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# Geoscience Education: Understanding System Earth

GeoSciEdV

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International Geoscience Education Organisation  
(IGEO)

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**Titelbild:** German kindergarten children discover the nature of sandstone using activities developed by the Earth Science Education Unit at Yale University, UK. (Foto: Hlawatsch)

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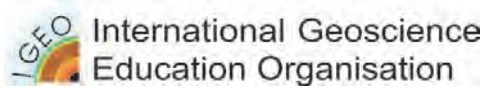
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International Year  
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## **Introduction and welcome by the Minister of State for the Environment, Health and Consumer Protection**

I have very gladly accepted the patronage for the Geoscience Education Conference 2006 in Bayreuth and am very happy to see this international conference taking place in Bayreuth this year. In my position as minister of state for the environmental resort I would like to welcome everybody here in Bayreuth in the name of the Bavarian state government.

The professional challenges for the geosciences have never been greater than they are today. The problems to be solved are not just of a local or regional nature but are on a global scale.

The population of our planet is increasing, the finiteness of mineral resources is becoming more and more obvious, clean drinking water is not available in many parts of the world, soil protection has become a central topic, the ecosystems are under rising pressure and the climate is changing. This is why the geosciences are among the survival-sciences for mankind. It is therefore all the more important that they be firmly anchored in our educational system, in the schools and outside. True to the principle "You only can and want to protect what you know".

I therefore highly appreciate it that the International Geoscience Education Organisation (IGEO) addresses a wide spectrum of important and current topics at this conference. I am also pleased to see that the geology of northern Bavaria and of the neighbouring regions, including the Czech Republik, takes up a prominent place in the programme. The field trips which are being offered are aimed at providing you with an insight into the special features of these regions. Apart from the scientific aspects I am sure that you will also enjoy the beauty of our Bavarian landscape.

I wish you all a pleasant stay in Bayreuth and a successful conference. May it provide you with many stimuli that will increase our knowledge on how to safeguard the natural resources and on how to convey this knowledge in a didactically sound way.

Dr. Werner Schnappauf

Minister of State for the Environment, Health and Consumer Protection

## **Welcome to the V<sup>th</sup> International Geoscience Education Conference (GeoSciEd V)**

On behalf of the Leibniz Institute for Science Education (IPN), Kiel, the Geo-Centrum at the German Deep Drilling site KTB, Windischeschenbach, and the University of Bayreuth, we welcome you to the Fifth International Geoscience Education Conference (GeoSciEd V) in Bayreuth.

This old Bavarian city is not only famous for its cultural tradition and its Franconian- Bavarian life style, but also well known for its geological surroundings. These characteristics form set-ups for stimulating excursions and relaxed conversations. The modern University of this city provides perfect facilities for a successful international meeting.

The organizers have tried to develop a conference program which comprises the major dimension of Earth Science Education. A great many contributions follow an interdisciplinary approach integrating geographical and geological aspects as well as biological, chemical and physical ones. This is in accord with the educational aims set by the Geoscience Associations of this country. It also corresponds with the educational approach of the IPN project "System Earth", which marks a milestone of the quality improvement of Geoscience Education in Germany.

We are looking forward to stimulating and productive contributions and discussions during this meeting of excellent geoscience educators from all over the planet Earth.

Horst Bayrhuber, IPN, Kiel

Sylke Hlawatsch, IPN, Kiel

Ulrike Martin, KTB, Geo-Centre

Gabriele Obermaier, Univ. Bayreuth

## Welcome

The Council and Senior Officers of the International Geoscience Education Organisation (IGEO) have much pleasure in welcoming you to GeoSciEd V. We have a varied and interesting program and know that you will find it stimulating and informative.

IGEO runs an international Conference approximately every four years, alternating with a representation at the International Geological Congress, which also takes place at four year intervals. The first conference was at Southampton in the UK in April 1993. This first conference sparked interest but it was not until 1997 that GeoSciEd was proposed as the name of the conference. IGEO was founded at that 1997 GeoSciEd II in Hawaii. GeoSciEd III in 2000 was held in Sydney, Australia and GeoSciEd IV was in Canada in 2003.

The aims of the International Geoscience Education Organisation (IGEO) are to promote geoscience education internationally at all levels, to work for enhancement of the quality of geoscience education internationally and to encourage developments raising public awareness of geoscience, particularly amongst younger people. We are affiliated with the International Union of Geosciences which provides us with some financial support for conference attendance by delegates who would not otherwise be able to attend. This year we have been able to support 14 delegates from our own and IUGS resources.

The conference comes at an important time with the declaration of 2008 as the *International Year of Planet Earth* and the recognition of the significant role of geoscience education in creating a sustainable future for humans and their planet.

If this is your first GeoSciEd conference, welcome to the IGEO family. If you are a regular, welcome back. We look forward to the usual friendly interactions between members during the formal sessions, the breaks and the social events.

GeoSciEd V will be an exciting four days. Please immerse yourself in all aspects of it.

Once again, welcome. Enjoy GeoSciEd V and make plans for GeoSciEd VI.

Ian Clark, Chair of the International Geoscience Education Organisation (IGEO)

## **Greeting from Professor Dr. Dr. h.c. Helmut Ruppert, President of the University of Bayreuth**

Dear participants of the Fifth International Geoscience Education Conference,

geographical factors as soil, water or air not only shape our livelihood but also provide our economic basis. With regard to the growing population it becomes even more important to know these resources and their simultaneous interrelations in

order to assure their efficient usage and to guarantee their sustainability.

Along to the research of the geographical factors the transfer of the newest research findings to young people poses a challenge, which we have to meet in order to ensure the continuous further advancement of knowledge. A profound didactic preparation of topics in the field of Geosciences serves as a foundation for creating an access to the according topic area for young people and for transferring the knowledge about our earth.

I am glad to welcome you to the Fifth International Geoscience Education Conference at the University of Bayreuth and wish you a successful and interesting meeting!



A handwritten signature in black ink, which appears to read "H. Ruppert". The signature is fluid and cursive, with a long horizontal stroke at the end.

Professor Dr. Dr. Helmut Ruppert, 28<sup>th</sup> of June 2006

President of the University of Bayreuth

## The IPN Leibniz Institute for Science Education at the University of Kiel

The Leibniz Institute for Science Education (IPN) was founded 1968 as a research center for science education. It is located in Kiel at the Baltic Sea. As an institute of the Leibniz Association with a nationwide function IPN receives funds from the federal government and the German states (Bundeslaender). IPN is also affiliated to the University of Kiel.



The institute's mission is to develop and promote science education through research. This research deals with the full scope of issues concerning teaching and learning in

the sciences inside and outside schools. The institute is made up of four departments: Biology Education, Chemistry Education, Physics Education and Educational Science (including Research Methodology and Statistics). Of the approximately 110 IPN staff members about 80 with an university degree are working as scientists, including 30 doctoral students. About 40 % of the staff members are working on projects funded by different research foundations or clients.

The IPN concentrates on long-term and nationwide research projects which cannot be covered by universities.

In 2000 the IPN started the project "System Earth". This is an effort to introduce geoscience topics to upper secondary and primary school education in a systematic and interdisciplinary manner. The IPN aims at mediating between geoscientific research and schools as well as the general public. The project has been funded by the BMBF (German Federal Ministry of Education and Research) within the framework of the program "Geotechnologies"; it has been advised and evaluated by a scientific advisory committee with representatives from earth science research institutes and museums as well as representatives from the 16 German Bundeslaender ministries of education.

Science and geography teachers, educators and geoscientists worked together to produce an interdisciplinary teaching concept and corresponding teaching materials. Research on teaching and learning geosciences and evaluation studies was carried out. For the primary school the book "Our Earth for children who want to understand the world" was published. It contains a CD-ROM with two learning games. For the upper secondary level the CD-ROM "System Earth for upper secondary education" was produced. Scientific articles have been published.

Further information: [http://www.systemerde.ipn.uni-kiel.de/systemerde\\_eng.html](http://www.systemerde.ipn.uni-kiel.de/systemerde_eng.html)



Projekt „SystemEarth“

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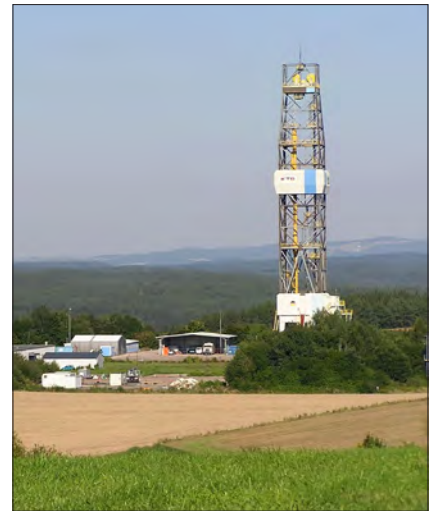
Olshausenstr. 62

24098 Kiel

Contact: Prof. Dr. Horst Bayrhuber ([Bayrhuber@ipn.uni-kiel.de](mailto:Bayrhuber@ipn.uni-kiel.de)) or  
Dr. Sylke Hlawatsch ([hlawatsch@ipn.uni-kiel.de](mailto:hlawatsch@ipn.uni-kiel.de)).

## **Geo-Centre at the continental drilling site (KTB): A geo-scientific and geo-educational outreach**

The two super-deep boreholes (4000 m and 9101 m, drilled from 1987-1994) of the German Continental Deep Drilling Program are worldwide unique masterstrokes of drilling engineering. It yielded essential insights in the structure and processes of the upper crust of the Earth. For this reason it is one of the most important geo-scientific and geotechnical research projects ever undertaken in Germany. Key questions that have been addressed by continental deep drilling included the evaluation of fundamental processes occurring in the lithosphere, the outer skin of our planet and resource base for mankind. Among these are the understanding of earthquake activities and the formation of ore deposits, important questions in a world of growing population and vast development. The drilling activities near Windischeschenbach formed the German contribution to worldwide efforts on understanding our planet.



After finishing the project the geo-education centre has been established, which is a unique place where geo-science and teaching go hand in hand and where science is made transparent to the public by public education. The philosophy of the Geo-Centre at the KTB is to provide the possibility for earth scientists, teaching professionals, students and pupils to learn in a practical and interactive way more about the system earth.

Dr. Ulrike Martin

### **GEO-Zentrum**



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# **Keynote speakers**

## Geosciences and outreach: Examples from the program “City of Science 2005 Bremen/Bremerhaven”

GEROLD WEFER

DFG Research Center Ocean Margins (RCOM), Bremen University, MARUM, Bremen, Germany,  
Email: gwefer@rcom-bremen.de

Bremen and Bremerhaven scientific institutes have been working closely together for many years. For this reason the two cities submitted a joint proposal for developing a program for the “City of Science” for the year 2005. The program is directed at the specific target groups children/youth, teachers, high-school seniors, college students, information distributors/decision makers, and the interested general public.

It didn't contain the standard, already-planned activities, rather it consisted of “highlights” developed specifically for the “City of Science”, by which the communication and culture of science can be effectively strengthened for the long-term.

The building blocks of the science city developed for this purpose consisted of five modules, each comprising numerous events. These modules were framed by an opening ceremony in Bremen and a closing ceremony in Bremerhaven.

The first two modules, with exhibits and settings in central locations in Bremen and Bremerhaven, were directed at all target groups. In a third module, events such as technology talk shows and open-door afternoons in businesses specializing in science-economics interfacing were grouped. These were carried out in cooperation with the Bremen Chamber

of Commerce, the IHK in Bremerhaven, and technology representatives of the free Hanseatic City of Bremen. Module four was dedicated to the important target groups students and teachers, and included the school project HIGHSEA, the Girls' Day and the summer schools, as well as continuing education for teachers. Inspiring the public with science – and doing it in unusual ways, this was the mission of the fifth module, which was achieved through film festivals, moderated concerts, readings, sound productions and exhibitions.

The program was supported by partners in the media, including the Bremer Tageszeitungen AG, Nordseezeitung Bremerhaven, and Radio Bremen. Additional important support was provided by Bremen Marketing GmbH and through the cooperation of artists who, among other things, worked on the corporate design of the program book, the flyers, posters, and press releases. The web presence was represented at addresses such as [www.city-of-science.de](http://www.city-of-science.de), [www.stadtderwissenschaft-2005.de](http://www.stadtderwissenschaft-2005.de).

A few examples will be presented from each module, including the opening ceremony, container exhibits, and Circus Quantenschaum. Further programs will continue in the House of Science ([www.hausderwissenschaft.de](http://www.hausderwissenschaft.de)). It opened in 2005 and is located in Bremen across from the city hall.

## A geoscientific approach to the PISA 2006 framework of scientific literacy

SILKE RÖNNEBECK

IPN Leibniz Institute for Science Education at the University of Kiel, Germany,  
Email: roennebeck@ipn.uni-kiel.de

Are students well prepared to meet the challenges of the future? Are they able to analyse, explain and communicate their ideas effectively? Do they have the capacity to continue learning throughout life? Parents, students, the public and those who run education systems continually ask these questions. PISA, the *Programme for International Student Assessment*, aims at providing some answers. PISA is an OECD (Organisation for Economic Co-operation and Development) project that assesses the extent to which students near the end of compulsory education have acquired some of the knowledge and skills that are essential for full participation in society.

PISA started in the year 2000 and is supposed to monitor the achievement of 15-year-olds in the principal industrialised countries on a three-yearly basis. The number of participating countries increased from 43 countries in the first assessment in 2000 to 57 countries (including all OECD countries) in the third assessment in 2006. The main domains that PISA assesses are reading (main component in PISA 2000), mathematics (main component in PISA 2003) and science, the latter being the main component of the PISA 2006 survey. In all cycles, these domains are covered not merely in terms of mastery of the school curriculum, but in terms of important knowledge and skills needed in the students' personal, social and global life. The term that best describes the purpose of the PISA 2006 science assessment is the evaluation of *scientific literacy*. In the context of PISA 2006, scientific literacy refers to an individual's:

- scientific knowledge and use of that knowledge to identify questions, to acquire new knowledge, to explain scientific phenomena, and to draw evidence-based conclusions about science-related issues;
- understanding of the characteristic features of science as a form of human knowledge and enquiry;
- awareness of how science and technology shape our material, intellectual, and cultural environments; and
- willingness to engage in science-related issues, and with the ideas of science, as a reflective citizen.

It may be characterised as consisting of four inter-related aspects:

- Recognising life situations involving science and technology. This is the *context* for the assessment.
- Understanding the natural world, including technology, on the basis of scientific knowledge that includes both knowledge *of* the natural world and knowledge *about* science itself. This is the *knowledge component* of the assessment.
- Demonstrating competencies that include identifying scientific questions, explaining phenomena scientifically, and drawing conclusions based on evidence. This is the *competency component* of the assessment.
- Responding with an interest in science and showing support for scientific enquiry. This is the *attitudinal dimension* of the assessment.

This relationship is represented graphically in Figure 1:

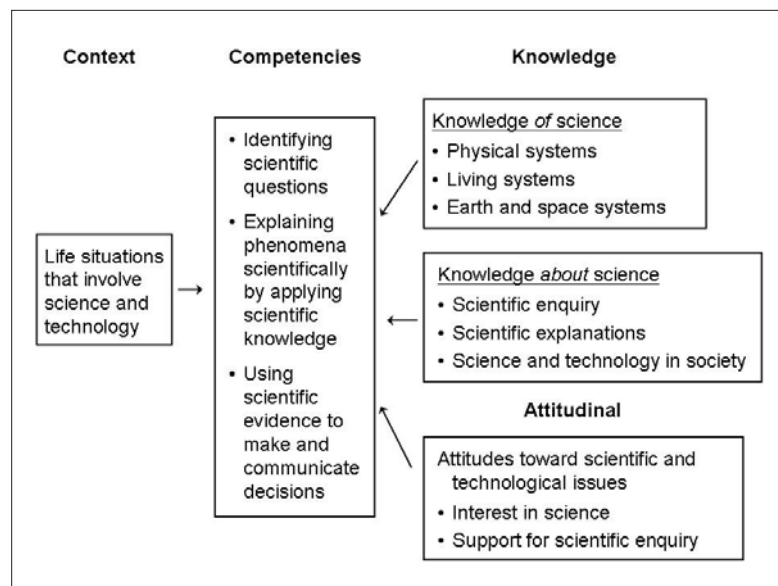


Fig. 1

This talk will present and discuss the different aspects of the PISA 2006 Framework of Scientific Literacy while paying special attention to the geoscientific content. The domains, competencies, knowledge categories and attitudinal approaches will be illustrated by example items. Interactions between the different domains of the PISA assessment (reading and mathematics with science) and possible research questions concerning the geoscientific items at an international or national level will be presented.

## Earth systems education in Germany: Project "System Earth"



SYLKE HLAWATSCH<sup>1)</sup> & HORST BAYRHUBER

IPN Leibniz Institute for Science Education at the University of Kiel, Germany,  
Email: [hlawatsch@ipn.uni-kiel.de](mailto:hlawatsch@ipn.uni-kiel.de)

The Project "System Earth (German: Forschungsdialog: System Erde)" was established in 2000 to introduce modern Earth science research issues into German primary and upper secondary biology, chemistry, geography and physics education.

The educational argument is to stimulate a rational discourse on issues of planet Earth. This discourse needs well founded scientific knowledge. This is why the natural sciences as well as geography are taught in a geoscientific context in the project frame. This educational approach is quite new for biology, chemistry and physics teaching. The same is even true for geography teaching which focuses on socio-geographic contents and issues rather than on natural science contexts in Germany. In addition, the new materials of project "System Earth" meet the requirements of interdisciplinary science and geography teaching. The cooperation of teachers from the different subjects can be achieved in several courses or in projects at the upper secondary level. Nevertheless, such an approach is not common. However, in primary schools geoscientific contents are taught interdisciplinary – if at all.

The project "System Earth" established a three step approach to achieve its goals:

- Subject matter analysis: Based on the scientific framework, a subject matter analysis was conducted in cooperation with Earth scientists and science educators.
- Educational framework: A system of basic concepts and teaching methods for the development of pilot teaching material was established.
- Empirical research: Analysis of students' conceptions, students' interests and the process of implementation was carried out.

Accordingly, the project "System Earth" aimed at carrying out research on teaching and learning in the fields as well as developing teaching materials that focus on an understanding of the System Earth with its interacting subsystems. The framework of Earth science themes was collected in cooperation with 18 German Earth science institutes as well as biology, chemistry, geography and physics educators.

A module list for upper secondary education was constructed from this framework. This list was discussed with teachers and a strategy for developing teaching materials based on explorative studies about students' perceptions of and interests in the Earth

system was then derived. The developmental work focussed on upper secondary education during the first project phase. The teaching materials were tested in schools and teacher training workshops, evaluated and then improved step by step. Finally the materials for the upper secondary level were compiled on a CD-ROM "System Earth – teaching materials for the upper secondary level (German "System Erde – Unterrichtsmaterialien für die Sekundarstufe II)":

- System Earth – an introduction
- The rock cycle: Documents of the earth's history
- The carbon cycle
- Resources and recycling
- Convection in the atmosphere, hydrosphere and lithosphere
- Origin and development of life
- The climate system and the history of climate change
- The water cycle and the protection of drinking water
- Chemistry and physics of the atmosphere
- Plate tectonics and volcanism
- Earthquakes and waves: Information about the earth's interior

For primary schools a richly illustrated book entitled "Our Earth. For children who want to understand the world" has been published. The book includes two interactive educational games on a CD-ROM, learning tasks and instructions for student experiments. Information for teachers is provided in the internet. The following themes are dealt with:

- Our Earth – a planet full of mysteries
- Earthquakes
- From the depths of the Earth
- By wings from continent to continent (migration of the stork)
- With the river from mountains to sea
- A garden full of life
- In and round the pond
- Clouds, wind and weather
- From shore to deep sea
- Fossils: Witnesses to past ages of the earth
- Treasures of the earth
- How everything is interrelated

During the plenary talk we will explain the modes of interdisciplinary cooperation among geoscientists, educationalists and teachers of the various subjects, the teaching concept "System Earth" and specifics of the implementation of the project results in the educational system of Germany.

## A vision for geoscience education in the 21st century

IAN F. CLARK

University of South Australia, School of Natural & Built Environments,  
Email: [ian.clark@unisa.edu.au](mailto:ian.clark@unisa.edu.au)

Geology has only existed as a separate science discipline for a little over 200 years. For most of that time it was considered as a weakly linked set of sub-disciplines (petrology, paleontology, economic geology, structural geology etc.) This was reflected in textbooks and school and undergraduate curricula that were commonly presented in four main sections: Earth Materials; Earth Structures; Earth History; and Earth Resources (Read and Watson 1962; Holmes 1965). The widespread acceptance of the theory of plate tectonics during the 70s not only revolutionized the understanding of the way Earth works but also caused a shift in the way that curricula were designed. Plate tectonics was used to link the sub-disciplines and the biggest debate about curriculum design was whether to teach plate tectonics at the beginning of a course, at the end or woven throughout as a theme.

Today Earth System Science is proposed as the new revolution in the approach to geology curriculum ((Iretton, Manduca et al. 1996)). Earth System Science, first proposed in the early 90s (for example, (Earth Systems Sciences Committee NASA Advisory Council 1988; Mayer 1991)) has produced a similar re-examination of the way curricula should be designed and geology should be taught. The goal of Earth System Science is to obtain a scientific understanding of the entire Earth System on a global scale by describing how its component parts and their interactions have evolved, how they function, and how they may be expected to continue to evolve on all time scales. Earth system *science* embraces chemistry, physics, biology, mathematics and applied sciences in transcending disciplinary boundaries to treat Earth as an integrated system and seeks a deeper understanding of the physical, chemical, biological and human interactions that determine the past, current and future states of our planet. Earth system science provides a physical basis for understanding the world in which we live and upon which humankind seeks to achieve sustainability. Achieving sustainability requires us to grapple with topics such as global warming and climate change and an ESS approach seems to be a logical framework within which to teach such topics. At the same time as geology educators grapple with this, other educators from a variety of disciplines are promoting the concept of incorporating sustainable development into the wider curriculum.

Sustainability education promotes explanation and understanding of the meaning of sustainability and encourages students into an active engagement with sustainability issues in order to promote lifestyles that are compatible with the sustainable and equitable use of resources. To achieve this, sustainability education must be truly interdisciplinary involving science, politics, economics, philosophy and other social sciences. As part of the proclamation of the United Nations General Assembly to have the 10-year period from 2005 through 2014 as the United Nations Decade of Education for Sustainable Development, governments around the world have been invited to integrate education for sustainable development into their national educational strategies and action plans at all appropriate levels.

Sustainable development is not a term that has a simple agreed meaning because it is the result of discussion between parties who come from essentially quite distinct paradigms or world views. Many conservationists argue that ecological sustainability should be a goal in its own right, unshackled to development. On the other hand, some representatives of business, industry and commerce argue that it is necessary to put economic sustainability ahead of ecological sustainability because environmental regulations and conservation principles are expensive and businesses need to be profitable to be able to afford them (Fien 1997).

Is Earth System Science the best approach to address these issues? And does Earth System Science mean that we have to teach differently or do we still have to teach the basics of the four sub-disciplines before we can develop in students an understanding of the systematic interaction of the parts of Earth and indeed the Solar system.

This presentation will address these issues and look at suggested approaches to curriculum design and teaching in the light of information gained from the IUGS/IGEO worldwide survey of geology curricula.

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## From a scientific drilling project to a geoscience education centre: The KTB drilling site, Bavaria, Germany

HELGA DE WALL

Institut für Geologie der Julius-Maximilians-Universität Würzburg, Germany,  
Email: deWall@geologie.uni-wuerzburg.de

About 20 years ago Germany has started the active phase of a scientific drilling project named the “*Kontinentale Tiefbohrung der Bundesrepublik Deutschland, KTB*” nearby the small city of Windischeschenbach in East Bavaria. Two boreholes, the 4.0 km deep pilot hole and the 9.1 km deep main hole have been drilled into metamorphic basement rocks as part of the Bohemian Massif, the largest basement outcrop in Central Europe. This project was the largest and most expensive geoscientific research program ever undertaken in Germany and has become a milestone in the geoscientific exploration of continental crust. The 9 km section into the earth crust has given new insights into the architecture of the Variscan basement and has monitored the variation of physical and thermal rock properties with depth.

The KTB drilling has been a challenging project also for the development and testing of new drilling technology and downhole logging tools. After the end of

the active drilling phase the two drillholes have been used as a set-up for the KTB Deep Crustal Laboratory of GFZ Potsdam, an international project of geosciences and high-tech developments forming part of the International Continental Scientific Drilling Program (ICDP).

There was a continuous public interest on the KTB project which did not even stop after the active period of drilling. Since 1998 an exhibition hall, the science centre (the “Geozentrum an der KTB”) shows results and exposures of the KTB project and related geoscientific projects. With around 25.000 visitors per year the KTB is still one of the most attractive geoscientific sites in Germany. A new branch in geoscience education has been established in 2004 with the so-called “Demonstrationslabor Geotechnik” which provides facilities and lectures for school classes and student groups.



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# **Public understanding of Earth science**

(e.g. geoparks, museums, demonstrational  
and educational laboratories)

Chair: *Gary Lewis & Ulrike Martin*

## Marine sciences in schools: Networking researchers, teachers and students

AVAN N. ANTIA<sup>1)</sup> & REIMERT NEUHAUS<sup>2)</sup>

<sup>1)</sup> Leibniz-Institute of Marine Sciences, Kiel, Germany,

<sup>2)</sup> UNESCO Project- School Integrierte Gesamtschule Kiel-Friedrichsort, Germany,

Email: <sup>1)</sup>aantia@ifm-geomar.de

Oceanographers of all disciplines (biology, chemistry, physics and geology) at the Leibniz-Institute of Marine Sciences in Kiel have opened their doors to high-school teachers and students from neighbouring schools with the aim of stimulating interest in science in a manner that is usually not possible within the school curriculum. The programme, “NaT-Working Marine Research” that is funded by the Robert Bosch Foundation, fosters personal dialogue between scientists and students and enables students to directly participate in ongoing research projects, thus being exposed first-hand to current topics in the natural sciences. To this end, multiple platforms have been used including projects in the research laboratories,

experiments in schools, field studies and cruises on research ships. The role of the teachers as multipliers is highlighted by teacher-training seminars. Through personal dialogue between all participants and a flexible approach that addresses topics of relevance within the school curricula that can be illustrated in the oceanographic setting, the programme tests and develops new methods of communicating science to schools. In this talk, an overview will be given on the highlights and pitfalls within the programme from the point of view of the researchers as well as schools, both of which operate under different, varying constraints.

## Student labs as out-of-school settings promoting interest – efficacy and determining factors

INGRID GLOWINSKI

IPN Leibniz-Institute for Science Education at the University of Kiel, Germany,

Email: glowinski@ipn.uni-kiel.de

A number of student labs have been established in recent years at the universities and research laboratories. The students find another approach to the sciences and have the chance to do practical activities using apparatus in these professionally equipped labs. In addition, they also become familiar with contexts and areas of application of scientific knowledge to everyday life. The stated goal of all student labs is to promote students' interest in the sciences.

