and on meanings of vocabulary words used in different practices (school and work);
- Ultimately, crossing the 'zone of proximal development', so as to use theoretical knowledge in practice and vice versa.

Five trainees and their supervisors will be followed at their trainee posts, while subjected to 'prescribed' and justified pedagogic measures to put the intended learning process into practice. These case studies will include the following research activities: content analysis of logs made by trainees and supervisors, work placement reports and of fieldnotes taken during one-day participant observation of workplace activities. Besides this, interviews with trainees based on completion of an assignment in the workplace and interviews with supervisors based on the outcomes of these assignments will be held. The case studies will be carried out next Spring. Similarities and differences between the intended and actual learning processes and outcomes should identify design criteria for effectively connecting school and work placement. Data analysis will be completed next May. Results and implications for educational design will be presented and discussed at the conference.

31 Students' discussions about socio-scientific issues (ISS): Kind of arguments and scientific knowledge, beliefs and values on which the students argue to defend or attack some positions.

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Taking in consideration that school has to contribute students became competent for having reasoned opinions and for taking decisions on socio-scientific issues (SSI), the development of argumentative skills of students has to be an aim of school. Related to socio-scientific issues, opinions and decisions are related to scientific knowledge but also to beliefs and values shared by people. Our general interest is to contribute elements to a science education that integrate moral and ethical values and beliefs linked to socio-cultural environment in the building of scientific knowledge. In the specific study we present here, the propose is collecting information from students' written answers to some questions and students' discussions arguing about socio-scientific issues (SSI) in order to know about kind of arguments and scientific knowledge, beliefs and values based on which students argue to defend or attack some positions. The topic of discussions is Human Reproduction and biotechnology. The group class was of 50 students aged from 16-18 years old. They were divided into groups of four students and every group discussed about three cases related to human reproduction and biotechnology. For the analysis of written responses the technique of systemic networks is used, and for the analysis of the discussions we identified arguments and categorized them according our theoretical framework. The main conclusion of this study is that students' arguments are mainly based on opinions or beliefs more than on scientific knowledge, which coincide with what occurs commonly in everyday contexts discussions.

94 Identifying and describing students competencies during experimentation in science

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The presented poster gives a short overview over a planned explorative video study for secondary schools. Coming fall, October 2009, students aged 10 to 11 (7th grade) and 13 to 14 (9th grade) will be grouped as a couple. They will be video and audio recorded while carrying out a problem-oriented and authentic investigation task. A taxonomy of practical skills will be essential for a qualitative video and audio analysis a well as an evaluation of students written reports.

The study concentrates on the relation between scientific inquiry competencies and the practical realization of experiments in a performance assessment with biological tasks. In order to improve the summative and/or formative implementation of such hands-on assessments short and inexpensive tasks were designed. The aim is to obtain information on competencies and skills which are used by students during experimentation in a problem-solving process. One assumption is that practical investigation skills are influenced by expert knowledge, higher-order thinking skills and students' methodical knowledge of science work.

The qualitative pilot study includes the video and audio recording of students which perform a biological, practical task. In addition, written reports which they carry out during the experiment are part of the study. The qualitative reporting and analyzing are done with Videograph and MAXQDA, as well as with an approach for qualitative content analysis. The video technology allows the recording of each process during a science hands-on investigation as well as a repeated analysis of those inquiry processes.

The video and audio findings allow to describe inquiry skills or experimental competencies and to interpret the practical tasks. Based on results, the theoretical taxonomy of competencies can be revised in terms of scientific inquiry. Accordingly, a relation between scientific methods of practical operations and higher-order thinking skills can be expected. First results of the pilot video study as well as the categorization system of practical skills will be presented at ERIDOB.

97 *Case Method of Teaching* to promote cross-linked thinking in the master of education

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This paper aims at introducing the concept of an intervention study in Master student's ability of cross-linked thinking. The module "Fachbezogenes Unterrichten", which prepares students for their future employment as a biology teacher, will be *intervened* on the basis of video-based teaching cases.

The model of cognitive complexity by Schroder et al. (1975) serves as the theoretical background of the study. It distinguishes three components, discrimination, differentiation and integration, which again represent different aspects of cross-linked thinking.

The video cases show teaching situations that are specifically designed and generated for the module "Fachbezogenes Unterrichten" in order to promote the student's capability to think in a cross-linked way. Their focus will be on problems dealing with pedagogical content knowledge. The biological topic of the video sequences will be about plants and plant physiology.

The intervention's effectiveness will be controlled by using a two-group pre/post-test design. The intervention and the test will be carried out between April 2010 and April 2011 with the main focus laying on the comparison of the intervention group and the control group with regard to their ability of cross-linked thinking. Whereas the measurement of discrimination and differentiation will be conducted according to Möller (1999), the student's ability of integrating different dimensions will be evaluated on the basis of qualitative text analysis.

The results of the intervention group are expected to be available in October 2010. Those containing a comparison between the intervention group and the control group will be on hand in April 2011.

98 Lessons with living harvest mice – an empirical study on motivational and cognitive learning effects

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Biology education with living animals is supposed to enhance knowledge acquisition and intrinsic motivation (Köhler, 2004). Surprisingly, there is hardly any empirical evidence for these advantages for the lack of current studies (Klingenberg, 2008). In this study the possible benefit of living Eurasian harvest mice compared to films on laptops was evaluated. Living mice offer learners more challenges and more opportunities for interaction than secondary experiences (films on laptops). Thus, their perception of competence and autonomy might be supported. Since these are the most important basic needs for learners (Deci & Ryan, 2000) their intrinsic motivation might increase as well. Furthermore, a set of lessons with living animals might provide a better constructivist learning environment than films on laptops. In particular the active and emotional dimensions of Reinmann and Mandl's (2006) process characteristics might be fulfilled.

Our research question reads as follows. Is the use of living animals in science education beneficial for knowledge acquisition and intrinsic motivation?

In a pre/posttest design 185 5th graders of the highest stratification level were subdivided into an experimental group (N=74) taught with living harvest mice and a control group (N=111) taught with films on laptops. The knowledge acquisition was tested with a set of closed and open ended items (Cronbachs Alpha =.703) while the intrinsic motivation was tested with KIM (*interest/enjoyment* α = .855; *perceived competence* α= .727; *perceived choice* α =.609; cf. KIM: Kurzskala Intrinsischer Motivation, = short scale of intrinsic motivation, Wilde et al., 2009).

Results: Despite our hypothesis films on laptops showed to be equally effective on conceptual outcomes as living animals. In accordance with the hypothesis, intrinsic motivation was enhanced by the primary experiences.

