BIODIVERSITY IN EDUCATION FOR SUSTAINABLE DEVELOPMENT – REFLECTION ON SCHOOL-RESEARCH COOPERATION

Edited by
Karin Ulbrich,
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Sofia–Moscow
2010
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The book should be cited as follows:

First published 2010
ISBN: 978-954-642-537-9 (paperback)

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Pensoft Publishers
Geo Milev Str. 13a, Sofia 1111, Bulgaria
info@pensoft.net
www.pensoft.net

Printed in Bulgaria, July 2010
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Biodiversity Education, ICT, Collaboration and ESD: What have we learned?
Karin Ulbrich, Josef Settele and Faye Benedict
PREAMBLE

The thematic workshop **Biodiversity in Education for Sustainable Development: Reflection on school-research cooperation** was organized by the Helmholtz Centre for Environmental Research-UFZ\(^1\) as a core activity of the EU Comenius network project **SUPPORT: Partnership and Participation for a Sustainable Tomorrow**. The workshop was held in Kassel, Germany on September 24-27, 2009.

The SUPPORT network\(^2\) of education experts in the field of education for sustainable development (ESD) includes more than 40 partners and members from over 20 countries. This consortium works together to promote and enhance the quality of education for sustainable development. SUPPORT is particularly interested in collaborative relationships in ESD and the role of ICT. The goal of the biodiversity workshop was to bring together teachers, teacher trainers, education experts, researchers and program developers to explore in greater depth the nature of collaborative relationships between schools and researchers in biodiversity education.

This book summarizes the results of the workshop and sheds light on current issues in ESD. It should be of interest to educational policymakers and practitioners as well as biodiversity- and education experts. In the first section, six ESD experts reflect on biodiversity education and school-research collaboration, situating these issues in the context of ESD and the challenges of school development. The next sections present five recently developed internet based communication tools and software and seven examples of best practice. In the final chapter, Dr. Karin Ulbrich and Dr. Josef Settele from the Helmholtz Centre and Dr. Faye Benedict make concluding remarks, focusing on application of ICT tools and school-research collaboration.

Professor Armin Lude and other keynote speakers discuss the relationship between biodiversity education and ESD. Biodiversity is a central theme in ESD, offering rich and exciting content. Direct collaboration between schools and re-

\(^1\) www.ufz.de

\(^2\) www.support-edu.org
searchers enhances the relevance and quality of the education. Yet, we need to continually re-think and re-create biodiversity education in the context of ESD. Biodiversity education often represents very high quality science education. How can we build on this to ensure that biodiversity education is not only good science education, but also supports the wide set of learning outcomes and competencies that we associate with ESD?

The ICT tools and case studies for biodiversity education presented at the workshop set off a lively discussion of the potential and challenges of biodiversity education and ESD in schools as well as the specific role of ICT. ICT can create a direct and highly motivating communication link between researchers, communities and schools. ICT can also promote pupil competencies such as the ability to acquire scientific knowledge, apply it to local activities, simulate and evaluate nature management alternatives and communicate results.

The SUPPORT project sends sincere thanks to everyone who participated in the workshop and the production of this publication. Special thanks to the Helmholtz Centre and Dr. Karin Ulbrich for their dedication to biodiversity education and ESD, and for their many contributions to the work of the SUPPORT network. Both the workshop and this book advance our understanding of the meaning of school-research collaboration in biodiversity education and ESD.

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Oslo, Norway
March 5, 2010
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BIODIVERSITY EDUCATION,
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AND COOPERATION
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This short article (story) indicates how international networking and collaboration evolves, how national impulses can become fruitful on an international level and how this international exchange creates a wider momentum which in return influences and encourages national developments.

This story began in the year 2006. For me several international events which focused on Education for Sustainable Development, on Research and Education cooperation and on Biodiversity made this year remarkable.