The goal of the evaluation study presented here is to investigate the general efficacy of student labs and to analyse the various conditions of student labs and their importance as significant predictors of affective outcomes. The results are meaningful for the arrangement of out-of-school settings for all sciences.

The study concentrated on following research questions:

- Can the described specific student lab conditions (practical work, contexts, authentic learning environment) be analysed as separate efficacy factors and be related to each other?
- Which reciprocal effects are shown by the student lab conditional factors with the attributes of students

(individual interest, gender) or the degree of connection of the student lab activities to the regular lessons (concept knowledge)?

A total of 600 upper secondary students participated in the study for two measurement points (directly following the lab activities and about three months later).

The instrument was constructed by reference to special student-lab aspects and conditions considering the valences of interest and the student attributes.

The instrument was found to be sensitive to different approaches to laboratory activities in student labs. Several conditions by which the student labs are characterized can be classified as scales in a factor analysis and interaction effects can be studied. Regression analyses were completed with a view to determining the size and direction of relationships as well as the degree to which the relationships were modified by gender, level in school, individual interest, competency experience and integration in regular school lessons.

## Applied geophysics one-week experiment

H.-H. LEWINSKY<sup>1)</sup> & SIMON SCHNEIDER<sup>2)</sup>

<sup>1)</sup> Anna Schmidt Schule, Frankfurt, Germany

<sup>2)</sup> Koordinierungsbüro GEOTECHNOLOGIEN, Potsdam, Germany,  
Email: <sup>2)</sup>simon@gfz-potsdam.de

The Department of Geophysics at the Johann Wolfgang Goethe University, Frankfurt on Main, in cooperation with the Anna Schmidt Schule in Frankfurt on Main were organizing one-week-field-experiments for school-classes.

These field-experiments were designed to integrate geophysical methods into the main course of physics. The project aims on transferring the usual indoor-learning situation to a different environment and to transfer school-physics to unexpected areas.

The one-week-experiment deals with Geoelectrics, Geomagnetism and Ground-Penetrating Radar. The students should be able to work with all three methods to map an archaeological site.

By doing scientific relevant studies, the pupils get in touch with natural sciences and learn to understand scientific work in progress.

The One-Week-Experiment was accomplished three times till now without funding but with support from the Physical Society Frankfurt and from the geophysical prospection office Posselt und Zickgraf.

## The Earth Science Centre – saltash.net community school

GORDON NEIGHBOUR

The Earth Science Centre, Saltash.net community school, Cornwall, United Kingdom,  
Email: neighbour@saltash.cornwall.sch.uk

The Earth Science Centre at saltash.net community school is taking an innovative approach to the study of geology at both primary and secondary school. The project is looking at enhancing the provision of materials and training for both students and staff across the whole age range from Key Stage 1 to Key Stage 5.

The school is working in conjunction with the Combined Universities in Cornwall (Camborne School of Mines) and the University of Plymouth. A major component of the project has been the close liaison with the aggregate extraction industry within the southwest region.

The project is part of a major undertaking to increase both the breadth and quality of teaching in Earth Sciences across both the primary and secondary sector and it is expected to share the use of the facilities with the four secondary school partners and the

associated partner primary schools, either electronically (i.e. using video conferencing) or with on-site visits.

A part of the outdoor classroom will take the form of a 'sensory' walk. A major component of this project is to get large blocks of stone from quarries in the Cornubian region. This walk takes the form of a 'geological walk' around the region. The large blocks of stone have been obtained from a variety of sources, both aggregate extraction sites and other minerals industry operators. The aims are to stimulate a wider interest in Earth Sciences and hopefully to encourage more students to think of the Earth Sciences as a possible career path. This is especially important in the South-West of England as there are a number of opportunities in Earth Science as a career and the extractive industry is a major player in the region.

## KwaZulu-Natal rocks – a case of an evolving learning resource in South Africa

TANJA REINHARDT<sup>1</sup>, DEANNA L. METH<sup>2</sup>, GREG P. WHITMORE<sup>3</sup> & ALLAN H. WILSON<sup>1</sup>

<sup>1</sup>) School of Geological Sciences, University of KwaZulu-Natal, Durban, Email: reinhardt2@ukzn.ac.za

<sup>2</sup>) University of Sheffield, Sheffield, United Kingdom,

<sup>3</sup>) URS Corp., Manchester, United Kingdom,

In 1993 people from the Geology Department at the former University of Natal identified the need for geological learning resources in schools. Funding was however, a problem, and the drive for public understanding of science, engineering and technology was yet to be born. Although, the Chamber of Mines had previously produced a box of rocks and minerals as an educational resource, these were high budget, long out of print, and had minimal local significance.

The project was revisited in 1995. The general aim was to make local geology relevant to people. Until then, the bulk of exposure to the earth sciences for the general public was from countries such as the U.S.A. and Britain. As such, the lack of locally produced and locally relevant teaching aids was identified as a large problem (Meth et al. 2002). To stimulate and educate the general public about their local geological environment, the Geology Education Museum in collaboration with the School of Geological & Computer Sciences at the former University of Natal initiated a variety of projects. The evolution of these projects was as follows:

1. Geology of Durban brochure (Meth et al. 1998) (a good relevant starting point, and comprehensive for the immediate surroundings, but something of broader relevance was needed).
2. Geology of KwaZulu-Natal (KZN) brochures (Whitmore et al. 1999) (good as handouts, but something larger was needed for classroom teaching and general display).

3. Geology of KZN posters (Uken et al. 2000) (well received in English, but needed a Zulu version to reach a wider audience, so a Zulu version was produced (Whitmore et al. 2001) (to complement the visuals, something more hands-on/tangible was needed to add meaning and 'life' to the maps).
4. Interactive Geology of KZN website ([www.geology.ukzn.ac.za/GEM/kzngeol/kzngeol.htm](http://www.geology.ukzn.ac.za/GEM/kzngeol/kzngeol.htm)) and completing the project,
5. the Geology of KZN rock boxes.

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## **Informal education about geologic materials by means of an exhibition on “geologic materials in the arts”**

JOSÉ SELLÉS-MARTÍNEZ

University of Buenos Aires, Argentina, Email: pepe@gl.fcen.uba.ar

Combining Art and Science has rendered very good results when wishing to widespread geological knowledge through general public and students at pre-university level. This exhibition combines the description of metals, other minerals and rocks (their ores, properties, origin, etc.) and images of master work in stone of different cultures and epochs.

Gold, Silver, Copper, Quartz, Malachite, Alabaster, Marble, Basalt, Obsidian or Andesite are, among many others, geologic materials that have been -and in many cases still are- intensively used by artists. Catching the interest of the public by high quality, big size images of works of art offers the opportunity to explain what is the substance they are made of, how the material is obtained and introduce the visitor to the world of minerals, rocks and the Rock Cycle, and even to the identification and interpretation of several primary or secondary structures.

The giant stone heads found in Central America lead to the explanation of what Andesite is, how did it get its name and also about its geodynamic meaning.

The bright green colour of a Russian monumental stone cup introduces what malachite is and how sedimentary rocks of chemical origin form.

The translucency and morbidity of a woman head sculptured in alabaster is the key to the explanation of how gypsum deposits form and how pressure and low metamorphism work on them.

The yellow reflexes of gold in an inca bag for coca -made in the shape of an animal- are so much attractive that nobody will miss the opportunity to learn about native metals and pre-hispanic metallurgy in América.

These, and several others alike them, are the basic concepts that guided the design of the exhibit in which Science and Art meet together for the sake of education.

## From museum to web: The evolution of Earth science outreach at the British Geological Survey

DAVID BAILEY<sup>1)</sup>, EMMA WARD & IAN WILKINSON

British Geological Survey, Nottingham, United Kingdom,

Email: <sup>1)</sup>deba@bgs.ac.uk

The BGS has performed an educational role since its earliest days, opening the Museum of Economic Geology in 1841. However, we have not been able to maintain a permanent public exhibition in recent years. Here we describe how we have instead adapted our approach to earth science education to reach a wide audience in a cost-effective way.

While educational outreach is not a primary objective of a geological survey, we take seriously our responsibility to communicate our science to the wider community and to encourage a geo-scientifically literate society. And, as an employer, BGS relies on a supply of quality recruits to reinvigorate its research programs.

This presentation will:

- address what attributes we look for in recruits and, thus, what we hope educationists will deliver;  
Email: reinhardt2@ukzn.ac.za consider, from an employers' perspective, constraints on the educational system from national curricula to the Bologna Accord;

- set out how the BGS is supporting earth science education at all levels; and
- discuss some of the constraints, not only of cost, but also of expertise and scientific 'culture' which influence what we can do.

Our strategy has involved a move from print publications towards electronic, and especially web-based, interactive, resources such as 'Make-a-Map', the 'Geological Timeline' and our 'Ask-about-geology' service. We will discuss the pros and cons of paper and electronic resources and will demonstrate some recent online products.

We will also describe the importance we place on direct interaction between our scientists and students and teachers through school visits and educational events; our role in supporting the establishment of geo-parks; and the need for our own School of Field Geology for the teaching of essential field techniques.

Finally, we will explore the potential for new developments, including resources that draw on developments in 3D visualisation and multimedia.

## Milestones in exhibition-planning

SIMON SCHNEIDER<sup>1)</sup>, LUDWIG STROINK, GRIT SCHWALBE & NICOLE ADAMCZAK

Koordinierungsbüro Geotechnologien, Potsdam, Germany,

Email: <sup>1)</sup>simon@gfz-potsdam.de

How to prepare a Travelling Exhibition? Which are the key factors of successful organization? How to get in contact with potential cooperation-partners?

This discourse will highlight some milestones on the way to an informative and exciting exhibition. Experiences made by the GEOTECHNOLOGIEN coordination office within the last three years may be vitally important to realize your exhibition-ideas. GEOTECHNOLOGIEN arranged in 2004 and 2005 the travelling Exhibition “In die Tiefe gehen (Going Underground)” which was able to show to more than 100.000 visitors how scientists observe and use the

underground. This talk will show, how the experiences made within the organisation-process lead to the recently started exhibition “Unruhige Erde (Restless Earth)”.

It is challenging to bring the complex ideas and principles of geoscientists to a broad, but not only scientifically trained visitor-range. Therefore easy and simple guidelines of preparing information are on focus of this discourse. The way to an exciting and still informative exhibition and the hurdles to take will be pointed out.

## **A comparative study on the structures of exhibition scenarios of natural history museums: Earth science-related topics**

CHAN-JONG KIM<sup>1)</sup> & SUN-KYUNG LEE

Seoul National University, Department of Earth Science Education, Korea,

Email: <sup>1)</sup>chajokim@snu.ac.kr

The purpose of this study is to identify and compare the structures and content of exhibition scenarios in four natural history museums with regard to informal earth science learning material. Data are collected from the Earth Science-related topics of American Museum of Natural History at New York, Australian Museum at Sydney, Smithsonian Museum at Washington D.C, and Seodaemun Museum of Natural History at Seoul. The exhibition scenarios at the Natural History Museums are explored by means of a macro- and micro-analysis. On the macro-level, titles

and contents of the exhibition are analyzed for prologue, development, and epilogue of the scenario. On the micro-level, scientific arguments for explanations presented in exhibition panels are analyzed through the lens of Toulmin's framework. The results of this study show that there are some different characteristics in the way of presenting stories with information data in exhibitions. It also shows that logically structured scenarios reflecting learner interest is essential to the understanding of science teaching-learning materials.

## **The effect of using simple equipment on the acquisition of plan map concepts in the vocational schools**

ESKANDAR FATHI-AZAR

Educational Technology Department, University of Tabriz, Iran,

Email: fathiazar@tabrizu.ac.ir

The purpose of this study was to investigate the effectiveness of using simple equipment on teaching plan map concepts as a main topic in a surveying course of vocational education. Six groups of students, enrolled in the surveying course, were randomly selected and pre-tested to examine their experience on plan map concepts. Three groups received traditional methods of teaching and used theodolite in plan map-making, while the other three used simple equipment

as an extra fieldwork activity. At the end of the semester, all participants were post-tested. A significant difference was found between experimental and control groups on post-test scores. Also, there was a significant difference between the two groups with respect to students' high-level understanding of plan map concepts. The use of the simple equipment was strongly recommended in science and vocational schools to overcome some main problems.

## Relating current geoscientific research topics and public interest in regional geo-phenomena

ANDREAS BERGNER

Universität Potsdam, Germany,

Email: bergner@geo.uni-potsdam.de

Thematic fields of geosciences undergo a transformation in the 21<sup>st</sup> century. In the course of worldwide globalization, continuing shortage of natural resources and related environmental stress, public awareness and political interest are mostly related to new *geo-technical solutions* and reliable *probability models*. Such solutions are considered to elucidate current problems in resource management, infrastructural extension and environmental vs. climatic change. Consequently, technically oriented geosciences are more in the focus of public awareness than classically more question-oriented fields. However, at the same time, European societies develop an increasing interest in natural phenomena which are observed in their personal surroundings. In terms of geosciences, this new interest is not related to technical solutions, but focuses on specific and much more local *geo-phenomena*, such as exposed rock deposits and quarries.

The main objective herein is to interpret such phenomena in the regional context of landscape formation and cultural history. An increasing number of popular-scientific geoexcursions, newly formed

national Geoparks and museums as well as upcoming Earth science media (print media and TV) illustrate the significance of such public interest.

Comparing the present-day intent of modern geosciences and the public interest in geological, geophysical and mineralogical phenomena, a discrepancy exposes between current research topics and its public awareness. Often scientific laymen do not understand the relation between present-day research focuses and their social, regional and/or personal relevance. To overcome this dilemma, a coupled instruction of geoscientific topics in regional *and* global context is required. As far as regional geological, geophysical and mineralogical phenomena are explained in their large-scale geoscientific background, societies will realize the relation between globally and more technically oriented modern geosciences and regional small-scale natural exposures. Obviously, leading research institutions are requested to provide popular-scientific explanation of their current scientific objectives which allow an easy application on better-known regional phenomena.

## Earth caching – Earth science geocaching

GARY B. LEWIS

Director, Education & Outreach, Geological Society of America, Boulder, Colorado, USA,  
Email: [glewis@geosociety.org](mailto:glewis@geosociety.org)

Finding a way to attract the general public to become more aware of the importance of science in their environment is a difficult task. The broad socio-economic spread of our society, the range of educational backgrounds, and the vast choices that our society offers to members of our community make it difficult to capture groups to raise awareness. To really make an impact, structured activities are needed, through which the science message can be promoted.

Other than some family-based museum programs, there are few opportunities for families to participate in self-directed informal education activities. One such activity, however, is Geo-caching. Geo-caching is an outdoors phenomenon that is growing rapidly worldwide. It is an adventure game for GPS users and consists of the creation and placement of physical caches by players, and the subsequent searching and locating of these caches by other players. All the details about each cache is recorded on a website. Currently there are more than 230,000 caches hidden worldwide.

*Earth caches* are education-based virtual caches. The cache is the location itself, and features a unique geologic formation or process. Caches are located in both urban and rural settings, on private or public lands such as national parks and forests. People who search for the Earth-caches obtain educational notes about the sites and activities related to the site from the website. Earth-cache visitors will log their findings on the web site after their visit. Many will go on to develop their own Earth-caches and therefore increase the impact.

*Earth cache* sites will illustrate the wonder and importance of geosciences in understanding environmental and natural resource management. Positive science-based learning experiences may influence the education and career choices made by the next generation of citizens.

Earth caching has been developed by the Geological Society of America in association with Groundspeak INC and other partners

## Engaging the public on a GEOTIME trail – a case example from Waterloo, Ontario, Canada.

ALAN V. MORGAN

Department of Earth Sciences, University of Waterloo, Waterloo, Ontario Canada,

Email: avmorgan@uwaterloo.ca

Urban development is accelerating in southwestern Ontario, particularly within commuting distance of Toronto. One such area is in the urban conurbation of Kitchener-Waterloo, some 100 km west of Toronto. Urban growth often comes at the expense of rural areas. This leads to conflicts over greenspace, natural habitats, sensitive landscapes and can threaten local water supplies.

In order to help raise public awareness of environmental conflicts and to promote a better understanding of the basic geoscience concepts behind these concerns a series of “talking” signs were created for the City of Waterloo to help educate the public about the importance of the local moraine and its aquifers and aquitards. Building on this came two additional initiatives. The first was to establish a 4.5 km trail to help students from local schools and the universities as well

as the general public, understand the immensity of geologic time. The trail will ultimately have 40 signs spanning 4.5 billion years with each meter of the trail representing one million years. Signs are correctly positioned along the trail to provide key insights into geological events that have influenced the world, and in certain cases, regions of Canada. These signs are tied to more lengthy explanations that can be accessed through the Internet.

The second initiative is to provide an explanation of the biological and stratigraphic position of fossiliferous blocks of Devonian rocks that have been introduced as retaining walls along steeper sections of the trail. These are also tied in to a web site, and allow students to explore fossiliferous units since the local bedrock is deeply buried beneath a cover of glacial deposits.



## Scientific public understanding of ancient gold mines in Portugal

CLARA VASCONCELOS<sup>1)</sup>, ALEXANDRE LIMA, JOSÉ BARROS, ALEXANDRA MENDONÇA & NATÁLIA FÉLIX,

Department/Centre of Geology of Oporto University, Portugal,

Email: <sup>1)</sup>csvascon@fc.up.pt

Developed by a multidisciplinary group, the research project upon which this communication is prepared consisted of divulgation of a number of Mining-Geological aspects that can be observed in Castromil Gold Mines, in Paredes – Portugal. There, one can find a gold ore deposit, which was discovered and intensively exploited at least since the Roman occupation of the Iberian Peninsula. The aim of the study was to promote scientific public understanding within a traditionally rural region, characterized by a recent process of industrialization and a huge deficit in scientific knowledge. The main objective was to contribute to the knowledge of Geology/Ecology through the conception of scientific-didactical material regarding geological aspects and the significance of local and regional habitats, thereby facilitating a better evaluation of the environmental impacts on society. The study culminated with field visits, and included the accomplishment of the following tasks:

(i) literature review; (ii) public divulgation of the project; (iii) documentation and description of the various mining-geological aspects through geological

cartography; (iv) production of field guides; (v) underground visits to the mine; (vi) construction and application of questionnaires designed to evaluate the activity. Additionally, an exposition took place, involving the design of (i) posters; (ii) experimental models (explaining the formation of benches, fossils, folds, geological faults); (iii) 3D virtual models (explaining the formation of ore deposits and other complex processes); (iv) DVD-Rom compiling all the information, and its set-up in the facilities made available; (v) boards related to the local biodiversity; and (vi) interactive guides accompanying the exposition, based upon the scientific-didactical studies previously developed. Beyond the divulgation previously mentioned, prepared with a view to upholding the environmental impacts in the region, the project focused on promotion of a local tourism, attempting to improve the economic conditions in the region. As a final objective, the team aimed to smoothen the progress of similar projects, to take place in other mining areas in Portugal, thereby contributing to the promotion of geological scientific culture.

## Development of teaching materials and methods concerning natural disasters from the viewpoint of geoscience educational partnership in Japan

TATSUYA FUJIOKA<sup>1)</sup> & HIROO NEMOTO<sup>2)</sup>

<sup>1)</sup> Graduate School of Education, Joetsu University of Education, Japan,

<sup>2)</sup> Graduate School of Science, Osaka City University, Japan,

<sup>1)</sup> Email: fujioka@juen.ac.jp

We discuss the partnership which the universities of education have to construct with other educational institutions or schools for the solution of recent geoscience education problems.

At first, a significance of geoscience education concerning natural disasters is discussed as an example of “the Niigata Flood Disaster on July 13, 2004” occurred at Sanjou City in Niigata Prefecture, Japan. It seems reasonable to conclude that the Voluntary Activities are important especially for the universities of education when natural disasters have occurred. Not only at a rural area but also in an urban area like Osaka City, we should notice that the river environment is useful for the observation from the point of view of geoscience education. Moreover, we should not overlook the role of prefectural education centers of these days. Secondly, we discuss the in-service teacher training for the step towards the improvement of geoscience

teaching. For instance, we wish to show the significance and problems of the Science Partnership Program from the point of view of practice in the in-service field training of teachers around the Rokko Fault and the Nojima Fault in Hyogo Prefecture, Japan. In these areas, many people were injured by the 1995 Hyogoken nanbu (Kobe) earthquake. Many trainees in this program learned about natural landscape and natural disasters. This program makes it clear that partnership between scientists and the staffs in education center is very important for the effective in-service field training of teachers.

The universities of education have to advance not only coordinating with schools and other educational facilities, but also cooperating with prefectural education centers. Moreover, they should consider the retraining and promotion of their staffs under the collaborating with other educational institutions.

## The Hercynian Orogen in Europe: towards a European Geopark

JÖRN H. KRUHL

Technische Universität München, Munich, Germany,  
EMail: kruhl@tum.de

The Hercynian orogen is the backbone of Europe. Its mountain chains cover large parts of central and southern Europe and form the basis of the Alpine orogen. The Hercynian period spans nearly 250 Ma and its morphological moulding to the present landscape approximately the same period. The variety of geological structures and processes comprises (i) a small-scale pattern of mountains, (ii) exposures of different levels of the continental crust as well as exposed relics of oceanic crust, partly exhumed from the upper mantle, (iii) a variety of large-scale geological processes: magma generation, plutonism and volcanism, compressional and extensional tectonics, including folding and nappe formation, basin formation and sedimentation.

It appears attractive to take this multifaceted geolandscape as an open-air textbook for the public. It is not essential to form an agglomerate of independent geosites but to create a network of geosites which are linked on a textual level and would represent a true

‘European Geopark’. Based on a didactical concept, such geo-park may constitute a valuable instrument to increase the public understanding of geological structures and processes and the formation of landscape. Such a geo-site network should emphasise the relationship between geological complexity and the complexity of culture in Europe.

In practise such a geopark would be built by a number of single geoparks or geosites which would complement one another in order to provide a comprehensive overview on principle geological structures and processes and form a textual unity. Naturally, the link between the different parts of the European geopark is not formed not so much on an administrative level but mainly virtually through the internet and by a series of printed matter. A continuous evaluation of the geopark by an independent European board should be assured. Further details of the concept – didactics, possible sites, etc. – will be presented and discussed.



# **Best practice in geoscience instruction**

inclusive field trips  
and teaching biology, chemistry and physics  
through an Earth context

Chair: Alan Morgan & Horst Bayrhuber

## The GLOBE program in Germany

MARK MÜLLER & BIRGIT RADEMACHER

IPN Leibniz Institute for Science Education, Kiel, Germany,

Email: mark.mueller@ipn.uni-kiel.de

GLOBE (Global Learning and Observations to Benefit the Environment) is a worldwide hands-on, school-based education and science program involving students of primary and secondary schools throughout the world. The program started in 1994 in the U. S. and focuses on the study of the Earth as a system. Since then students and teachers from over 17,000 schools in more than 100 countries are measuring environmental parameters at or near their schools and are reporting their data through the Internet.

GLOBE is designed to use environmental research as a means to enhance environmental awareness and to improve student achievement in basic sciences like biology, chemistry, physics, mathematics and geography. It furthermore aims for educational use of technology. GLOBE trains teachers to teach students how to take measurements of environmental parameters at quality levels acceptable for scientific research.

Student-collected GLOBE data is freely accessible through the web and can be used for scientific research and for educational purposes in classrooms. GLOBE gives students numerous opportunities to practise and discuss science in partnership with scientists.

The presentation of GLOBE on the geosciEd5 - conference will give an introduction to the GLOBE - program, his types of measurements and a brief summary of more than 10-year of GLOBE in Germany. The way GLOBE can contribute to improve geoscience education will be discussed. As the GLOBE-Germany country-coordination moved to the Leibniz Institute for Science Education at the University of Kiel (IPN) in 2005 synergy effects with other IPN-projects like "System Earth" will be one focus of the presentation. Furthermore first results of a GLOBE-Germany evaluation run, which is to be accomplished in spring 2006, will be presented.

## **Our eye in the sky – METEOSAT images and the international GLOBE project**

VOLKER HUNTEMANN

Wolfgang-Borchert-Gymnasium, Langenzenn, Germany,  
Email: volker.huntemann@gmx.de

This project started more than 15 years ago as an optional course called “Satellite Geography”. Our aim was to make use of satellite images in the classroom. Realizing that there was a tremendous range of areas of application, we soon concentrated on the analysis of METEOSAT images. Our aim was to find out more about the sequences of the weather in central Europe, to do our local weather observations, to compare them with the satellite images and to produce our own weather forecasts.

At the end of 1996 I took part in the training programme for the GLOBE (Global Learning and Observations to Benefit the Environment) project. As a certified GLOBE teacher you are qualified to guide students in taking GLOBE environmental measurements, reporting GLOBE data and using GLOBE environmental images. All these activities are pursued in the interest of achieving the objectives of the programme: to enhance environmental awareness

throughout the world, to contribute to scientific understanding of the Earth and to improve standards in science and mathematics education.

It became clear that our optional course “Satellite Geography” could support the GLOBE project with its data from the digital local weather station. The other fields of data could be integrated into the activities of our school (regular lessons in “Nature and Technics” in grade 5 and geography lessons in grade 11).

The optional course is formed by a group of 10 – 12 students every school year. There should always be a good mixture of students from all grades between 7 and 13. This course has always been co-educative. Teamwork should be a basic skill. It takes place for two lessons on one afternoon per week. If students want to concentrate on some enhanced work or if they want to take part in the national competition “Young People’s Science Fair”, additional time is required.

## Geocological investigation of a small creek: An interdisciplinary project of the 12th grade

RAINER LEHMANN

FWS Hannover-Bothfeld,

Email: Rainer.Lehmann@gmx.net

Since summer 2004, the students of the 12th classes at the Waldorf-School Hannover-Bothfeld, Germany, are carrying out a scientifically based survey of an anthropogenically influenced and straightened creek, the Laher Graben. The approach of the project is inter-disciplinary. It is situated between physical geography, biology and chemistry lessons. Aim is to introduce the students into theoretical and practical scientific working methods.

Topics are:

- Historical development of the Laher Graben
- Water quality, input and transportation of harmful substances, monitoring
- Structure of the trench, behaviour of flow, discharge
- Re-naturalization of the creek bed: Meander, flood plain, biosphere

Used methods are:

- Interpretation of historical maps
- Field work: Measurements, taking samples of water, sediment and organisms
- Labour work: Chemical analysis of water, sediment and soil

- Planning and calculation of meanders
- Data management and design, evaluation of results

Future planning:

- Positioning of dead logs in the channel
- Further monitoring of water quality, structure of meander development and biosphere

The students work on a subject in the school's neighbourhood, which they know since about 12 years. They learn correlations and interrelations between the non-biotic geosphere and the biotic parts of a small river system. In summer 2005, the Laher Graben was renaturalized by the city of Hanover. Experiences with the students have shown that they are very committed to the lessons because of the direct relation to the subject and the combination of practical and theoretical work.

Cooperation takes place with the Deutsche Umwelthilfe (German environmental aid) in the project "*Schulen fuer eine Lebendige Weser*" (Schools for a living Weser river) and with the town of Hannover, Germany (Office of town drainage).