103 The influence of teachers' content and pedagogical content knowledge on the development of students' system competence in biology

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System competence includes cognitive, motivational, and volitional skills to solve problems by considering the objects as a system. Empirical studies show that students' system competence varies among classes of the same grade taught by different teachers. In fact, several studies point out that teachers' professional knowledge influences the development of students' competence. The goal of this study is to analyse the impact of teachers' content knowledge and pedagogical content knowledge on the development of students' system competence in biology.
Eighth grade students and their biology teachers will be tested in a pre-post test design of a quantifiable field study. In one part of the study, the development of students' system competence will be analyzed, monitoring the teachers' influence. In the second part of the study the teachers' influence will be varied. Biology teachers will instruct their own students. Measuring instruments will be developed within the framework of this study. Data collection will be realized via concept mapping, multiple-choice items, and open questions. Furthermore, the IST 2000 R and the KFT 4-12 +R will be used to validate the measuring instruments.
Biology is the science of living systems. Therefore, the systematic view is part of biology education for all ages. Currently, there are only few empirical data on teachers' influence on the development of students' system competence in science. Therefore, the results of this study should point to the causal relations that influence the development of system competence.

104 Does knowledge of nature of science (NOS) improve prospective teacher skills in constructing and performing open inquiry lessons to meet scientific educational standards?

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International and national educational standards emphasize the importance to teach the knowledge of basic scientific skills as well as a basic knowledge of what science is and how it works, the so-called nature of science (NOS). Inquiry-based lessons are a good way to provide students with such knowledge, since students are supposed to actively use the same methods as scientists do and thus learn about scientific thinking and working processes.
However, recent studies imply that inquiry-based lessons often fail to transfer scientific knowledge. This may be, because the instruction of such lessons requires a profound knowledge of science, since teachers must judge school students' ideas, experimental designs and conclusions during a lesson. This is probably very difficult without knowledge of how science works.
Observations at the University of Siegen, Germany, suggest that prospective teachers are basically able to design and conduct inquiry lessons, but fail to transfer essential scientific concepts such as formulating hypotheses and predictions or add a control group to the designed experiments. This deficit may be due to a lack of a profound understanding of the NOS. Thus, we are interested in whether a deeper knowledge of NOS improves prospective teachers' skills to design and conduct inquiry-based scientific lessons in terms of transferring scientific thinking and working processes. In an ongoing study we investigate general NOS beliefs of prospective teachers and evaluate the impact of NOS instruction on designing and conducting inquiry-based lessons. We test the effect by using an intervention study by comparing an experimental group with a control group not participating in the intervention. Additionally, with a pre-post test design we will assess whether our intervention is suitable to impart knowledge of the nature of science.

110 Human population aging in basic education: What do the teachers think?

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In Brazil, since 1960, the phenomenon of human aging following global trends. In the coming decades, the elderly population will increase producing a significant demographic change. This results in a tangle of economic, social, cultural, ideological and psychological, that characterize the overall social relationship, whether family, professional, dedicated to caring for the elderly, the role of women in society, the place for discussing these issues in school, among other things. Due to the special characteristics and peculiar to the old layer of the human population, the Brazilian society faces the challenge to formulate new concepts and models of care, not only of health issue, but about the space occupied in society and in preparation for aging. It is important to understand the aging human population not only as a matter for public health, but as an educational topic. Therefore, basic education is presented as the axis for discussion, given that aging is irreversible and unavoidable, and its approach is relevant in the classroom. This study aimed to identify the teachers' perception about the aging human population and its environmental consequences. This is a qualitative action research, which analyzed the responses from the application of a questionnaire to teachers of basic education in a group study of a town board of education**.** The results indicated that teachers have a confused view on longevity and life expectancy; they connect education with topics that extend the understanding of aging to improve the life's quality; it prepares for life, it receives little attention in class, usually restricted to the health aspects (food, lifestyle and exercise. Added to this the way the question appears in the textbooks, especially in a superficial and short. The organization of the curriculum in disciplines makes it difficult to approach, considering the interdisciplinary nature of the subject. Given this, the findings of this research indicated that some deepening of the 'human aging' occurs, in part, by the lack of discussion of materials and teacher support manuals and textbooks, among others, as well as the processes of training and continued. In view of this, it is proposed the insertion of human aging issue in the initial training of all teacher education programs to further the continuing education.

111 Promoting 'quality interactions' through questioning - a case study with a biology undergraduate course

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The study reported here is part of a larger naturalistic research program started ten years ago at the University of Aveiro, Portugal. The main goal is the study of questioning processes and their role to improve teaching and learning in higher education (Pedrosa-de-Jesus & Moreira, 2008). Four biology Professors, teaching undergraduate students are collaborating with our research group, since 2007. The most recent line of research has been focused on how teachers deal with classroom questioning, considering their global preferential teaching approach. According to Trigwell and co-workers there are two, context dependent, 'ways' academics go about teaching: ITTF (Information Transmission Teacher Focused) or CCSF (Conceptual Change student Focused). Their preferences can be identified by using the Approaches to Teaching Inventory – ATI (Trigwell, Prosser & Ginns, 2005).
The preferential teaching approach of the Professors involved was first identified through the administration of a validated Portuguese translation of the ATI (Pedrosa-de-Jesus, da Silva Lopes & Watts, 2009a), at the beginning of the academic year 2007-2008. In order to better characterise each Professor's teaching approach, in particular his questioning practices, each of them was followed during one semester in one curricular unit by (i) observing and taping ten lectures (non-participant observation), (ii) taking field notes of every meeting held and (iii) conducting two semi-structured interviews on the beginning and at the end of the semester.
First results indicate that Professors with distinct teaching approaches indeed have different questioning practices and influence students' questioning behaviour (Pedrosa-de-Jesus, da Silva Lopes & Watts, 2009b).
This paper aims at exploring the questioning practices of one University Professor, identified as being more ´CCSF', since students tended to intervene more often with this teaching approach. It will also be presented and discussed data showing teacher-students interactions gathered from a curricular unit dealing with *Evolution*, in two different learning contexts (traditional lectures and online discussion forum 'questions in biology').
It is believed that this case provides important insights for biology teachers, in particular those teaching undergraduates, having into account their questioning practices and the way they encourage students' thinking.

112 Using students own observations to enhance the interest in biology – a model for combining cognitive and affective sides of learning

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This paper presents some theoretical considerations on a study of interest development in science education among students in upper secondary school. The purpose of the study is to present new angles in to the science lessons in order to make the students more interested in science.
The paper presents a model for developing and planning lessons in science education. This model is developed with inspiration from the French Theory of Didatical Situations (TDS) which is an empirical tested theory for mathematics education. The model also contains elements from the motivational Self-Determination Theory (SDT) and the person-object interest development theory (POI). This paper combines some of the aspects of TDS with these motivational (SDT) and interest developmental (POI) theories and thereby introduces a tool for science education that takes into account both the cognitive and the affective sides of students learning in science education. In this paper the focus and examples will be within the teaching of biology. The key point in this model is the use of the students own observations in science classes. The argues that there is to little focus on proper observation skills in science education, and that this could be improved by focusing more on observation training By teaching the students to observe in a more scientific way one also gets the opportunity to give the students epistemological experiences in science education that triggers both the cognitive and the affective sides of the students. Since this is a work in progress there is no results to present by now, but the theoretical considerations are exemplified with a proposal for use of the model in primary school.

