Departamento de Didáctica das Ciencias Experimentais
Universidade de Santiago de Compostela

III Conference of European Researchers In Didactic of Biology

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PROGRAMME & ABSTRACTS

Facultade de Ciencias da Educación

Santiago de Compostela

September 27th- October 1st 2000

III Conference of European Researchers In Didactic of Biology (ERIDOB)

PROGRAMME
&
ABSTRACTS

Santiago de Compostela

September 27th- October 1st 2000

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FOREWORD

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

1. Learning about concepts: students' conceptions and conceptual change
2. Attitudes development: students' values, interest, motivation, attitudes
3. Reasoning: students' reasoning, scientific thinking
4. Teaching: teaching strategies, metacognive strategies, educational technology
5. Environmental education and Biology education
6. Social, cultural and gender issues
7. Practical work and field work in Biology education
8. Research methods and theoretical issues

PROGRAMME

Wednesday, 27.09.2000:

16.00 - 18.30 h Registration

19.00 h Welcome and information

20.00 h Dinner

Thursday, 28.09.2000

9.00 - 11 h Paper Session

Topic: Learning about concepts: students'conceptions and conceptual change

Chair: UTE HARMS

- *Bayrhuber H., Schletter J.C. IPN. Kiel. (Germany).* Learning and Memory - Problems of integrating students' conceptions and scientific knowledge
- *Camino, E., Casassa, E., Perazzone, A. University of Torino (Italy).* Biology education for future teachers of primary school: a challenging experience
- *Saraiva, A., Russell, T. Instituto Politécnico of Leiria (Portugal). University of Liverpool (UK).* Ideas about conditions and mechanisms of growth

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11.30 - 13.30 h Paper Session

Topic: Social, cultural and gender issues

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- *Harms, U. University of Oldenburg (Germany).* Effects of different teaching contexts on students' interest in molecular genetics
- *Upmeier zu Belzen, A., Vogt, H., Schäflein, F., Universität Münster (Germany).* Personal influences on the development of interests and non-interests of children in primary school with special concern given to biological contents
- *Hammelev, D. Roskilde University (Denmark).* Students´images of DNA and the use of DNA-investigations

13.30 - 15.30 h Lunch

15.30 - 17.30 h Poster Session I

Topic: Teaching: teaching strategies, metacognitive strategies, educational technology

Chair: PEDRO MEMBIELA

- *Amir, R., Campbell, B. The Science Teaching Centre. The Hebrew University, Jerusalem (Israel). University of York (England).* Teachers' awareness and use of students' prior knowledge

- *García Barros, S., González-Rodriguez, C., Martínez-Losada, C. Universidad de A Coruña (Spain).* Which procedures are developed in the activities included in obligatory primary and secondary education text books

- *Boulter,C.J., Buckley, B.C. University of Reading (UK).* Constructing and using typologies of models in science education: Models of the heart, decay and ecology

- *Gándara, M., Gil , M.J., Sanmartí, N. Universidad de Zaragoza. Universidad Autónoma de Barcelona (Spain).* The biological adaptation model:obstacle or e didactic recours?

- *Hammann, M. IPN. Universität Kiel (Germany).* Comparative Biology in High School Education

- *Potyrala, K. Instytut Biologii.Krakow (Poland).* Teachers' and Biology students' preparation for attempts at didactic innovations in human genetics at the secondary school level

- *Sánchez-Mora, M. C.. National University of Mexico (Mexico).* The teaching of biological evolution based on students' alternative conceptions

- *Zogza, V., Ergazaki, M. University of Patras (Greece).* The development and evaluation of a teaching scheme for improving scientific thinking skills in the context of Genetic Engineering

17.30 - 18.00 h Coffee break

18.00 - 19.00 h Workshops

Workshop A

Chair: HORST BAYHUBER

- *Biedris A., Dislere, V. University of Agriculture. Zalenieki Jelgava (Latvia).* Pedagogical means of students' communicative skills level increase for environmental education

- *Caurín, C., Gil , M.J., Llopis, J. A. IPFP "La Costera", Valencia. Universidad de Zaragoza. Universidad de Valencia (Spain).* Analysis, evaluation and change of attitudes in environmental education: is it possible?

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Chair: LAURENCE SIMONNEAUX

- *Membiela P., Nogueiras, E., Suárez, M. Universidade de Vigo (Spain).* Environmental Education for a curriculum project in science

- *Nowak, A. University of Szczecin (Polan).* Teachers' and Students' activities during field classes

- *Papalambros, L. 1 Gymnasium-High School. Livadia (Greece).* Teaching the phenomenon of acid rain. An experimental approach using "real world" materials

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20.30 h Dinner

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9.00 - 11.00 h Paper Session

Topic: Reasoning: students' reasoning, scientific thinking

Chair: CAROLYN J. BOULTER

- *Colucci, L., Camino, E., Perazzone, A.. University of Torino (Italy).* Role playing in science: a tool for an nonviolent approach to environmental conflicts

- *Díaz de Bustamante, J., Jiménez Aleixandre, M.P.. Universidade de Santiago de Compostela (Spain).* Communication in the laboratory sessions and sequences of arguments

- *Hößle, C., Bayrhuber, H. Universität Hamburg. (Germany).* Research on students' ethical argumentation on genetechnology in biology teaching

- *Simonneaux, L. Ecole Nationale de Formation Agronomique. Castanet-Tolosan (France).* Comparison of the impact of a role play and of a classical discussion on students' argumentation concerning an issue in animal transgensis

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11.30 - 13.30 h Paper Session

Topic: Teaching: teaching strategies, metacognitive strategies, educational technology

Chair: MICHAEL REISS

- *Helldén, G. Kristianstad University (Sweden).* 15-year-old students' ideas about the development of their own understanding of biological processes

- *Magro, A., Simonneaux, L., Navarre A., Hemptinne, J.L.. E. N. F. A. Castanet-Tolosan (France).* The teaching of ecology in the agricultural secondary curricula in France: a new didactic approach

- *Prechtl, H., Urhahne, D., Davier, M.von, Schenzer, M. IPN. Kiel (Germany).* Animations, self-regulation and motivation in a computer-based learning environment for neurobiology instruction

- *Selles S. E., Ayres, A.C., Reznik, T. Universidade Federal Fluminense (UFF). Universidade do Estado do Rio Janeiro. Escola Técnica Federal de Quimica, Rio de Janeiro (Brazil).* Models of human cirulatory system in science textbooks: building a framework for representation analysis

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15.30 - 17.30 h Poster Session II

Topic: Learning about concepts: students' conceptions and conceptual change

Chair: GUSTAV HELLDÈN

- *Bandiera, M., di Macco, V. Università "Roma Tre" (Italy).* "Through the windpipe and intestine down into the stomach…": Attitude and competence of prospective primary school teachers
- *Mondelo Alonso, M., García Barros, S., Martínez Losada, C., Vega Marcote, P. Universidade da Coruña (Spain).* The evolution of knowledge about the cell as living unit among Biology degree students
- *Muñoz, X., Puigcerver, M. Escola Pia Sant Antoni. Barcelona. Universidad de Barcelona (Spain).* Interactions between students conceptions of the digestive system and the teaching process
- *Reiss, M., Tunnicliffe, S.D.. Homerton College. Cambridge (UK).* Students' Understanding about Organs and Organ Systems in Different Animals

Topic : Reasoning: students' reasoning, scientific thinking, and Attitudes development: students' values, interest, motivation, attitudes

Chair: GUSTAV HELLDÈN

- *Pereiro Muñoz, C., Jiménez Aleixandre, M.P.. Universidade de Santiago de Compostela (Spain).* Relevant knowledge in decision making about the environment: a case study
- *Sóñora, F., Garcia-Rodeja, I., Brañas, M.P. Universidade de Santiago de Compostela.* Discourse Analysis: Pupils' discussions of soil science
- *Tamayo, O., Sanmartí, N. Universidad Autónoma de Barcelona (Spain).* Analysis of the discourse of the students of first level high school about the conceptual field of respiration
- *Teixeira, F.M. Federal University of Pernnambuco (Brazil).* Children's categorisation of animals: Does culture make a difference?