In March 2006 Austria organised the first official EU conference on Education for Sustainable Development in the frame of its EU presidency. This event convened educational experts, scientists, NGOs, administrators and policy makers and gave a fruitful example of the dialogue between these different stakeholder groups. I was one of the responsible organisers of this conference in the Austrian Ministry of Education. For details see: (http://www.bmukk.gv.at/europa/bildung/esd.xml).

For the context of this story important was the dialogue among the Finnish and Austrian high level education representatives: Finland had the EU presidency in the second half of 2006 and agreed to also involve ESD in its presidency conference programme.
In June 2006 we had a planning meeting of ENSI country coordinators and experts in Vienna to discuss the possibilities and outline of a new EU COMENIUS network project. The participants decided on “cooperation between research and education in ESD” as one of the three focus themes for this new EU Comenius network project. Norway as long term ENSI member country took the initiative to lead the strenuous application process and then to coordinate this EU project SUPPORT (2007 – 2010, see below).

I took part in this meeting as Austrian ENSI country coordinator and then also ENSI president (for details about ENSI see www.ensi.org).

In parallel during 2006 the Austrian Ecology Institute started the planning of a FP 6 (Sixth Framework Programme, http://ec.europa.eu/research/fp6/index_en.cfm) research project called “Form it- Take part in research” (www.form-it.eu/) in close collaboration with the Austrian Federal Ministry of Science and Research. The aim of “Form it” was to systematically strengthen the collaboration between education research and science teaching in Europe to promote young people’s interest in science and to enhance a more critical and analytical way of thinking and learning. The official project start of Form-it took place in Vienna on November 1st, 2006. I represented the Austrian Ministry of Education which was project partner.

During summer 2006 I was invited to take part in the Finnish conference of the European Platform for Biodiversity Research Strategy (EPBRS) which was held under the Finnish Presidency of the EU in Helsinki from November 17 – 19, 2006. For the first time in the EPBRS history (which was stimulated by the Austro-Finnish EU presidency agreement on ESD made in Vienna in March 2006, see above) this EPBRS conference had also a focus on research and education cooperation.

“Youth and biodiversity” was a main issue focusing on biodiversity in school education. A preceding e-conference chaired by Professor Mauri Ahlberg (University of Helsinki) and the working groups at the conference discussed two topics:
- Innovations to promote biodiversity by co-operation of teachers and scientists
- Schools as driving forces to monitor environmental change.

An important result of this very intense exchange and discussion were the “Recommendations of the meeting of EPBRS concerning ‘Biodiversity education’” (http://www.epbrs.org/PDF/EPBRS-FI2006-Education%28final%29.pdf).

During this EPBRS meeting in Helsinki Karin Ulbrich from the Helmholtz Centre for Environmental Research in Halle and I met in the education work shops and we had a long and fruitful exchange of ideas. Together with our Norwegian colleagues we invited her to take part in the main planning meeting of the EU Comenius network project SUPPORT in Budapest, January 2007. (see http://support-edu.org/)
In January 2007 the Helmholtz Centre for Environmental Research as well as the Austrian Institute of Ecology, which coordinated “EU-Form-it” decided to cooperate with the planned COMENIUS-3 project SUPPORT. At this Budapest meeting also the work plan for the research and education collaboration segment of SUPPORT was developed. Its two highlights were:

- The international FORM it Conference »Bridging the Gap between Research and Science Education« in Vienna, Austria, from 12\(^{th}\) – 14\(^{th}\) of March, 2008, and

The Form it conference served to present all the work done by the project consortium and provided a platform for discussion and networking for persons involved in Research and Education Cooperation REC (teachers, promoters, researchers, students,...). Karin Ulbrich and Josef Settle from the Helmholtz Centre for Environmental Research-UFZ (Germany) presented results of the EU-funded research projects ALARM (A large scale risk assessment for biodiversity with tested methods; FP6) and MacMan (Maculinea Management; FP5). In the national project PRONAS (www.pronas.ufz.de) they have been developing educational software to facilitate communication of research results to pupils. This project is part of the SUPPORT network. For details please see the conference proceedings under: http://www.form-it.eu/download.php?id=236.