114 Transition from primary to secondary school as well as the transitions between biological subjects – an interview based study

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School has an effect on pupils' self-development and the development of attitudes towards school and towards learning natural sciences (Weinert & Helmke 1997). Transitions often cause emotional problems for learners (Büchner & Koch 2002). Previous studies illustrated the influences of the methodical design of education in Germany on learners' perceptions (Kleine & Vogt 2003) but didn't pay attention to the question how Biology as a discipline is constituted and perceived.

The main focus of this report is the percipience of the transitions between primary school to secondary school and between the different subjects "Sachunterricht" (1st to 4th grade), Natural Sciences (5th and 6th grade) and Biology (from 7th grade) in Berlin. Another central aspect is the general importance of the topic biology within these subjects. Biology is the natural science which deals with animated beings, their inimitable character and uses specific methods of the attainment of scientific knowledge (KMK 2004). These aspects are requirements of the educational standards in Germany to the subject Biology.

Following research questions form the basis of this study:

- Which position has the Biology as a discipline as part of "Sachunterricht", Natural Sciences and Biology from a learners point of view?
- How do learners experience the transitions from primary to secondary school as well as the transition of the subjects "Sachunterricht", Natural Sciences and Biology?

A group of thirteen selected pupils from four different primary schools in Berlin were interviewed pre and past the transition from primary school to secondary school. They had different attitudes towards school and towards different biological subjects. Furthermore their attitude developments within the three years longitudinal study were variable.

The interviews were arranged within a structured guideline. The children were 4th graders and 6th graders (9 to 12 years of age) - because in Berlin after both grades transitions appear. Besides transitions occur between the subjects "Sachunterricht" and Natural Sciences after grade 4, and after grade 6 between the subjects Natural Science and Biology.

The interviews were recorded, transliterated and edited. Actually the edited data are analyzed with MAXQDA. The analyses will be completed in winter 2009.

158 The model of digestion: Negotiating scripts for a theatrical performance

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The aim of this study is to analyze the difficulties of reading and writing that 19 students of 6 º of Primary school have when they have to write the script of the theatrical representation: The digestion.

Our main research questions are the following:

What difficulties do students when reading texts biology? What kind of texts are the students capable of elaborating from their readings? In which way does the theatrical representation help to reconsider the scripts and to build a model of digestion?

We work with a class, 12 pupils of 6 year of primary school (12 years old), the University teachers have a collaboration with this school since two years. The University teachers go periodically to the Primary classroom and work with the teachers and the learners.

The pupils were encouraged to make a theatrical representation for the whole school, explaining the digestion of a sandwich, a glass of water, an apple and a piece of chewing gum.

The students elaborated scripts that were discussed by the teachers. The successive scripts were analyzed, classifying the text written by the pupils (narrative, argumentative) and the consistency of the model of digestive system (which elements were related and in which way). The pupils also had to design the sets. The discussions were recorded and the final representation was videotaped.

In the first script, the pupils just copy passages of the texts, narrate the road that the different food follows before reaching to the colon. They use scientific terms they are not able to explain and do not establish relationships between concepts, as reflected in his writing.

The play helped to develop not only knowledge but also to develop language. Having to produce a text for two different audiences took the students to debate between using “academic” vocabulary or a more everyday vocabulary.

Overall we found that they were more concerned with writing "academic" scripts, influenced by the texts were consulted, that with making a play accessible to all audiences.

115 Inquiry learning in life science projects through collaboration of students and scientists

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This paper presents and discusses the working model of the project "Kids Participation in Educational Research" (KiP), which is currently being tested at the Faculty of Life Sciences at the University of Vienna. Fife Biologists invited teachers and students of 10 science classes (grades 5 to 11) to take part in one of the research projects in the fields of neurobiology, environmental research, marine biology, forensic botany and evolutional biology..Data from the qualitative evaluation of the collaboration will be reported.

The paper discusses both how the research concept changes through participation by the students as well as the nature of the students' specific learning processes. The challenge bridging structures for cross-institutional collaboration between two contrary social systems like school and university will be reported, which is highly relevant for sustainable collaboration..

The Research undertaken can be classified as systematic formative evaluation. Data was collected by different methods such as interviews (pre-and post) of representatives of all stakeholders, systematic process observation, field notes, participatory observation and group discussions. The interview data are analysed by qualitative content analyses. Following the idea of participatory action research students are involved in producing, analysing and interpreting data.

First results show different factors promoting and inhibiting collaboration on a personal level between teachers, students and scientists as well as on an institutional level between schools and universities, i.e.

- Epistemology versus transfer of knowledge: Scientists tend to hide their epistemological knowledge and put their emphasis on teaching facts such as the anatomy of a spider.
- Time constraints: Teachers work in a structured time context of lessons whereas scientists spend plenty of time in flexible time-frames.

116 Concretising and evaluating the subject-specific competence profile for biology in teacher education

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In 2008 the Standing Conference of the Ministers of Education and Cultural Affairs of the Länder in the Federal Republic of Germany (KMK) published a new central paper: Common federal requirements with regard to content for sciences and didactics in teacher education (KMK 2008). Subject-specific competence profiles were constructed, which formulate the fundamental skills in each subject. This means that for the first time in Germany also in teacher education binding standards for every subject are claimed and an outcome-orientation in university is going to take place.

This research project deals with the biology-specific competence profile for student teachers. The aim of the study is to substantiate those standards, to develop an instrument to measure student teachers´ competences in the field of didactics of biology and to develop adequate interventions and learning situations to advance the competences of the student teachers. Furthermore the correlations between the students´ assessment of the standards and their own subject-specific competences are explored. Finally, the question is asked which role the processing depth (theory + exercises + practice according to Mayr 2006 and Oser / Oelkers 2001) plays by generating one´s own subject-specific competence.

After concretising the standards and an expert-validation two rounds of data collection take place. First, the knowledge of 250 student teachers concerning the standards, their assessment of the standards and the places where they learned about the standards are investigated using a standardised questionnaire with a Likert scale. In the second round of data collection the operationalising of the standards with tasks is focused, and 600 student teachers of different universities in Germany are tested.

Data thus obtained will provide information about the impact and the outcome of biology teacher education. Furthermore they give insight into the understanding and the successful implementation of the KMK-Standards in different Federal States of Germany and in different universities with distinct structures of teacher studies. As a consequence, the question of whether the structure of the respective university capacitates the students to obtain the subject-specific competence profile in biology can be answered. And last but not least indications are detected to develop interventions and learning situations to foster the competences of the student teachers, because evidence suggests that professional didactic competence improves the quality of their own teaching and of the learning progress of the scholars (Baumert / Kunter 2006; Baumert, Kunter et al. in press; Carpenter / Fennema 1992).