## Earth system science teaching for geology and geography undergraduate students in Campinas, Brazil

CELSON D. R. CARNEIRO<sup>1)</sup> & PEDRO W. GONÇALVES

Institute of Geosciences, The State University of Campinas (UNICAMP), Brazil,

E-mail: <sup>1)</sup>cedrec@ige.unicamp.br

Earth system science is more holistic and integrated than a conventional introduction to Geosciences. We are endeavoring to improve teaching about the terrestrial spheres for geology and geography students attending the State University at Campinas, São Paulo, Brazil, by means of better describing the relationship between nature and human society. We believe that it can help to give a geologist a more informed social view and, at same time, enable a teacher of geography to better face the challenges of teaching. Each year we introduce geological knowledge to up to 70 new students who are enrolled in a professional program to prepare geologists and teachers of geography. The courses we are involved are called Earth system science – I and II –, and they form the initial geological courses for these students. We want all students to be able to understand how the Earth works

as an integrated system and how the different systems are interrelated. The interconnections between geologic and geographic studies are needed to allow students to understand Earth systems because, in this way, they can gain knowledge and experience from their self-interest. Field and laboratory activities are an essential component of the teaching experience in Earth system science. Recent changes in our academic curricula have forced adaptation of separate disciplines to include Earth system science. The new situation has left the separate disciplines with slightly reduced classroom time. It did not affect however the primary disciplinary concepts which include an understanding of linkages between science, technology, society, and environment, and the understanding of historical and epistemological aspects of modern studies on the dynamics of planet Earth.

## The didactical transfer of basic knowledge in plate tectonic at schools: a new approach

ULRIKE MARTIN<sup>1)</sup>, ANDREAS AUER & GERNOT KÖCHER

Geozentrum an der KTB, Windischeschenbach, Germany,

Email: <sup>1)</sup>[martin@geozentrum-ktb.de](mailto:martin@geozentrum-ktb.de)

The Earth has three layers: the core, the mantle, and the crust. Rigid plates, called the lithosphere, are made of the crust and the uppermost mantle. The plates move on the softer, convecting mantle called the asthenosphere. Plate margins are identified by the distribution of earthquakes and volcanoes. There are seven major plates and 20 smaller plates. Plates move towards, away from, or slide past each other.

The model here introduced is based on a world map containing topography and plate boundaries and cross-sections developed at the geoscience education centre at the KTB (continental deep drilling project). The novel aspect of the exercise is the „jigsaw“ manner in which pupil groups access the map and cross-sections through the Atlantic or the Pacific and use them to discover, classify, and describe plate boundaries, layers of the earth, rock types related to

special regions, distribution of volcanoes on earth.

Supported is the jigsaw fit puzzle by a collection of rock samples, a library and a collection of photos related to special geological settings.

The exercise is based on observation and description, which makes it useful at a wide variety of levels. The material is not consumed during the exercise, which makes it inexpensive in use. Because the exercise is not based on the access to the web, it is not dependent on classroom technology equipment. The length of the exercise varies depending on the grade of difficulty, and involves the pupils in making presentations to one another in small groups as well as to the whole class. The pupils come away from the exercise with knowledge of the key features of the plates and their boundaries and a sense of why each looks and acts the way it does.

## Controversy-based Earth science

YOSHIO OKAMOTO

Tennoji high school attached to Osaka-Kyoiku University, Japan,  
Email: yossi@cc.osaka-kyoiku.ac.jp

Geoscience education in Japan, especially at senior high school level is on the road to extinction because of the long decline of the students who select it and of the teachers who have geoscience background (Okamoto, 2004). Although a lot of effort has been made in geoscience education the trend continues to decline. Therefore, urgent actions are necessary. Our study is the one of these efforts by which the students might change the perception of geoscience and which also provides a new viewpoint to the geoscience community for education and outreach. For this purpose, we introduced some controversies as baselines in our geoscience class which are now considered crucial among researchers. We choose three controversies from various field as follows; i) “earthquake prediction”, ii) “dinosaurs extinction”, and iii) “global warming or climate changes”. Those issues belong to the fields of geophysics, geology or paleontology and climatology or oceanography. The first debate shows us the difficulty of interpreting noisy or unreliable data and also the mysterious chaotic or complex behaviour of nature. The second debate shows how the best collaboration of high technology and devoted geological field investigations can reveal the secrets of ancient Earth. The debate also illustrates the modern confrontation between uniformitarianism and catastrophism. The third shows the complicated

earth-ocean-climate coupling derived from rapid developments of numerical simulation employing super-computers and precise observations from satellites. We introduced these controversies to provide backgrounds for additional discussion involving basic knowledge about the Earth sciences or even researchers’ characters and popular gossip. The controversies also reflect the relation between science and society, which is getting more and more important in 21st centuries. The students can understand, through these debates, how to study Earth science or how famous scientific theories are constructed and established. Also we can recognize the painstaking human process during confirmation of theories. Moreover these debates question whether; i) disastrous catastrophes may be predicted in the near future. ii) what science can deliver to society and whether these results can be regarded as reliable or sceptical. iii) the deterministic or probabilistic existence of our civilization. In other words, these debates relate directly with keeping our peaceful and convenient daily lives. The issues involve philosophy, economics, politics and even religion showing the benchmarks of our contemporary knowledge and thinking. So, the debates are quite interesting and fascinating not only for science-oriented students but also for non-science-oriented ones.

## From access to throughput: A change in policy and practice for teaching first-year geology at the University of the Witwatersrand, Johannesburg, South Africa

GILLIAN R. DRENNAN<sup>1)</sup> & P. DIRKS

School of Geosciences, University of the Witwatersrand, South Africa,

Email: <sup>1)</sup>drennang@geosciences.wits.ac.za

In the eighties and nineties it was important to the government and tertiary institutions alike to increase the access of students from previously disadvantaged backgrounds to tertiary education. The University of the Witwatersrand introduced a number of interventions and the Faculty of Science initiated a two-year bridging program called the College of Science. Students that successfully completed the program were admitted into the second year of the mainstream BSc program i.e. a four-year BSc degree. The success of the college program lay in small group tutorials in which students were involved in problem-based, self-learning exercises. Initially students received extensive structured support but as they progressed the scaffolding was reduced to promote independent learning. The college Earth sciences program enjoyed good success rates with around 70 % of learners passing the first year and between 80 and 100 % passing the second year of the program. In recent years up to 20 % of Geology honors students have been ex-college Earth sciences students.

### Changes in policy

For many years the student body in the School of Geosciences has been representative of the demographics of the country and the need to increase access to previously disadvantaged individuals was not an issue. The majority of first-year learners, however, are 'English second-language students' who have not been exposed to geology at school level.

Many of them are from rural backgrounds where academic skills were poorly taught. The School of Geosciences recognized the need for the introduction of study skills into the first-year program in order to address the issues associated with this transformation. Consequently, communication skills, time management skills, life skills, as well as subject-specific skills, were introduced so that all first-year geology students would benefit from a College-type experience. The School of Geosciences was the first, within the Faculty of Science, to introduce such a shift in teaching policy and other schools have now embraced similar teaching approaches

### Change in philosophy

Since 2005 College Earth Sciences tutors have redesigned the first-year mainstream teaching program to be more akin to the College Earth Sciences program. The emphasis has shifted towards a problem-based, self-learning course with continuous assessment playing an important role in the success of students. Skill training forms an integral part of the course with content serving as a vehicle for introducing both life skills and academic skills. Students who have little or no prior knowledge with regards the subject matter of geology are invited to participate in additional small-group tutorials. The students enjoy a more personalized relationship with the tutors who are also involved in lecturing these students. The first-year program was positively assessed by students.

## Developments in tertiary level geoscience education in the UK

HELEN KING

Higher Education Academy Subject Center for Geography, Earth & Environmental Sciences (GEES),  
United Kingdom,

Email: [h.king@plymouth.ac.uk](mailto:h.king@plymouth.ac.uk)

UK tertiary level education has been subject to many changes over the last few years. These have been led mostly by Government initiatives and agendas and a changing student population. The Subject Center for Geography, Earth & Environmental Sciences (GEES) is part of one such initiative: the Higher Education Academy, whose mission is to help institutions to provide the best possible student learning experience.

Approximately 2/3 of geoscience graduates enter employment not directly related to their degree subject. This, together with the shared belief that universities have a role to play in providing graduates who can contribute to the knowledge-based economy, is one of the main driving forces behind the introduction of 'employability' skills within the curriculum. These skills include presentation, communication, team working and also more 'business-specific' aspects such as enterprise and corporate / social responsibility. Additionally, sustainable development is becoming increasingly higher profile at all levels in UK education

and faculty are being encouraged to include it in all subject curricula. The GEES Subject Center has developed a variety of resources in these areas which are available on-line at <http://www.gees.ac.uk/>

The student population has changed considerably over the last 10 years or so. They now represent a wider range of socio-economic backgrounds, many are juggling their studies with part- or full-time work, and most have experienced a very different youth culture particularly in terms of technology. As there are relatively few connections between secondary and tertiary education it can be easy to lose touch with students' prior learning experiences and current learning needs. To help with this process the GEES Subject Center is leading a research program exploring the conceptions that school students have of the disciplines.

This presentation will discuss these current key issues and share information on current GEES Subject Center resources and projects.

## **Creating an understanding of how to effectively convey geo scientific concepts to tertiary education students who are culturally, linguistically, socially and academically diverse.**

TRACEY MCKAY

Environmental Management and Energy Studies University of Johannesburg, Department of Geography, South Africa,

Email: mckayi@goesciences.wits.ac.za

Informed by the work of Zamel (1988) and Biggs (2000) it is clear that university departments and lecturers need to change the way in which information is conveyed to students (didactics), as well as the kind of information conveyed (relevancy) to ensure that students who come from a wide range of backgrounds engage with the material, develop geo scientific skills and elect to enter professional geo science career paths. To this end, a rigorous study of current course material is required to ensure that the content is of such a nature that it develops geo science core knowledge, but is also relevant to the lives of a wide range of students. The department and the lecturers also need to engage in alternative didactics to ensure student success, as the ‘traditional formula’ of lecture and tutorial style teaching is ineffective in the new reality of the modern university. In this study of a geo science course at a South African university

it was found that making these changes were both necessary but difficult to implement. Lecturers and departments who face this challenge have to engage with institutional resistance, institutional inertia and lack of professional support for such initiatives. For instance, many university staff are of the opinion that diversity in the student population should not be a factor in the creation, development and presentation of courses, but that students should rather “adapt” to departmental “traditions” as these “traditions” are seen as academically sound and, therefore, justified. Balancing these two opposing forces is now a challenge facing most academic departments in many universities around the world. Thus, this paper addresses firstly the rationale for making changes to accommodate a diverse range of students and, secondly, examines possible strategies that could be employed to make the changes.

## Maps across the curriculum: a South Carolina model

JOHN R. WAGNER

School of the Environment, Clemson University, USA,  
Email: jrwnr@clemson.edu

The SC MAPS project (South Carolina Maps and Aerial Photographic Systems) is an award winning middle school Earth science curriculum package produced through collaboration among a variety of state agencies, geoscientists, and educators. It was developed originally to help students visualize relationships between South Carolina geology and statewide patterns of land use and development by interacting with a variety of cartographic products and remotely sensed images. These products range from topographic and shaded relief maps to high altitude photographic and satellite images, which together serve as the framework for hands-on student learning activities. Each of the five major landform regions of South Carolina is illustrated by one or more local study site representatives of that region. Each site highlights areas of geological or historical interest and contains features that are clearly visible on high resolution infrared aerial photographs and/or infrared satellite images, as well as on topographic maps. A separate set of special purpose maps and images of the entire state provides information on topography, geology, soils, land use/land cover, and cultural features. Middle

school students use classroom sets of these cartographic products, laminated for repeated student use with wet-erase pens, to investigate the influence of geological and cultural processes on landscapes of the past, present, and future. A Teaching Manual contains narrative background information and sets of student activities and exercises, which are keyed to the various cartographic products. The expanded SC MAPS materials model current middle school initiatives towards providing interdisciplinary team approaches to learning. Using the geological framework of South Carolina as the basis for thematic study, new curriculum components emphasize social studies (historical and economic data), mathematics (computational and problem solving skills), language arts (storytelling and cultural diversity), as well as science (environmental concerns). Pedagogical strategies such as cooperative learning, constructivism, and performance-based assessment are incorporated within the program. The emphasis on local and statewide concerns stimulates student interest and involvement and provides common ground for interdisciplinary problem solving.

## Excursions and field trips as a core interactive method in school, university, extracurricular and adult Earth science education

GÖTZ HEINRICH LOOS

Biological Station of Western Ruhrgebiet (Biologische Station Westliches Ruhrgebiet), Oberhausen, Germany,  
Email: Goetz.H.Loos@gmx.de

Excursions and field trips are proved to be an effective method in geographic education, especially in teaching and learning more complicate aspects – like ecological context including its network and system approaches. The interactive structure of a well-prepared and managed excursion consists of a triangle of relationships: Teacher / lecturer – student – objects. In school or university lessons or lectures there is (or should be) a dialogue between the teacher / lecturer and the student, while the objects (the learning objectives) are theoretical – or (in modern electronic learning concepts) could be studied in virtual reality. Teaching in the field implies the mentioned dialogue, but additionally the objects could be studied in the genuine reality and it is possible to discuss and practise directly comprising the objects.

Though the participants of the excursions are of different groups (from Elementary School pupils – exceptionally also Kindergarden children – to adult amateurs of all ages), the methodology is always the same. Evaluation of learning success of university students from different study grades within excursions over seven years has pointed out that the learning success was higher than from lectures. While it was difficult to get contextual explanations of aspects that were only treated in lectures, it was much easier for the students to explain facts and context remembering

the real objects. Significantly, some aspects, which were only explained during excursions, without illustrating them by real objects, are as forgotten as facts from lectures. The combination of different objects seems to be more instructive for pupils, if at least one part of them is a living object (especially animals); but if you choose such objects, it is possible to teach more earth science in context of all compartments (the way pupils are instructed on extracurricular excursions e. g. by Biological Stations).

An important part of the methodology of excursion teaching / learning is a kind of connectional teaching / learning by telling / listening to stories. Such stories could be of a short anecdotic character or a longer story (for example: introduction of potato in Europe). While the learning success of university students seems not to depend on such stories exclusively, the remembering of the excursion topics by adult amateurs is often built on stories like „corner stones“ of remembrance. Finally, it is a remarkable observation that in mixture excursion participant groups (students and adult amateurs), the amateurs animate the dialogue in most cases, while discussion contribution or questions of students are only few. But in pure student excursion groups every group is different (some are quiet at all, some like to discuss or ask as „typical“ adult amateur groups).



## Teaching material development of TV programs for Earth systems education and fieldwork

MASAKAZU GOTO

National Institute for Educational Policy Research of Japan, Curriculum Center, Japan,  
Email: masakazu@nier.go.jp

I have developed 10 Television programs for outdoor education (fieldwork) for children at the ages of 10 to 15 years in collaboration with the national educational broadcasting association. The ten programs cover mineral hunting, fossil and rock hunting, adventure on the river, nature study in the mixed forest, nature study in the dry beach, nature study on the rocky seacoast, nature study in the paddy field, nature study in the park, etc. These TV program were broadcast throughout Japan for children's study in local nature settings. They also include the core content, competencies, and habits of mind that EE and ESD should support. Children understand how to study their local nature and work together to contribute to conservation and sustainability of nature through watching the various segments. After watching the programs and acting locally through studying local environments, children can foster the environmental literacy that allows an understanding

of their life styles and introduces the concepts of care and stewardship for the Earth. The programs are interesting and have been well-received by some 2.500.000 children all over Japan. They have also been used by a number of elementary and secondary teachers for their science lessons and outdoor or environmental education throughout the country. I have also developed some additional thoughts by using one of these TV programs and by implementing and evaluating the quality of the TV program in my curriculum and practice. I have also made use of them for in-service teacher's training workshops for novice science teachers in Japan. These TV program are evaluated as being very useful for children and teacher's education. I will have a presentation about TV program development for Earth science education and environmental education, my educational practice with them and assessment of it.

## Geologic problem solving in the field: Student mapping strategies shown by GPS tracks

ERIC M. RIGGS & CHRIS C. LIEDER

Department of Geological Sciences, San Diego State University, USA, Email: eriggs@geology.sdsu.edu

Field mapping and problem solving are among the most essential aspects of geoscience education. However, many students find these complex skills difficult to master. Students must visualize the landscape from a map, work to discover structural and lithologic information, create integrated models of their field area from prior knowledge and new, often incomplete information, and then re-encode this information as a geologic map. Independent map tests also require students to do these tasks under time pressure and physical stress. We have a poor understanding of how students gain field expertise, and educators have few measures of student thought processes other than final maps. Cognitive models developed in studies of Naturalistic Problem Solving apply well to geologic mapping, as problem solvers must be able to 1) identify relevant features, 2) elaborate on findings using prior knowledge, 3) plan strategies for gathering more information, and 4) execute their plans. We present evidence that these problem solving stages are seen in GPS tracking of student movements during geologic field exams, especially when augmented by

analysis of student maps, field notes, and post-examination interviews. We analyzed GPS data collected from units worn by students constructed density plots of key locations relative to the underlying geology, and conducted speed/dwell time/trajectory analysis of students' navigation. Results show that successful mappers maximize the total number of key location visits by planning traverses which minimize path repetition, maximize chances to test multiple hypotheses, and take advantage of topography. Successful students also show evidence of longer stops at key locations and use efficient traverses, which maximize field area coverage. GPS analyses are corroborated by student interviews about mapping sessions, and by analysis of student map accuracy and the quality of field notes. Our study provides a new, external measure of field mapping skill, and potentially provides new tools to help students better develop problem solving strategies and spatial skills. It also provides a means to better understand the evolution of geologic field skills.

# **Internet and multimedia in geoscience education**

Chair: Bronte Nicholls & Sylke Hlawatsch

## **E-learning in the geography, Earth and environmental science (GEES) disciplines: A practitioner survey in the UK**

DEREK FRANCE & STEVE FLETCHER<sup>1)</sup>

University of Chester, Southampton Solent University, School of Maritime and Coastal Studies, United Kingdom,  
Email: <sup>1)</sup>steve.fletcher@solent.ac.uk

This paper will provide an overview of the findings from a national survey of GEES practitioners based in higher education (HE) institutions throughout the UK to establish the current use, re-use and development of e-learning materials. The research was funded and co-ordinated by the Higher Education Academy Subject Centre for Geography, Earth and Environmental Sciences. It was found that most practitioners commonly used email and PowerPoint, but far fewer used online discussion or assessment methods. Motivations to develop e-learning materials in the GEES disciplines primarily related to improvements in personal and teaching efficiency, but there were nume-

rous barriers impeding the realisation of such benefits. Barriers included limited personal technical knowledge, lack of departmental and institutional support, and perception of significant time required to develop new materials. In order to overcome these barriers and to encourage re-use of e-learning materials, the GEES Subject Centre through valuing e-learning, has provided resources and support for practitioners. This paper summarises the key findings of the national survey and outlines the support provided by the Higher Education Academy Subject Centre for Geography, Earth and Environmental Sciences.

## Embracing "climate change" in high school science curriculum

YI-WEN HUNG<sup>1)</sup> & YING-SHAO HSU

National Taiwan Normal University, Department of Earth Sciences, Taiwan,

Email: <sup>1)</sup>v3256@ms36.hinet.net

There are three key topics identified for consideration: the questions of "why," "what," and "how" to embrace "Climate Change" in high school science curriculum.

Why Climate Change should be included? It begins with two events, El Nino and global warming. El Nino, coming about every several years and making the climate system anomalous globally, has called a lot of attentions from 1970's. In addition, global warming, as another popular topic in the past two decades, has raised much more controversy for the uncertainties of causes. These two events play important roles in the issue of Climate Change that had urged the emergence of Earth System Science. As aforementioned, Climate Change is important to students' everyday lives and, thus, also an essential scientific literacy for 21st century.

With new understandings through observation data, the climate system is considered non-linear in nature. Moreover, there are three limits in understanding the climate system: (a) a partial understanding about the

nature of the climate system (i.e. a lack of observations); (b) a partial understanding of how biophysical processes operate in the climate system; (c) a partial understanding of how anthropogenic gases will evolve in the future.

Considering all these uncertainties above, what should be taught in Climate Change curriculum in high school? The scientific history of Earth System Science will be a main theme, which is, introducing the development of the "Earth System" concept with the evidence from observation data, like the perturbations of CO<sub>2</sub> concentration, rather than the uncertain theory or inference. From the evidence provided, students might learn to separate the differences between natural and anthropogenically induced variability in the climate system. At last, how Climate Change should be taught? Through inquiry activities with data on line students will experience the process of science research, and hence recognize the climate system are actually operating in different quasi-stable states.

## Need for geo-information science education in Nigeria

ALEXANDER I. IDORNIGIE

Geology and Mining Department, University of Jos, Nigeria,  
Email: alex1982002@yahoo.co.uk

Five key factors constitute a National Spatial Data Infrastructure (NSDI), which determines a country's ability to produce, manage and use geo-information. These factors include existence of core data sets, availability/accessibility of data, availability of standards to enable integration of data sets, existence of policies and practices promoting the exchange and reuse of information, and availability of sufficient human/technical resources. All of these factors are known to be present in most African countries, but lack of human resources has been identified as the most crucial in the Nigerian setting. This is primarily due to the dearth of relevant pedagogic framework in the curricula of the nation's educational system. The only viable way to redress the situation is to engage in conscious and result-oriented capacity building efforts through standardized curriculum and modularized training and retraining courses designed for Nigerians in the fields of Remote Sensing (RS) as

a vehicle for data capturing, Geographic Information System (GIS) as a data analysis/management and integration engine, and Digital Cartography as a data visualization/enhancement medium; this may be complemented by the provision of the required facilities needed for web-based self-education. It follows that sustained accelerated provision of appropriate education in these three aspects of the geo-information technology (GT) will, in the immediate future, produce a crop of motivated stakeholders and decision-makers who will help to fully realize the nine-fold objectives of the Nigerian NSDI of 2003, - the 'National Geo-information Policy (NGP)'. This research suggests important items on the different areas of the GT (RS, GIS, and Digital Cartography) that should be factored into a state-of-art-driven revision of syllabi for the primary, secondary and tertiary educational systems in Nigeria.

## Spare Time University - backing into the public into science literacy

MICHAEL GLANTZ, RUSSANNE LOW<sup>1)</sup> & LANCE JONES

Center for Capacity Building, National Center for Atmospheric Research, Boulder, Colorado USA,  
Email: <sup>1)</sup>rlow@ucar.edu

Spare Time “University” (STU) is an open-access, virtual, informal science education initiative to support guided self-education about climate, water, weather and society. Spare Time “University” seeks to demystify global change science and make science accessible and usable by “backing the public into science”. It does so through an examination of societal and cultural settings impacted by quick onset, abrupt, and extreme Earth events, as well as slow onset (creeping) global changes. STU activities can easily be meshed with digital learning objects that promote deep understanding of underlying scientific concepts. Spare Time University takes advantage of “teachable moments” by promoting “usable science” as well as emerging mobile technologies, including pod casting and cell phone data access. Ultimately, Spare Time University, using the web, satellite radio, and cell phones of the future, seeks to create an international forum centered on global to local environmental

change issues. It also provides a relevant and engaging vehicle for geoscientists to learn about the socio-economic, political and cultural setting in which their research findings are to be embedded.

Corresponding research on the non-scientist public use of Spare Time University contributes to three themes: (1) socio-cultural barriers to access, inclusion, and participation in informal scientific learning communities; (2) non-scientist application of scientific understanding in socio-political and economic decision making processes, and (3) multi-modal and social dimensions of interactivity, exploring the potential of technologies in terms of enhancing communication and collaboration and in building of learning communities and networks. Spare Time University does not confer credits or degrees. “University” is used as a metaphor to connote “universal” access and identify a targeted adult learner audience.

## **Digital technologies, public spaces and problem solving: Local community partnerships supporting teacher training in Earth sciences**

MARGARET ROBERTSON

La Trobe University, Department of Education, Launceston, Tasmania, Australia,  
Email: margaret\_robertson19@yahoo.com.au

This paper reports on a community based project involving final year pre-service Bachelor of Education students at the University of Tasmania. Using digital technologies, including Geographical Information Systems linking field based data with relevant local area digital maps, students worked collaboratively with local government experts in town-planning, engineering and strategic development. Faced with the dilemma of finding valid solutions for redevelopment of targeted local area public sites for redevelopment the students first received an introduction program on site planning by local government officials. Their 'plans' for redevelopment were presented at a hearing held in the local Council Chambers in the presence of the local Mayor and town planning officials. Acting as a planning tribunal the panel of experts provided feedback on the final plans presented and made the final award for the solution that best met the actual

criteria for the redevelopment site. Decisions were based on such criteria as attention to regulatory requirements as well as longer term directions of the site in relation to its surrounding context.

This process provided the first phase in the study. The second phase involved application of the skills gained to field based sites of their choice. Student feedback on this action learning field based study has been extremely positive. New skills have been developed and above all students have learnt to appreciate the importance to collaborating with local community. In brief, the study shows that capacity building in the teacher training area for the earth sciences can be enriched and expanded through building connections with local area authorities. Modeling authentic learning experiences helps to build personal confidence for future teaching experiences.



## How to judge the level of interaction in e-learning units of geography

HELMUT SCHRETTENBRUNNER

University Erlangen-Nuernberg, Chair Educational Geography, Faculty of Education, Nuernberg, Germany,  
Email: schrett@ewf.uni-erlangen.de

### Assumptions:

Computer and Internet have opened new and interesting possibilities for learning strategie.

Most learning platforms, however, prevent educational issues of interactivity.

With every new medium we suffer from a methodological backstroke as far as teaching strategies are concerned, in our case: the Internet has sent us back to the turning of pages in encyclopaedias.

The checklist to measure interaction is taken from: <http://paedpsych.jk.uni-linz.ac.at:4711/LEHRTEXTE/Sanke99.html>

Distinction is made between elementary, intermediate, and complex levels.

Examples to verify the different levels.

The ESPERE (www.espere.net use the English version) teaching units (Upper Atmosphere, Weather, Climate and the City, Food) constitute fine examples of an international and multilingual project carried out between 2003 and 2005. The main issue is the combination of "scientific texts" explaining clima details and "worksheets" for teaching purposes (levels "basic" and "more") for the use of both teachers and students. Thus 3 levels of difficulty are available.

The WEBGEO homepage is a very lucky result which goes back to the joint efforts of *physical* Geographers (Freiburg) and of *educational* Geographers. The units demonstrate a wide range of interesting units (climatology, pedology, geology, geomorphology, vegetation geography etc) and include a variety of methodological approaches (quiz, scored results, optional information, simulation etc).

### Findings:

It is not so easy to learn exploratively and interactively in Geography (and in all other subjects).

Our internet tools (cms, learning platforms) have marked limitations and there are sometimes very rigid safety restrictions (especially for University servers) which hinder the documentation and storage of student data.