The EU-SUPPORT partner meeting in Frankfurt / Germany in June 2009 gave the forum to present and discuss the outline of the international workshop “Biodiversity in Education for Sustainable Development – Reflection on School – Research Cooperation” among the SUPPORT partners and thus to highlight the importance of this event whose results are the content of this publication.

RÉSUMÉ

We see the long waves of network collaboration emerging from the International Network Environment and School Initiatives ENSI (since 1986, www.ensi.org), the ENSI stimulated and supported Comenius Networks “SEED School Development through Environmental Education” (2002 – 2005, www.seed-eu.net) and “SUPPORT -Partnership and Participation for a Sustainable Tomorrow” 2007 – 2010 (http://support-edu.org), the interaction with the EU Presidencies in 2006,
with huge EU research projects such as ALARM (www.alarmproject.net) and initiatives like EU Form it (2006 – 2008) and the European Platform for Biodiversity Research Strategy EPBRS.

This story gives an example how international networking and collaboration can work, how national impulses and contributions are effective on an international level and how international exchange gains momentum which in return influences and encourages national developments.
THE SPIRIT OF TEACHING ESD – BIODIVERSITY IN EDUCATIONAL PROJECTS

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1 INTRODUCTION

“I often go outdoors into Nature with children and show them native animals and plants. But I ask myself: Is this actually ESD…” Similar statements can be heard from many educators. Five years after the beginning of the United Nations Decade of ESD, “Education for a sustainable development” is still an unknown, abstract or inapplicable construct to many. Only one third of teachers are familiar with the concept of ESD or have heard about the Decade (Rieß & Mischo 2008).

Of course, education for sustainable development is more than the teaching of species names. Naming of organisms might be seen as a starting point, but must be followed by knowledge of complex interrelations and connections and by student activities. This way, all relevant dimensions of sustainability – ecological, economic and social – can be embraced when teaching biodiversity. Biodiversity education can then be seen as a model for education for sustainable development. It becomes much more than “showing them animals and plants” and illustrates how concepts of ESD can be applied in teaching.

This article will first provide a short overview of ESD and then outline the connection between ESD and biodiversity. Special focus will be put on teaching applications, the need for an orientation toward competencies for students, challenges when teaching biodiversity and key themes and methods.
1.1 Milestones in the history of ESD

There has been a marked progression in the theoretical, methodological and social understanding of education for sustainable development, as evidenced by several important conferences held over the course of more than three decades. The 1972 Stockholm Conference on Environment and the 1977 Tbilisi Principles on Environmental Education can be viewed as a starting point. These conferences focussed on political statements as a reaction to the environmental crisis of the 1970s and provided some of the first fundamental proposals on actions to fight pollution of the environment. In 1983, the secretary-general of the UN established the ‘World Commission on Environment and Development.’ This commission is frequently referred to as the Brundtland Commission, after Gro Harlem Brundtland, the head of the commission and formerly the prime minister of Norway. The commission was asked to propose a global agenda for addressing the world’s environmental problems. In their study they discerned that environmental issues were intertwined with social and economic issues. The Brundtland Commission developed the following definition of sustainable development, which emphasizes meeting needs, not just now, but in the future as well:

“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” (WCED 1987, p. 43)

After that, large UN conferences addressed the subjects environment and development. The Rio Earth Summit was held in 1992 (United Nations Conference on Environment and Development – UNCED) followed by the World Summit on Sustainable Development – WSSD in Johannesburg in 2002. According to the Rio document “Agenda 21”, Chapter 36, education is critical for promoting sustainable development and improving the capacity of the people to address environment and development issues. In 2002, the United Nations proclaimed the World Decade of ESD for the years 2005 to 2014 to establish the role of education in enabling sustainable development. The United Nations Educational, Scientific and Cultural Organization (UNESCO) became the lead agency and was given responsibility to define ESD and encourage national education systems to re-orient towards sustainability (portal.unesco.org). In Bonn in 2009, the UNESCO World Conference on Education for Sustainable Development took stock of implementation of the UN Decade and developed strategies for the way forward (www.esd-world-conference-2009.org/en).