22 Are you SLiM from a biological perspective? Evaluating scientific literacy in media regarding biological terms

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Promoting scientific literacy has been one of the ultimate goals in science education for decades over the world. But how to cultivate individuals' scientific literacy? In school life, textbooks are the central resource to receive knowledge for students, but after school, newspaper becomes one of the main sources. To embrace scientific terms from both of these knowledge resources, an instrument to assess civic scientific literacy in media (SLiM) was developed by mapping media terms from United Daily News in Taiwan and Taiwanese junior high science textbooks in spring 2009. SLiM includes 50 multiple-choice items covering biology (45.26%, 22 items), earth science (37.90%, 19 items), physics (11.58%, 6 items) and chemistry (5.26%, 2 items). From the results of a pilot study conducted in Taiwan, SLiM was shown highly reliability (0.863, KR20). The purpose of this study is to introduce the development of SLiM and also to adopt its 22 biological items in Sweden to evaluate Swedish senior high students' scientific literacy in media regarding the biology subject. A total of 64 Swedish senior high students covering 10^{th} graders (n= 23), 11^{th} graders (n=19) and 12^{th} graders (n=22), were invited to participate into this study. The students were all from the same background of combined science/social science program. The numbers of females were 42 and males were 22. The results indicated that, among whole participants' performance, 10 out of 22 items showed lower percentages of correct answer (rate ≤ 50%), which are all related to daily life context or molecular sciences (i.e. gene). Such as item 1 is about the function of eyeglass is to correct malfunction of the lens in the eye, and only 25% of students answered correctly. Item 16 is about the functional product of genetic engineering, and only 11% students knew the answer should be protein. In terms of overall performances on SLiM, we found that higher level of senior high students performed better on SLiM. After ANOVA computing analysis combining Scheffe test, there was significant difference among 12^{th} graders (Mean= 14.32±3.33), 11^{th} graders (Mean=9.21±3.29) and 10^{th} graders (Mean=8.65±2.64) ($p < .05$), but no significance shown between the groups of 10^{th} and 11^{th} graders. Concerning gender perspective, male students performed better than female students, but no significant difference was found by T test analysis between female (Mean=10.64±3.73) and male students (Mean=11±4.56). The implications to teaching and research are discussed.

123 "Is it dangerous?"- Interest of zoo visitors as a key to biological education

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Visitors to zoos may be regarded as independent learners. It is crucial to engage and develop their interest and thus encourage learning. Therefore, we wanted to find out which specific features in zoos support the development of interest for different categories of learners.

Our theoretical framework, was the Person-Object-Theory of Interest which states that an interest represents a relationship between a person and an object and that realization of interest requires interaction between the person and the object. Whether or not an interest emerges depends on the quality of the interaction. Two types of interest have been identified: interest that emerges in response to situational cues (situational interest), and interest that resides with the individual over time (individual interest). These can be distinguished by their reflection of knowledge, feelings and value concerning the object of interest.

This paper considers data from work in different zoos. The project sought to find out which specific features catch the attention of visitors and make them stop, look and start interpreting or explaining the biological themes presented. The behaviour of visitors of all age groups, from both school and leisure visits, was observed and spontaneous conversations were recorded and analyzed. Structured interviews were conducted with some visitors after their viewing. During the analysis, special attention was paid to the visitor's interpretation of the phenomenon presented, as well as to affective comments, reactions and value attributions, being indicators for an emerging situational or an existing individual interest.

The data indicate that visitors rarely read the information provided (texts) and interpret at the level of their existing biological knowledge. They are especially attracted by young animals, big and dangerous animals and action in an enclosure and by phenomenon which connect with their personal experiences. These include every day observations of animals around, media representations and narratives and deal with human/animal interactions. The features identified through the data analysis are the portals to the visitors' interests.

We conclude that the educational role of a zoo can be met by developing their initiatives in respect to the visitors' knowledge and building them on anchor points common to the majority of visitors. Furthermore, visitors should be enabled to relate their previous experiences to the phenomenon presented. Adopting such an approach offers visitors opportunities to develop situational interests. This interest is likely to render them open to accommodate new knowledge.

40 Biological concepts signification in study situations to the basic education

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The text presents discussions about one of the activities that constitutes a curricular innovation purpose, called Study Situation (SS), and developed in classroom. This conception of education reunite, on its production and development, teachers from college and basic education, and licentiate on Biological Science, that discuss the students life, when contextualize the study and looks to insert these people as learners, followed by the research. The qualitative methodology, on the investigation-action way, was chosen, cause it looks to a better formation of all the involved people. (Lüdke &André, 1986). The licensing, were nominated with fictitious name beginning with the letter L. The results were taken on the Supervision Stage I classes, in two groups from the Biological Science Licentiate Course, from Unijuí, by the text analysis, report and activities of systematization, produced by the academics. To identify the biological concepts and its nominations in a student life situation of this licentiate, which agrees the more consciousness decisions we analyze the following question: that significant are produced and that biological concepts are mobilized by students when discussing the production of a home bread, on SS "Aliment: Production and Consume – Human Alimentation"? Its objective, still, to incentive these licentiate to produce pedagogical purposes, that discuss situations from the quotidian, in a way the scholar contents can be articulated between itself and interdisciplinary. One of the characteristics of SS is to permit to the future professor autonomy and authenticity in the biology and naturals sciences curricular organization, articulated with other learning fields, in the basic education. The biological concepts, necessary to understand the SS Aliments: Production and Consume – Human Alimentation were identified during its development in the licentiate. The significant attributed by the licensed were discussed and systematized in new levels of complexity. Some questions were traced and answered during the investigation: *Which transformations biofisicalquimical occurs in the process of bread production? Which factors (flour, fat, yeast and sugar, temperature, humidity, oxygenation) interferes in the produced aliment quality?* The manifestations of students elucidate the consciousness of imbricates concepts. To Leandro: *The wheat flour is mixed with half hot water, salt, sugar and ferment that makes the bread grows. The ferment is composed by yeast (…). The half hot water helps the yeast, because these needs ideal temperature to make its metabolism happens.* It's possible perceive the manifestation on the scientificity of hit concepts, that demonstrates the appropriation and internalization of the same.

125 Biology teachers PCK development during an in-service teacher training course in ecology

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Pedagogical content knowledge (PCK) is a domain of teacher knowledge (beside pedagogical knowledge and content knowledge) which is important for the teaching of a specific subject (Shulman 1986; 1987). PCK is primarily developed during practice of teaching and the reflection of the teaching experience. Most of the studies about the growing of PCK are conducted in Physics and Chemistry teaching, there is still a lack of studies with Biology teachers and development of PCK. Park and Oliver (2008) developed a model, where the growing of the teacher's PCK is central due to Reflection in Action as well as Reflection on Action.