17.30 - 18.00 h Coffee break

18.00- 19.00 h Workshops

Workshop A

Chair: FRED BRINKMAN

- *Campbell, B., Kelly, C.. University of York (UK).* The Purposes of laboratory practical work in natural sciences degree courses
- *Tomkins S., Tunnicliffe, S.D. Homerton College. Cambridge (UK).* The stories diaries tell us: Qualitative observation, interpretation and hypothesis making by 12 year old pupils keeping brine shrimps
- *Tunnicliffe, S. D. Homerton College. Cambridge (UK).* Field work - Teaching for attitudes as well, as for facts

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Chair: Mª PILAR JIMÉNEZ ALEIXANDRE

- *Fleszar, E. University of Szczecin. Szczecin (Poland).* Didactical foundations of preparing students - the future biology teachers for performing environment-oriented and ecological education.
- *Lumer, J., Hesse, M. Institutt für Didaktik der Biologie. Münster (Germany).* Concept mapping in the teaching of biology

19-20 h Business meeting and discussion in plenary

20.00 h Conference Dinner

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9.00 - 11 h Paper Session

Topic: Learning about concepts: students' conceptions and conceptual change

Chair: MILENA BANDEIRA

- *Baalmann, W., Kattmann, U. University of Oldenburg (Germany).* Towards a better understanding of genetics and evolution - research in students' conceptions leads to re-arrangement of teaching biology

- *Knippels, M.C.P.J., Waarlo, A.J., Boersma, K.Th.. Universiteit Utrecht (The Netherlands).* Coping with the abstract and complex nature of Mendelian genetics in upper-secondary biology education

- *Wallin A., Hagman, M., Olander, C. Göteborgs Universiteit (Sweden).* Teaching and Learning about the Biological Evolution: Conceptual understanding before, during and after teaching

- *Zogza, V., Gritsi, F. University of Patras (Greece*). The deveploment of ideas of pre-scholl children regarding the organization and function of human body organs through a socio-cognitive intervention

11.0 - 11.30 h Coffee Break

11.30 - 13.30 h Paper Session

Topic: Environmental education and Biology education

Chair: JOAQUÍN DÍAZ

- *Barkmann, J., Bögeholz, S. Universität Kiel. IPN Kiel (Germany).* Quantifying the development of moral judgement on environmental issues in adolescent

Klee, R., Erten, S., Bamberg, S., Graf, Dittmar. Justus-Liebig-Universität. Giessen (Germany). Practising educational methods in Environmental Education - a Comparison between Turkish and German teachers using the theory of Planned Behaviour

Lude, A. IPN. University of Kiel (Germany). Influence of students' nature experiences on nature consciousness and reasons for conservation

Brinkman, F. Hogeschool Holland (The Netherlands). Integration of environmental and health education in contaminated areas. The contribution of Belarussian teachers

13.30-15.30 h Lunch

16.30 h Visit Santiago de Compostela

20.00 h Own dinner arrangements

Sunday, 1.10.2000

Departure

ABSTRACTS

Teachers' awareness and use of students' prior knowledge

Amir, R. & Campbell, B.

Semi-structured interviews with teachers about teaching photosynthesis were used to elicit practices regarding:
methods of evaluation of what students know before teachers start teaching a topic;
what information teachers have about students' prior experiences and levels of attainment;
teachers' rationale for the sequencing of teaching topics and teaching order within a particular topic;
activities undertaken at the start of a new topic and why these are done;
how teachers' awareness of students' prior knowledge serves to guide their teaching practices.
Analyses of the interview transcripts show a range of assumption that teachers' make about students' prior knowledge, illuminate methods used to elicit prior knowledge and identify degrees to which teachers use this to guide their teaching. At one end of a spectrum are teachers who assume that prior teaching equates with student understanding. They progress with teaching in accord with the teaching schedule. Others evaluate prior knowledge through discussion and loosely structure their teaching on the outcomes. Others act in a systematic way to elicit students' prior knowledge and then teach in accord with students' understandings.

Towards a better understanding of genetics and evolution - research in students' conceptions leads to a rearrangement of teaching biology

Baalmann, W. & Kattmann, U.

In biology teaching, genetics is supposed to be taught before evolution as a prerequisite for understanding. In contrary teachers and students rarely make use of genetical considerations in the field of evolution.
The central research question is, how students combine their knowledge in the fields of genetics and evolution or whether they keep them apart in their mental constructs. The studies were conducted within the model of Educational Reconstruction. Within the empirical investigations of students' understanding the concepts in question were particularly "gene", "genotype", and "heredity" in the field of genetics, in the field of evolution e.g. "natural selection", adaptation, and "variability". Characteristic domain specific findings are presented in our contribution. The results are used to develop new guidelines for an improved instruction which takes students' conceptions intensely into consideration.
As a consequence of our findings we propose a new approach for conceptual change based on the students' ability to combine and reflect their own conceptions in both fields and consequently to reach an adequate understanding of genetical and evolutionary change.

"Through the windpipe and intestine down into the stomach …" - Attitude and competence of prospective primary school teachers

Bandiera, M. & di Macco, V.

Students' total, generalised inexperience in science, and a widely inadequate proportion of course time aimed at science literacy (60 classrooms hours and 20 in the laboratory), represent a true challenge in launching university initial training of primary school teachers.
Consequently, at "Roma Tre", degree curriculum definition took special care in designing the basic method of studying scientific topics, the strategies for thorough knowledge acquisition (guided by the teacher and autonomously), labwork (as a way of cognitive interaction), and ad hoc teaching methodologies were adopted with two main aims: to help students assume (or, at least, experience) an adequate experimental attitude, and to explore their actual level of competence in the fields of study and the most diffuse mechanisms for knowledge organisation and learning.
Therefore, in the first two years after the institution of the degree, documents and data have been collected and analysed; some shared and relevant peculiarities of these science novices have been singled out concerning their interest for scientific "atmosphere", their image of science, their cognitive interaction with natural phenomena, gaps in knowledge and the use of scientific instruments and formal scientific languages that handicaps rather than facilitates observation and analysis.
Significant examples will be presented and discussed.

Quantifying the development of moral judgement on environmental issues in adolescents

Barkmann, J. & Bögeholz, S.

This paper reports on a study on the development of moral judgement on environmental issues in adolescents. Moral judgement is investigated using four patterns of argumentation that are employed to justify environmentally relevant decisions (cf. Breit & Eckensberger 1998). The patterns embody a developmental perspective that starts with an interpersonal-heteronomous type and ends with a transpersonal-autonomous type.
A questionnaire with 16 multiple-choice items was administered to 238 students from different secondary school types. Linear multiple regressions were run with age and school types as predictors. For the least "advanced" pattern, we hypothesised a negative, for more "advanced" patterns a positive age effect. Age was *negatively* correlated with the inclination to use an interpersonal-heteronomous type of argumentation (–0.16 [β-weight], p=0.01). Age was *positively* correlated the interpersonal-autonomous type (0.11; p=0,005). The age effect was not significant on the transpersonal-heteronomous type (p=0.128) and absent from the transpersonal-autonomous type.
As predicted, the least "advanced" pattern of moral argumentation was used less frequently by older students. Consistent with theory, age was positively correlated with the more "advanced" interpersonal-autonomous pattern. For the absence of an age effect in the two most "advanced" transpersonal patterns, two explanations are discussed, including the tendency for socially expected responses.

Learning and Memory- Problems of Integrating Students' Conceptions and Scientific Knowledge

Bayrhuber, H. & Schletter, J. C.