Interactive units of complex dimensions require a high level of programming skills (in FLASH, MACROMEDIA DIRECTOR etc) and are therefore so expensive that the normal budget of a project is not sufficient.

Teachers should be aware that it is still their major job to organise interactive learning situations in the classroom, even if the material is sub-optimal.



# **Educational geoscientific research**

*Interactive session*

Chair: Nir Orion & Gabriele Obermaier

## Investigating Earth science teachers' preferences and practices of goals of Earth science education in Taiwan

CHUN-YEN CHANG & WEN-CHI LEE

**Block 1**

National Taiwan Normal University, Taipei, Taiwan,  
Email: changcy@ntnu.edu.tw

The purpose of this study was to investigate earth science teachers' preferences and practices of goals of earth science education in the secondary school (grades 7 - 12) of Taiwan. A national survey based on a national probability sample of schools and earth science teachers in grades 7 - 12 was conducted. Every eligible school and earth science teacher in the target population had a known, positive probability of being drawn into the sample. A questionnaire was randomly sent out to a national probability sample of hundred secondary school (one earth science teacher in each school) to acquire their preferences and practices of goals of earth science education at the end of school semesters in 2002. Overall, a total of 60 surveys were returned, resulting in an overall

response rate of 60%. Results indicated that (a) 'Students acquire basic Earth science concepts' is the most important goal of earth science education in the secondary earth science education in Taiwan; (b) 'Preparing students for the entrance examinations' rises as an important practical goal of earth science education, despite it is one of the least preferred goals appreciated by the teachers; and (c) the differences between teachers' preferred and practical goals of earth science education are contingent on teachers' age and their teaching experiences. Discussion on the gaps identified between the preferred and practical goals of secondary earth science education was also emphasized.

## Secondary school teachers' expected Earth science literacy of students in Taiwan

WEN-CHI LEE<sup>1)</sup> & CHUN-YEN CHANG<sup>2)</sup>

**Block 1**

<sup>1)</sup> Zhu-Wei Junior high school, Taipei, Taiwan,

<sup>2)</sup> Department of Earth Sciences, National Taiwan Normal University, Taipei, Taiwan,

Email: <sup>1)</sup>tea0012@twjh.tpc.edu.tw

The purpose of this study was first to investigate Taiwan's secondary school science teachers' Expectations with regard to the Earth Science Literacy (ESL) of their students. Furthermore, the purpose was to analyze the similarities and differences in the views about ESL held by teachers from different backgrounds. The initial sample of this study included one thousand secondary school earth science teachers who taught earth science courses from September 2003 to June 2004 in Taiwan. There were a total of 1000 secondary high schools in Taiwan with 70 % junior high schools and 30% senior high school during the academic year of 2003. Overall, a total of 830 surveys were returned. As Kerlinger and Lee (2000) have suggested that returns of less than 40 to 50 percents are common in mail surveys, so the response rate was quite high. In order to get the most accurate data, we further took out 128 participating teachers' responses due to their incompleteness. Finally, there were 702 valid survey data to be analyzed. Thus key concepts in earth science, students' understanding of

which may be used to evaluate their earth science literacy, were ranked in order of importance based on teachers' opinions. The results were as follows: (1) the three earth science themes judged by teachers to be most significant in terms of earth science literacy concerned "environmental" protection, yet all acknowledge that we can hardly avoid teaching this course if we want to follow the world-wide trend; (2) teachers consider the most important skill for judging earth science literacy to be "students apply skills to daily life", and thus this was given the highest ranking; (3) according to the ranking of teachers' attitudes toward earth science literacy, earth science teachers are hoping above all to train students to be very conscious of nature, cherish nature and understand the importance of environmental protection. The findings of this study may suggest future guidelines for instruction and curriculum goals for secondary school earth science teachers, as well as future goals for research.

## Children's geoscience interests

ROGER TREND

Block 1

University of Exeter, School of Education, United Kingdom,  
Email: R.D.Trend@exeter.ac.uk

Interest research has many facets and the concept of „interest“ itself has received considerable research attention in recent years. Empirical research undertaken by the author with 11- and 12-year-old UK children suggests that children's „individual interest“ and „situational interest“ can be clearly delineated in relation to geoscience phenomena. However, the motivating power of geoscience „topic interest“ remains unclear.

The empirical research results are summarised, but the two main foci of this talk are (i) the methodology used in the empirical research and (ii) the implications of the findings for teaching and for wider geoscience educational research. In particular, what particular geoscience interests might profitably be investigated and how can (transient) situational interest be converted into (robust) individual interest? Are some

aspects of geoscience likely to lead to more secure learning than others?

For the empirical research, a sample of 652 11- and 12-year-old children was surveyed in 27 classrooms across 11 UK schools in order to identify existing geoscience interest. Results indicate that children have high interest in major geo-events set in the geological past, present and future and in current environmental changes, which have direct implications for the future of humanity. They also have coherent topic interest in gradual (i.e. uniformitarian) change in the geological past. Girls have a preference for phenomena perceived as aesthetically pleasing and boys have a preference for the extreme and catastrophic. Children from middle (8-12 years) schools have less interest in geoscience generally than do children of the same age in secondary (11-18 years) schools.

## Student's interests in geo-scientific topics

INGRID HEMMER<sup>1)</sup>, MICHAEL HEMMER<sup>2)</sup>, HORST BAYRHUBER<sup>3)</sup>, PETER HÄUSSLER<sup>3)</sup>, SYLKE HLAWATSCH<sup>3)</sup>,  
LORE HOFFMANN<sup>3)</sup> & MARION RAFFELSIEFER<sup>3)</sup>

**Block 1**

<sup>1)</sup>Katholische Universität Eichstätt-Ingolstadt, Germany,

<sup>2)</sup>University of Muenster, Germany,

<sup>3)</sup>IPN Leibniz Institute for Science Education, Kiel, Germany,

Email: <sup>1)</sup>ingrid.hemmer@ku-eichstaett.de

Standardised questionnaires were used to survey the interest of more than 300 German students, aged 16-18, in 11 geo-scientific topics. All subject matters were related to eight different terms among which 'individual', 'society' and 'social responsibility' achieved highest attention scores. The most promi-

nent result was the lively interest in issues related to human activities, everyday life and environmental hazards. The attraction of different teaching practices was another subject of the study. Consequences for geo-science education are proposed.

## Factors responsible for the declining pattern of geo-science learners' interest – a study on the geo-scientific student community from Assam, Northeast India

MANJIT KUMAR MAZUMDAR<sup>1</sup>, AMULYA CHANDRA MAZUMDAR & ARUN KUMAR BORAH

Block 1

University of Gauhati, Guwahati, Department of Geological Sciences, Assam, India,

Email: <sup>1</sup>mmazumdar2003@yahoo.co.in

In the recent years, the geo-scientific fraternity from different parts of the world has observed a rapid dwindling in the number of students opting for geosciences. (Shankar 2003). Geoscience is not among the subjects generally sought after by the best students (Vaidyanathan 1998). Reasons for such a disastrous trend can be wide and varied, and has been a matter of concern and debate in the recent years. A survey carried out in Netherlands in 2002, has yielded startling revelations, including a negative image of the subject among common masses, low awareness level of the subject among the prospective learners, monotonous teaching methodology, among others. (Sneider & Spears 2002).

In view of all the above, an attempt has been made, through the form of a questionnaire survey, among the undergraduate and postgraduate Geology Major (Honors) students from the different colleges and universities of Assam, with a view to achieve several objectives like ascertaining the impact of socio-economic factors on the geo-scientific career of any particular learner, determining the appreciativeness of

the students with regards to the various components of any particular geo-science curriculum, determining the compatibility of the personal traits of the students with the professional traits expected from a prospective geo-scientist, gathering ideas on the expectations of the geo-science learners as regards to their career and to elicit constructive ideas from the geo-scientific student community, for bringing about overall changes in the entire learning system currently prevalent locally.

The data generated has been analyzed, by ranking and categorizing questionnaire responses, using statistical software.

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## **Student's conception on circadian and seasonal cycles**

INGRID HEMMER & SYLVIA WEIZINGER

**Block 2**

Catholic University Eichstätt-Ingolstadt, Department of Geography Education, Germany,  
Email: [ingrid.hemmer@ku-eichstaett.de](mailto:ingrid.hemmer@ku-eichstaett.de)

Adapted from the theory of conceptual change, a 10-12 years age group of students was analysed concerning their pre-curricular conceptions of circadian and seasonal changes, polar night and midnight sun. The results were used to propose educational concepts.

## Students' concepts about meteorite impacts on Earth – geographical assessment and pedagogical consequences

MARTIN MÜLLER

**Block 2**

Catholic University Eichstätt-Ingolstadt, Department of Geography Education, Germany,  
Email: martin.mueller@ku-eichstaett.de

Meteorite impacts have been an ongoing phenomenon throughout Earth's history. In order to sample students' concepts and ideas, the topic has to be assessed from a geoscientific perspective.

Not only in the past but also today asteroids and comets pose a high risk for our planet. Small meteorites occur most often and only cause local damage but can nevertheless be a danger for cities. Larger meteorites are considered a risk for coastal areas due

to highly likely tsunami generation. Objects with more than 2km diameter require special supervision for they can cause a global "nuclear winter" and lead to a mass extinction, including humankind. Interviews with representatives of the Munich Re Group, the WBGU (scientific council of the German government) and the DKKV have also shown that meteorite impacts are dealt with as a high-risk potential and one of the most dangerous natural hazards.

## Misleading analogies of mantle dynamics introduce the belief that it is liquid

JOSÉ SELLÉS-MARTÍNEZ

**Block 2**

University of Buenos Aires, Argentine,  
Email: pepe@gl.fcen.uba.ar

Analogous models have proven to be useful tools for enhancing comprehension of complex scientific concepts but, in several cases, they may render undesired results.

The rheology and dynamics of the Earth's Mantle are usually modelled using a fluid heated in a pot. Convection currents forming there are supposed to mimic those in the Mantle. A survey through introductory science books designed for children yield alarming results. Most of them, taking the analogue for the object of study, assign the properties of the materials used in the model to those in the Earth. As long as water or oil are liquids the mantle is also a liquid, which is certainly not true.

This mistake is reinforced in at least two ways: First is that most illustrations about volcanoes show these structures being fed directly from a molten mantle. Second is the fact that scaling parameters are never taken into consideration when describing or performing the simulation, what precludes any possibility of differentiation of short and long term behaviour.

The situation should not be neglected. Not only is it widespread among general public, but it appears to be the belief of many teachers and, even worst, the mistake has been found in at least one book on better educational practices.

In order to modify this situation -and assuming that editors are not likely to make these books been reviewed by a person who knows about Earth Science before sending them to the market- teachers should lead the task. Several facts should be stressed when working with models: a- That models are limited approximations to reality, b-That differences in time and space scales between models and reality introduce important limitations to the analogy, c- That, as a consequence, model and reality are not fully equivalent, and d- Combining different models to explain different aspects of the same object of study will help students in the process of valuating what is comparable -and what is not- in each case, and thus reducing models to their real significance.

## Instructional implications of the survey on content mastery level in Earth science of secondary school students in Japan and Philippines

DIGNA C. PANINGBATAN<sup>1)</sup> & TAKESHI KOZAI<sup>2)</sup>

Block 2

<sup>1)</sup>Quezon City Science High School, Metro Manila, Philippines,

<sup>2)</sup>Naruto University of Education, Tokushima, Japan,

Email: <sup>1)</sup>dignapaningbatan@yahoo.com

This research analyzed the instructional implications of the survey on content mastery level in Earth Science (ES) of secondary school students in Japan and the Philippines. It was primarily based on the perspective of assessing the cognitive level in ES of the secondary school students in the two countries for the purpose of enriching the national curriculum designed for general public high schools especially for the Philippines. Furthermore, it aimed to: (1) determine the effect of the different existing science curricula in the Philippines on the students' level of understanding of earth science concepts; and (2) compare the Earth Science curricula of both countries in terms of content and teaching pedagogies. Likewise, the results of the survey were the basis for developing instructional materials in Earth Science. There were 191 8<sup>th</sup> graders in Chiba and Kumamoto prefectures (Japan Junior High School or JJHS) and among 480 2<sup>nd</sup> year high school students in Manila and Pangasinan province in the Philippines. The respondents were

between ages 13-15 years. Chi-test was used to probe on the significant differences in the performance of the students. Further investigation on the possible causes of the identified weaknesses among students through science class observations and the like was undertaken. Instructional materials were developed and tried out in the Philippine schools. However, in this paper, only the results of the survey on cognitive level in earth science will be discussed. Findings of this study showed that: (1) there is homogeneity in the performance of Japanese students as compared to the heterogeneity in the performance of Filipino students; (2) In Japan, teaching pedagogies were basically exploratory, holistic and experiential in nature; (3) The Earth Science curriculum in the Philippines must be trimmed down putting greater emphasis on quality rather than on quantity; and (4) Science teachers must consider proper emphasis and integration of concepts.

## Educational reconstruction of Earth science concepts - an approach to change secondary and university students' preconceptions of groundwater

SIBYLLE REINFRIED

**Block 2**

Ludwigsburg University of Education, Germany,

Email: reinfried@ph-ludwigsburg.de

Research has established that students enter their science classes with ideas about the natural world that do not correspond with accepted scientific findings. The diagnosis of these preconceptions may be seen as a crucial, initial step in the process of teacher-facilitated conceptual change at all grade levels. To promote conceptual change, educators may employ new ways of constructivist teaching. The model of educational reconstruction developed by Kattmann et al. (1997) has proven to be a useful frame for integrating empirical research on teaching and learning into instructional development. It allows balancing science content structure with educational issues. This research tested the hypothesis that students' erroneous ideas about groundwater will change towards more valid concepts if they are taught on the basis of educational reconstruction. To examine the hypothesis a quasi-experimental research design was chosen. The methodology adopted in the study used both qualitative and quantitative methods. To promote conceptual change, a teaching and learning approach aiming at mental model building was adopted in the experimental group, while the control group was

taught by direct instruction. Before the intervention more than 75% of the students' conceptions were either unclear or incorrect, based on simple, 'common sense' views of groundwater deposits. After the intervention the experimental group revealed significantly fewer misconceptions in their mental models about groundwater than did the control group. Teaching and learning by the mental model-building approach therefore seems to help undergraduate students to improve and refine their mental models of the abstract concept of groundwater occurrence in nature. The approach of educational reconstruction is seen as a feasible strategy to induce conceptual change of preconceptions in other earth science and geographical areas.

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## An automated scoring system for qualitative problem solving in Earth science

CHUN-YEN CHANG & HAO-CHUAN WANG

Block 2

National Taiwan Normal University, Department of Earth Sciences, Taiwan,  
Email: changcy@ntnu.edu.tw

Science education researchers have noticed that although students may do well in solving quantitative problems in science tests correctly and efficiently, such as being able to manipulate Newtonian physics formula to derive the quantitative answers desired by testing items. However, when asking the students to explain the physics under physical phenomena qualitatively in their own words, such a task appears to be challenging for many of them. It is considered that prospective science education curriculum must put stronger emphasis on developing students' science process skills and creative problem solving abilities. Under the condition, a new set of instrumentation suitable for assessing and diagnosing learners turns to be essential for the new breed of research on problem solving activities that require students to design, plan and explain their own solutions.

The use of essay questions is considered helpful in assessing students' qualitative problem solving abilities. However, the labor required to process these open-ended natural language answers may obscure the scalability of this approach. An automated scoring system aims to support researchers' and teachers'

needs of processing a large quantity of students' open-ended essays in the contexts of earth science problem solving (debris-flow hazard topics) has been built and preliminarily evaluated. The core idea of the system is that students' natural language responses would contain invaluable information regarding their understanding of the subjects and abilities to derive solutions. By using contemporary artificial intelligence and natural language processing technologies, the system aims to efficiently build students' formal learning profiles and derive quantitative measures of their problem solving abilities for a later analysis or instructional decision-making.

The preliminary evaluation shows that the system is able to achieve satisfactory scoring performance that its scoring result was significantly consistent with human experts' results in terms of holistic scoring. Potential benefits of the automated scoring systems include (1) to support large scale educational survey in various scientific disciplines, and (2) to enable the possibility of online tutoring for qualitative perspectives of science education either performed by human tutors or computer programs.

## Elementary students' system competency

CORNELIA SOMMER

Block 3

IPN Leibniz Institute for Science Education, Kiel, Germany,  
Email: sommer@ipn.uni-kiel.de

In this presentation, data will be presented from the evaluation of the newly developed teaching materials for elementary schools in the German “System Earth – primary school” project. The material from the project contains science contents in a geoscience context, thus offering possibilities for interdisciplinary teaching. It included worksheets, experiments, student information and a computer game on a young white storks adventurous voyage. The guiding idea in developing teaching materials for the “System Earth – primary school” project was to promote the students' competent handling of systems. This lead to better linking of individual, isolated bits of knowledge to cohesive overall knowledge.

The present empirical study focuses on considering how students at primary level handle complex systems in terms of system competency. System competency involves knowledge about the elements and relationships of the system. In addition, the recognition of a systems characteristics as well as the understanding of its dynamics are necessary preconditions of system competency. Within the frame of the accompanying

research it must be classified whether elementary school students already show the beginning of system competency.

A sample of 363 students were examined to identify to which degree students from elementary schools already show system competency or are able to develop this kind of competency respectively. The study was performed according to a pretest-posttest design. Special tasks about the understanding of biology subject knowledge were used in the questionnaires in order to find out the extent of necessary preliminary knowledge. The students were also asked to complete concept maps for certain topics. These concept maps offer indication of the degree of system competency.

The results support the hypothesis that even elementary students show the beginning of system competency, especially where there is enough preliminary knowledge about a system's elements. This system competency and domain-specific subject knowledge can be further promoted by using the “System Earth” teaching materials.



## An approach of modelling minimal climate models: Fostering an understanding of nature of the models and complex systems

MARCO THIELE

**Block 3**

IPN Leibniz Institute for Science Education, Kiel, Germany,  
Email: thiele@ipn.uni-kiel.de

The thermohaline circulation is a global conveyor belt in the oceans and has a significant effect on the climate especially on the northern hemisphere. As shown in the movie “The Day after Tomorrow“, the topic of a breakdown of the global Thermohaline Circulation has reached a wider public. It is to question whether these occurrences contain any scientific content. On a more general level one can address the question how knowledge is generated about complex systems, like the climate system, and in science in general.

Models are an important research tool in science. An appropriate view on models is part of the understanding of the nature of science. It is often stated that pupils and even teachers have an inappropriate understanding of the role and nature of models in science.

Due to the growing computational power an increasing importance of computer models and “numerical experiments” can be observed, for example in economics, technology, astronomy and complex systems. The aim of our study is to stimulate thinking about

models in general – and especially with dynamic computer models about complex systems.

For this purpose a teaching unit questioning the breakdown of the Thermohaline circulation is developed. This is realized by an iterative development of a simple stock-flow computer model of the global conveyor. The focus lies on the models’ investigation by the students and a discussion about the explanatory power of the models. The final version of this model, although highly idealized, shows a sudden breakdown of the conveyor. This behaviour is also found in more complex models of the climate system, as well as in climate history. Therefore, there are some analogies between the findings in climate research and the movie “The Day after Tomorrow“, although the events are highly dramatized in the movie. Nevertheless, this model is no proof that an abrupt breakdown could happen in the real world in the near future.

These lessons were taught in four classes (11th to 13th graders). A pre-post-test design was used to investigate the abilities of the students in the field of the nature of models, as well as their interest. The results will be presented.





## Promoting system competency with “System Earth” education – evaluation results of the German project “Forschungsdialog: System Erde”

MARKUS LÜCKEN<sup>1)</sup>, SYLKE HLAWATSCH, & NINJA RAACK

**Block 3**

IPN Leibniz Institute for Science Education at the University Kiel, Germany,  
Email: <sup>1)</sup>luecken@ipn.uni-kiel.de

The project “Forschungsdialog: System Erde“ aims at developing interdisciplinary system earth education for secondary high school classes. A multimedia CD-Rom was developed involving interactive elements, detailed information about the System Earth, and elaborated instruction material. This material was designed to be as attractive and illustrative as possible to foster students’ interests and performances in (geo-)science contents. The topics of System Earth Education are highly interconnected with other science subjects like Biology, Chemistry and Physics and offer many more or less complex systems (e.g. climate system, carbon cycle) that are ideal opportunities to acquire system competency as defined by Rost, Lauströer and Raack (2003).

The evaluation study wants to figure out, if the new developed instruction material is capable of promoting students’ interests in System Earth Education, students’ acquisition of

(geo-)science knowledge and their system competency. To this end a control-group design with questionnaires for teachers as well as their students was realized after teachers had used the new material in their classes. Eleven teachers with their 222 students used the new material in their classes and were compared with 10 teachers and 205 students that were in the control condition.

The results of the evaluation study confirm the suitability of the “System Earth” instruction material for secondary high school classes. Students that were taught with these materials showed significantly more interest in (geo-)science topics and significantly more knowledge about these topics than students in the control condition. In addition, the degree of system competency was also significantly higher in the “System Earth” condition than in the control condition. These results were discussed with respect to a conception of scientific literacy focussing on competencies and their promotion in the classroom (Klieme, 2003; KMK, 2004).

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## The development of an oceanography unit as a part of the Israeli high school Earth sciences program

NIR ORION<sup>1)</sup> & CARMIT COHEN

**Block 3**

Weizmann Institute of Science, Science Teaching Department, Israel,  
Email: <sup>1)</sup>nir.orion@weizmann.ac.il

The Israeli high school earth sciences program is based on the earth system approach. It includes three components: a) an introductory unit which mainly focuses on studying the earth systems on the context of the rocks' and hydrological cycles and the structure of the earth and the plate tectonics. b) An environmental-based interdisciplinary unit such as „the global warming and the earth system“, „Earthquakes in an environmental context“, „Evolution in deep time perspective“. c) The „Geotop“ – a mini research project.

The new unit „Oceans and the earth systems“ has been developed as part of the environmental-based interdisciplinary component of the program. The development of this unit has been conducted as a design based research. The unit starts with the film „The day after tomorrow“ which establishes the environmental context and the motivation for studying the next lab-based unit that comes to explore the scientific basis of the movie. Following the lab activities the students develop an understanding of basic oceanography concepts and phenomena. In the last part of the unit each student has to select an oceanography related phenomenon such as hurricanes, El-Niño, climate changes, sea pollution for a self study

that later should be presented to the class through a power-point presentation.

The study included about hundred 12<sup>th</sup> grade students and was based on qualitative and quantitative research tools. The predevelopment study revealed several misconceptions concerning the location of oceans and continents; the dynamic of the oceans' water; the interrelationships between oceans and continents; the influence of the oceans on the climate.

Following the learning process the students passed through a meaningful conceptual change. The predevelopment study also revealed that most of the students came with a minimal background in other sciences namely chemistry, physics, biology and even reluctant to study these disciplines. Following the learning those students improved significantly their understanding of basic concepts such as pressure, heat transfer, chemical composition of water, dissolution, food web.

Following our results it is suggested that the earth systems approach could serve as a powerful platform for motivate students to study complicated scientific concepts and processes from all the scientific disciplines.

# **Geoscience in international comparison**

Chair: Ian Clark and Chan-Jong Kim

## **International Earth Science Olympiad: New challenges for geoscience and geoscience education community**

CHAN-JONG KIM

**Block 1**

Seoul National University, Department of Earth Science Education, Korea,  
Email: chajokim@snu.ac.kr

At the International Council Meeting in Calgary, Canada in 2003, International Earth Science Olympiad (IESO) was adopted as one of major activities of IGEO. IESO Committee was established. Seoul Conference for IESO was held on Nov. 2004 in Seoul, ten countries participated to share earth science curricula of the countries participated and ideal way to compete was suggested and discussed. The time and place of First IESO was also decided as 2007 in

Korea in a committee meeting during the conference. As the earth science curricula were diverse in terms of their content and grade levels taught, IESO Syllabus Commission was organized. One of the special features of IESO decided is making international cooperative teams consisted of participants from different countries to collaborate during field work or practical work tests. Details of IESO are also described.

## Skills and abilities that students should acquire towards the International Earth Science Olympiad (IESO)

NIR ORION

**Block 1**

Weizmann Institute of Science, Science Teaching Department, Israel,  
Email: nir.orion@weizmann.ac.il

The first International Earth Science Olympiad (IESO) is going to take place in South Korea during 2007.

An international committee developed an earth systems based syllabus that will allow the different countries to prepare their students countries towards the international Olympiad. The following are the some examples of skills and abilities that students should acquire towards the IESO:

1. To be able to locate a geospheric phenomenon in the sequence of processes of the rock cycle.
2. To be able to do cyclical thinking in context of matter cycles in the Earth systems.
3. To be able to identify the components of a specific system and to characterize each component in size, rate and complexity.
4. To be able to think systemically in order to understand the interaction between a specific system and the development of interwoven interactions among the components of the system.
5. To be able to identify the interactions among the components of a specific system as dynamic processes of the transition of matter and energy.
6. To be able to identify dynamic processes in the time dimension.
7. To be able to identify environmental problems and to suggest solutions based on the understanding of the principles of the reciprocal relations among and inside the Earth systems.
8. To be able to think scientifically and make the distinction between an observation and an experiment, conclusion and hypothesis, the ability to hypothesize, draw conclusions and suggest solutions.
9. To be able to represent and present knowledge in writing and orally using various means like research reports, a scientific poster and a computer presentation.
10. To be able to forecast and prevent the natural disasters such as earthquakes, volcanic activity, typhoon/hurricane, tsunami, landslides, and flooding.

The detailed syllabus will be presented during the session.

## Preliminary survey for the nature of Taiwan with the image of KOMPSAT 1 as an Olympiad subject

Moo YOUNG SONG<sup>1)</sup> & Hyo – Suk LIM

**Block 1**

Chungnam National University, South Korea,  
Email: <sup>1)</sup>mysong@cnu.ac.kr

For the unknown region, geographical map used to be the unique information, and these days some of satellite image provides recent information. The Google Earth is attractive software to provide recent geographical information using satellite image. For 4 weeks' stay in Taiwan, I have provided with Korea Multi-purpose Satellite (KOMPSAT) 1 image with 6.4 m of ground resolution for the area SinZu of the north-west part of Taiwan.

Through the referencing of the image interpretation as basic characteristics of shape, size, pattern, tone, texture, shadows, site, association and resolution, we obtain the distribution of airport, harbour, railroad, highway, bridge, river, and some of the land covers too. The recent dated image of the satellite suggested more detail progress of the different steps of the road construction or High Speed Railway construction.

The reflectance difference gives us idea of the characteristics of the land cover such as naked or

vegetation, and of water contamination with suspended material between two adjacent river waters.

Taiwan nature is different from Korea in the point of its Tropical climate, high relief, relative young geological age, volcano and high seismic activity, and natural gas reservoir of low quantity though. And this difference can give rise to strong attraction from Korean students, and tourists. The current geological process, which gives the idea for the interpretation of the geological structure like the famous phrase "The present is the key to the past", is a good real experiment subject for the earth science students.

Through the internet site browsing and the image interpretation of the satellite image, cybernetic natural field excursion can be performed very effectively. Some of the geologic map, geological structure and volcano sites can be provided previously.