We developed an in-service teacher training course in field ecology which lasts for half a year with six days of joint action by the teachers. For in-depth analysis of the course we conduct research in three parallel activities: * looking at the development of participants' PCK;* measure students´ reactions to the teacher training with questionnaires, * and a participatory observation of an external person in the course.

In this paper we will concentrate on the development of teachers' PCK in ecology, a fruitful topic for PCK research following Shulman (Berry, Loughran et al. 2008). An overall evaluation question is the following: Where, in our in-service teacher training course, do the teachers learn? Moreover, we are interested in: How is the teachers´ PCK developed by participating in our in-service teacher training?

Six teachers were interviewed prior to and will be interviewed after the in-service teacher training course following a semi-structured guided interview with narrations about their lesson planning behaviour and reasoning about their teaching. In pre-interviews the teachers give an example of a "nearly perfect" lesson, in the post-interview the focus is on an excursion the teachers planned and conducted during the in-service teacher training course.

Analysis is done via qualitative content analysis with deductive categories derived from PCK literature as well as inductive categories found in the interviews.

The first analysis of the pre-interviews shows that the interactions and connections of the different PCK elements vary from teacher to teacher. This idiosyncrasy of the teacher knowledge has implications on the development of the PCK in our in-service teacher training and we hope to figure out the individual learning pathways through our post- interviews. Through comparison of the single cases, the generalisation of the findings and the implications for further in-service teacher training programmes for PCK development are discussed.

41 Biodiversity in compulsory education textbooks

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In this paper, we intend to establish how biodiversity is dealt with, within the study of the ecosystem, in books for the 4th year of Compulsory Secondary Education, ESO, (15-16 year-old students).
The reason for choosing 4th year of ESO textbooks is that the topic of ecology is specifically dealt with. The analysis was carried out using a key issues dossier based on school science, which not only provides a description of reality, but also introduces a theoretical explanatory framework. Regarding biodiversity within the study of the ecosystem, particularly addressed to here, we focused on the descriptive approach, considering the link between diversity and trophic relationships, ecological succession and ecosystem stability through change, consequences for biodiversity of human activities and mechanisms to face such consequences; and on the explanatory perspective, which provides an interpretative answer for all the aspects previously mentioned.
The findings drawn from textbooks show that biodiversity is linked both to the study of the ecosystem and to the impact of human societies on its maintenance. However, such study is particularly focused on the descriptive, rather than on the interpretative level.
Such findings suggest that it is necessary to redirect science teaching towards more explanatory approaches, since they are relevant to provide students with a wider view of the relationship between human beings and the environment, which will allow them to develop grounded opinions.
Note: This study is part of research project INCTTE08PXIB106098PR, financed by the Xunta de Galicia (Spain).

130 Empowering teachers to use bioinformatics tools in biology education

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This poster reports part of the data of a design research on empowering high school teachers to use bioinformatics in their classrooms. Bioinformatics is an inherent part of research in molecular systems biology which is developing fast mainly due to modern developments in retrieving genomics data and upgrading computer power. The work done by bioinformaticians can be simulated in the classroom using regular computers. Searching through DNA databases and manipulating 3D protein structures is a feasible way for high school students to get in touch with authentic and up to date science. First experiences show that students can work with bioinformatics pretty well.

In the Netherlands, bioinformatics is a scientific topic which is relatively unknown in non-scientific contexts, such as high schools. Preliminary research indicates that teachers consider the topic too technological, with little relevance to learning biology and time-consuming to prepare for class.

The focus of this study is to develop a strategy for teacher training in bioinformatics. Based on preliminary research on the attitude of teachers towards bioinformatics, and on literature about teacher training, an educational program is set up. The training will be tested several times on an estimated amount of 40 teachers. Extended evaluation and revision should provide a framework for developing future teacher trainings. Particular attention will be given to learning outcomes, changes in attitude towards bioinformatics, the capability of flexible transfer of the information and the incorporation of bioinformatics in the biology curriculum. The research question can be formulated as follows:

“What expertise is needed to use bioinformatics tools in genomics classes and how can science teachers be facilitated to acquire this expertise and to incorporate bioinformatics into biology education?”

The dominant research approach will be design research, combined with a survey among biology teachers. Theory-informed design activities, field-tests and reflection activities will alternate.

The research has started September 2009 and will continue till August 2010. First results will be presented on the Eridob conference.

19 How do we understand systems? - System competency at the elementary level

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Here we report data from a pilot study concerning system competency at the elementary level. As there is evidence for system thinking even at elementary age, we focus on the reason for different levels of system competency within one age cohort. In addition, we are interested in age-dependent effects concerning the development between 4th and 8th grade. The purpose of our study is to investigate the effects of individual-related and subject-related factors on the extent of system competency of 4th grade and 8th grade students.

The main focuses of the paper are the effects of four different factors on the extent of system competency: (1) the amount of content knowledge about a system, (2) the subject-specific content of a system, (3) the different experiences with systems in general and (4) the age effect. We designed two different intervention units to provide different subject-specific information about experiences with systems of different character. The units include "Blue mussel" as a complex dynamic and biotic system as well as "Sandstone" as a complex dynamic and abiotic system. All test persons participated in these two different intervention units. Each unit was framed by a pre-post test unit including multiple choice items as well as open questions about content knowledge and system competency. Additionally the students were asked to map their knowledge about each unit by drawing a concept map for an overview about their understanding of system organization.

Data from a group of 100 elementary students (4th grade) were compared to data of a group of 100 8th grade students by documenting their abilities in system competency.

The results clarify the effects of individual-related and subject-related factors in system competency concerning the domain system organization. Further indications for system competency assessment and the validity of the model of system competency will be discussed. We await the first data from the pilot study in February 2010.

133 Knowledge about and attitudes toward evolution among students in Slovenia

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Neo-Darwinian theory of evolution is recognized by some as the most important biological theory, which not only explains the mechanisms of a particular process but also integrates Biology into a whole unit and establishes Charles Darwin as the most influential scientist of all time. Yet the teaching of evolution as a socio-scientific issue can be a difficult task for teachers. In the prospective study, we try to identify the current level of knowledge about and attitudes toward evolution among students in Slovenia. The findings are planned to be used to improve pre-service and in-service teacher training and to develop new teaching materials to help build Science competence in students.

139 Model Competence in Biology Education - Operationalization and Validation of a Theoretical Model of Model Competence using Multiple-Choice Items

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In accordance with the shift from input-orientation to a stronger focus on the outcomes of the German educational system, educational objectives are increasingly being operationalized in terms of *competence* (Klieme et al. 2008). The implemented German educational standards and curricula defining learning outcome for 16 year-olds particularly include aspects of model competence (KMK 2005). Model competence functions as a "door-opener" for an elaborated understanding of the nature of science, leading to advanced qualities of scientific thinking and problem solving (Leisner 2005). It is therefore a profound part of scientific literacy (Driver et al. 1996, Gilbert & Boulter 2000). Yet various studies have identified that students are not aware of the role of models in an epistemological process and focus on descriptive aspects of models, perceiving them as depicting miniatures of real life objects (e. g. Grosslight et al. 1991, Treagust et al. 2002).