In a previous study we found that grade 13 students used neurobiological and psychological terms, but attached meanings to them that strongly deviated from their scientific meanings. Furthermore the analysis showed that the students' conceptions could be divided in two general categories: conceptions derived from external sources (e.g. school, television) and internal sources (i.e. based on students own reflections about individual experiences with learning and memory processes). The students made next to no connection between scientific concepts and their own experiences.
Two questions were the focal point of an intervention study, using an experimental control group design. The first addressed the extent pre-conceptions derived from external sources will move towards scientific concepts during intervention. The second was to what extent the students will connect conceptions derived from internal sources with scientific concepts taught in lesson.
The study indicates that by a constructivist learning environment, where students' pre-instructional conceptions are explicitly incorporated, the connection of psychological and neurobiological concepts with conceptions based on internal sources can be supported, whereas the growth of conceptions derived from external sources cannot be appreciably influenced.

Pedagogical means of students' communicative skills level increase for environmental education

Biedris, A. & Dislere, V.

This paper reports about pedagogical means of students' level increase for environmental education. Communicative skills are a vital feature of young specialist's social competence highly evaluated in the world. They supply sending and receiving of information by means of interactions. Participants of communication become partners as a result of interacting and partnership develops. *Subject to object* relations dominated in the normative pedagogy. Belittling of any person's own views and autocratic position in pedagogical interpersonal relations had a negative impact on the development of one's personality. *Subject to subject* relations include the interactions of equal and mutually respecting partners thus promoting mutual intellectual enriching, control and responsibility, improving communicative skills and influencing the development of one's personality positively. Pedagogical means to increase the communicative skills level characteristics were worked out theoretically and corresponding teaching/learning methods, exercises and forms of work organization were chosen. Changes of the communicative skills characteristics level was the hypothesis assessment criterion. Initial level of each communicative characteristic was assessed during the *control experiment*. Changes of student's communicative skills characteristics level were achieved during the *applied experiment* using the pedagogical means and corresponding teaching/learning methods, exercises and forms of work organization. At the end of the experiment each communicative skills characteristic level was determined repeatedly and assessed its changes. Communicative level has increased thus confirming the hypothesis of the research.

Flowers and Horses for Girls? On Gender-Specific Differences in Nature Experience, Environmental Knowledge and Environmental Action

Bögeholz, S.

This paper reports on potential gender-specific differences in environmental education. The analyses are based on a nation-wide, cross-sectional study (n=1243). All results are significant at least at the 0.05-level.
Female students report 11 nature experiences per month more than male students. Specifically, female students report more frequent and more appreciated aesthetic and social nature experience, while male students show more ecological nature experience. Frequency and appreciation correlate stronger in boys than in girls. Thus, the gender-specific difference in the ratios between appreciation and frequency is higher for girls, especially, highest in the ecological dimension. Female students know more plant species, but male students show higher action-specific knowledge and higher knowledge on global life support systems. Girls show higher motivation and intention for environmental action. Appreciation (frequency) of nature experience explains 32.9% (30%) of the variance in the intention to act in girls; and 30.2% (27.3%) in boys.
The higher frequency and appreciation of nature experience in girls is reflected in their higher intention for direct environmental action, especially, in the aesthetic and social dimension ("flowers and horses"). Because of the high difference between frequency and appreciation, girls also reveal the highest potential to respond to instructions promoting ecological experiences.

Constructing and using typologies of models in science education: Models of the heart, decay and ecology

Boulter, C. J. & Buckley, B. C.

It is through models and representations that we come to understand the phenomena of the world as we appreciate them though our senses. These may be apparently simple objects like a tree or a time bounded interaction, an event, such as leaf fall, or a series of events making a process such as decay, or a complex interacting system operating at many levels, such as a woodland habitat. The mental models which we form in our minds as we encounter these objects, events, systems and processes of the world are not available to others until expressed either in a concrete or symbolic form. Often these expressed models are mixed and include say both material objects and symbolic textual labels. The symbolic may be visual, verbal or mathematical text or gesture. These concrete and symbolic modes are the ways that mental models can be expressed. When any representation is formed it expresses the behaviour of the mental model shown in the particular behavioural aspects of the representation which may be dynamic or static, deterministic or stochastic and also the numerical precision of the model which may be either qualitative or quantitative. These two parameters of models, the modes of representation and the aspects of the representation form the two axes of our constructed typology of models. We have arrayed within the typology the expressed models we found in the classroom of the heart and in decay in woodland habitats. We discuss the usefulness of the typology for teachers and for research in making explicit the potential range of models and their likely use in explaining phenomena and in the design of research into the effects of differing representations and the sequence of model development in learning.

Integration of environment and health education in contaminated areas. The contribution of Belarussian teachers

Brinkman, F.

Teachers participate regularly in in-sevice courses. The lesson material and the way in which we developed it was presented in one of the experimental schools to 35 science, biology and health teachers from the region during a one day in-service organised by the regional educational inspector. Next to the teachers, people from the Red Cross and the educational department assisted to the course in which the use of pupils' ideas and local contexts in lesson material was presented.
In this course the participating teachers developed a lesson in which they integrated man in a local foodcycle. This is in contrast with the school curricula in which such an integration never occurs. Evidently, the concept that man is an integral part of the cycle in nature is easily acceptable for them.
Pupils' ideas are only used by half of the teacher groups. So this didactical approach presented in the teacher course is taken over less eagerly.
Local conditions are generally taken up by the teachers in their new lesson scheme. Although not present in the curricula, this contextual didactical approach meets no resistance in the Belarussian teachers.
Contamination with radioactive materials was integrated by the teachers in a variety of subject areas, like Biology, Science and Physics. This in contrast with the curriculum where we found 'radiation' treated as a subject on its own, separated from health and environmental subjects' areas.

Biology education for future teachers of primary school: a challenging experience

Camino, E., Casassa, E. & Perazzone, A.

Since 1998/99 future teachers of primary school attend a four year University degree. One of the first year compulsory courses is a module of 30 hours on "Didactics of biology".
Owing to such limited time, we selected few key-concepts on spatial and temporal life webs, and we guided a reflection on scientific contents and on didactic transposition.
Students have been involved in various activities (lectures, work-groups, individual questionnaires) and at the end of the course they were asked to carry on a written test and an oral exam.
The material produced by the students gave useful information about initial knowledge, pre-conceptions and cognitive obstacles. As concerns in particular two topics (food webs, species evolution) on which we report here in detail, the result of our research shows that most students hold a 'nominal' knowledge, and perceive science as a collection of information, rather then a dynamic process. Moreover they have difficulties in the practice of linguistic function – both verbal and written - and hardly recognize functions and limits of metaphor.
When asked to set up a teaching/learning activity, students resort to traditional models, interiorised during their previous school experience, rather than to the new tools offered during the course.

The purposes of laboratory practical work in natural sciences degree courses

Campbell, B & Kelly, C.

University teachers rated the importance of 31 declared purposes of practical work on a 5-point scale that ranged from essential to not necessary. Respondents were also asked about the factors shaping their views and the extent to which views had change over time and why. A number of staff were also interviewed in depth to explore the reasoning behind their responses
The results show that the purposes most frequently declared as essential were those of practising investigative skills, learning about safety procedures, developing an ability to plan experiments and the stimulating interest. These views are discussed in relation to the practical activities undertaken and conclusions are drawn about the extent to which theoretical views and practical reality are in accord. Data also indicate that experienced staff had changed their views on the purposes of practical work in the degree courses they teach particularly in relation to encouraging problem solving skills and in developing an understanding of the nature of science. The indications are that changes in technology, the reduced availability of resources, new curriculum priorities and a greater awareness of the affective areas of learning have acted as the major influences on change.

Analysis, evaluation and change of attitudes in environmental education: ¿is it possible?

Caurín Alonso, C., Gil Quílez, M. J. & Llopis Blasco, J. A.