## Four years' National Earth Science Olympiads in Korea and reparation of 1st International Earth Science Olympiad

MOO YOUNG SONG<sup>1)</sup>, SEOK WON YON & MYEONG KYEONG SHIN

**Block 1**

Chungnam National University, Department of Geology, South Korea,

Email: <sup>1)</sup>mysong@cnu.ac.kr

In order to improve the importance of the earth science among natural science fields in the middle school education, the Korean Earth science Society (KESS) has performed the national Earth science Olympiads through the contest of written tests for and individual interviews with the contestant students every year since 2003. The earth science subject, in Korea, was composed of geology (40 %), astronomy (30 %), and meteorology and oceanography (30 %) for the junior high school students and the senior high school students according to their standard level of educational policy, respectively.

Generally the first step of the Olympiad was carried out as preliminary contest for about 1000 students recommended by their principals as their school's representatives, and the second step of the Olympiad for the qualified about 200 students has been run through the written test and the individual interview for the experiment. During the events the Municipal Education Bureau supported the KESS through the recommendation, official announcement, and dispatches of teachers and students. Moreover the parents of the students have been high interested in their children's contest record.

The best students have been awarded Medallion as gold, silver, and bronze, respectively. Then, some of the students got favour for the entrance to Science High school or highly recognized University. The result was effective for the acknowledgement of earth science in the society. Some of the test items will show as an example.

Since the GeoScEd4 Congress in Calgary June, 2003, has decided to have International Earth Science

Olympiad, the IGEO and KESS took several measures for the first IESO for 2007 in Korea, in which the KESS will host the 1<sup>st</sup> International Earth Science Olympiad. At the preliminary meeting for the IESO, Nov. 26-30, 2004, in Seoul, the delegates of 8 countries and Korean scholars had the symposium for the Olympiad and organized advisory committee, coordinating committee, and later also syllabus committee and decided the Status of IESO with directing of President-elect of IGEO, Dr. KIM, Chan Jong. The Syllabus Committee of which Dr. Orion has the chair prepared the subject and mainframe of the IESO.

The Korean Earth Science Society has endeavoured for the financial support from Korean Government and other fund raising for the 1st IESO, and composed the Organizing Committee with several sub-committees for the international performance. We need our active cooperation for the participation from as many countries as possible, and sufficient financial support for the accommodation of the contestants and leading group during the events in Korea. And we want to get support from all the governments of participants and some international Union such as IUGS, UNESCO.

The Organizing Committee is composed of well known leaders in Korea, in the specialized fields of Geology, Astronomy, Meteorology, and Oceanography in Governmental Institutes and University, closely connected to the Korean Government either Ministry of Education or Ministry of Science and Technology. We hope all the attendants to the 1st IESO to share not only earth science experience, but also much international cultural progress.

## From Earth science to Earth system science: A high school science curriculum reform in Taiwan

YI-WEN HUNG<sup>1)</sup> & YING-SHAO HSU

**Block 2**

National Taiwan Normal University, Department of Earth Sciences, Taiwan,  
Email: <sup>1)</sup>v3256@ms36.hinet.net

Calls for science education reform have prevailed for last two decades. One of the major themes is the integration of different disciplines of science curricula. At the same time, the earth science is undergoing a revolution, that is, many scientists have discovered that the earth is a “complex system” with some properties that cannot be explained through understanding its components separately. To meet these trends, Ministry of Education in Taiwan proposed a new guideline for Earth Science in high school science curricula. The major shift is the inclusion of Earth System concept, and there are three new components in the guideline. They are “The Dynamic Earth”, “Climate Change” and “Human Dimension”. There is not merely content knowledge of traditional earth science disciplines in the first component, and it also emphasize the interactions between the subsystems, geology, meteorology and oceanography. Thus it foster a holistic view, in which disciplinary processes and feedback mechanisms lead to synergistic interdisciplinary relevance, to form a

physical basis for Earth System Science. In “Climate Change” part, the guidelines attempt to introduce the short-term and long-term global temperature variations in earth history. By way of this introduction, students might be aware of the differences between natural and anthropogenically induced variability in the climate system. Since human activities could cause profound impacts on the regional environment, like land use, and even the whole earth, like ozone depletion, the role of Humans should not be considered as external to the Earth System, especially when facing the increase in carbon dioxide concentration in the atmosphere. Earth System Science studies the functioning of, and interactions between Humans and bio-physical systems via biogeochemical cycles. The last component, Human Dimension, help students note that Humans initiate the change, but Human development may, in turn, be affected and constrained by the changes in the bio-physical systems. This is the “Sustainable Development” that modern citizens should understand.



## Basics for geoscience education

JOSEF BIRKENHAUER

**Block 2**

Sektion Geographie LMU München, Germany,  
Email: j.birkenhauer.seefeld@t-online.de

1. Geoscience (G) Education (E) is confronted with at least five formidable tasks such as helping towards a better understanding of G phenomena.
2. Geoscientists themselves must agree on a definition of what geosciences are about. Such definition is proposed here. Any G deals with objects, which anywhere are characterized by the categories of “where”, “when” and “why”.
3. It is exactly the close “togetherness” of these three categories which puts up the gravest problems of understanding for people not trained in this kind of “G-thinking”.
4. The quality of teaching about G (=E) rests on a particular “trinity” (consideration of the mental “horizon” of the addressee; helping towards an intense awareness; choice of a worth while object.)
5. The method best suited for any approach to G-Objects is the inductive one (as opposed to the deductive one, which, most unreflectedly, is taken to be the one and only matter-of-course way)
6. Deep frustrations of the addressees have to be avoided. Frustrations have at least seven causes (such as the deductive way, a well-meant but unnecessary systematic introduction etc.)
7. Actual G-objects looked at in the field should have particular qualities such as structuredness, terseness, an inherent aesthetic quality etc.
8. Note  
A good illustration of the many pits into which even a well-meaning G-man falls is for instance Bill Fritz’s “The Roadside Geology of the Yellowstone Country”.

## Different points of view for educational materials and curricula related to earthquakes at elementary and secondary educations in Japan, New Zealand, Egypt, Brazil, and Argentina

HIROO NEMOTO<sup>1)</sup>, SANDRA E. MURRIELLO<sup>2)</sup>, GLENN D. VALLENDER<sup>3)</sup>, MOHAMED A. A. M. RASHED<sup>4)</sup>,  
TATSUYA FUJIOKA<sup>5)</sup> & YOSHINOBU TOKITA<sup>6)</sup>

**Block 2**

<sup>1)</sup>Graduate School of Science, Osaka City University, Japan,

<sup>2)</sup>State University of Campinas, Brazil,

<sup>3)</sup>Ashburton College, New Zealand,

<sup>4)</sup>Faculty of Geology, Suez Canal University, Egypt,

<sup>5)</sup>Graduate School of Education, Joetsu University of Education, Japan,

<sup>6)</sup>Graduate School of Education, Joetsu University of Education, Japan

Email: <sup>1)</sup>nemo@sci.osaka-cu.ac.jp

The science curriculum of schools, based on Japanese standard curriculum have a very little contents of relationships between people and nature in the field of geoscience such as earthquakes, volcanoes, typhoons, and so forth. That is to say, this curriculum shows that the contents are not enough to understand about relationships between people and nature. Therefore, Japanese geoscience researchers and educators need to propose a new curriculum to the Ministry of Education, Culture, Sports, Science, and Technology in Japan about geoscience education for students in elementary, secondary, and tertiary educations. Moreover, they need to improve the methods of teaching for ordinary people as well.

We, therefore, should analyze many materials, syllabi, curricula and so forth based on a global viewpoint. Here, global viewpoint has two main meanings. One means that it can be adopted for worldwide because of global relevance. Another means that it has many points of view such as science, the humanities, disaster education, social science, and so forth. At first, we focused our main subject on syllabus content of earthquakes. With international cooperation (Japan, New Zealand, Egypt, Brazil, and Argentina) we compared school textbooks and other materials for earthquakes curriculum content.

Results indicate that earthquakes are taught in different subjects in these countries. At upper secondary schools in Japan, earthquakes are taught within mainly the subject of Geoscience (“Chigaku”). On the other hand, earthquakes are taught within “The environmental science and geology”, “Geography” and “Science”, “Science” and “Geography”, and “Geography” and “Geology” at mainly upper secondary schools in Egypt, New Zealand, Brazil, and Argentina, respectively. Also, syllabus contents of earthquakes among these countries are different. For instance, Earthquakes are taught in the New Zealand science curriculum and the New Zealand geography curriculum. The emphasis in geography is impact on society. Emphasis in science is on distribution, relationship to plate tectonics (origins), measurement and usefulness in understanding geological history. Main interested domain of earthquakes is not relationships between people and nature of earthquakes but mechanisms of them in Japan.

In this presentation, we will focus on the current status of earthquakes education and try to report our results, which clarify difference view points about earthquakes education among these 5 countries.

## A survey of geological education in West Africa

T.C. DAVIES<sup>1)</sup> & M.K. DARENG<sup>2)</sup>

**Block 2**

<sup>1)</sup>Department of Geology and Mining and <sup>2)</sup>Department of Science Education  
University of Jos, Nigeria,

Email: <sup>1)</sup>daviestheo@hotmail.com

Geological education in West Africa is truly in crisis. This is a region that has been plagued in the last decades by instability, including military coups, civil wars and periods of economic stagnation. As a consequence, stress in living in the region's domestic and occupational scenes leads to poor classroom performance by students, and induces "teacher burnout", described as physical, emotional, and attitudinal exhaustion resulting in a detached client attitude and reduction in work performance. Deficiencies in the basic training of geology graduates abound and are a reflection of inadequacies in teaching resources and research facilities, including staffing, curriculum, equipment, fieldwork, library and student attitude. We present a review of the effect of these factors on the quality of geological education in universities in Nigeria, Ghana and Sierra Leone.

There are about nineteen departments offering Geology or Earth Science in Nigeria, two in Ghana and only one in Sierra Leone. The sheer size of the Nigerian enrolment (typical staff / student ratio > 1 : 50, compared with the recommended 1 : 20 by the Nigerian Universities Commission) tends to amplify the effect of the other militating factors that are common to virtually all the departments.

The prospect of this crisis breeds loss of confidence, but it also offers opportunities for improving the situation. A vital part of this process is the provision of authoritative and easily accessible information about Geology Departments in the universities, and evolution of higher education in general, within the region. Next, we present a study of the interactions of factors that are precipitating the crisis, since such analysis carries important implications for our understanding of the education process as well as for policy formulation. Questions regarding the lack of motivation among students in Geology programs and the role of extracurricular participation and classroom performance level of students, for instance, can provide useful pointers for determining selection criteria.

Finally, we examine how the lack of effort in addressing the crisis has resulted in a gradual decline of employer confidence in geology graduates produced by the regions' universities. We end by prescribing some practical measures that would help to improve the situation - network activities, promoting and organizing regional field courses, making more use of teaching aids, etc. It is hoped that this contribution will go some way towards correcting the decline and addressing the losses.

## A review of geosciences in the new South African school curriculum and its reception in the classroom

IAN J. MCKAY,

**Block 2**

School of Geosciences, University of the Witwatersrand, Johannesburg, South Africa,  
Email: mckayi@goesciences.wits.ac.za

This paper reviews the extended coverage of Geosciences in the new National Curriculum for schools in South Africa. It also looks at difficulties that are being experienced with implementing Geosciences in the curriculum and reports the results of interviews with education department officials and practicing teachers.

In the past, coverage of geosciences in the South African school curriculum was restricted to Geography and Evolution was not mentioned because it was not compatible with Natural Christian Education. In 2006, however the situation changed with the introduction of Outcomes based education. For learners from Grade 1 to 9, in the General Education and Training Phase (GET), Geosciences has been included in Geography and History as part of the social sciences. It is also included as part of the Natural Sciences for the first time. For learners from Grade 1 to 11, in the Further Education and Training Phase (FET) geosciences may be found in the History curri-

culum, the Geography curriculum, the Physical Sciences curriculum and the Life Sciences curriculum.

Although geoscientists are generally thrilled by the extra Earth Sciences in the new Curriculum, there are still problems. The curriculum is spread over so many subjects that learners will not get a holistic understanding of how the Earth works. Preliminary interviews with education department officials suggest limited resources for training science teachers in this new subject. Subject advisors would still prefer to spend limited funds on training teachers to teach traditional “hard core” Geography subjects like Geomorphology and Mapwork. Science teachers may prefer teaching their area of expertise, usually chemistry or physics. Some Geography teachers resent the transfer of what they consider to be “their subject” to the natural sciences. However, many science teachers enjoy teaching about the Earth Science; they say their learners really enjoy the topic and that it “does wonders for their general knowledge”.

## Competency improvement of geoscience education in Indonesia based on geo-resources sustainability and geo-hazard vulnerability awareness

DONATUS H. AMIJAYA

Block 2

Gadjah Mada University, Geological Engineering, Yogyakarta, Indonesia,  
Email: hamijaya@ugm.ac.id

Indonesia is a unique region in the sense of geographical-geological setting. Indonesia lies in tropical area and located between two oceans (Pacific and Indian) and two continents (Asia and Australia). Geologically, Indonesia region is the meeting point of three tectonic plates (Eurasia, Pacific and India-Australia plates). The result of those phenomenon is that Indonesia is rich in geo-resources (petroleum, minerals, coal, geothermal, etc.) but also vulnerable to geo-hazard (earthquake, volcanic eruption, tsunami, landslide, etc.). Considering those facts, geoscience education acts as the backbone of teaching and

learning processes, formally in the schools and universities or informally in community development activities, to understand the natural condition of Indonesia. However in the past, geoscience education focused more on the spatial aspect and disregarded the temporal-dynamical aspect of earth. Concept of earth as a dynamic system is enriched nowadays in the geoscience lecture given in all level of education. Knowledge and understanding of that concept leads to an appreciation for the importance of managing geo-resources in a sustainable way and also for the vulnerability of Indonesia region to geo-hazard.



# **Teacher instruction in geoscience**

Chair: Chris King & Ingrid Hemmer

## Using experience from one country to develop a curriculum initiative in another: Earth science workshops for Scotland

CHRIS KING

Keele University, Earth Science Education Unit, United Kingdom,  
Email: c.j.h.king@educ.keele.ac.uk

The Earth Science Education Unit had been successfully established to deliver Earth science workshops to secondary science teachers (teachers of 11 – 16 year olds) across England and Wales through a network of specially appointed and trained facilitators. This initiative, funded by the offshore oil and gas industry (UKOOA), had presented workshops to science departments in schools and to pre-service teacher training institutions and was being very well received.

However, if ESEU wanted to expand into Scotland, it had to meet new challenges. In England and Wales, most of the Earth science is found in the secondary science curriculum, but in Scotland, most Earth science is found in the primary curriculum (aimed mainly at 11 year olds). It would be impossible for ESEU facilitators to visit all primary schools in Scotland – there are too many of them. So, a new strategy had to be developed, presenting workshops to primary teachers gathered in central locations.

New workshops had to be developed too – appropriate for primary teachers and pupils and appropriate for

Scotland. ESEU was fortunate to be able to work with the Scottish Earth Science Education Forum (SESEF) and their Development Officer to devise two new workshops, to pilot the workshops, to appoint and manage a team of facilitators and to promote the workshops to primary teachers across Scotland. This Scottish form of ESEU activities has been very successful, such that workshops have now been presented to more than 1000 teachers in Scotland, receiving very positive feedback.

Important elements of this success have been to:

- fund the initiative in the country concerned;
- build on a support network within the country;
- work with local teachers to develop practically-based, hands on workshop materials appropriate for the teachers, the curriculum, the pupils and the context of the country;
- pilot the workshops before national roll-out;
- appoint local facilitators;
- maintain a booking/promotional office in the country concerned;

monitor the progress of the initiative closely.



## Why Earth science CPD workshops in the UK are successful: What teachers say

SUSANAH LYDON<sup>1)</sup> & CHRIS KING

Keele University, Earth Science Education Unit, United Kingdom,

Email: <sup>1)</sup>s.j.lydon@educ.keele.ac.uk

The Earth Science Education Unit (ESEU) provides continuing professional development (CPD) workshops for teachers in the UK. Since 1999, ESEU has delivered more than 600 workshops across England, Wales and Scotland, involving more than 4400 teachers and 3400 trainee teachers. Around 50 Earth science specialists around the UK visit local schools and teacher training institutions to present workshops, forming a nationwide network which is administered by a central hub based at Keele University.

Workshops typically last 90 minutes and address Earth science topics within National Curriculum science. The workshops focus on practical activities which teachers can use to demonstrate Earth science concepts and processes in the classroom or laboratory. Teachers try out activities in pairs, demonstrate activities to the group and discuss the potential for incorporating the activity in their own teaching, given their individual circumstances.

Follow-up surveys conducted a year after a workshop has taken place show that schools make long term changes to their teaching of Earth science in response to an ESEU workshop. This is encouraging, particularly since the current consensus in educational research is that short workshop-based CPD is rarely effective in bringing about change in the classroom.

Feedback collected from teachers who have participated in a workshop can help to explain why the ESEU approach is successful in changing classroom practice despite the short duration of workshops. Teachers greatly value being given new teaching ideas which they can easily implement in their own classrooms, and the opportunity to try them out. They also value having contact with a subject specialist who can deal with specific Earth science questions, making teachers more confident in their own knowledge and understanding.

## **Empowering student teachers to teach Earth science; a collaboration between science and education at the University of Victoria, Canada**

EILEEN VAN DER FLIER-KELLER

Chair EdGEO National Program, School of Earth and Ocean Sciences, University of Victoria, Canada,  
Email: fkeller@uvic.ca

Canada has a well-established program, EdGEO, for providing earth science workshops for in-service teachers. In 2005, a student teacher EdGEO workshop was offered for the first time, as part of a first year university earth science course, „Introduction to the Earth System II“. The goal of the ‘Education Lab’ was to cover the same science content, but in a way that would facilitate learning of earth science using a variety of teaching techniques and hands-on interactive activities transferable to the K-10 teaching environment. During the ten weeks of labs, student teachers worked with teaching resources such as rock, mineral and fossil kits, books and posters, which they will bring with them into their future classrooms.

To measure the impact of this approach, pre and post lab surveys were undertaken, and lab assignments, midterms, final course exams and course evaluations were also evaluated. Questions on the surveys were

designed to measure changes in student’s attitudes to earth science, and their earth science knowledge particularly with respect to common misconceptions.

The Education lab was a highly energetic, interactive learning environment. In spite of a concern among some of the Education students that they were having too much fun to be learning science, final course results showed that the ‘Education Lab’ students averaged final marks over 5% higher than the course average. Survey results showed that these students made similar or greater gains in knowledge compared to the non-Education lab students. Although the Education lab students came into the course with generally less interest in earth science, over 50% said their interest had increased greatly. These students also registered a marked increase in how relevant to society they felt earth science to be.

## **Teacher training is the most effective method of promoting geosciences at school level in Sri Lanka**

ASHVIN WICKRAMASOORIYA

Faculty of Applied Sciences, South Eastern University of Sri Lanka,  
Email: awickramasooriya@yahoo.com

Recording different types of natural and environmental hazards in Sri Lanka has been increasing very rapidly within last ten years. Rapid change in environmental conditions and human activities are directly responsible for this. As the geosciences has a close connection with the environmental hazards, the Sri Lankan government understood the importance of introducing the geosciences awareness programs to the community as well as for the secondary school syllabuses for various subjects. Establishing of the Disaster Management Centre in Sri Lanka, is another important step that the Sri Lankan government done for the promotion of geosciences in Sri Lanka. But there is a shortage of specialists and experts in some of the fields of geosciences in Sri Lanka. Therefore, it is very important to produce many graduates and postgraduates in geosciences within next few years. However, introduce the basics of the geosciences from the school level will be extremely important. Learning is considered one of the greatest means of

education and is not only the acquisition or the familiarization of particular knowledge but also the acquisition of skills and the establishment of a principle system. Therefore, a teacher has the responsibility to produce skilful students.

In the simplest term, teaching is nothing but a powerful tool that the teacher can give his/her knowledge to the students. However, to become an excellent teacher, first a person must have a sound knowledge about the subject that he/she is teaching. That is why gathering the subject knowledge is considered as one of the most important step in teaching. That is why a teacher must train before he or she will start teaching. As the geosciences is new for the school students, basic principles of geosciences to be introduced step by step for them. For this, lesson plans should be designed properly and appropriate teaching methods to be used for teaching. Therefore, teacher training is very important for the promotion of geosciences in schools in Sri Lanka.

## **The Scottish Earth science education forum: promoting Earth science teaching in Scotland, past, present and future**

CLARE BRITTON

Scottish Earth Science Education Forum, Grant Institute, United Kingdom,  
Email: Clare.Britton@ed.ac.uk

The Scottish Earth Science Education Forum (SESEF), is a national grassroots network of people and institutions committed to earth science education. Its structure consists of a Trust, Steering Committee and Project Management Group representing the funding, generation and realisation of projects that promote earth science at all levels of Scottish education.

Ongoing projects include CPD workshops that are earth science based, with clear links to the current 5 - 14 curriculum. Aspects of their success include free rock kits and maps that allow students to see and feel how geology works. Workshops are run by a network of facilitators, supported by collaboration with the Earth Science Education Unit (England), facilitating access to remote areas and the generation of local contacts for bookings.

Current projects include visits to secondary teachers of geology from professionals in earth science

education, providing support for the teacher and feedback for SESEF to inform future projects. We plan visits to encourage and support teachers who would like to teach geology in future years.

Future projects include the provision of resources for the secondary curriculum, which is currently under review. If SESEF is to remain a key CPD provider it is essential to understand the way the curriculum will change. This understanding will inform development of new secondary level resources and guide the regeneration of existing workshops in light of new teaching methods as well as content. In essence SESEF believes the key to success in promoting earth science teaching in Scotland is also one of the key principles that underlies earth history – evolution and adaption - at all levels of project generation spanning funding, science and educational content, and mode of delivery.

## **Interdisciplinary approach by means of earth sciences: new framework and educational law and teachers' cultural necessities in Ribeirão Preto Area (São Paulo State, Brazil)**

GONÇALVES P. WAGNER<sup>1)</sup> & NATALINA A. L. SICCA<sup>2)</sup>

<sup>1)</sup>Institute of Geosciences – The State University at Campinas, Brazil,

<sup>2)</sup>High Level Program in Education – The University Moura Lacerda, Brazil,

Email: <sup>1)</sup>pedrog@ige.unicamp.br

This paper shows up what the teachers of secondary school think about Earth sciences. It was done a survey to know what teachers of Geography, Biology, Physics and Chemistry of Ribeirão Preto area (Sao Paulo State, Brazil) think about environmental problems and to evaluate what we need to do for teacher education. The study shows up which teachers develop situated learning but they adopt low deep because they do not teach geologic subjects. We defend that there are many legal possibilities to

integrate teaching subjects though few teachers are able to adopt interdisciplinary approaches. The low level of understanding of opportunities offered by Earth sciences is a crucial point that creates difficulties to teachers of secondary schools. Teachers cannot understand that geology would be an area to integrate several disciplines. Basing on this situation we create a program for teacher education in Earth sciences and the group of teachers changed their opinion about the educational roles of the study of the Earth.

## Enactment of Earth system education through curriculum material and in-service workshops

KLAUS-HENNING HANSEN<sup>1)</sup> & SYLKE HLAWATSCH

IPN Leibniz Institute of Science Education, Kiel, Germany,  
Email: <sup>1)</sup>Hansen@ipn.uni-kiel.de

This paper presents an empirical study on problems and prospects of the enactment of Earth system education (ESE) in the classroom. The study is exploratory, using data that were collected in the project “System Erde” during in-service workshops in several German Bundesländer. We were asking how teachers enact an innovative approach to ESE, who have access to innovative curriculum material combined with well structured in-service workshops. Conceiving implementation as the process in which teachers and students enact the new curriculum in the classroom we focused on the teachers’ activities to put new teaching material into practice. First a theoretical framework was developed that describes the innovative character of the curriculum, the enactment process and the in-service workshops. Then an empirical study is presented that was based

on a sample of teachers, teacher educators and educational authorities that took part in these workshops. We analyze the participants’ ratings of the workshop, the material, and of supportive or prohibitive factors of local enactment. In the center of the study are implementation scenarios in which the participants design lesson plans. They allow analyzing the interactions between the ESE curriculum, teachers’ resources, and the actions that they perform to put the curriculum into practice. The outcomes support the importance of providing in-service workshops combined with the curriculum material for implementing ESE. They also indicate a need for a local customization of the material. Based on these results a model for the local enactment of ESE is elaborated. It helps to improve in-service workshops for and the enactment of ESE in German schools.



## **The Alabama Rocks! Project: A student-led initiative to improve geology education in public schools in southwestern Alabama, USA**

DOUGLAS W. HAYWICK<sup>1)</sup>, LANE DORMAN<sup>2)</sup>, JESSICA WIGGINS<sup>1)</sup> & GLENN R. SEBASTIAN<sup>1)</sup>

<sup>1)</sup>Department of Earth Sciences, University of South Alabama, Mobile, USA,

<sup>2)</sup>Department of Geological Sciences, Clemson University, Clemson, USA,

Email: <sup>1)</sup>dhaywick@jaguar1.usouthal.edu

The Alabama legislation recently modified State science curricula for public schools to better reflect the diversity of science. The curricula now include important elements of geology (e.g., the rock cycle, tectonics, and rocks and minerals) that are specified for each grade levels in middle school (grades 6-8) and high school divisions (9-12). Unfortunately, many teachers feel unprepared to teach these subjects to their students. Some, quite possibly the majority, of the teachers never took basic geology courses while in college. Many schools also lack important instructional materials that are necessary to teach geology subjects such as topographic and geological maps, mineral testing kits and most importantly, basic rock collections. In January 2005, undergraduate geology students at the University of South Alabama began the Alabama Rocks! Project to equip middle and high schools in two counties in the southern portion of the state with a comprehensive collection of state rocks.

A total of 100 kits will be distributed this year. The project was supported with a grant from Legacy Inc, an environmental partnership involving state and federal agencies and public citizens, and the University of South Alabama Geological Research Fund. The Geological Survey of Alabama provided geological maps at reduced cost for inclusion within each kit. The 44 rocks comprising each of the 100 kits are a vast improvement over traditional store bought versions in several important ways. They represent the most important rock units within the state thereby providing locally relevant examples of geology to the students. They are also much larger specimens (500 – 1000 g each) which allows students and teachers to better recognize compositional and textural difference between the rocks. Lastly, we provided very detailed information about each specimen to the teachers so that they would be more confident about the specimens when instructing their students.