The precondition for the diagnosis of model competence in biology education and the design of interventions to foster students' and teachers' model competence is the development of a diagnostic instrument based on an empirically tested theoretical model of model competence suited to this domain (cp. Hartig & Klieme 2006, Schecker & Parchmann 2006) – a gap that needs to be filled. Krüger and Upmeier zu Belzen (2009) used various studies evaluating with students' and teachers' comprehension of models and modelling (e. g. Grosslight et al. 1991, Justi & Gilbert 2003, Crawford & Cullin 2005) to develop a theoretical model of model competence. It identifies two cognitive dimensions of model competence, differentiated into three qualities with an increasing degrees of reflection. This structure still has to be validated empirically.

In this study, multiple-choice items are developed and evaluated in order to operationalize and validate the model of model competence (Krüger & Upmeier zu Belzen 2009). Each item will be answered by about 25 students at grade 7 (Realschule) and 25 students at grade 10 (Gymnasium), all in all about 300 students. In a second step, these items will be used to empirically validate the model by confirmatory factor analyses of competing statistical models, by variance analyses and by IRT (Rasch) models.

The results of a pilot study show that the items have an adequate difficulty and some malfunctioning distractors. Students think about features of models while solving the tasks, supporting item content validity. The analyses of the operationalization and the first internal validation will be completed in spring 2010.

143 Secondary school students conceptions and opinions on forensic genomics

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THE NETHERLANDS

The advances in genomics research also impacted the field of forensic science. Interest in forensic science increased because of television series such as Crime Scene Investigationv (CSI). Less positive side effects of the popularity of these shows are misrepresentations of how forensic science really works. Promoting scientific literacy that empowers students in decision making on socioscientific issues is widely recognised as a major goal of science education. As forensic genomics raises important socioscientific issues, education on forensic genomics should be developed. A research was done to analyze which conceptions and attitudes secondary school Year 11 students have on forensic genomics an what opinion these students have on socioscientific issues in forensic genomics. The participants were a group of 63 students, age 15-16. The methodology involved analyzing written responses to questionnaires with both open and multiple choice questions on student conceptions on forensic genomics and opinions on related socioscientific issues. The first part of the research focused on the conceptions of students on forensic genomics. The results show that students have (mis)conceptions about forensic genomics mainly based on media information. The second part of the research focused on opinions of students with respect to socioscientific issues in forensic genomics. To the question "*Would you voluntarily donate your DNA to forensic researchers for making a DNA-profile out of it?"* 44% of the students answered '*yes'*, 25% answered '*no*' and 31% answered '*don't know'*. Arguments pro and contra were 2 categorised. Most mentioned were 'Cool *and interesting to see how DNA-profiling works and what my DNA-profile looks like*' as a pro-argument and '*I don't know what they are going to do with it now or in the future'*, as a contra-argument. To the question "*Who should be included in the forensic DNA-database?"* again students were divided. 38% of the students chose '*The DNA of all Dutch citizens'* and only 15% chose the current practice in the Netherlands:'*The DNA of all persons convicted for serious crimes'.* These results provide useful information on the conceptions and opinions already present before education on the subject.

144 Expertise development of biology teachers in a community of practice

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Context based biology education, including the handling of socio-scientific issues, puts high demands on biology teachers. This paper reports on the results of a research project aimed at enhancing biology teachers' expertise, in particular concerning teaching biology in the personal health context of genetic testing. Recent research on professional development indicates that enhancing expertise is a complex constructivist process, based on experience and stimulated by social interaction. We wondered how teacher expertise would develop while teachers were experimenting with the development and application of learning activities for context based genetics education. To start with, ten biology teachers built a community of practice (COP), and were informed about the required expertise. The latter had been mapped before, based on exploration of clinical genetic practice, and the educational practice of expert biology teachers. During COP-meetings the teachers translated the described expertise into their own classroom practice, e.g. by developing suitable learning activities. Based on interviews, digital diaries, classroom observations, artefacts such as lesson plans, and the observations made during the COP-meetings, we described and analysed the what and how of their expertise development. This data, collected in 2008 and 2009, is now being analyzed using an ethnographic research approach: a multiple case study resulting in 10 thick descriptions of the teachers and their individual learning processes. Trustworthiness will be checked, e.g. for plausibility and credibility via a member check and for dependability and conformability via an audit procedure. First results indicate that professional teachers learn most through interaction with colleagues, and through experimenting in their classrooms, i.e. interaction with their students. None of the teachers reported documents or internet sites as impacting their teaching performance, although these information sources were used and classified as informative by them during lesson preparations. Their background, e.g. their personal experience with genetic testing, and the school context, e.g. curricular freedom or involvement in other school tasks, seems to be an important determinant of their personal expertise development. The final results and their implications for teacher education programmes and in-service-training to implement context based biology education will be discussed in this paper.

142 Animal survival. Learning by inquiry and design in primary science education.

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THE NETHERLANDS

For several years studies were performed concerning the development of science concepts as well as to the development of so-called 'scientific attitudes' as effects of learning by inquiry and design. From a part of the study the outcomes are presented of a series of lessons including these aims that were carried out with pupils of key-stage 4 (age 10 – 12 years).

The lessons were elaborated into a scenario with instructions for teachers to facilitate inquiry and design activities by the pupils. The underlying concept developed by the pupils in these lessons was ‘form-function’. Pupils were invited to investigate form-function relationships by questioning and prerequisites the second aim of the study, the development of scientific attitudes of the pupils. Subject of the lessons was the problem how wild animals are able to survive in their environment and subsequently, what that means for their survival in a zoo shelter. Pupils discuss the natural behaviour and the appearance of wild animals, their properties or (form) in relation to how they survive (function) in their environment. How do behaviour and properties of wild animals fit into the properties of the environment they live in? Finally, they were asked to design and construct an animal shelter in a zoo in which the wild animals they investigated could survive.

Participating teachers were following a course in learning by inquiry and design. The concept form-function was discussed and they were instructed how to intervene and to reflect with the pupils on their findings.

To investigate both the development of the concept form-function and the scientific attitudes of the pupils video and audio recordings of pupils were collected during classroom activities and discussions, as well as written work sheets, questionnaires and the constructed shelters.

The results will show to what extent the learning & teaching strategy learning by inquiry and design contributes to the development of the concept form-function as well as to the development of scientific attitudes.