This paper reports the methodology employed in a study with Secondary Education students over environmental attitudes. It discusses the difficulty of scanning the students attitudes in order to obtain reliable results and not results that depend on the method employed.
Our work is based on the comparison in the change of environmental attitudes that different groups of students possessed before and after working on an environmental programme. This programme consists in working different degrees of interaction between conceptual, procedural and attitudinal contents. We employed, in the promotion of the change, activities that combine various techniques, that range from persuasive communication to co-operation and active participation techniques.
To gather data we used several methods: open problems, activities, interviews etc.. Also the methods of data analysis that we used were different (quantitative, qualitative and descriptive): Networks, tables of categorisation, tables of percentages and direct observation of the activities.
The results obtained with these different strategies allow us to conclude that students attitudes measured in this research are reliable and don't depend on the techniques used.

Role playing in science: a tool for a nonviolent approach to environmental conflicts

Colucci, L., Camino, E. & Perazzone, A.

We investigated how teachers and students cope with complex environmental issues, by proposing a new role-play about intensive aquaculture of shrimps in tropical regions. This activity, promoted by International Institutions to improve proteins' input in the diet and offer new opportunities of employment, has also produced widespread damages to coastal ecosystems, and weakened local economies.
Players were asked to investigate positive and adverse effects of shrimp farms, by searching data, writing reports, preparing group strategies, arguing during a debate, answering to questionnaires.
The issue requires a multidisciplinary approach; as concerns biology, players have to master ecology, zoology, botany, in order to understand situations occurring in the real world (e.g. food chains and ecological webs within the context of global trade and local scenery).
Moreover the role-play asks for linguistic and arguing abilities.
Our preliminary results suggest that:
information dealing with applied science is more often used in the debate than basic science data
only when guided into a 'full immersion' in the simulation the players grasp a systemic view of the problem
the presence of a conflict besides the controversy allows to introduce a discussion on needs and interests, which is preliminary to the nonviolent approach.

Communication in the laboratory sessions and sequences of arguments

Díaz de Bustamante, J. & Jiménez Aleixandre, M. P.

This paper reports a case study about discourse and argument in the Biology laboratory (microscope). 3rd grade students (14-15 years) were asked to solve a problem: to identify an unknown biological sample. The purpose was to explore the classroom discourse, the system of communication, being the focus the argumentation pattern, the relationships that the students establish among data and theoretical hypothesis, the operations by which hypothetical statements are transformed into data and the uses of justifications. A dyad of students was video and audiotaped while solving the problem. The transcriptions were analyzed using Toulmins' (1958) layout.
The focus of this paper is the methodology used through the analysis, and the inscriptions designed for reporting the paths of argument. The criteria used for deciding whether a dialogue was an argument or not and which exchanges belonged to the same argument are discussed. We designed a flow diagram to represent the sequence of arguments along the discussion. The sequence and instances of arguments are analyzed, focusing on the substantive arguments, related to relevant biological knowledge. The results show how students are able to use argumentative reasoning, to justify their claims. Implications for promoting talking and doing science in the biology laboratory are outlined.

Didactical foundations of preparing students - the future biology teachers for performing environment-oriented and ecological education

Fleszar, E.

The environment-oriented education must be based on information indispensable for integrating complex phenomena that model the environment. The programme of environment-oriented education should find connections of teaching processes with the surrounding reality. It should concentrate activities of pupils, students, and nature lovers around the environment problems.
We may state therefore that the ecological education:
ensures a direct contact with the nature for pupils,
affords possibilities for getting knowledge on the environment protection and modelling,
makes studies, i.e. observations and experiments in the natural living conditions of plants and animals, possible,
affords possibilities for studying natural objects and phenomena,
makes the modelling of attitudes possible taking into consideration the knowledge, emotions and activity depending on the age of a participant,
affords possibilities for the active work, individual or collective, observing the rules and injuctions of working in the field,
enables parents to be included into the work for the benefit of environmental protection within the family-school relation (co-operation),
obliges to look at the surrounding nature in the economic aspect provoking moments of reflection,
affords possibilities for showing independence while performing different types of works for the benefit of the surrounding nature, and
affords possibilities for confirming the statement that pupils (participants) have to carry into effect the foundations of ecological education in the field to gain the conviction that only there they can obtain factual, i. e. real and up-to-date results of the observations or experiments performed.

The biological adaptation model: ¿ obstacle or didactic recourse?

Gándara Gómez, M., Gil Quilez, M.J. & Sanmartí Puig, N.

With this study we attempt to configure *the knowledge which has to be taught* about the adaptation in the Obligatory Secondary teaching (12-16), in our country and in relationship to the adaptation concept that biologists use.
To do this two parallel studies were carried out. In the first, the *Previous Study*, we identify the scientific adaptation model, through the specialised literature, using various sources. This study was submitted to a panel of experts, for their validation as a scientific reference for the transposition. The second phase consists of a *Study of the Transposition of the scientific model to the context of Secondary Obligatory textbooks.*
It is proven that, in both sorts of institutions, the adaptation is a concept that is adjusted to a model developed in two dimensions. In the *ontological dimension*, the adaptation concept operates as an *object of knowledge*, where the principal differences affect the description and the explanation of the *adaptation process*. In the *epistemological dimension*, the adaptation operates as a *conceptual tool*, and the principal differences refer to the methods suggested to arrive at a theory on adaptation.
The study concludes with advice on the *speculative image* of the Biology transposed in the Secondary textbooks.

Which procedures are developed in the activities included in obligatory primary and secondary education text books

García Barros, S., González-Rodríguez, C. & Martínez Losada, C.

In this paper we intend to analyse the type of activities related to living beings which are included in Primary and Secondary Education text books belonging to the most widely-used publishers in our area. We shall also analyze the objective and the procedures which these activities help to develop. In this respect, we have discovered that the presence of practical activities is particularly scarce -32 out of the 934 analyzed (3.4%)-. The objective of these activities is based around the application of theory and obtaining new knowledge, although in Secondary the percentage of activities concerned with the application of theory (71.2%) is higher than in Primary (44.4%). With regard to the procedures developed in the activities, we must point out that the ones concerned with planning -proposal of a hypothesis, control of variables, design of experiences- are practically non-existent (percentages below 1%), and it must be added that these are not found in any of the practical activities. On the other hand, all the activities develop communication, the most habitual being written expression. The interpretation of facts and situations is over 15% in Primary and 22% in Secondary, although, paradoxically, this procedure is only developed in 6.2% of practical activities.

Comparative Biology in High School Education

Hammann, M.

Among science theorists, the comparative method is widely regarded as "an alternative to experimentation" and estimated to have brought forth "probably more new insights than all experiments combined" (Mayr 1982). The method's relevance for the advances in Biological knowledge contrasts with its marginalized position in educational research. This situation is aggravated by the fact that in the educational literature available, the functions and organisation of comparative work are often neglected or treated cursorily. Also, little is known about the aims teachers pursue when they engage their students in comparative Biology. As with experiments, comparisons can be regarded as a source of factual knowledge of Biology or as a method of genuine scientific inquiry used for solving problems.
A study was launched to investigate the aims that German teachers pursue when they use the comparative method in Biology education. A questionnaire was sent to high schools taking part in the BLK model program "Enhancing the Effectiveness of Mathematics and Science Instruction". The findings of this study will be presented (n=316) and related to Meyer's (1987) and Welzel`s et al. (1998) studies on the aims of experimental investigations in Biology education.

Students images of DNA and the use of DNA-investigations

Hammelev, D.