# Poster session

## Goscience education and training in India: problems and prospects

MADHUMITA DAS<sup>1)</sup> & TAPOS GOSWAMI

Utkal University, Department of Geology, India,  
Email: <sup>1)</sup>madhumitadas\_geo@rediffmail.com

There have been spectacular advances in the field of Information Technology, Genetic Engineering, Biotechnology, Material sciences and Extraterrestrial Geology during the last century. But man has become a part of the Earth system in bringing potentially serious consequences for our future. The growth of human population has created an irreparable environmental degradation, loss of biodiversity and environmental pollution. The sea level is rising about 3mm per year, the average global temperature may rise 10 degree centigrade by the year 2050 which will bring enormous change in the climate. To combat this situation Geoscientists must come forward with some definite goal and rational solution to obtain a scientific understanding of the entire Earth system and its evolution on all time scales. Compared to other primary branches like Physics, Chemistry, Mathematics and Biology Geoscience is neglected. In India Geoscience is taught only at the higher echelon of education system and hardly it figures out in the curricula of primary and secondary levels of school. Formal academic programme at Graduation level started in the

Presidency College, Calcutta in 1886. Presently out of the regular 220 Universities Geoscience is being taught in some 50 Universities. The University Grants Commission introduced a uniform curriculum for all the universities since 2002. But academic curricula and standard varies within the states due to difference in socio-economic status and other reasons. The present paper aims at suggesting a model curriculum to address the environmental problems like water and energy scarcity, desertification, climatic changes and other issues. The young generation must be trained and taught to utilize the marine resources, use non-conventional energy resources, use low grade ores optimally by beneficiation and recycle solid waste materials. Interdisciplinary branches like Biogeochemistry, Groundwater ecology, Geoinformatics, Medical Geology etc may be introduced taking local geological conditions into account. Another important responsibility of the Universities and other geoscientific organisations is to popularise geoscience among the community through public awareness campaigns.

## Geology teaching in Algeria: A program overview

OMAR KOLLI

Laboratoire de Métallogénie et Magmatisme de l'Algérie, Dept. de Géologie, Faculté des Sciences de la Terre, Alia, Bab Ezzouar, Alger, Algérie,  
Email: okollidz@yahoo.fr

The teaching of geology sciences is quite recent in the Algerian universities. It goes back to the last three decades. There is common degree programme for the first three years. The first year assumes no prior knowledge of geology and is devoted to the teaching of mathematics, physical sciences, chemistry, biology and a little geology.

The followed two years are devoted to provide an essential background to studies in areas. The topics dealt with include: general geology, mineralogy, sedimentology and stratigraphy, structural geology, paleontology, geological maps, geochemistry, petrography and regional geology of Algeria. In the fourth year, there are specialist courses and the students' major either in petrology and structural geology, sedimentology, hydrology, geophysics, engineering geology or economic geology.

These undergraduate courses are not purely academic study but they also prepare for a professional career in geology. They consist of lectures, laboratory exercises, practical training, and a considerable part of the study takes place in the field during fieldwork and excursions. Each year, fieldwork includes a class during one or two weeks learning the techniques of geological field mapping.

The students can achieve the basic degree, the DES (Diplôme des Etudes Supérieures) in four years and the diploma of state engineer in five years.

In addition, a small number of graduate students proceed to postgraduate taught and research degrees within the national PhD training programmes in geology.

At present a reform based on the LMD (Licence Master Doctorate) system is being progressively implemented, and where the environment has a great importance.

## The emergence of Earth system science: a historical view

YI-WEN HUNG<sup>1)</sup> & YING-SHAO HSU

<sup>1)</sup>National Taiwan Normal University, Taiwan,

Email: v3256@ms36.hinet.net

Geosciences are now experiencing a revolution arising from the accumulation of diverse observation data and a new approach of systematic thinking.

Not until 1957, the International Geophysical Year (IGY), large systematic scientific monitoring programs had put under way, the concept of “Earth System” remained only a simulation theory. From that time, large amount of sufficient observation data was documented and models were also proposed to account for the global environmental change, like ENSO, upwelling, and drought in Sahel, West Africa. From 1985 to 1995, an ambitious program, Tropical Ocean-Global Atmosphere Program (TOGA), was carried to observe and simulate coupling effects of ocean-atmosphere system and the impacts on climate change. This program had not only improved the understandings toward El Nino, but it also called lot attentions toward global warming, possibly induced by anthropogenic greenhouse gases. Combining with the earlier issue of ozone depletion, the interactions between human and biophysical systems seemed

more profound than ever thought for science communities in 1980s. Besides, the biophysical systems are regarded non-linear in feedback mechanisms as global observing programs increasingly revealed. A new approach to Earth studies was then desperately needed.

System Theory provides a conceptual framework toward the new approach. Thus, the Earth was considered as a single, inter-linked, and self-regulating system. Moreover, according to System Theory, the Earth System is hierarchically structured; therefore each level of the Earth System and subsystems has its own laws, which cannot be derived from the law of the lower level. Considering Kuhn’s perspectives, a new revolutionary theory might be merely a higher level theory than those known before, one that integrated whole lower level theories without substantially changing any. Nowadays the revolution is undergoing with changes of world view. Most of all, Earth System Science, the new paradigm, it re-evaluates the nature of the Earth System so that the full complexity will be considered.

## How did people interact with nature in East Asia in the past? - Reconsidering the relationship between humans and nature

HISASHI OTSUJI

College of Education, Ibaraki University, Japan,  
Email: otsujih@mx.ibaraki.ac.jp

We can define science and/or scientific activity as examples of the relationship between human beings and nature, as are eating, playing, and using the materials supplied by nature. We now live in a time of crisis in this relationship. To learn lessons from the past that could help the future relationship between humans and nature, I examined the actions of three significant Japanese men from times gone by.

Shingen TAKEDA, a famous general in the Warring States Period of Japan, instigated his policy on flood control and application of river water for rice crop before 1600.

Moemon NAGATA, a gold miner in Takeda's region, applied the technique to rice farming after 1650s in the area occupied by the Mito Clan. Gold mining techniques were used as a basis for supporting local governments of several clans around Japan in the rice

standard period. This flourishing of gold mining can be found in fairy tales of the period, too.

Goryo HAMABUCHI, the president of a private company in 1850s, put his money into constructing a 600-m long bank in his home town after the town had been damaged by a tsunami. He, too, used a unique recovery plan to benefit the local community.

The conclusions that we can draw from the efforts of these three people are that we can try to coexist with nature; use the power of nature; give positive feedback to other people; and not only build a strong physical structure but also rebuild something stronger in people's minds.

These primary lessons can also be applied in today's society to prevent future environmental issues on the one hand, but also to deliver a powerful message in regard to the strategies that we select and initiate.

## Universal design of geoscience learning

SHARON LOCKE

University of Southern Maine, Research Initiatives and Geosciences, USA,  
Email: slocke@nsf.gov

The U.S. National Science Education Standards emphasize the importance of science education and literacy for all students. At the same time, changing U.S. demographics suggest that to ensure a continuous supply of highly skilled scientific workers, science educators must reach out to groups that have been traditionally underrepresented in science, including women, minorities, and persons with disabilities. Universal design of geoscience learning is a pedagogical approach that has the potential to significantly enhance the accessibility of geoscience curricula for diverse learners. Universal Design in Education (UDE) has its origins in the fields of architecture and design, where physical spaces and technological devices are designed so as to be accessible to persons with different physical challenges. Universal design principles applied to education means that teaching and learning activities are structurally and functionally designed from the start so as to maximize learning for

all students. As an instructional approach, universal design is being used at both the K-12 and undergraduate levels as a strategy for improving learning outcomes for students with disabilities; however, a consensus is forming that universal design (UD) benefits all students and could be much more broadly infused into science education. A limited number of programs have applied universal design to the geosciences through incorporation of three fundamental UD strategies: multiple means of presentation of material, multiple strategies for engaging students in exploration of a topic, and multiple means of assessment of student learning. For this project, teaching scenarios for the characterization of earth materials, interpretation of maps, and hydrologic field data collection were evaluated in the context of UD. A reengineering of instruction is proposed that allows for multiple pathways through which students can reach the desired learning goals.

## Soil science in school

GABRIELE BROLL

University of Vechta, Geo- and Agroecology, Germany,  
Email: [groll@ispa.uni-vechta.de](mailto:groll@ispa.uni-vechta.de)

Like geoscience soil science is not integrated in school. Understanding soils linking geosphere and biosphere is one precondition for understanding of ecosystem processes. In most cases it is still depending on the teacher who has some possibilities to teach soil topics in geography, biology and chemistry for example. Always soil has to be presented in connection to a subject like sustainability for example which is of high relevance for the society. Those subjects dealing mainly with soils like soil functions are up to now of minor relevance in school although it is important to understand soil functions in order to prevent soil

degradation for example. Objective of the presentation is to give an overview about the activities in Germany to integrate soil science in school. The German Soil Science Society initiated many activities in order to push soil subjects in school. A lot of materials for schoolchildren already exist but in many cases this material is of low quality. Another problem is that most of the teachers are not educated in soil science. Thus, another important target group besides the children are the teachers and especially those students who are going to become a teacher.

## The evolution of images of the earth interior through time can illustrate non-specialists about how earth science is built

JOSÉ SELLÉS-MARTÍNEZ

Universidad de Buenos Aires; Argentina,

Email: pepe@gl.fcen.uba.ar

History of Science if more than a mere collection of dates, names and facts, it can also provide an useful tool to teach about the permanent interaction of hypothesis and facts and how these are influenced by technological advances produced in other areas of Science.

The interest in the structure and internal composition of the Earth has appeared late in the history of human curiosity and most speculations started after the end of Renaissance and extends -with increasing scientific rigour- to present days.

Less than 15 km of the almost 6.000km of the Earth's radius have been directly tested and this is so in only one site, thus the lack of direct information about composition and structure of the materials below surface and about the evolutionary trends of temperature and pressure with depth called for indirect approaches.

Extrapolation of observable facts, structures and rock types in the crust have marked first theories about the earth interior in the 16th to 18th Centuries, while the advances in seismic recording and interpretation produced the first accurate pictures of the earth structure in the end of the 19th Century. Astronomical

calculations and geographical measurements resulted in density values required for the Earth material that were not compatible with those observed in the outer layers. Meteorites, on the other hand, gave evidence that rocks different from observable ones could be hidden down in the Earth. The popular "onion" model of the Earth interior was fully developed along 20th Century, and close to its end, Global Tectonics imposed the need for a geodynamical interpretation of those features observable in the surface and discernible in the crust and upper mantle. In the beginning of the 21st Century, seismic tomography is giving the first detailed pictures of the mantle in which dynamic features (e.g. sinking plates) can be interpreted with an acceptable degree of confidence.

During all these evolution, many interesting illustrations have been published which are not only aesthetically attractive but whose theoretical bases, the elements they show (and of course those they miss) and how they compare with the ones that followed them in the continuous process of knowledge generation, bring an attractive bases for the discussion of how scientific theories pass from incipient ideas to paradigmatic frameworks and to dusty books in old libraries with the everlasting pass of time.



## Problem solving in geology teaching: a preliminary study

SUSANNA CARRASQUINHO, CLARA VASCONCELOS<sup>1)</sup> & NILZA COSTA

Department of Geology; Faculty of Science of Oporto University, Portugal,

Email: <sup>1)</sup>csvascon@fc.up.pt

Regarding the “Teacher Training in Geosciences” we have developed a classroom management plan, problem solving based, related to “Consequences of Earth Internal Dynamic – Earthquakes and Volcanoes”; and explained models of internal earth structures. Firstly, the earthquakes and volcanoes are interpreted as consequences of the earth dynamics; secondly, science and technology (especially the study of earthquakes and volcanoes) contributes to the understanding of internal earth structures. This task was undertaken through a diverse range of classroom activities: diagnosis exercises, PowerPoint presentations, book exercises, motion picture, acetate (with

several pictures in order to develop student interpretations) at internet sites, magazines, books, etc. This investigation took place in 2005, at a school in the north of Portugal, with students aged between 12 and 13 years. The investigative methodology was of qualitative type, in a perspective of action research, therefore using “snapshots” (student’s simple questionnaire) and a teacher classroom diary (receiving feedback on the thoughts and feelings of students and teacher regarding the application of a classroom management plan). This poster highlights the results of the investigation and the future perspectives for an upcoming research project.

## How gender and race of geologists are portrayed in introductory physical geology textbooks

STEPHEN R. MATTOX

Grand Valley State University, Department of Geology, USA

Email: mattox@gvsu.edu

Attracting more students to geosciences is imperative. Many students first experience with geology is in a freshman college course. The American Geological Institute estimates that 315,000 physical geology text books are sold in the United States per year. Is there a bias in how geologists are portrayed in these books and, if so, what are those biases?

I selected 15 texts from nine different publishers. Data was collected on the number of photos, the number of photos with scientists and the number of scientists in each photo. Gender data was divided into male, female, and unknown. For each gender I noted if the individual was Caucasian, African-American, Asian, Latino, or unknown. I noted if the geologist was active or passive.

Only 258 (3 %) of the 8,573 figures showed geologists. Of the 296 geologists in the figures, 204 are male (68.9 %), 60 are female (20.3%), and 32 are

of undeterminable gender (10.8 %). Out of 204 males, 156 are Caucasian (76.4 %), 10 are racially diverse (4.9 %), and 38 are unknown (18.6 %). Out of 60 females, 51 are Caucasian (85 %), 4 are racially diverse (6.7 %), and 5 are unknown (8.3 %). Geologists are shown as active or passive in near equal numbers.

Physical geology books portray males as 3.5 times more likely to be geologists compared to females. This ratio significantly exceeds the current proportion of men and women entering the workforce (58 % male and 42 % female for B.S. degrees in Earth science) or the near equal proportions in the U.S. population. The books imply that Caucasian geologists are 15 times more abundant in the work force compared to their non-white peers. This ratio differs significantly from the data for recent graduates and the general U.S. population (about 3:1 for both data sets). I will offer possible solutions to book authors and publishers.

## Understanding soil function and soil protection

KARIN GEYER<sup>1)</sup>, HANS-GEORG BRAUCHMANN & GABRIELE BROLL

University of Vechta, ISPA, Div. of Geo- and Agroecology, Germany,

Email: <sup>1)</sup>geyer@ispa.uni-vechta.de

Teaching about rural ecosystems, soil and water protection with experiments and in the field.

Teaching geoscience includes soils as important parts of ecosystems linking geosphere and biosphere. Soils are influenced highly by land use, especially agriculture. Many rural ecosystems in Northern Germany are dominated by intensive agriculture. The amendment of mineral fertilizer, manure and other organic fertilizers lead to eutrophication and contamination of the soil with metals, for example. Also, the ground water and therefore the drinking water are affected. Thus, the objective of this project was to combine a didactical exhibition for water protection in an agricultural area with soil related topics.

Informing materials and experiments are developed to show children of the age from 6 years up to 16

years the problem of drinking water quality in the sandy “geest” regions of northern Germany. There are three steps of learning: first of all the children learn experimentally to understand the function of soil filtering water for example. In a next step the children learn at a soil profile how substances are washed out in the ground water. Finally, soil protection strategies like soil management, crop rotations and restrictions for fertilization are discussed.

An evaluation was made to find out, how these very complex facts and circumstances are understood by children of different ages. Pictures drawn by the children were used to find out, what children do learn about soil concerning the production of food and drinking water.

## **International workshop on education for natural disaster preparedness and its implementation mechanism in the context of ESD**

MASAKAZU GOTO

National Institute for Educational Policy Research of Japan,  
Email: masakazu@nier.go.jp

Major natural disasters have been taking place in countries of the region in the last decade. Earthquakes (Kobe Japan, Bam Iran, North West Frontier Province and Kashmir (2005 in Pakistan, India and Afghanistan), tsunamis in 2004 (Indonesia, Thailand, Sri Lanka, Maldives), volcanic eruptions (Indonesia, Philippines), floods and landslides (China, Philippines), and other disasters have caused so much stress in lives of people, damaged properties, changed the landscape, and destroyed infrastructures. Education systems have been affected, not only in terms of destruction of school infrastructure and facilities, but also in losing lives of children, teachers, parents, community leaders and members. There is therefore, a priority need to provide education for all on natural disaster preparedness and coping strategies. The Asia/Pacific Cultural Center for UNESCO (ACCU) prepared an inventory of existing materials and developed literacy materials on natural disaster prevention; while the National In-

stitute of Educational Policy Research Japan (NIER) participated in the development of teaching-learning materials for curriculum integration as one of the units in the UNESCO Resource Pack on "Leading and Facilitating Curriculum Change." NIER also organized a UNESCO regional seminar on ESD in 2004, and the International Symposium on Educational Reform in March 2005 "Sustainable Development and Education for the 21<sup>st</sup> Century". Both seminars came up with recommendations for the implementation of the DESD.

To initiate the project and as a follow up on the various efforts, as a contribution to the celebration to the Decade of Education for Sustainable Development (DESD), this International Workshop on Education for Natural Disaster Preparedness and its Implementation Mechanism in the Context of ESD is being organized.

## **Promoting geoscience education for all: Towards the development of adaptive culture in a geohazard vulnerable area in Indonesia.**

DWIKORITA KARNAWATI<sup>1)</sup>, SUBAGYO PRAMUMIJOYO<sup>1)</sup> & KUNCORO<sup>2)</sup>

<sup>1)</sup> Geological Eng. Dept. Gadjah Mada University, Indonesia,

<sup>2)</sup> Faculty of Psychology, Gadjah Mada University, Indonesia,

Email: <sup>1)</sup>dwiko@indosat.net.id

Due to the dynamic geological conditions in Indonesia, various types of geological disasters frequently strike most of the Indonesian region. Interactions of the three active plates, i.e. Indo-Australia, Eurasia and Pacific Plates result in high vulnerability of the region to the earthquake, tsunami, volcanic eruption, and landslides. However, the communities living in such vulnerable area have not yet really understand and aware with the threaten of geohazards and this become the main reasons for many casualties and fatalities when the disasters occur. Despite some efforts that have been done to disseminate and educate the communities to improve their awareness on potential geohazard in their environment, the evidences show that such efforts have not yet effectively resulted in sufficient public empowerment. Moreover, consideration on the potential threatens of geohazards are poorly accommodated in most of the regional development plan. Therefore, the needs to promote geoscience for all, i.e. for the communities and policy makers, are urgently required.

The strategy, approach and method to promote Geoscience Educations for all towards the development of adaptive culture in geohazard vulnerable are will be the main concern discussed in this paper. Adaptive instead of challenging approach is recommended. The main strategy of this approach is to provide most simple information related to the potential geohazards through various media which can be easily accessed by the individual person. Thus both formal and non formal approach can be implemented. Some of selected local wisdom has to be identified to be adopted as part of the education program. The involvement of various stake holders from Government Sector, Private Sector as well as Non Government Organization and Educational Institutions are crucial to support the effectiveness of the program. The law for disaster management also urgently required to reinforce that the geohazard education program is the right and responsibility for all. Indeed, effectivitiy improvement of the approach and method for this education program is very important to ensure that adaptive culture to live in harmony with the nature can be appropriately developed.

## Making of Tsunami pamphlet for school children in Indonesia and disaster prevention education

SHIBAYAMA MOTOHIKO, DICKY MUSULIM, NAOKO KAGAWA, SHIBAKAWA AKIYOSHI & YOSHITUGU HIRAOKA

Natural Environmental Institute, Osaka, Japan,

Email: shibayama@themis.ocn.ne.jp

A large earthquake that occurred off the coast of Sumatra (Indonesia) caused the Tsunami disaster that not was so far on December 26, 2005. It is necessary to support it on a soft side in disaster help besides support in hard respect. That has not progressed still so much after one year though it was talked to the immediate aftermath in countries where the necessity of the disaster prevention education that is the one received damage.

This research is the one having thought how to do the disaster prevention education to the children on the Java island (Indonesia) that will be the Sumatra surrounding area where the possibility is high when the future though did not encounter this tsunami damage so much. The school child was targeted because of thinking that there is a period when the tsunami is generated for a long time, and it is effective

to teach disaster prevention to the school children with long life in the future.

The poster and the pamphlet for the tsunami disaster prevention decided to be made as one of the disaster prevention teaching to the school children. The poster will be posted in each school, and the pamphlet schedules to distribute it to all the sixth graders. The distribution region is an elementary school of about 400 around the Indian Ocean shore on the Java Island. The distributed one is a pamphlet (A4 and 16,000 pieces) for the sixth-year students and poster (A2 and 3 pieces) for each school. The student at the Padjadjaran University plans to distribute it.

This distribution of the first time becomes it as a trial in Indonesia it was not so far that the printed matter of the pamphlet etc. is distributed to each child.

## Some modeling-based practices in geoscience classes

YOSHIO OKAMOTO

Tennoji high school attached to Osaka-Kyoiku University, Minami-Kawahori-cyo, Tennoji-ku, Osaka, Japan,  
Email: yossi@cc.osaka-kyoiku.ac.jp

We introduced some modeling-based practices at K-12 levels by which natural phenomena are reproduced showing the fundamental principles. These process and results strongly inspire our students and they can learn to enjoy the making models for themselves. The themes are about geo-linked phenomena such as landscape evolution, earthquake mechanism, plate motions, volcano related phenomena, climate models and sedimentary processes. The themes which our students chose in this year are as follows: Karst landscapes, stalactites in limestone cave, volcanic eruption, meteorite impact, rock magnetism measurement, fault mechanisms, rock joints and greenhouse effect by carbon dioxide. It is important how complicated natural phenomena are reduced into simple mechanisms, and also the selection of the themes, too. Models are basically made of cheap kitchen tools, one-dollar-shop items and food materials. Moreover high-technology tools are used for precise measurement and data recording, such as video camera, digital camera and some measuring apparatus, whose prices have decreased down because of their mass production. For example, the students use a bath sparkler for volcanic eruption, water solution of aluminium sulfate for stalactites making, styrene foam

balls for sand dune and liquidizing of sediments, and melting sugar candy for cooling joints. We already developed an analogue experiment showing reverse fault mechanisms using flour and cocoa powder (Okamoto, 2003). The movement using such analogue models, named kitchen earth science (Kurita, 2001), is now getting more popular particularly among researchers. Advantages of use those models in geoscience study are as follows: first; thinking process of how constructing models is the best ways for scientific consideration, second; making and measuring process of their models are the best trainings for scientific experimental skills. Those models are quite useful not only for natural science course students but also for humanities science course students. However, the preparation and evaluation of students work are sometimes troublesome and painstaking matter for teachers. Because some students can not make their themes rapidly or sometimes they may select a theme hardly constructive, so we sometimes prepare some suitable candidates as their research themes. Apart from such demerits, our students enjoyed those modeling and also made interesting presentations whether they success or not. They learn many things even from failed experiments.

## Impact of land uses and land cover changes on environmental sustainability of western Himalaya

B. W. PANDEY

Department of Geography, Shaheed Bhagat Singh Ev. College, University of Delhi New Delhi, India,  
Email: bindhywasini@hotmail.com

The present research is an attempt to examine, investigate and analyze the environmental sustainability in the Western Himalaya. The research findings highlight that there has been a large scale changes in the land use pattern, mainly the transformation from the forest land to agriculture, horticulture, recreational and hotels due to tourism based urbanization, which has created a large scale environmental degradation, soil erosion, crises of water resources, deforestation and pollution . The research is based on empirical research of Upper Beas basin of Western Himalaya. The basin is located in the temperate zone of Himalaya. Geographically, Pir Panjal and Dhauladhar Ranges confine the valley. River Beas form the major drainage. The research methodology is based on both the primary as well as secondary data sources. For the primary data sources stratified random sampling (SRS) technique was applied, while the secondary data were collected from different Governmental and Non-governmental Offices and institutions.

The Himalayan geosystem had a congenial relationship

in the past with abundant natural resources for life support systems of the local communities. The land use pattern was more or less similar up to early Eighties. The basic changes occurred due to large scale unplanned tourism development, hence, to support to the tourism, infrastructures development led a heavy congestion of buildings and roads.

The present anthropogenic activities have degraded not only the local environment, but also have reduced the natural resources base of the local community. Apart from above, the anti-ecological approaches of the government, particularly, "Natur Land Act, 1968" (distribution of land to landless people), in which the forest land (hatches) were redistributed to the landless communities of Himachal Pradesh. Hence, a new dimension has been emerged between economy and ecology, dependence and self reliance. An urgent and immediate action and remedies have become the need of the time to save the environmental sustainability and ecological management in the highly polluted region of the Himalaya.



## Fusulinids from the carboniferous strata in the Gangdong area, Taebaeksan Basin, South Korea

CHANG ZIN LEE

School of Science Education, Chungbuk National University, South Korea,  
Email: leecz@chungbuk.ac.kr

The goal of the study is to recognize the fusulinid biostratigraphy of the Carboniferous limestone distributed in the Gangdong area of Samcheok coalfield, Korea. The Carboniferous strata of the study area mainly comprise alternation of dark gray shale, dark gray, reddish sandstone, and gray limestone. The limestones consist mainly of wackestone-packstone contained various bio-skeletons such as crinoid, coral, brachiopoda, and bryozoa, which indicate the shallow marine environments. In order to recognize the biostratigraphy of the limestones, total 12 species belonging to five genera of fusulinids are identified from the 8 stratigraphic horizons of the Gangdong geologic section: *Ozawainella turgida* Sheng, *Oza-*

*wainella* sp. A, *Ozawainella magna* Sheng, *Pseudostaffella antiqua* (Dutkevich), *Pseudostaffella paracompressa* Safonova, *Pseudostaffella kimi* Cheong, *Pseudostaffella* sp., *Beedeina lanceolata* (Lee & Chen), *Beedeina samarica* (Rauser-Chernousova), *Beedeina* sp. A, *Neostaffella sphaeroidea* var. *cuboides* Rauser-Chernousova, and *Hanostaffella hanensis* Cheong. Such fusulinids species were reported from the lower part of Geumcheon Formation in the Samcheok coalfield and the middle Moscovian Stage in China and Russia. The overlapped strata by faults and folds are found in the process of the fusulinid biostratigraphic study of the Gandong geologic section.

## Competition and limitation in planktonic communities – a student investigation

REIMERT NEUHAUS<sup>1)</sup> & AVAN N. ANTIA<sup>2)</sup>

<sup>1)</sup>UNESCO Project- School Integrierte Gesamtschule Friedrichsort, Kiel, Germany,

<sup>2)</sup>Leibniz-Institute for Marine Sciences, Kiel, Germany,

Email: <sup>2)</sup>aantia@ifm-geomar.de

Seasonal changes in marine phyto- and zooplankton populations throughout the year in temperate regions show cycles that reflect the ups and downs of planktonic life in dependence on light, temperature and nutrients as well as all kinds of biotic interactions such as predator-prey relationships or simple competition for the abovementioned factors. For a school situated at the waterline such as our school, the “Integrierte Gesamtschule Kiel-Friedrichsort”, these topics offer themselves quite naturally as a focus for ecological courses.

We thus cooperate in the NaT-Working „Marine Research“ Project (funded by the Robert Bosch Foundation) with the Leibniz-Institute for Marine Sciences at the University of Kiel.

We combine two scientific mainstreams, monitoring and experiment in sampling. Baltic waters are sampled

at regular intervals to measure nutrients and plankton-organisms, monitoring their changes through time. Additionally, experiments are set up in the school with representatives from phytoplankton groups to study nutrient limitation and competition. That means, we simulate the nutrient situation at a point, where plankton communities change their assemblage. This change is due to advantages of different organisms under various nutrient levels, resulting in different dominant species from different taxonomic groups.