145 In search of design criteria for teaching evolutionary thinking an exploration of authentic research practices

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THE NETHERLANDS

Despite evolution's central explanatory function in biology, the topic of evolution plays a minor and often isolated role in secondary biology education. It's unlikely that when evolutionary concepts are treated in isolation, that they will be applied spontaneously afterwards and used in a coherent way. Context-based biology education, grounded in activity theory and situated learning theory, constitutes a promising approach to overcome obstacles in conceptual development. It seems worthwhile to focus on the longitudinal development of evolutionary thinking, using a variety of contexts. Contexts are here defined as authentic social practices in which specific knowledge and skills are used, adapted for use in classroom settings.
The focus of this study is the exploration of a number of authentic biological research practices, in order to 1) define evolutionary thinking and 2) to develop design criteria for learning and teaching evolutionary thinking. This study is part of a larger research project aimed at designing, testing and evaluating a context-based learning and teaching strategy in upper secondary biology education.
The methodology involved twelve recognised life scientists, that participated individually in 90-minute, semi-structured expert-interviews, focusing on the role of evolution and evolutionary thinking in their diverse fields of research. Audio recordings of the interviews were made and interpreted for each specific practice in terms of the following categories: 1) the function and importance of an evolutionary perspective in the specific research practice, 2) conceptualisation of evolution, in particular of evolutionary mechanisms, 3) research methods, 4) level(s) of biological organisation covered, 5) biological phenomena under study, and 6) specific research question(s). These categories reflect the main interview topics.
Data from interviews is being analysed at the level of conceptualisation and operationalisation of evolutionary thinking. It is determined for all six categories mentioned above what differences and similarities exist between authentic practices. For each practice the conceptual content relevant to the specific research activities employed will be represented as a concept map. These concept maps cover key biological concepts, mechanisms, and propositions related to evolution. We will define evolutionary thinking by describing the network of common core concepts and propositions, shared across different research practices. The differences described between authentic practices will be important in the process of selection and sequencing of potential educational contexts, and their positioning in the secondary biology curriculum. The theoretical framework developed and empirical results derived from this study will inform design criteria for a LT-trajectory aimed at developing evolutionary thinking.

149 Following the footsteps of the Neanderthals – project for gifted pupils

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The program "Following the footsteps of the Neanderthals – project for gifted pupils" was designed interdisciplinary to include topics, such as art, the Slovene language, history, geography, chemistry, and biology. This paper focuses on the biology part of the program. The program was intended for gifted pupils who attended 9th grade class and were introduced to biology concepts in 8th and the beginning of 9th grade classes. The program was designed as a response to a public debate in 2008 and 2009 in Slovenia about whether the reportedly oldest instrument in the word – a flute, found in Slovenia in 1995 – was the work of the Neanderthals. The program was carried out using the 5E Instructional Model (Friedrichsen & Pallant 2007). The goal was to encourage pupils to use various sources of information and methods of work to gain new knowledge, develop a critical attitude to information acquired in a variety of settings, and form and present their opinions on whether or not the flute could have been made by a Neanderthal. The pupils were guided through different stages of the program and different teaching strategies were used; they searched for literature concerning human ancestors, wrote reflections, took active part in workshops, participated in discussion meetings, modeled a Neanderthal woman, and arranged a public exhibition. The program was designed as an extracurricular activity, during which the pupils did most of the work at school or as field work (approximately 36 school hours) under the guidance of a biology teacher. They also needed to do some work (approximately 5 hours) at home. This program represents one of the ways to expand the Slovenian national curriculum for biology and, by applying different teaching strategies in one program, give gifted students an opportunity to broaden their knowledge and acquire new experiences.

150 Learning about plants in the context of every day life and nature experience

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The PhD-project described in this paper could point out relations between knowledge before lessons, concepts, nature experience and the actual willingness to learn about plants. This empirical study combined quantitative data (270 students) with qualitative data (34 students) in 5th and 6th grades in grammar schools (9 to 12 years of age).
Within the quantitative part of the study, data concerning nature experience, different liking and knowing about plants were collected from nine different classes. Within the qualitative part of the study, motivation, interest and self-determination (Deci & Ryan 2000) in class were main aspects of the study. The qualitative study was combined with a treatment in a 6th class.
The focus of this paper is the five different types of nature experience. They could be developed on the data about nature experience and their dimensions.
Dimensions of nature experience revealed in the study can be compared with dimensions from Lude (2001) and Bögeholz (1999), but show new aspects concerning younger pupils. The dimensions of nature experience surveyed in this study lead to five different types of nature experience. These types show different knowledge before class. In class they benefit differently from the treatment. In the end they show different individual growth in knowledge and competences.

151 Structures and levels of competence of different scientific methods - *observation, comparing and experimentation*

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This survey presents data from a pilot study with 3000 students (9th and 10th grade). It focuses on the development and empirical validation of a competence model that predicts and describes pupils' skills of scientific inquiry competence in three scientific methods, *observation*, *comparing* and *experimentation*. In Germany, comprehension and application of different scientific methods is one educational goal in future longitudinal large scale assessments with paper-and-pencil tests. Within the project ESNaS (Evaluation of the National Educational Standards for Natural Sciences at the Lower Secondary Level) a test was developed and is currently introduced in schools.

Aim of this paper is to create a better understanding how to improve the application of different science process skills. To design a learning environment that encourages students to participate in science processes it is crucial to describe and to differentiate subskills. The operationalization of these subskills is important to measure the outcome of inquiry competencies.

To assess students' competencies in scientific inquiry, the inner structure of various scientific methods is differentiated according to its specific hypothetical-deductive approach.

Consequently, the test items represent the four main skills *question*, *hypotheses*, *design* and *data*, which were all referring to the scientific methods *observation*, *comparing* and *experimentation*. The four skills are divided into five levels of *complexity* and four *cognitive processes*, each with separated degrees of difficulties.

On the basis of 114 open and multiple-choice items a multi matrix sampling is used and transferred into a multi-dimensional Rasch-model. Personal parameters such as gender, age and grade are estimated with different variables.

First results from a pre-pilot study with 293 students show that inquiry competence can empirically be differentiated in the four skills *question*, *hypotheses*, *design* and *data*. These four skills are building the competence cluster *scientific inquiry*. The skills differ in their level of difficulty: students have fewer problems formulating questions than formulating hypotheses, testing them and interpreting data.

The underlying models of competence as well as further results from a pilot study with 3000 students, currently taking place, will be introduced at the ERIDOB conference 2010.

152 Recontextualising cellular respiration

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The new curriculum for upper secondary biology education in the Netherlands aims for context-based education with special attention to the transfer of biological concepts across contexts. This curriculum is based on situated cognition and activity theories. Activity theory states that knowledge needs to be reshaped to be transferred across contexts. This reshaping process is called '*recontextualising'*.

This paper reports on research that is part of a larger PhD-project that utilises a developmental research approach. During a preceding exploratory research phase, we identified design principles for a learning-and-teaching (LT-) strategy for recontextualising. In order to test the validity of these design principles, they were used in the design of an LT-strategy for recontextualising a biological concept. As the main concept we chose the concept of "cellular respiration" for its complexity, its central position in biology and the large amount of difficulties students have with understanding "cellular respiration".