The aim of this project is to clarify students' envisions of DNA, DNA-analysing methods and their application og the result in the society.
The method used is an analysation of the student's answers on one of the written examination questions for A-level biology 1999.
Student's answers have been coded from the following point of views:
ability to describe and explain the investigation method used
knowledge of the function of restriction enzyme
ability to explain the gel-electrophoresis picture
correct images/misconceptions on DNA
their practical DNA labwork during teaching.
Some preliminary results:
75 % of the students that worked in their school lab with DNA-analysis showed correct images. Only 36% of students that had attended a course outside their school showed correct images.
Only 39 % of students that did not work with DNA labwork showed correct images.
Discussion:
The correlations between doing labwork and ability to use the knowledge gained from these practicals are discussed.
The strength and weekness of the methods used are examined. The result of further work, using other methods, to clarify students images of DNA, the related technology and the application is reported .

Effects of different teaching contexts on students' interest in Molecular Genetics

Harms, U.

In this contribution first results of a quantitative empirical study about the effects of different teaching contexts on students' interest in molecular genetics are presented.
The theoretical background of this investigation is the interest theory developed by Krapp et al. that describes the construct 'interest' as an interrelationship between a person (e.g. the student) and a particular object (e.g. the issue 'molecular genetics'). Recent empirical studies in biology didaktik - dealing with the construct 'interest' - focused on the side of the person of the interest theory. For example, it was analyzed which biological topics students of a particular age are especially interested in. This investigation - in contrast- focuses on the object side of the interest theory, i.e. the question, how a particular issue becomes interesting for students. It is analyzed, how the context in which a certain biological issue is presented to the students - contexts that relate to students' conceptions versus scientific contexts - affects their interest in this topic.
This qualitative cross-sectional study is carried out in a pre-/posttest design with upper secondary school students of German biology courses. First results of the study conducted will be presented.

15-year-old students ideas about the development of their own understanding of biological processes

Helldén, G.

The present study of twenty-eight students' thinking about their own understanding, builds upon data from a longitudinal study of students' conceptualisation of conditions for growth, decomposition and the role of the flower in plant reproduction. Each student was individually interviewed on different occasions from age 9 – 15. At the age of 15, after the last interviews about ecological processes, the students were interviewed about their views of the development of their own understanding. The students listened to the tape-recorded interviews with them when they were 11years old. After that they were asked to make comments on what they said in the interviews and try to describe how they thought they had developed their understanding. They were also asked to describe what they thought had been of greatest importance in the development of their understanding. They could recognise statements in the interviews as results of experiences from an early age. A majority of he students could describe concrete experiences that had contributed to the development of their understanding. The students explained how their understanding had changed through the years. Conceptions developed at an early age seemed to be important for the future conceptual development.

Research on students` ethical argumentation on genetechnology in biology teaching

Hößle, C. & Bayrhuber, H.

Our interest was focussed on the question if students` moral judgement on genetechnology might be improved by teaching topics in biology lessons which are connected to students` hopes and fears on genetechnolgy. The interventional study followed the principles of a qualitative research. According to Kohlberg (1978) moral judgement has been defined as the ability to make a reasonable decision on a dilemma. To explore students` moral judgement on genetechnology we presented students in face to face interviews different dilemmata on genetechnology and ask them for their reasonable decision. In a qualitative analysis (Mayring 1993) students` arguments were assigned to six categories of moral judgement. Those categories were leaned on the pedagogical theories of Bayrhuber (1997), Dulitz & Kattman (1990) and the ethical theory of Tödt (1977) and Frankena (1972). One most important categorie was to formulate an own reasonable decision . The evaluation of the interviews should give answer to the question which ethical tradition (deontological or teleological ethical tradition) students prefer in their judgement and if they are able to consider both traditions in a balanced way when judging on genetechnology.
We tried to investigate if students` moral judgement on genetechnology might be improved by teaching topics in biology lessons by which students are highly affected.
After the intervention in school the students have been interviewed a second time to investigate if the moral judgement has been changed. The results of the study will be demonstrated in our presentation.

Practising Educational Methods in Environmental Education - a Comparison between Turkish and German Teachers using the Theory of Planned Behavior.

Klee, R., Erten, S., Bamberg, S. & Graf, D.

The presented study has three main goals: 1. To find indications for reasons which hinder or foster the use of practical work, excursions, and schoolbooks in environmental education. 2. To test the applicability and power of Ajzen's Theory of Planned Behavior (TPB) in our research fields. 3. To compare results from two different countries. As theoretical background we use the TPB. It's a general rule of this theory that the more favorable the attitude and the subjective norm, and the greater the perceived behavioral control, the stronger the person's intention to perform the behavior in question should be.
The variables of the TBP were measured via a standardized questionnaire. 180 questionnaires were filled out by Turkish teachers (Ankara), and 120 BY German teachers (Hessen). For the empirical test of the TPB the structural equation approach (AMOS) was used.
The presented results confirm the utility of using the theory of planned behavior for explaining the teachers' intention to use different methods in environmental education. In the presentation the findings of the three investigated educational methods will be given as well as the obtained results about the beliefs. The findings will be discussed in view of their practical consequences.

Coping with the abstract and complex nature of Mendelian genetics in upper-secondary biology education

Knippels, M.C., Waarlo, A.J. & Boersma, K.Th.

This PhD study aims at developing a strategy for learning and teaching Mendelian genetics, based on theoretical notions and cyclic empirical testing in co-operation with teachers ('developmental research').
Literature review and focus group interviews with Dutch biology teachers revealed that a separation of inheritance from reproduction and meiosis (resulting in abstract subject matter) and the occurrence of heredity at different levels of biological organisation (its complexity) account in considerable degree for learning problems.
Research activities which focused on defining design criteria included literature review, classroom observations, interviews with teachers and students, iterative consultation of experienced biology teachers and conceptual and curriculum analysis of (school) genetics. Gradually, promising learning activities and their sequence emerged and were transformed into a new genetics curriculum outline.
This preliminary educational strategy has been tested in a case study last January. Research data originated from different resources (triangulation): classroom observations; content analysis of completed worksheets and written tests; interviews with teacher; audio-taped oral discussions and students' logbooks.
The research findings gave rise to further reflection on and elaboration of the educational strategy. The revised curriculum will be tested in a second case study next semester.

Influence of students' nature experiences on nature consciousness and reasons for conservation.

Lude, A.

Conservation is an important issue in German school curricula. Despite this, studies observe a decreasing esteem and an abuse of nature. NGOs as well as state environmental centres address this problem with increased environmental education.
Many studies have shown little influence of knowledge on environmental attitudes and action. Yet, not much is known about the influence of nature experiences. Therefore, a standardised questionnaire was designed for assessing nature experience, reason for nature conservation, environmental knowledge, conservation attitude and conservation action.
Eight dimensions of nature experience were defined and proofed in a factor analysis. Experiences in the social dimension (i.e. pets) are the most common ones, followed by aesthetic experiences for female students and recreational experiences for male students. The most rare dimension is nature conservation experience. Students were also assigned to latent classes using MDM - Mixture Distribution Models. The ones characterised by a general high nature experience showed highest environmental attitude and action.
Secondly, seven independent dimensions of reasons for nature conservation were analysed. The most favoured reasons are bio-centric with a significant preference by female students, religious reasons are found to be the least. Using MDM, students assigned to a latent class characterised by favouring economic reasons, showed least environmental attitude and least action.

Concept mapping in the teaching of biology

Lumer, J. & Hesse, M.