Students profit from this work by gaining ecological and methodological knowledge at the scientific level. They are expected to improve their “soft skills” such as self-organization, team work and communication capabilities. Last but not least, students can experience a learning environment outside school and close to reality and get the taste of scientific life with a relationship to their everyday environment.

## Information/communication technologies and plate tectonics

SANDRA AMOEDA, HELENA MARTINS & CLARA VASCONCELOS<sup>1)</sup>

University of Oporto- Portugal, Department of Geology of the Faculty of Science, Portugal,

Email: <sup>1)</sup>csvascon@fc.up.pt

The idea of developing a multimedia tool for the teaching of geology classified under the theme “Plate Tectonics” emerged as a consequence of learning difficulties which are linked to this specific theme and to the existence, in Portugal, of insufficient educational resources supported by computer technology in problem resolution. The CD-ROM “Plate Tectonics” is a multimedia application developed for us as a learning tool directed at the evolution of skills that allow the understanding and exploration of concepts connected to the theme. The conception of this CD-ROM underwent several stages. One of these stages related to specific bibliographical research of the theme. Through this research an analysis of the contents of three schoolbooks that exist in Portugal was undertaken. The purpose of the analysis was to

gain greater understanding about the way the theme is approached, namely concerning scientific concepts that should be referred to. In this way, CD-ROM suggests alternatives that can simplify the construction of scientific knowledge by the students. The CD-ROM has some characteristics that make its use in the context of the classroom possible, and can be used during the school year without an overlapping of the concepts. This CD-ROM explores the geological aspects which are linked to Plate Tectonics and which can be used either by students or teachers, to show that it is possible to create scientific multimedia hyper-documents. It could be said that a greater availability and interest by the people who make didactic materials is required.

## Field trip to Cabo Mondego (centre of Portugal): Teachers' training and evaluation

CLARA VASCONCELOS<sup>1)</sup>, LUIS MARQUES<sup>2)</sup>, DORINDA REBELO<sup>3)</sup>, LEONEL NUNES<sup>3)</sup> & JOAO PRAIA<sup>4)</sup>

<sup>1)</sup> Center/Department of Geology of Oporto University, Portugal,

<sup>2)</sup> Center of Didactics and Educational Technologies, University of Aveiro, Portugal,

<sup>3)</sup> Secondary School, Portugal,

<sup>4)</sup> University of Aveiro, Portugal,

Email: <sup>1)</sup>csvascon@fc.up.pt

The role played by Field Trip (FT) in Education was the object of this study to better understand its value, effectiveness and relationship with the construction of scientific knowledge. The gap between the required perspective and school practice has become an emergent indicator. Therefore, a research project was developed with the objective of implementing a teachers' training plan (TLP) involving a FT related to *Cabo Mondego* (region in the center of Portugal). Teachers' training and evaluation were assumed as non-separable processes, and evaluation involved a permanent and complex task, dynamically involving teachers and learners that had elaborated: (i) reflections concerning FT as a didactic resource in Geology lessons; (ii) reflections on their own performances and conceptions about the tasks proposed

to them and subjects discussed in FT; (iii) snapshots of FT development; (iv) reflections on the field trip undertaken in the geologic area (*Cabo Mondego*) to produce didactic resources; and (v) replies to a questionnaire. From the analysis of results concerning the development of FT, the following could be concluded: i) a constructive, integrated and deeper discussion about FT as a didactic resource was made; ii) a systematic questionnaire about the didactic and geologic aspects related to the visited area was implemented; (iii) necessary knowledge on the elaboration of curricular materials capable of developing in students, competences defined on the official curriculum was elaborated. Some of the results, which were achieved through the evaluation instruments referred above, will be presented in this communication.

## Field work on the beach in variscan context (northern Portugal): construction of a field guide

PAULO FERREIRA, CLARA VASCONCELOS<sup>1)</sup> & MARIA DOS ANJOS RIBEIRO,

Centre/Department of Geology of Oporto University, Portugal,

Email: <sup>1)</sup>cvascon@fc.up.pt

The western margin of Iberia consists of a Variscan Orogen fragment, also referred to as the Hesperic Massif. This Variscan Massif is the geological framework of Iberia, and consists mainly of folded and metamorphosed rocks of Precambrian and Paleozoic age, which were extensively intruded by magmatic bodies. The coastal zones of northern Portugal, namely the beaches, correspond to large and well exposed outcrops of metamorphic and magmatic rocks, near the big urban centre – Porto (that is near a great deal of schools).

This area is of special and privileged significance to realize field work, not only because of its proximity to schools, but also because fieldwork in these beaches permits direct identifications, descriptions, measures, sampling and mapping to be made on the products (rocks and structures) that are the outcome of the internal geodynamic processes, which are not observable or tested in laboratorial experiences. These activities allow the students to conduct analysis and interpretations and, in the post-field work phase, organise the information collected. Integration with

theoretical knowledge, namely that concerning the Earth's internal structure and its dynamic systems will also provide an approach to the understanding of the geological hazard. This geological evaluation is an important contribution to the promotion of competencies on the ecological sustainability of human life quality in the Earth's systems.

Taking in account a problem solving strategy several key questions were organized considering the specific knowledge of each search point.

The elaboration of the guide book included: (i) geographic localization and accessibility; (ii) identification of the boundaries of the study area and localization of the search points; (iii) activities proposed and guidelines; (iv) data sheets including drawing schemes. These activities were hierarchized through concrete observations, descriptions and measurements (mineralogical and/or textural aspects, measuring of structural directions) to more abstract concepts (relative dating, geological context of genesis, relationship between magmatic and metamorphic rocks).

## Volcanic hazard atlas of the Lesser Antilles – a multimedia version

STACEY M. EDWARDS<sup>1)</sup>, RICHARD E.A. ROBERTSON, ALI SHAHIBA, JAN LINDSAY & JOHN B. SHEPHERD

The University of the West Indies, Seismic Research Unit, St. Augustine, Trinidad & Tobago, India,  
Email: <sup>1)</sup>staceyedwards@uwiseismic.com

In May 2005, the Seismic Research Unit of the University of the West Indies launched the *Volcanic Hazard Atlas of the Lesser Antilles*. The first of its kind in the world, this comprehensive reference text summarizes the current state of knowledge of each live volcano in the volcanic islands of the Lesser Antilles. The primary purpose of the *Atlas* is to provide an essential blueprint for planners and public officials with responsibility for managing the economic infrastructure of Eastern Caribbean islands and dealing with the hazards of these volcanoes. Discussion of hazards from specific volcanic processes, such as pyroclastic flows and surges associated with lava dome growth, are used to generate a colour-coded hazard map for each volcano. Although the

*Atlas* has been well received by scientists, government officials and tertiary educators across the globe, it is still a very technical text with limited appeal to the general public or secondary level students/teachers. In March 2006, staff at the Unit secured funding and began designing a multimedia version of the *Atlas* with the specific intent of transferring much of the text's valuable information into a format that could be more easily utilized by the general public as well as teachers and students at the secondary level. This poster provides details on the format of both the text and the multimedia version of the *Atlas* as well as it examines how the *Atlas* has been modified to appeal to a broader audience.

## Free-choice learning in paleontological exhibitions

SANDRA E. MURRIELLO

Departamento de Geociências Aplicadas ao Ensino, Instituto de Geociências, UNICAMP Campinas, Sao Paulo, Brazil,

Email: sandramu@gmail.com

Museums, as spaces for “free-choice learning”, allow their visitors an autonomous experience which is the object of several researches in the field of *visitors studies*. Its high long-term educational potential turns them into instruments useful for generating concern about and building scientific concepts in a diverse public but certain context conditions are required. Based on the *contextual model of learning* (Falk and Dierking, 2000) this research considers learning as a process/product of interaction of the personal, socio-cultural and physical contexts over time.

In this work I have tried to understand which factors influence learning in visiting paleontological exhibitions in an Argentinian natural history museum. The research was conducted at the *Museo de La Plata* (Province of Buenos Aires, Argentina) with non-scholastic public (made up of families, children, un-

accompanied adults, foreigners, tourists, etc.) during 2002-2005. Use was made of photographic and documental sources, as well as data supplied by the museum itself, through interviews, surveys and observations of the behaviors of the visitors. This institution has important paleontological collections and among these, the one of Quaternary South American fossils is the one that stands out most, but in this work I assume that the visitors are unable to differentiate these collections from the Mesozoic fossils - dinosaurs - also present in the exhibition. This factor leads to the question of which are the geo-scientific concepts transmitted by the institution and how they interact with the meaning constructed by the visitors.

Falk, J. and Dierking, L. (2000). Learning from museums. Altamira Press.

## The Digital Library for Earth System Education: a catalyst for geoscience education

RUSSANNE LOW

University Corporation of Atmospheric Research, Digital Library for Earth System, Boulder, USA,  
Email: rlow@ucar.edu

The Digital Library for Earth System Education (DLESE) is a U.S. National Science Foundation-funded project to support excellence in geoscience education by providing broad access to a library of innovative web-based resources for teaching and learning.

DLESE is the largest Earth science member of the U.S. National Science Digital Library (NSDL) and provides collaborative opportunities for scientists, educational researchers, and educators to catalyze the critical substantive change in how science is taught in K-12 classrooms, and equally substantive change in the professional development of teachers, (U.S. National Research Council, 1997).

DLESE provides scientists and geoscience research programs an opportunity to contribute to scientific

literacy and education and impact a broader segment of society more rapidly, more directly, and more cost-effectively than ever before. For educators, the library provides high-quality, scientifically accurate, pedagogically reviewed materials that are freely available to anyone in the world with Internet access. For faculty in science education departments, the rapidly evolving technological and scientific cyberinfrastructure present new and exciting venues for science education and geoscience education research. In addition, DLESE supports international efforts to improve geoscience education and has developed a suite of technological standards and services that are freely available for adoption by geoscience education websites in other countries to enhance usability and access to high quality educational resources.



# **Workshops**

## Teaching physics in new Earth-related ways

CHRIS KING<sup>1)</sup> & SUSIE LYDON

Keele University, The Science Education Unit, United Kingdom,  
Email: <sup>1)</sup>c.j.h.king@educ.keele.ac.uk

My only memory of science at school was of staring out of the window and waiting for it to be all over. I was completely bored by the teachers writing formulae on the board. This is what Bill Bryson, the author of 'A short history of nearly everything', has said, but the 'Science in an Earth context' workshops can change all this for you. Look through the window

for science that is relevant to pupils. Then test a range of biology activities that show how science can be taught in Earth contexts to engage and motivate pupils. **WARNING** - this workshop is not about teaching Earth science - it is about teaching biology in new Earth-related ways.

## Project “System Earth”: teaching materials for upper secondary education

SYLKE HLAWATSCH<sup>1)</sup> & CORNELIA SOMMER

IPN Leibniz Institute for Science Education at the University of Kiel, Germany,

Email: <sup>1)</sup>Hlawatsch@ipn.uni-kiel.de

In 2000 the project “System Earth” started in Germany as an effort to introduce Earth systems education to secondary geography and science education as well as to primary school education. It aimed at carrying out research on teaching and learning in the fields as well as developing teaching materials that focus on an understanding of the System Earth with its interacting subsystems. The educational argument is to stimulate a rational discourse on issues about the planet Earth. This discourse needs a well founded scientific knowledge.

The teaching materials for the upper secondary education are assembled in 11 modules covering topics like climate change, rock cycle, origin and development of life, water cycle, resources and recycling, physics and chemistry of the atmosphere, convection in the Earth mantle, the ocean and the atmosphere and the carbon cycle. They are distributed nationwide on

a CD-ROM and comprise subject matter analyses and specific educational advice as well as work sheets for each module. Furthermore, various interactive computer based teaching materials are provided.

The evaluated educational concept fosters an interdisciplinary approach for teaching and learning by adapting the system theory for classroom use. The concept is introduced via the module “System Earth: The Basics” and will be presented during the workshop. Since integrated approaches are not common in German upper secondary science education the interdisciplinary material can be used in biology, chemistry, geography and physics courses. Nevertheless, interdisciplinary cooperation among the teachers is encouraged.

The workshop and selected teaching materials will be presented in English, while the CD-ROM is published in German.



## Teaching chemistry in new Earth-related ways

CHRIS KING<sup>1)</sup> & SUSIE LYDON

Keele University, The Science Education Unit, United Kingdom,

Email: <sup>1)</sup>c.j.h.king@educ.keele.ac.uk

My only memory of science at school was of staring out of the window and waiting for it to be all over. I was completely bored by the teachers writing formulae on the board. Physics and chemistry are germane to everyone's lives but the teachers always made them seem terribly remote.' This is what Bill Bryson, the author of 'A short history of nearly everything', has said, but the 'Science in an Earth

context' workshops can change all this for you. Look through the window for science that is relevant to pupils. Then test a range of chemistry activities that show how science can be taught in Earth contexts to engage and motivate pupils. **WARNING** - this workshop is not about teaching Earth science - it's about teaching chemistry in new Earth-related ways.

## Project “System Earth”: teaching materials for primary school

CORNELIA SOMMER<sup>1)</sup> & SYLKE HLAWATSCH

IPN Leibniz Institute for Science Education at the University of Kiel, Germany,

Email: <sup>1)</sup>sommer@ipn.uni-kiel.de

In this workshop the participants will be introduced to the materials developed in the project “System Earth – primary school”. One aim of the project “System Earth - primary school” was to develop educational materials for teaching science in the context of geosciences in primary school. Based on the experiences of young pupils in every day live, an understanding of scientific concepts should be established. The explanations of coherences between several parts of the earth system are the main goal in this educational concept.

The aims of the project and their realization in the teaching materials will be explained in the theoretical part of the workshop. Furthermore, the effects of teaching and learning with the developed materials will be explicated on basis of empirical studies.

The material, which emerged from the project “System Earth – primary school” will be introduced in the practical part of the workshop. One of these materials is a schoolbook for primary science learning. It

contains chapters like the emergence of landscape, earthquake and continents, the white stork as a migratory bird between the continents and fossils as witnesses from the past.

The schoolbook is accompanied by two interactive computer games which exemplarily show the coherences from the parts in a system. In the computer game “Ciconias adventurous voyage” the children accompany a young white stork on his first experiences in his summer and winter habitat as well as on his flight from Europe to Africa. In the “dino mystery” the children can unravel the mystery of the death of the dinosaur Anatotitan.

The participants of the workshop are invited to test the computer games and to gain experience with some experiments that are part of the teaching materials in the textbook.

Teaching materials are published in German explanations. English translation will be provided.



## Teaching physics in new Earth-related ways

CHRIS KING<sup>1)</sup> & SUSIE LYDON

Keele University, The Science Education Unit, United Kingdom,

Email: <sup>1)</sup>c.j.h.king@educ.keele.ac.uk

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context' workshops can change all this for you. Look through the window for science that is relevant to pupils. Then test a range of physics activities that show how science can be taught in Earth contexts to engage and motivate pupils. **WARNING** - this workshop is not about teaching Earth science - it is about teaching physics in new Earth-related ways.

## Getting below the line – what students really think! A story based curriculum evaluation process

BRONTE NICHOLLS

South Australian Department of Education, Youth Engagement Team, Department of Education and Children's Services, Adelaide, South Australia,

Email: slab@internode.on.net

There are many examples of schools, who have designed innovative programs to engage young people in meaningful learning in the sciences. We can read about the effectiveness of these programs in journals and conference proceedings but these evaluations are often based on quantitative research methods and lack the student voice necessary to find out what they thought and felt about the program.

This paper explores the application of an evaluation technique to “get below the line” - to find out what students really think of a program. The process developed by the author and modelled in this presentation is in the area of dialogical story-based evaluation. Research conducted by Jessica Dart and Rick Davies has informed the development of this tool.

The examples used in this paper are from program evaluations conducted in schools across South Australia including an evaluation of part of the curriculum offered by the Australian Science and Maths School (ASMS) in Adelaide, South Australia. One might ask why we would use a dialogical tool to evaluate the effectiveness of a program in a school. The teachers of the programs had clear ideas about what was or was not working and why, and wanted to test these. The richness of the data produced through this story based process enables a detailed analysis of the issues about the students' learning experience and provides a way forward for teachers to enhance their curriculum and methodologies used in the classroom.

## Deep time project: understanding of geological time across societies

ROGER TREND<sup>1)</sup>, CHUN-YEN CHANG<sup>2)</sup> & NIR ORION<sup>3)</sup>

<sup>1)</sup>University of Exeter, United Kingdom,

<sup>2)</sup>National Taiwan Normal University, Taiwan,

<sup>3)</sup>Weizmann Institute, Israel,

Email: <sup>1)</sup>R.D.Trend@exeter.ac.uk

This workshop deals with cross-cultural research into perceptions of geological time. An international workshop to be held at Exeter University, UK, in June 2006 will start this new collaborative project and interested colleagues are invited to participate. The central theme of the core project is the understanding of geological time in contrasting cultures. The

Bayreuth workshop will present the interim results of the Exeter workshop, including detailed proposals for a major 3-year collaborative research project. Proposals for satellite projects are invited, to run in individual countries or clusters and to focus on any aspect of deep time. Curriculum and wider implications of deep time understanding will be considered.



## Teaching ethical aspects of Earth sciences: Consequence mapping and goals-rights-duties framework

MIGUEL C. CANO

St. Stephen's High School, Manila, Philippines,  
Email: jurassic\_mike@yahoo.com

Two strategies in teaching ethical aspects of Earth Science have been used in the Year 7 Class at St. Stephen's High School - Consequence Mapping and the use of Gerarld Dworkin's "Goals-Rights-Duties" framework.

Consequence maps or "future wheels" encourage students to come up with broad range of implications (consequences) arising from an issue. The recent issues of the implications of the Philippine Mining Act, Cherry Hills Tragedy, The Diwalwal Gold Rush among others were mapped to understand how people and environment were affected by such occurrences.

After doing consequence maps, the Goals-Rights-Duties framework was used to understand the conflicts existing among individuals or stakeholders involved in the issue. It explores what one intends to accomplish (goal), what treatment he is entitled to have (rights), and his obligation to act or behave in a certain way.

These two approaches encourage higher order thinking and highlight the affective learning of students about their environment, thus considered two of the best practices in teaching Earth science at St. Stephen's High School.



# **Deutschsprachige Session**

mit Workshops und Vorträgen  
(Session in German with workshops and talks)

Chair: Gabriele Schrüfer

## Unterrichtsmaterialien des Projektes „Forschungsdialog: System Erde“: Sekundarstufe II und Primarstufe

Sylke Hlawatsch<sup>1)</sup> & Cornelia Sommer

IPN Leibniz Institute for Science Education at the University of Kiel, Germany,

Email: <sup>1)</sup>hlawatsch@ipn.uni-kiel.de

Im Rahmen des Projektes “Forschungsdialog: System Erde” des Leibniz-Institutes für die Pädagogik der Naturwissenschaften (IPN), Kiel wurden Unterrichtsmaterialien für geowissenschaftlichen Unterricht in

den Schulfächern Biologie, Chemie, Geographie und Physik entwickelt und evaluiert. Wir werden die Materialien vorstellen und Ihnen die Gelegenheit geben die computergestützten Materialien auszuprobieren.

### Teaching materials of the project „System Earth“: Upper secondary and primary education

In the frame of the project “System Earth (Forschungsdialog: System Erde)” of the IPN Leibniz Institute for Science Education at the University Kiel, teaching materials for biology, chemistry, geography and physics classes were developed and evaluated.

We will present a CD-ROM for the upper secondary education and a book with CD-ROM for primary education. There will be the chance to work with the computer based materials.



## „Geowissenschaftliche Grund- und Leistungskurse im naturwissenschaftlichen Aufgabenfeld der Sek II“

REINHARD FISCHER<sup>1)</sup> & ANDREAS WENZEL

Universität Bielefeld Oberstufen-Kolleg, Bielefeld, Germany,

Email: <sup>1)</sup>rfischer@uni-bielefeld.de

Wohl an keiner anderen Schule in Deutschland werden geowissenschaftliche Inhalte und Methoden in einer so großen Breite in das reguläre Unterrichtsangebot einer Sekundarstufe II einbezogen, wie am Oberstufen-Kolleg (OS) in Bielefeld.

Nach einer Änderung des Bildungsauftrages für das OS im Jahre 2002 schließt die Ausbildung der OS-Kollegiaten jetzt mit dem Abitur ab. Die Ausbildung ist daher an die Rahmenbedingungen allgemeiner Schulen herangerückt. Als eine Besonderheit des OS konnte der fächerübergreifende, themenorientierte Grundkursbereich erhalten werden.

Unsere langjährige Erfahrungen im Unterrichten der Geowissenschaften, die wir auch als Autoren in das IPN-Projekt „System Erde“ einbringen konnten, werden Hintergrund unseres Workshops sein.

Impulsreferate stellen Beispiele für drei Bereiche vor:

1. Leistungskurse für das Fach Geologie im Rahmen einer Studienfachausbildung von 11/2 bis 13/2. Informationen unter: [http://www.uni-bielefeld.de/OSK/NEOS\\_Versuchsschule/Ausbildung/Studienfaecher/Geologie/index.html](http://www.uni-bielefeld.de/OSK/NEOS_Versuchsschule/Ausbildung/Studienfaecher/Geologie/index.html)
2. Eine 2-semesterige Grundkurssequenz in der Qualifikationsphase mit dem Thema: „Feuer, Erde, Was-

ser, Luft - das System Erde“. In der Sequenz werden die geowissenschaftlichen Grundlagen zum Verständnis von Bau und Funktion unseres sich ständig wandelnden Planeten erarbeitet. Mit chemischen, physikalischen und biologischen Methoden werden die verschiedenen Teilsysteme und einzelnen Kreisläufe untersucht und ihr Zusammenwirken erforscht. Die Geowissenschaften bilden den integrativen Rahmen.

3. Ein Grundkurs für die Orientierungsphase 11/1 mit dem Thema: „Globale Umweltprobleme am Beispiel der Klimaänderung“.

Die Grundkurse haben fächerverbindenden und fächerübergreifenden Charakter. Sie repräsentieren das Lernniveau der gymnasialen Oberstufe unter dem Aspekt einer allgemeinen wissenschaftspropädeutischen Ausbildung.

- Wir bieten Erfahrungen, Kurskonzepte und Materialien.
- Wir erwarten eine lebendige und interessante Diskussion, bei der die Übertragbarkeit von geowissenschaftlichen Inhalten in Kurse der Geographie, aber auch Biologie, Chemie und Physik im Mittelpunkt stehen.

## Workshop im Geozentrum an der KTB

ULRIKE MARTIN<sup>1)</sup> & GERNOT KÖCHER

Geozentrum an der KTB, Windischeschenbach,

Email: <sup>1)</sup>martin@geozentrum-ktb.de

### 1. Von der Kontinentaldrift zur Plattentektonik

Hier kommen folgende Unterrichtsmodule zum Einsatz

- das ‘Kontinentaldrift-Puzzle’
- das Modell ‘Schalenbau der Erde’
- das Modell ‘Plattentektonik’

### 2. Gesteinsbestimmung

Hier kommen folgende Module zum Einsatz

- das Modell ‘Kreislauf der Gesteine’
- Gesteinsbestimmung mit Check-Liste und Experimenten (Ritz-, Strichprobe, Dichtemessung, Säuretest, Untersuchung der Sägeschnittstelle, Gefügeuntersuchung mit Lupe und Mikroskop, Physikalische Verwitterung)

### 3. Falten- und Bruchtektonik

Hier kommen folgende kleine Versuche zum Einsatz

- Faltenstrukturen bei der Entstehung von Gebirgen (mit großen und kleinen Schubkästen)

- Bruchvorgänge an divergierenden, konvergierenden und scherenden Plattengrenzen (mit Basaltmehl auf entsprechend geformten Papierbögen)
- Das Indenter-Modell (Kombination aus den beiden obigen Versuchen)

### 4. Die Haut der Erde – Unser Boden

- Kleine bodenkundliche Exkursion (Geo-Tour) mit Entnahme von Bodenproben mit Spaten und Boden-sonde
- Analyse der Spatenprobe im Labor des GEO-Zentrums
- Experimente mit den Bodenproben
  - Bestimmung der Bodenart mit der Trockensiebung
  - Bestimmung der Bodenart mit der Schlämmanalyse
  - Bestimmung der Bodenart mit der Fingerprobe
  - Bestimmung der Wasserspeicherfähigkeit und Wasserdurchlässigkeit
  - Bestimmung des Bodenmilieus (ph-Wert)
  - Bestimmung der Bodenhorizonte

## Alltagsvorstellungen von Schülerinnen und Schülern zum Thema Boden und Bodenzerstörung

KERSTIN DRIELING

Westfälische - Wilhelms Universität Münster, Institut für Didaktik der Geographie, Germany,  
Email: drieling@uni-muenster.de

Unterrichtsgegenstände werden vor allem von den lebensweltlichen Perspektiven der Lernenden, also von ihren bis dahin entwickelten Vorstellungen zum Gegenstand bestimmt. In einem Dissertationsvorhaben sollen die Alltagsvorstellungen zum Thema Boden bei Schülerinnen und Schülern geprüft werden.

Hier greife ich auf das in der Lehr- und Lernforschung international etablierte Modell der Didaktischen Rekonstruktion zurück (Kattmann et al. 1997).

Das Thema Boden wird in den Richtlinien von NRW als fakultatives Thema für die Jahrgangsstufe 11 vorgeschlagen und findet sich in den neueren Schulbüchern für die Oberstufe wieder.

Es werden einige grundlegende, in Leitfadeninterviews erhobene Schülervorstellungen zum Thema Boden vorgestellt. Dabei wird auf Alltagstheorien eingegangen, die sich mit dem Aufbau und den Bestandteilen des Bodens und den Bodenfunktionen beschäftigen. Individualität und Heterogenität der Vorstellungen werden an Interviewaussagen wie auch an von Schülerinnen und Schülern erstellten Skizzen konkretisiert.

So ist der Boden für den einen Schüler in Schichten unterteilt, die aus verschiedenen Materialien wie z.B. Erde, Sand oder Kies bestehen. Eine andere Schülerin stellt sich unter Boden eine mehr oder weniger einheitliche Materie, in der die Tiere wohnen und die nach unten hin vom Wasser begrenzt wird vor. Die Schülerinnen und Schüler sehen die Funktionen von Boden zum Beispiel darin, dass er Tieren und Pflanzen als Lebensraum dient und Nährstoffe bereit stellt, Pflanzen Halt gibt, damit sie nicht umkippen oder auch Wasser filtert.

Anschließend werden ausgewählte Strukturdiagramme zur Bodenzerstörung, wie z.B. zu Bodenerosion, Bodenversauerung und Bodenverdichtung, präsentiert, in denen die von den Schülern erkannten bzw. vermuteten Wirkungszusammenhänge deutlich werden. Diese wurden mit Hilfe der Struktur-lege-Technik erstellt (SCHEELE ET AL. 1992).

Die jeweiligen Alltagstheorien der Schülerinnen und Schüler werden miteinander und mit ausgewählten fachwissenschaftlichen Theorien verglichen.