The resulting LT-strategy for recontextualising "cellular respiration" in secondary education uses a problem-posing approach to have students develop a motive for learning about "cellular respiration". This motive results from an orientation on the context of sports physiology and the differences in energy need that exist between long- and short-distance runners. In order to explain these differences on the cellular level, students find out they need to explore another context. Finally, after developing "cellular respiration" from the viewpoint of a biotechnologist, students move back to the context of sports physiology to recontextualise and use "cellular respiration" in explaining the differences in energy use in long- and short-distance runners. The effectiveness of the LT-strategy was tested in two case studies. Both studies were conducted with students in year 10 in two Dutch schools. Before and after the intervention we tested student conception of cellular respiration using an individual concept-mapping assignment. Additionally, a written test was used to asses students' ability to use "cellular respiration" in other contexts. Preliminary results indicate that students can develop "cellular respiration" through recontextualising. Students seem able to utilise their conception in explaining problems in other contexts, and are able to explain why they engaged in specific LT-activities.

153 Teachers' motive for outdoor teaching in the school forest

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The focus of this presentation is to investigate the intentions teachers have for arranging part of their teaching outdoors as well as what abilities, skills and knowledge the teachers want their pupils to develop during outdoor sessions. Many teachers locate their teaching outdoors and are of the opinion that it has a positive effect on learning and that this type of teaching produces prerequisites for combining knowledge with experience based learning. This is well in accordance with our current science curricula, where some of the objective of science is to arouse interest and curiosity in nature, to make it comprehensible, to offer pupils the chance to discover it and create an urge among them to explore it.

The study is based on semi-structured interviews with four teachers who arrange outdoor teaching during school years 4 – 6 in the Swedish comprehensive school. A prerequisite was that the teachers continuously locate part of their teaching outdoors and that the schools have access to a school forest suitable for outdoor teaching. The interviews were transcribed and analyzed from the theories about intentional analysis.

The result shows that the main motive for arranging outdoor teaching is to create an alternative arena for learning. The skills and knowledge that the teachers wish to enable pupils to develop through outdoor teaching are above all cognitive combined with affective and social abilities. In the cognitive area the most important is to arrange teaching in a concrete, practical way to improve the understanding of how things relate in nature for instance conceptions like photosynthesis and carbon cycle and to make it comprehensible.

In the affective domain the alternative arena is described as a place for experience to arouse curiosity in nature and create an urge among the pupils to explore it. In the social domain the most important skills to develop among the pupils are confidence, self-esteem, stronger motivation toward learning and greater sense of responsibility for group cohesion and learning. The teachers stress the importance among pupils to develop more positive relationships with each other and with their teachers. Through this relocation, pupils with learning difficulties are given new chances to handle school, but this is also true of pupils who are doing well, considering they have to adapt and transform their knowledge to work on the new arena

156 Discourse analysis and human evolution in a context of board game

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This paper focuses on the discourse analysis in an elementary school classroom with three core themes which are: the types of speech acts; the types of communicative approach; and the construction of the scientific knowledge, that constitute the starting point to study the different interactions that take place in a small group, which is composed by three fourth-grade girls who receive a task from their teacher: to design a board game on the evolution of the human species. The pupils dedicate two daytime hours to this task for two weeks; the process was registered through audio and video recording. Additionally questionnaires were used as pre and post test and also personal interviews to each of the pupils of the group.

This qualitative and interpretive research, with several aspects and methods of the ethnographic tradition, is based principally on information from the classroom and on non participant observations. The aim is to characterize the different interactions that allow these pupils to construct their own scientific knowledge by the discourse analysis. The methodology used for the data collection has centered on the audio-visual record of ten episodes with the materials prepared by the teacher, with complementary field notes. The data of the classroom is literally transcribed, with a column to introduce the commentaries of the field notes. After the first reduction of data from the transcription we intend to carry out an analysis applying categories on communicative approach, types of speech acts and later to include phases of triangulation between the three core themes raised initially to identify processes of construction of the scientific knowledge in small groups.

Initially, for the discourse analysis of the group, we have adapted the communicative approach categories of P. Scott and E. Mortimer, in two categories named interanimation " with scientific knowledge " and " without scientific knowledge " to identify sequences dialogic interactive, dialogic non interactive, authoritative interactive and authoritative not interactive which will be applied in conversations where we give priority to the processes of co-construction of the pupils scientific knowledge and, especially, the processes of negotiation of the contents of the speech with pupils and teacher.

The preliminary results of our research indicates that the communicative approach between pupils and teacher is principally dialogic interactive, and that the answers to the questionnaires are mostly based on a Lamarck approach.

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Goedhart, Martin University of Groningen – **The Netherlands**		**108**	**9**	**74**
Gómez – Galindo, Adrianna Unidad Monterrey-Cinvestav/Nuevo León – **México**	**agomez@cinvestav.mx**	**45**	**4**	**114**
Grace, Marcus University of Southampton – **United Kingdom**	**M.M.Grace@soton.ac.uk**	**169** **179**	**7** **10**	**39** **104**
Gropengießer, Harald Leibniz Universität Hannover – **Germany**		**105**	**6**	**72**
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Hadjichambis, Andreas Ch. Cyprus University of Technology & Cyprus Centre for Environmental Research and Educatio – **Cyprus**	**a.chadjichambi@cytanet.com.cy**	**52** **53**	**8** **11**	**76** **117**
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Härting, Jennifer Universität Vechta – **Germany**	**Jennifer.Haerting@uni-vechta.de**	**56**	**14**	**59**

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Kidman, Gillian Queensland University of Technology – **Australia**	**g.kidman@qut.edu.au**	**70**	**4**	**125**
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Manaia, Alexandra European Molecular Biology Laboratory – **Germany**		**184**	**2**	**23**
Marbà-Tallada, Anna Universitat Autònoma de Barcelona – **Spain**	**anna.marba@uab.cat**	**88**	**6**	**135**
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Neuhaus, Birgit University of Munich – **Germany**		**119** **65**	**15** **12**	**78** **121**
Niebert, Kai Leibniz Universität Hannover – **Germany**	**niebert@biodidaktik.uni-hannover.de**	**105**	**6**	**72**

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Ossevoort, Miriam University of Groningen – **The Netherlands**	**m.a.ossevoort@rug.nl**	**108**	**9**	**74**
Ottander, Christina Umeå University – **Sweden**	**christina.ottander@matnv.umu.se**	**35** **153**	**13** **6**	**55** **169**
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Papadopoulou, Chrysa University of Patras – **Greece**		**36**	**14**	**56**
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Petersen, Morten Rask University of Southern Denmark – **Denmark**	**mrask@imada.sdu.dk**	**112**	**11**	**147**
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Reumer, Jelle Utrecht University – The **Netherlands**		**145**	**4**	**164**
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Rogge, Christian Leibniz University Hannover – **Germany**		**118**	**9**	**77**
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Saunders, Kathryn University of Waikato – Hamilton – **New Zealand**	**Kathy@waikato.ac.nz**	**166**	**3**	**29**
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