Empirical studies, designed to test the conceptions senior grade pupils have of "The path from the gene to the enzyme", have shown that a large percentage of pupils questioned were not capable of giving a well-grounded presentation of the basic facts. The establishment of these facts revealed the following: 1) For a comprehensive grasp of this subject, precise knowledge of the structure of proteins and DNA plays a key role. 2) During the lessons, a wealth of terms is used and although pupils often remember the terminology, they do not appear to meaningfully understand what is behind it. 3) Having a command of selected specialist terminology, as well as a basic knowledge of chemistry, are prerequisities for the understanding of complex biological contexts.
Concept maps can, in many ways, be an invaluable aid for teachers, either in the situation that the teacher incorporates his "model concept map" in the lesson plan (Müller & Kloss, 1990) or that a teacher prepared map is used in an expository setting (Cliburn, 1990) or that a map is devised together with the pupils (Graf, 1989). Thus the following objectives can be targeted:
• The teacher is assisted in choosing the "basic" concepts needed to give a sufficiently short, precise and terse description of processes.
• Single pieces of information can be linked during a course of lessons; giving the pupils access to a learning tool.
• Concept maps can help the teacher to detect interpretations of material by the pupils which are not compatible with the actual subject matter.
• A concept map can be of help in adhering to the selected concepts; this sort of consistency is absolutely essential for pupils in the process of building up a knowledge base.
• Concept maps provide a good base for practising and repitition.
In connection with the latter aim, we have already presented a task in form of a concept mapping procedure, which shows the supportive nature of such a process when consolidating core concepts and interlinking elements of the subject material dealing with "The path from the gene to the trait" (Lumer et al., 1998).
We would now like to present a task that is meant to activate or reorganize the learners´ prior knowledge and thus help to avoid the learning obstacles we have revealed concerning molecular genetics.

The teaching of ecology in the agricultural secondary *curricula* in France: a new didactic approach

Magro, A., Simonneaux, L., Navarre, A. & Hemptinne, J-L.

The teaching of Ecology in the agricultural secondary *curricula* in France is relatively new. The displaying of the programmes has been causing some problems to the teachers (general frustration and difficulties to motivate their pupils).
The objectives of our research were to gain empirical information on the reasons why the set up of the programmes was not working and then try to overcome the detected difficulties by implementing a different didactic approach. We based our approach on the same principles that are nowadays applied to the research in Ecology, namely taking individuals as the basic subject and going from there to higher hierarchical levels in an "Bottom-up" (Golley, 1993) perspective. Experiences are included in the proposed teaching sequence.
The results of the research on the identification of teachers conceptions about teaching in Ecology and the construction of the didactic approach are presented. The implementation of this approach on teachers and pupils will be assessed; the parameters subjected to evaluation are mentioned.

Environmental education for a curriculum project in science

Membiela, P., Nogueiras, E. & Suárez, M.

In the field of environmental education, urban environments are of great importance. The school cannot ignore these problems and, in this line, we have prepared a curriculum project for the Natural Sciences in the first cycle of secondary education (12-14 year olds) called *Nature in the City*. This project is centered on the study of the local environment, and its design and implementation has been carried out for the last eleven years by a research group on collaborative action made up of four secondary school teachers and two university professors. The programme is designed according to the infusion model, that is, each of its units includes environmental topics.

The evolution of knowledge about the cell as a living unit among Biology degree students

Mondelo Alonso, M., García Barros, S., Martínez Losada, C., & Vega Marcote, P.

This paper sets out to compare the ideas and forms of reasoning among first and second year Biology degree students with regard to the cell as a functional unit. The functions most readily understood by the students as a whole as characteristics of all cellular types are reproduction and respiration, while the "reception" of nutrients -13 % in the first year and 34 % in the second-, the elaboration of their own natural material -5 % and 20 %- and the elimination of waste substances -13 % and 30 %, respectively-, are attributed to specific cells. This shows that the students base their reasoning on the most relevant functions of the cells, over-generalizing the fact of cellular specificity. On the other hand, the 37 % of the second-year students only 5,3 % of first-year students recognized the need for the supply of oxygen and nutrients for the functioning of the myocardium. The results obtained allow us to conclude that although there is an important improvement in the knowledge of second-year students in comparison with first-year, these are specific, and there still exists little capacity for applying general principles to concrete examples and for relating concepts, the basis of significant learning.

Interactions between students' conceptions of the digestive system and the teaching process

Muñoz, X. & Puigcerver, M.

We investigate the interactions between students' conceptions of the anatomy of the digestive system and the teaching process, in a sample of 111 students of Secondary Education (14 years old) in Barcelona (Spain).
Students were required to draw a model of the digestive system at three moments: before teaching (1st stage), after it (2nd stage) and one year after (3rd stage). From these drawings we calculated complexity and correctness indexes of each model, together with a diversity index of the models.
Results show a high diversity of models in stage 1, especially concerning the structures after the stomach; liver and pancreas are poorly represented, and 27.9 % of the students connect lungs with the digestive system. Complexity and correctness are clearly low.
In the 2nd stage, diversity decreases, although it is still very high; correctness and complexity increase, reaching the latter the levels of the real model; however, few students reach it. Liver and pancreas appear now in a high number of models, while connection of lungs to the digestive system decreases remarkably.
In the 3rd stage, correctness decreases, although it does not reach the low levels of the 1st stage. Diversity increases to a higher level than that of the 1st stage.
In summary, teaching process produces an increase in correctness, complexity and diversity of the models; however, a new teaching strategy is needed.

Teachers` and students` activities during field classes

Nowak, M. A.

An organisation teachers` and students` work during biology lessons has an influence on the course and results of a didactic process. Thus, a research on the activities of teachers` and students` seems to be very important as it increase our knowledge on the structure of biological skills and the process of their development.
The aim of my research was to investigate teachers` and students` activities during field classes on the natural didactic trial in the Arkoński Forest, the subject of which was a determination of conifers. The basic method of research was pedagogical observation based on the observation card. Teachers` and students` activities were recorded on a preparatory, realisation and control part of the field classes what provided me with a detailed description of their work on the determination of conifers in the Arkoński Forest (on the natural didactic trial).

Teaching the phenomenon of acid rain. An experimental approach using "real world " materials

Papalambros, L.

The synchronous conception of teaching life sciences demands the use of real world examples and the use of household or everyday life materials. The experiment approach of acid rain phenomenon offers the opportunity to develop the method of teaching topics like acids bases, pH, neutralization reaction, combustion and chemical equilibrium. Two series of experiments are presented to students. In the first we make an effort to familiarize them with i) The use of natural indicators (red cabbage juice). Using white vinegar we observe the color of red cabbage juice changes from purple to pale red pH 4-6 or to deep red pH 1-3. Using household ammonia we observe the color of red cabbage changes from purple to blue pH 8-10 or to green pH 11-12 .We soak coffee filter or household paper towel to red cabbage juice so we make pehametric paper for our experiments. ii) The equilibrium between plants and animals that occur in the nature. (Exchange of carbon dioxide). iii) The intervention of human factor in equilibrium above. iv) Using red cabbage juice or chemical indicators we prove the acid natural of carbon dioxide or sulfur dioxide solutions. When carbon dioxide and sulfur dioxide, products of combustion, are diluted in atmospheric vapors creates acid rain. We teach the acid reaction off two gasses using the optical observations of indicators and so introduce the students in the meaning of acid rain. In the second series we make an effort to I) Calculate the pH of rain. We don't observe scientific announced results. The effort is the introduction of students in this progress. ii) Calculate the buffer capacity of limestone soil in our town. We use pehametric papers from red cabbage, limestone, vinegar and household soda. The visual aids of indicator color prove to the students the buffer capacity of limestone soil.

Relevant knowledge in decission making about the environment: a case study

Pereiro Muñoz, C. & Jiménez Aleixandre, M. P.

Decission-making and the criteria considered when choosing one path or action is one capacity to be developed in environmental education (e.e.). A case study is presented on the knowledge –concepts, issues, relations– considered by secondary school students working on a environmental management problem. E.E. is a matter of values, attitudes, behaviour, but in our perspective the development of values and attitudes should be founded on relevant knowledge, otherwise the risk is that an apparent change in the value system of students turns out to be little more that a slogan.
This paper is part of a project about the relations between argumentation and concept learning. Participants are 11th Grade students working on a real issue about water drainage in a wetland: they were videotaped and audiotaped and the transcriptions analyzed by means of discourse analysis. The problems explored are: which elements are viewed as relevant by the students and which relationships are established among their conceptual knowledge and the decissions. Results show that the students take several elements into account, almost the same that would take experts. Instances about the relationships between conceptual knowledge and decissions are discussed. The implications for problem-solving in Environmental Education are also outlined.