### Schoolgirls' and schoolboys' alternative ideas of soil and soil degradation

Topics in class are influenced to a great extent by the everyday experiences of the learner, i.e. by their developed ideas of the subject until then. In an intended dissertation the everyday life expectations of schoolgirls and schoolboys to the topic soil are being examined.

In this context I resort to the internationally established "Modell der Didaktischen Rekonstruktion" (model of didactic reconstruction) (Kattmann et al.1997).

The topic soil is proposed as a facultative topic for grade eleven in the guidelines of North Rhine-Westphalia and is found in the newer textbooks for the sixth form.

Pupils understanding of soil, collected in guideline interviews, are presented. I will take into account al-

ternative conceptions that deal with the structure and components of soil and its functions. Individuality and heterogeneity of the ideas are concretised in interview statements as well as on drafts drawn by schoolgirls and schoolboys. For one pupil soil is therefore divided into layers which consist of humus soil, sand or gravel. Another pupil is visualising soil to be a more or less consistent matter in which animals live and which below is delimited by water. For example schoolgirls and schoolboys are seeing the functions of soil in the fact that it serves animals and plants as a habitat and supplies them with nutrients, gives plants support so they do not tip over or filtrates water as well.

Afterwards selective structure diagrams of soil degradation are presented, such as soil erosion, soil

acidification and soil hardening. The identified and assumed connections of the pupils are revealed here. These were generated with the help of “Struktur-lege-Technik” (structure-lay method) (Scheele et al. 1992).

Pupils’ alternative conceptions are compared with each other and with selective scientific theories.

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## Lehren und Lernen mit dem Computer – Zwischenbilanz einer Untersuchung der Lernprozesse beim Einsatz multimedialer Lernsoftware im Geographieunterricht

JUTTA KUHN-BITTNER<sup>1)</sup> & ALEXANDER SIEGMUND

Pädagogische Hochschule Heidelberg, Abteilung Geographie, Heidelberg,

Email: <sup>1)</sup>kuhn-bittner@ph-heidelberg.de

Im Fach Geographie kommt der Analyse und Visualisierung raum-zeitlicher Strukturen und Prozesse eine zentrale Bedeutung zu. Dabei gewinnt der Computer nicht nur als Arbeitsmedium zur Erhebung, Verarbeitung und Untersuchung aktueller Daten an Gewicht, sondern auch zur interaktiven und schülerzentrierten Plattform für den Einsatz unterschiedlicher Lernsoftware. In zahlreichen Bildungsplänen wird der Einsatz von Lernsoftware wenn nicht explizit gefordert, wie etwa in der 7. Klasse des Gymnasium und der Sekundarstufe II, so zumindest angeregt.

Über die mit dem Einsatz computergestützter Lernsoftware verbundenen Lehr-Lern-Prozesse ist immer noch wenig bekannt. Die meisten Studien beschäftigen sich mit Vergleichsuntersuchungen der Lernergebnisse beim Einsatz von Lernsoftware im Vergleich

zum „herkömmlichen“ Unterricht, nicht aber mit den Prozessen des eigentlichen Lernvorgangs selbst. Wie lernen die Schüler mit Hilfe von Lernsoftware? Welche Strategien verfolgen sie bei ihrem Lernprozess – oder basiert die Anwendung letztlich nur auf dem „try-and-error-System“? Welche Merkmale und Eigenschaften von Lernsoftwareprogrammen fördern den Lernprozess, welche behindern ihn? – dies sind einige der zentralen Fragen, denen im Rahmen des Projektes nachgegangen werden soll.

Die dargestellten Fragestellungen werden mit Hilfe der Lernsoftwarereihe „Alex auf Reisen“ des Klett-Verlages untersucht werden. Dabei konzentrieren sich die Untersuchungen auf das Programm „Alex auf Reisen in der Wüste“.

### The computer as a tool in geography lessons in Germany

Nowadays the experiences that children and teenagers make are stronger influenced by the media than ever before. To prepare the pupils best to cope with the tasks of their future everyday lives and their world of work, the schools have to improve the pupil's competences in obtaining and processing information. Therefore the computer needs to be included in schools as a teaching and working medium, as it is mentioned in every curriculum. Because of the processing of up-to-date information and the visualizing of spacial-temporal processes, precisely the subject geography offers a lot of possibilities for the usage of computers. In that case the computer is not only a tool for the pupils but it also allows active learning processes by the use of special educational software. But the use of computers for learning-processes leads to the question how pupils work and learn with educational software and what kind of learning processes this involves. Most of the surveys deal with comparative tests of the results of learning

made by the use of educational software in comparison to “conventional” education but not with the process of learning itself. Therefore the project tries to find answers to different questions about the use of computers in education like: What are the strategies pupils follow during their learning process? Do these processes depend on their previous knowledge in dealing with computers or their sex? Which parts play the kind of questions the teacher asks concerning the use of educational software? Is the application of educational software only based on a “try-and-error-system” or do the pupils follow certain learning strategies? What kind of criteria and attributes support the learning process and which constrain it? These are some of the central questions which are checked in the context of an extensive test at schools with well-established educational software. As a result it is possible to derive suggestions for the set-up and the functionality of future educational software and for the didactical use in geography lessons.

## Die begehbare Geologische Karte von Rheinland-Pfalz

FRIEDRICH HÄFNER

Landesamt für Geologie und Bergbau Rheinland-Pfalz, Germany

Email: friedrich.haefner@lgb-rlp.de

Die Idee zur Gestaltung einer *Begehbaren Geologische Karte des Landes Rheinland-Pfalz* wurde vom Autor vor mehreren Jahren entwickelt. Die Realisierung ist eingebettet in die von der Behörde des Autors verfolgte Absicht, geologisches Basiswissen in geeigneter Weise für eine breitere Öffentlichkeit verständlicher, ja im wörtlichen Sinne begreifbarer, fassbarer zu machen.

Standort ist eine Fläche neben dem „Turm Luxemburg“ auf dem Gelände der früheren Landesgartenschau in Trier (2004). Diese Position eröffnet die Möglichkeit, das Objekt von der Höhe des Turmes zu überblicken und so die räumlichen Zusammenhänge besser zu erfassen. Die Umgebung ist ein parkähnliches Gelände zwischen dem der Universität Trier und dem so genannten Wissenschaftspark sowie einer im Bau befindlichen Wohnsiedlung.

Die begehbare geologische Karte von Rheinland-Pfalz ist gestaltet aus den original in Rheinland-Pfalz vorkommenden Gesteinen der jeweiligen geologischen bzw. stratigraphischen Einheiten. Die geologischen Einheiten werden stark vereinfacht, aber maßstabsgerecht dargestellt. Die Flussläufe von Rhein und Mosel sind als begehbare und befahrbare (Kinderwagen, Rollstuhl) Wege hergestellt. Die größeren Landschaftsräume wie z. B. Oberrheingraben und

Rheinisches Schiefergebirge sind durch Höhenstufen kenntlich gemacht. Die Abmessungen betragen ca. 37 x 27 Meter; das entspricht ungefähr einem Maßstab von 1: 7.000.

Der Landesumriss und die Flussläufe bilden die zentrale Wegführung, die Flächen sind entsprechend ihrer geologischen Zugehörigkeit mit Rohblöcken / Platten der jeweiligen Gesteine belegt. Es wurden ausschließlich Gesteine aus rheinland-pfälzischen Vorkommen zur Ausführung verwandt. Die Lage wichtiger Städte in Rheinland-Pfalz und die Position der Liefersteinbrüche ist mit Messingschildern, die an den entsprechenden Gesteinsblöcken angebracht wurden, gekennzeichnet. Die gesamte Karte kann begangen, die Höhenstufen können als zwanglose Sitzgelegenheit genutzt werden. Zwei Infotafeln dienen der Erläuterung der Geokarte und der kurzen Beschreibung der Gesteine.

Die begehbare geologische Karte von Rheinland-Pfalz wird in das touristische Konzept der Stadt Trier integriert, dient der Grundausbildung von Geographiestudenten und der gezielten Information von Besuchergruppen, insbesondere aus den Schulen des engeren und weiteren Umfeldes. Das Projekt wird ergänzt durch einen Naturerlebnispfad mit weiteren georelevanten Stationen und einen Rohstoffgarten.

### Geological map of Rheinland-Palatinate (federal state of Germany) which can be walked on

The idea to create a geological map of Rheinland-Pfalz, which can be walked on was developed by the author several years ago. The realization intends on to make basic geological knowledge clear to a broad public in a suitable way. In a verbal sense the object should be understandable and touchable.

This map is situated in the area next to the „Tower of Luxemburg“ on the site of the former regional garden fair in the city of Trier near the Luxemburg border. From the top of the tower it is possible to look at the map and to visualize the complexity of the landscapes. The surrounding area is a park-like space between university buildings and the so called scientific park as well as a housing area still in construction.

The geological map, which can be walked on is made of the original stones occurring in Rheinland-Pfalz and the corresponding geological and stratigraphic units. The geological units are presented extremely simplified but true to scale. The rivers of Mosel and Rhine are made as paths to be walked on or passed through (suitable for wheel chairs or prams).

Major landscapes like the Upper Rhine Graben or the Rhenish Massiv are distinguished in various heights through steps. The diameter is 37 x 27 meters which corresponds to a scale of 1: 7.000.

The contour of Rheinland-Pfalz and the rivers form the central paths and the surfaces are composed by

raw blocks and plates of the respective stones. The stones were taken exclusively from quarries in Rheinland-Pfalz. The position of important cities and the quarries are marked in the map by brass plates, which are attached to these stones. The whole map can be walked on. The steps are suitable to sit on. Two boards inform the visitors about the construction of the map and give short information about the nature and composition of the stones.

The geological map of Rheinland-Pfalz, which can be walked on will be integrated into the touristic concept of the city of Trier and is part of the basic training for students of geography. Furthermore this information is given to visitors of the city of Trier as well as to pupils of schools in the region. The project is completed by a nature-event track and a raw – materials garden. A brochure in German, French and English will be prepared.

## GIS macht Schule – praktischer Workshop

DANIEL SCHOBER

ESRI Geoinformatik GmbH, Kranzberg, Germany,  
Email: D.Schober@ESRI-Germany.de

Unsere Welt hat viele Dimensionen. Mit Raumbezug aber werden Informationen wertvoll. Um raumbezogene Daten zu erfassen, verarbeiten, bewerten und Ergebnisse anschaulich vermitteln zu können, werden Geografische Informationssysteme (GIS) eingesetzt. Längst sind GIS-Anwendungen ein unverzichtbarer Bestandteil unseres täglichen Lebens: einen Stadtplan, eine thematische Karte in der Zeitung, eine geplante Route oder eine interaktive Karte im Internet.

Nachdem GIS in der universitären Ausbildung längst zum Standard gehört, werden seit rund zehn Jahren Geografische Informationssysteme (GIS) auch an deutschsprachigen Schulen eingesetzt. Inzwischen ist bundesweit eine Vielzahl erfolgreicher GIS-Projekte an Schulen durchgeführt worden, insbesondere im modernen Geografie-Unterricht oder bei fächerübergreifenden Projekten. In zahlreichen Arbeitskreisen

wird der GIS-Unterrichtseinsatz vorbereitet. In die Lehrpläne der Bundesländer halten Geografische Informationssysteme schrittweise Einzug. Bei der Einführung von GIS verfolgen die Bundesländer jedoch unterschiedliche Ansätze und bewegen sich mit ungleicher Geschwindigkeit.

Was ist GIS? Was ist der Mehrwert im Unterricht? Wie kann ein GIS-Unterrichtsprojekt aussehen? Antworten auf diese Fragen und mehr werden der Inhalt des Workshops GIS macht Schule sein. Nach einer theoretischen Einführung in die Grundlagen von Geografischen Informationssystemen haben die Teilnehmer Gelegenheit, zunächst mit mobilen GIS/GPS-Einheiten Daten im Feld aufzunehmen, bevor sie anschließend am eigenen Rechnerplatz die ersten Schritte in der Welt Geografischer Informationssysteme zu machen.

### GIS in schools – practical workshop

Geographic inquiry and geographic information systems (GIS) are important in assisting educators, students, and their institutions to answer personal and community questions with local to global implications. GIS in the classroom helps foster critical thinking and problem solving, 21st century workforce skills, and citizenship and community participation among young people and educators.

The German educational system is organized by the federal states individually, each with their own terms regarding curriculum content, duration of school attendance and design of the school system. Although there have been efforts to harmonize the diverse system, major differences are still apparent. GIS has been successfully introduced in German K-12 education in most of the German states at various speeds with different approaches.

During the first part of the practical workshop participants will be working with mobile GIS / GPS units and gather data in the field. After returning to the computer lab they will transfer the data from the mobile units onto the desktop computers and work on visualizing and analyzing the data with the GIS-Software ArcView.

Since 1999 ESRI Geoinformatik GmbH has been involved in German K-12 GIS education organizing teacher trainings, giving support to schools and establishing networks around Germany. Daniel Schober has a teaching degree in English and Geography. Since 2003 he is K-12 and Higher Education Program Manager at ESRI Geoinformatik, the official ESRI Distributor in Germany.

## Geowissenschaften im österreichischen Schulunterricht

HERBERT SUMMESBERGER<sup>1)</sup>, ELISABETH GRÜNWEIS<sup>2)</sup> & GERTRUDE ZULKA-SCHALLER<sup>3)</sup>

<sup>1)</sup>Austrian Geological Society, Austria,

<sup>2)</sup>Billrothgymnasium Wien, Vienna, Austria,

<sup>3)</sup>Natural History Museum, Vienna, Austria,

Email: <sup>1)</sup>Herbert.Summesberger@nhm-wien.ac.at

Der Abbau des naturwissenschaftlichen Unterrichts im österreichischen Schulunterricht führte über Jahre zu einer Ausdünnung an erdwissenschaftlicher Grundlagenkenntnis in der österreichischen Gesellschaft einschließlich ihrer „opinion leaders“ wie etwa Politiker, Lehrer, Journalisten.

1. In den 70er Jahren des vergangenen Jahrhunderts kam es zum Verlust zweier Stunden naturwissenschaftlichen Unterrichts pro Woche in den 7. Klassen der meisten Zweige der österreichischen Gymnasien (AHS - Allgemeinbildende Höhere Schulen - Alter: 17). Der Lehrplan betreffend die Erdwissenschaften wurde von der 7. Klasse in die 5. Klasse transferiert - Alter: 15).

2. 1996/97: Kürzung des naturwissenschaftlichen Unterrichts (Biologie) in den 1. Klassen AHS (Alter: 11) von 3 auf 2 Stunden pro Woche.

3. 2003/04: Kürzung der Naturwissenschaften (Erdwissenschaften!) von 2 auf 1 Stunde wöchentlich in Abhängigkeit von der relativen Schulautonomie in den 3. Klassen der österreichischen AHS - Alter 13.

4. 1999 wurde der Studienplan für Lehramtskandidaten an der österreichischen Universitäten um etwa 50 % beschnitten. Das führte in den erdwissenschaftlichen Disziplinen für die Anforderungen des Schulunterrichts zu ungenügender Ausbildung der künftigen AHS - Lehrer. Einsprüche des Österreichischen Nationalkomitees für Geologie und der Österreichischen Geologischen Gesellschaft blieben wirkungslos gegenüber politischen Beschlüssen. Kon-

sequenzen können bei den nächsten PISA – Studien erwartet werden.

Die Anstrengungen der österreichischen Geowissenschaft zielen auf Entwicklung didaktischer Unterrichtsmittel und Verbesserung der berufsbegleitenden Ausbildung der Lehrer:

1. Das amerikanische didaktische Unterrichtsmittel GEOLAB wurde durch ein Team von Mitarbeitern des Naturhistorischen Museums, AHS-Lehrern und einer Initiative der Österreichischen Geologischen Gesellschaft (ÖGG) österreichischen Verhältnissen angepasst und erfolgreich im Schulunterricht eingesetzt.

2. Verbesserte Ausbildung der österreichischen Schulkinder durch didaktische Lehrmittel am Naturhistorischen Museum in Wien: Zeitmaschine, geologisches Zeitband, Videos, interaktive Projekte unter Leitung qualifizierter Museumspädagogen.

3. Ständiger Kontakt zu den Arbeitsgemeinschaften der österreichischen Lehrern: Exkursionen, Seminare, durch die Österreichische Geologische Gesellschaft (AG Geowissenschaften, Schule und Öffentlichkeit). Die kürzlich geäußerte Kritik des Österreichischen Rechnungshofs an der geringen berufsbegleitenden Fortbildung der Lehrer: nur ein Drittel der Lehrer betreibe erfolgreich postgraduierte Weiterbildung, trifft leider in noch höherem Ausmaß für die berufsbegleitende Fortbildung der österreichischen AHS-Lehrer in Biologie und Umweltkunde sowie Geografie und Wirtschaftskunde zu.

### Geo-education in Austria

Reduction of natural science education in the Austrian school system over years led to a decrease in basic knowledge of geosciences in the Austrian society including their opinion leaders such as politicians, teachers and journalists.

1. Already in the seventies of the last century: Loss of two hours natural sciences classes per week in the

7<sup>th</sup> class level (age 17) in most branches of the Austrian gymnasium. The syllabus of the 7<sup>th</sup> class (concerning geosciences) was transferred from the 7<sup>th</sup> into the 5<sup>th</sup> class (age 15).

2. In 1996/97: Reduction of natural sciences (biology) from three to two hours per week in the 1<sup>st</sup> class (age 11).

3. In 2003/04: Reduction of natural sciences (geosciences !) from two to one hour weekly depending on school autonomy in the 3<sup>rd</sup> class of the Austrian gymnasium (age 13).

4. In 1999, the academic education of future teachers (study plan) was cut down to 50 percent: education in geosciences of future schoolteachers does not provide a sufficient basis for the teaching necessity at school any more. Counter-measures carried out by the Austrian National Committee for Geology and the Austrian Geological Society against political decisions failed in all cases. Consequences may be expected, perhaps in the next PISA studies.

Efforts of the Austrian geoscience community are now directed on developing:








1. (GEOLAB, video). The american didactic tool GEOLAB was successfully adapted by the Austrian

Geological Society Museum and the Museum of Natural History in Vienna to Austrian relations.

2. Education of schoolchildren all over Austria with didactic tools at the Museum of Natural History (e.g. time machine, GEO-ribbon, videos, interactive projects under guidance of qualified museum educators).

3. Contact to teacher's working communities, organization of post graduate training colleges for school-teachers (excursions, fieldwork) by the Geological Society (Working Group on Geosciences, School and Public Relations). Recently the Austrian Court of Audit (Rechnungshof) criticized the inefficiency of the Austrian postgraduate teachers' training. Only one third of the teachers (in general) maintains postgraduate training sufficiently. This is evident to a certainly much higher degree in postgraduate ge-education of teachers in biology/environmental sciences and geography/economic sciences.

## **List of exhibitors IGEO 2006 Bayreuth**

<p>FWU Institut für Film und Bild in Wissenschaft und Unterricht gemeinnützige GmbH Bavariafilmplatz 3 82031 Grünwald www.fwu.de</p>	
<p>Schweizerbart'sche Verlagsbuchhandlung (Nägele u. Obermiller) Science Publishers Johannesstr. 3A D-70176 Stuttgart Germany Tel. ++49-711-351456-0 FAX ++49-711-351456-99 mail@schweizerbart.de</p>	
<p>Koordinierungsbüro GEOTECHNOLOGIEN Wissenschaftspark 'Albert Einstein' Telegrafenberg A6 14473 Potsdam Germany Fon: +49 (0) 331 288 1073 Fax: + 49 (0) 331 288 1077 www.geotechnologien.de</p>	
<p>IUGS Secretariat Geological Survey of Norway NO-7491 Trondheim Norway Fax: +47 73 50 22 30 Tel: + 47 73 90 40 40</p>	
<p>International Year of Planet Earth Slatingasse 8, 1130 Vienna, Austria janwer@pdg.at</p>	
<p>Volker Huntemann Wolfgang Borchert Gymnasium 90579 Langenzenn</p>	
<p>Fredy Vetter lic. phil. nat. Biologe ecovia Hackenrüti 8 CH-6110 Wolhusen www.ecovia.ch, www.regenwurm.ch www.grundwasser.ch, www.eausouterraine.ch Tel: +41 (0)41 492 50 90 Fax: +41 (0)41 492 50 99</p>	



# Field trips

## From the Baltic to Bayreuth (A1)

**LEADER:** SYLKE HLAWATSCH

**Date:** 14.09. - 17.09.2006 (4 days)

**Abstract:** The 4-day trip starts in Kiel at the Baltic Sea and ends in Bayreuth ready to join the "Icebreaker Party".

It covers selected facts of German geology (e.g. glacial deposits, cretaceous rocks with dinosaur footprints, ore deposits, volcanism) as well as educational aspects of diverse forms of informal learning sites (geo-institute, science center, outdoor museum, silver mine, a walk to an outcrop in the countryside).

As a special highlight the hotels are located at sites which have the status of UNESCO world heritage:

- The old hanseatic city Bremen with its famous market square.
- The medieval town Goslar which blends harmoniously into the picturesque Harz countryside.
- The Rhone biosphere reserve.

## Volcanotour (A3)

**LEADER:** ULRIKE MARTIN

**Date:** 17.09.2006 (1 day)

**Abstract:** The field trip will provide an overview of Tertiary volcanoes along the Eger rift in NE Bavaria. As a result of intensive quarrying in the past decades, quarries provide interesting insights into the Tertiary volcanic events in the northern Oberpfalz. Mainly basaltic rocks of a Tertiary volcanoes will be visited. Volcanoes comprise maars and scoria cones. From

didactical point of view the formation of these small volume volcanoes can be discussed in relation to geomorphological processes which includes erosion and weathering. The field trip includes also a visit to the KTB site (continental deep drilling site) where a new geo-educational centre has been established.

## Earth history for the public: The Bayreuth "Urweltmuseum" (A4, B3)

**LEADER:** RABBOLD

**Date 1 (A4):** 17.09.2006 (14.00 - 16.00)

**Date 2 (B3):** 20.9.2006 (14.00 - 16.00)

## The "ecological-botanical garden" of Bayreuth University (A5, B2)

**LEADER:** MARIANE LAUERER, GREGOR AAS

**Date 1 (A5):** 17.09.2006 (16.00 and 17.00)

**Date 2 (B2):** 20.09.2006 (1 hour during lunch time)

## Der "Ökologische-Botanische-Garten" der Universität Bayreuth (A6)

**FÜHRUNG:** MARIANE LAUERER, GREGOR AAS (IN DEUTSCHER SPRACHE)

**Datum:** 1 Stunde 17.09.2006 (16.00 und 17.00)

## Historical Bayreuth (A7)

**LEADER:** GABRIELE SCHRÜFER

**Date:** 17.09.2006, Sunday afternoon (14.00 - 16.00)

**Abstract:** On the basis of famous personalities (e.g. Wagner), who shaped the townscape, we will get to know Bayreuth. Margravine Wilhelmine, Joseph St. Pierre, Richard Wagner, who shaped the townscape, we will get to know Bayreuth

## Historical Bayreuth (special arrangement for accompanying persons) (B5)

**LEADER:** GABRIELE SCHRÜFER

**Date:** 20.09.2006, Wednesday (9.00 - 13.00)

Costs: 20 Euro (incl. entrance fees)

**Abstract:** On the basis of famous personalities (e.g. Margravine Wilhelmine, Joseph St. Pierre, Richard Wagner), who shaped the townscape, we will get to know Bayreuth. Including the visit of the Margravial Opera House and the Festival Theatre

## Field trip across the Bavarian part of the Bavarian-Czech Geopark and to the German Super Deep Borehole (KTB) (B1)

**LEADER:** GERHARD HÄNSEL

**Date:** 19.09.2006

**Abstract:** The mid-Conference field trip will visit the German part of the border-crossing Bavarian-Czech Geo-park which is recently in the state of establishing. This geopark is situated in the centre of Europe in one of the geologically most unique areas worldwide. Based on the complex geological structure and evolution along the north-western part of the Bohemian Massif the geo-park area is characterized by narrow contrasts of geology, landscape, hydrology, soils, vegetation, and even climate conditions which all are influencing the cultural, political, and economic

development of the region. Therefore, the Bavarian-Czech Geo-park is an ideal tool to reach the general public to promote the understanding of the effects of the System Earth for the society up to the understanding of fundamental geoscientific topics like the German Super Deep Borehole (KTB) or the occurrence of earthquakes. At already existing and developing Geo-sites (including the KTB) we will present outstanding examples for the geological heritage within the geopark area, their presentation to the public, and the geo-park concept.

## Earth history in the "ecological-botanical garden" of Bayreuth University (B4)

**LEADER:** ANDREAS PETEREK, RALF SCHUNK

**Date:** 21.09.2006 (Thursday, during lunch time)

**Abstract:** More than 3,000 tons of rocks from the Bayreuth region have been used for the Ecological Botanical garden of the Bayreuth University. By this, an outstanding example of an open-air museum for Earth history and petrology has been arisen in a lovely surroundings. Visitors of the garden inevitably come into contact with the great variety of rocks. Due to a

great demand guided tours for the public are offered several times per annum with explanations on principals in petrology, geology, and Earth history. During lunch time we will use the conference break for a walk through the garden and for discussion of geo-educational concepts for the presentation of its geological inventory to the public.

## Geology of the northern Franconian Alb - excursion to museums and outcrops (C1)

**LEADER:** ECKHARD MÖNNIG, MATTHIAS MÄUSER, WOLFGANG SCHIRMER

**Date:** 22.09.2006 (1 day)

**Abstract:** The excursion will focus mainly on public understanding of Earth science. The trip starts in Bayreuth and leads to the mediaeval town of Bamberg with its Natural History Museum. One exhibition of this museum is over 200 years old and reflects the natural science of the 18<sup>th</sup> century. Next station is a nature trail to the Staffelberg, a famous habitat for

Jurassic fossils. Here over 20 information panels explain the Earth history of the northern Franconian Alb. In the afternoon we will visit the Naturkunde-Museum Coburg and its large geological exhibitions. The practice in geoscience teaching at different levels will be demonstrated by the pedagogues of the museum. Then return to Bayreuth.

## Excursion to the Tertiary impact crater of the Nördlinger Ries (C3)

**LEADER:** GISELA PÖSGES, MICHAEL SCHIEBER

**Date:** 22. - 23.09.2006 (2 days)

**Abstract:** The Ries crater is one of the best preserved impact craters on Earth. 15 millions years ago an asteroid of about 1.2 km in diameter hit the Earth with a velocity of about 70.000 km/h and created a crater of 25 km in diameter. The Ries crater lies between the Frankonian and the Swabian Alb mountains in the triangle of the cities Nuremberg in the North, Munich in the Southeast and Stuttgart in the West. This huge cosmic catastrophe created completely new types of

rocks. The famous rock is the Suevite. This Suevite solved the mystery of the Ries origin in 1960. The well known planetologist and geologist Eugene Shoemaker discovered in the Suevite the high pressure modifications of quartz, Coesite und Shishovite. These minerals are the finger prints of the cosmic body. The Ries crater is the type locality of this kind of impact rock. All over the world this terminus is used for impact rock formation.

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