Teachers' and biology students' preparation for attempts at didactic innovations in human genetics at the secondary school level

Potyrala, K.

School reform in Poland, as well as the necessity of carrying out the transformation of cytological and genetic knowledge from a higher stage of education (grades 11-12) onto a lower one (grades 8-9) creates for teachers new tasks , requiring good specialist training as well as the training for applying in practice modern forms and methods of teaching, teaching aids, new ways of control and evaluation of students'achievements and adjusting them to real needs of the educational system.
Research carried out by the author was connected with the introduction to high schools unique concept of didactic solutions in human genetics. 386 students (9^{th} year of education), including 9 experimental classes and 2 control classes were involved in the research. Alother the course of 175 genetics lessons was observed. 87 times computer was used in the program. The research results were among others, used for establishing the degree of readiness of both students and biology teachers for undertaking teaching innovations in human genetics at the level of junior high school.

Animations, self-regulation, and motivation in a computer-based learning environment for neurobiology instruction

Prechtl, H., Urhahne, D., von Davier, M. & Schenzer, M.

In this study, 46 11th- and 12th- graders of German Secondary Schools worked with a computer-based learning environment, in which basic functions of the nerve cell membrane were demonstrated via illustrations with explanatory texts. The aim of the study was to investigate the effects of animations and self-regulation on learning gains and motivation. Therefore, two versions of the learning environment were used, one with animated illustrations and one with still images combined with textual descriptions of the dynamic processes. Furthermore the learning conditions were varied for high and low self-regulation. In a pretest questionnaire the learners´ factual knowledge was checked and their individual visual and verbal learning preferences as well as their motivational attitudes were registered as covariates. After working with the computer-based learning environment, students´ knowledge gains and the motivational effects of the learning environment were checked with another questionnaire. Individual motivational attitudes of the learners were significantly correlated with knowledge gains, whereas visual or verbal learning preferences had no influence on motivation or learning success. Interestingly, there were tendencies of interactions between animations and self-regulation. Results are discussed with special respect to the need for an instructional balance of instruction and construction in multimedia learning arrangements.

Students' understandings about organs and organ systems in different animals

Reiss, M & Tunnicliffe, S. D.

Almost nothing is known about what, if any, differences there are between what children know about human organs and organ systems and those of other animals. In this study, a cross-sectional approach was used involving a total of 150 students from six different age groups (ranging from 5 year-olds to 20 year-olds). Students were presented, on separate occasions, with preserved specimens of a brown rat, a starling, a herring and an edible crab and asked to draw what they thought was inside each specimen. On the last occasion, they were also asked to draw what they thought was inside themselves. Repeated inspections of the completed drawings allowed us to construct a seven point scale with levels ranging from level 1 (no representation of internal structure) to level 7 (comprehensive representation with four or more organ systems indicated out of eight: skeletal, gaseous exchange, nervous, digestive, endocrine, urinogenital, muscular and circulatory). Our analysis shows such things as the extent to which student knowledge increases with age and the degree to which pupils know more about human organs and organ systems than other animals and the very different understandings students have of different organs and different organ systems.

The teaching of biological evolution based on students´ alternative conceptions

Sánchez-Mora, M. C.

Although it is known that evolution is a very important topic in Biology and general culture, it is surprising to find that many students who are begining a Biology degree at the National University of Mexico have problems with this topic in spite of the fact that they have taken at least four Biology courses since Junior High School.
Starting from an examination designed to detect misconceptions, the knowledge of the concept of evolution in Mexican students from Junior High School until they finished a Biology degree in Biology was evaluated. This two-tier examination is based on the method of "conceptual trace analysis" proposed by Jensen and Finley (1996) and developed on pilot tests. Once the misconceptions that students usually have on evolution were identified, the subject was taught with a new approach at a pre- university school.
The procedure consisted in teaching the lessons according to a strategy of conceptual change, with a historical approach and with the support of analogies, examples and illustrations. Results show a better handling of the concept of evolution when analogies and the proposed approach were used, than with the traditional teaching method of lectures, if and when the starting point is the student´s misconceptions.

Ideas about conditions and mechanisms of growth

Saraiva, A. & Russell, T.

This paper reports some findings about the understanding of the concept of growth amongst pupils aged 6 - 17 years in Portugal, as well as student teachers, generalist primary teachers and science preparatory teachers who taught pupils involved in the study. A cross-age study probed ideas about conditions and mechanisms of growth to establish when an incremental shift towards more scientifically acceptable ideas occurred. Subjects' ideas about the conditions and mechanisms of growth were elicited using photographs and drawings of living things. Subjects' ideas were obtained through individual interviews.

The findings indicated that pupils up to the 10-11 age group have restricted ideas about sources of matter and energy in relation to all living things and seemed to see growth as a discontinuous process. Older age groups began to give explanations which involved a continuous process. The acquisition of the cell concept seemed to be crucial to the shift from the macroscopic to the microscopic understanding of the growth concept. The majority of student teachers and teachers seemed to have difficulty with the microscopic understanding of conditions and mechanisms of growth.

Models of human circulatory system in science textbooks: building a framework for representation analysis

Selles, S. E., Ayres, A. C. & Reznik, T.

The basic assumption of this paper is the understanding that scientific knowledge is representational and results from a modelling activity. Following the work developed on mental models (Gilbert, 1997), we will analyse a number of teaching models employed by fourteen textbooks from primary to secondary level to represent the human circulatory system, using as reference the work of Buckley and Boulter (1997). For them a mental model is an integrated knowledge of structure, behaviour and mechanism of a phenomenon. The general idea was then, to study to what extent textbooks representations included the components of the mental models. We developed a mode of analysis which maintained certain features of the Buckley and Boulter's work. Three representational dimensions of circulatory system were considered: *semantic-contextual dimension; correspondence dimension; abstract dimension.* Within each dimensions a set categories were used in other to check which component of the mental model (*structure, behaviour and mechanism*) is related to. The framework developed in this work grasped three elements of the data: the mental model components, the type of representation used and the teaching level targeted.

Comparison of the impact of a role play and of a classical discussion on students' argumentation concerning an issue in animal transgenesis

Simonneaux, L.

This paper compares the impact of a role play and a conventional discussion on students' argumentation on an issue involving animal transgenesis. Students were confronted with an imaginable but fictional situation. They had to decide whether or not to approve a giant transgenic salmon farm being set up in a seaside village. Students received the same teaching and information, the only differences being in the debate situation.
Students were asked to reach a decision on well-argued grounds, to identify areas of uncertainty and to define the condition or conditions under which a change of view might be considered. They had to write them down. Pre post-test were used to assess the students' opinions. The role plays and discussions were all videotaped and audiotaped, and transcribed in full.
Our analysis focuses on the argumentative structure of the students' discourse and identifies the reference areas that students draw on to deliver their arguments. The theory on economics of "grandeur", which has recently emerged as a framework for the sociology of justification, has also been used in analysing students' discourse.

Discourse analysis: pupils' discussions of soil science

Sóñora, F., García-Rodeja, I. & Brañas, M. P.

As a part of the RODA project on classroom discourse, we recorded taped pupil interaction during a one month unit on soil science. At the beginning of the unit, the pupils (aged 14-15 years) were presented with a land allocation problem that they would have to decide on, in groups, on the basis of information on soil properties. Throughout the unit, teaching, course materials and group activities were centred on acquisition of the knowledge and information required for solution of this problem. At the end of the unit, each group presented a report with its conclusions. The audiotaped group discussions were currently being analysed using Toulmin's methods. External observer notes suggest that the unit was successful in developing argument skills.

Análisis del discurso de estudiantes de segundo de bachillerato sobre el campo conceptual de la respiración

Tamayo, A. O. E. & Sanmartí, P. N.

Within science education, the current importance of studies on scientific language is based on several aspects; among them we select: the main function of language as a privileged communicative means in education; its role as a mediator and regulator of students' development of thought; its role as a mediator in meaning elaboration. Within this new perspective on the use of language, new ways of observing and talking are needed that involve students' active participation in their learning process and the use of different viewpoints when considering new situations. Based on these considerations, we developed a functional analysis, centred on coherence, of texts elaborated by students on the topic of respiration; this allowed us to identify obstacles which may orient didactical intervention. Among these obstacles, we underline the low global coherence of the texts and the elaboration of a discourse with low cognitive and conceptual demands. This leads to acknowledege, among other aspects, the importance of favouring, in science classes, the elaboration of non-causal texts, and of promoting the gradual acquisition of a wider global coherence in this subject.

Children's Categorisation of Animals: Does Culture Make a Difference?

Teixeira, F. M.

There is evidence that daily experience is one of several factors through which people construct biological knowledge. It can then be hypothesised that cultural context will affect people's biological knowledge. However, this hypothesis has been confirmed by some researchers and refuted by others. A study was conducted to examine if children's identification of animal's morphobehavioral features and how they classified animals is affected by their cultural background in order to contribute to clarification of the organisation and building of children's biological knowledge, and to consider how best to encourage its development. Brazilian children - 16 from an urban area and 15 from a rural area - all aged 9 were interviewed and asked to classify replica plaster animals. It is concluded that (1) children's apprehension of animal's morphobehavioral features and how they classify animals is affected by their cultural background; (2) children know facts such as an animal's morphology without establishing those facts into the structure of a biological knowledge-specific domain; (3) categories do not necessarily constrain biological knowledge; and (4) the identification of an animal's perceptible properties seems to be a way through which children build up their biological knowledge.

The stories diaries tell us: Qualitative observation, interpretation and hypothesis making by 12 year old pupils keeping brine shrimps

Tomkins, S & Tunnicliffe, S. D.

When given an observation task, pupils may report what they think they should and not what is actually seen. As part of a larger study made on pupils studying brine shrimps (small salt-water crustacea) eight twelve year old pupils from two English secondary comprehensive schools observed their own personal bottle ecosystem of animals over a two week period. Each pupil kept their own diary. There was no prior teaching or teacher interaction; the pupils wrote their thoughts and observations. Tape recordings were made of pupil's initial observations and their conclusions after keeping the animals for one week. Analysis of these tapes and the diaries was carried out through assigning statements to categories which were established after repeated reading of the transcripts and texts. These showed that observations were based largely on structural and behavioural observations and that pupils spontaneously raised questions and answered them from their subsequent experience. Clear personal constructs and hypotheses emerged. Pupils interpreted what they observed from their everyday experiences including topical news items and television programmes. The results indicate that pupils not only notice from their own undirected observations salient anatomical and behavioural features but that these provide a powerful base from which better biological observation may be developed.

Field work -Teaching for attitudes as well, as for facts

Tunnicliffe, S. D.

This paper reports the topics of conversation of pupils of 10-11 years made whilst collecting freshwater life in a fast flowing river. The spontaneous conversations of the pupils were recorded, transcribed and subsequently analysed using both a systemic network and a read/re-read approach. Most of the conversations were concerned with interpreting what was seen, naming specimens and their parts and describing behaviour, together with affective comments. The boys also referred to other aspects such as equipment. No comments were made about conservation or the natural habitat. Reading and re-reading the transcripts showed that there was also a personal and social aspect which ran alongside the factual observations and interpretations as well as some aspects of spiritual and moral awareness present. In addition, it was apparent that the content of the conversations changed in their focus as the visit progressed through the stages of orientation, focus and general attention. The study shows that there are two main aspects to the work: Firstly observations made and commented on by pupils in terms of interest and the academic curriculum and secondly, the area and personal and social aspects which emerge in parallel to the academic focus.

Personal influences on the development of interests and non-interests of children in primary school with special concern given to biological contents

Upmeier zu Belzen, A., Vogt, H. & Schäflein, K.

The theoretical framework of the study is a model based on the interest theory of Schiefele et al. (1983) and Krapp (1992) extended by the dimension non-interest consisting of the degrees passive and active non-interest.
In a longitudinal study children will be supervised from primary to secondary school. These children have already been investigated in nursery school concerning the objects of their interests and non-interests and the trigger for and personal influences on their interest and non-interest development. In the following part of the longitudinal study special concern will be given to biological interests and non-interests. We expect that the development of particular interests and non-interests is strongly motivated by personal influences such as parents, teachers and peers. In addition we hypothesize that children who have formed a person-object-relation at the time of nursery school are more likely to form new person-object-relations later on than children without these early kinds of interests are. Non-interested students concerning special biological topics should develop into more or less interested ones by adequate lessons. The influence of teachers' interests and non-interests on the development of interests and non-interests of the students - especially concerning biological issues during teaching - is analyzed aswell.

Teaching and Learning about the Biological Evolution: Conceptual Understanding before, during and after Teaching

Wallin, A., Hagman, M. & Olander, C.

This study is one part of a project with the main purpose of developing a teaching sequence that enables the students to construct a model of the biological evolution, focusing on the dynamics of change. Another purpose of the project is to document the students´ conceptual development. The theoretical background throughout this project is the model of conceptual change.
In this study we focused on two key concepts in evolution - "variation" and "natural selection". The development and the long-term retention of these concepts among Swedish students (17 – 18 years old) were studied. The students' prior knowledge was investigated by a pre-test before teaching. During the teaching period some students were interviewed about these concepts, and small group discussions of the same concepts were videotaped. Approximately a year after teaching the students was given a re-test, which was essentially identical with the pre-test.
The majority of the students abandoned their prior ideas of strive and need, and adopted a more scientific view of these concepts when solving our test problems. This was evident both in the interviews and in the re-test. The conceptual development of the interviewed students is discussed in the paper.

The development and evaluation of a teaching scheme for improving scientific thinking skills in the context of Genetic Engineering

Zogza, V. & Ergazaki, M.

The aim of this work was the development of an instructional strategy that improves thinking skills of Biology students in the University. The subject of Genetic Engineering offers an appropriate context for developing reasoning as it includes many concepts that should be interconnected by the learner and deals with experimental procedures. In particular we attempted to develop a didactic sequence based on the syllabus of Molecular Biology/Biotechnology course offered in the Biology Department of Patras University. This didactic sequence is consisted of a series of tasks constructed to develop cognitive skills while covering the syllabus, and is based on earlier work by Tamir and Zohar. The instructional strategy included the choice of group work for students as this is related with improvement of reasoning.
This paper reports on the design of the instructional strategy and the results obtained during the application and evaluation of it. The evaluation of the instructional procedure was based on the qualitative analysis of students' achievements at the pre- and post- instruction tasks, and qualitative analysis of the conversations of group members. The analysis of conversations was based on a socio-cultural theoretical framework, and was three-dimensional.

The development of ideas of pre-school children regarding the organization and function of human body organs through a socio-cognitive intervention

Zogza, V. & Gritsi, F.

This study is the product of our concern for developing teaching activities for young children, 4-6 years of age, that are applied experimentally and evaluated before the actual introduction in the classroom.
The identification of naïve conceptions of 5-6 years children is a prerequisite both for understanding as well as for developing further the way children think about inner organs of the body. This paper reports on the naïve conceptions of pre-school children about the inner organs of the human body and the development of their ideas through a socio-cognitive intervention.
In the first phase of the study the conceptions of 86 children were identified with personal interviews concerning their drawings of the inside of the body. Our findings showed that most children were familiar with the existence of some organs in the inside of the human body. However, very few children connected organs of the same organic system and had knowledge of their function. In the second phase of the study a socio-cognitive teaching intervention was developed about organic system structure and their functions. The teaching intervention was positively evaluated on the basis of differences between pre- and post- intervention conceptions of a sample of 20 children.

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