1.2 The spirit of ESD

The aim of ESD is to enable all people to act according to the overall concept of a sustainable development. ESD is thus one instrument for achieving a sustainable
future. Other ways to achieve sustainable development could be through technical innovations, restrictions by law, etc.

In a study with experts from different countries, Hesselink et al. (2000) outlined four possible relationships between environmental education (EE) and ESD:
1. ESD as a part of good EE.
2. EE as a part of ESD – because ESD is more comprehensive than EE and includes issues of development, North-South relationships, cultural diversity, social and environmental equity.
3. ESD and EE as partly overlapping, but different concepts.
4. ESD as a stage in the evolution of EE. Here, ESD is considered the next generation of EE, which includes issues of ethics, equity and new ways of thinking and learning.

In this article we view ESD as a new perspective that cuts across all traditional subject areas. ESD is a new viewpoint from which to see things in a different and more complex and often more contentious way (Kruse-Graumann 2008). ESD is viewed as an evolutionary stage of EE. In this understanding of ESD, sustainable development is not a fixed goal or steady state, but a concept, a goal, a strategy that needs definition, redefinition, negotiation of sub-goals, etc. The ecological, economic and social(-cultural) dimensions of sustainable development are analytical tools. Depending on the analysis, the dimensions that need to be included are selected, e.g. social-cultural, political-institutional, technological, etc. (see Figure 1).

Important components of ESD are:
• Ethical components such as intra- and intergenerational justice (e.g. equal chances for an adequate quality of life for present and future generations).

![Figure 1: The three dimensions of a sustainable development are tools for analysis and can be helpful in negotiating the understanding of sustainable development.](image-url)
Temporal components such as orientation towards a sustainable future. This involves acting in an unpredictable field, planning in a proactive way, and considering the consequences of action or non-action.

Cross-disciplinary components such as interrelatedness and interdisciplinary thinking.

Key issues of ESD – besides well-known areas such as preservation of nature and management of natural resources – also include topics such as mobility, justice, culture and cultural diversity, fair trade and participation.

1.2.1 “Gestaltungskompetenz” in Germany

For Germany, the first official political statement promoting ESD was published in 1998 (BLK 1998). The educational principles reflect the state of discussion at that time. It is a constructivist approach with an orientation toward competencies and learning outcomes. Educational principles included systemic thinking, problem solving, values orientation, co-operation, focus on participation and action, self-organization and holistic perception. Key competencies for participation in a school setting were integrated into a so-called “Gestaltungskompetenz” by de Haan and Harenberg (BLK 1999). This concept stands for the ability to contribute to and shape the future. Students should be able to identify situations of non-sustainable development and have the competence to apply knowledge about sustainable development.

In order to make “Gestaltungskompetenz” more applicable, various sub-competencies were then defined (8, then 10, and at present 12). Examples of such sub-competencies are: ability to think and act with foresight, ability to plan and act jointly, ability to motivate oneself and others to become active, and ability to reflect on guiding principles upheld by oneself or others. These sub-competencies could be adapted to the key competences defined by OECD (2005) for a successful life and a well functioning society. Materials have been developed for applying “Gestaltungskompetenz” in countrywide school projects in Germany such as BLK “21” and “Transfer 21” (see www.transfer-21.de).

1.2.2 The decade of ESD in Germany

The UN Decade on ESD in Germany is implemented and coordinated by a national committee convened by the German Commission for UNESCO (www.bne-portal.de). The committee represents federal and state ministries, the Parliament,
non-governmental organisations, the media, the private sector and the scientific community. An annual “Round Table Event” convenes sustainability stakeholders from all over Germany to work on implementation of the UN Decade.

Between sessions, the working groups set up by the Round Table contribute to implementation of the Decade. These groups draw up concrete proposals to embed the guiding principle of sustainable development in their respective educational areas. The working group on “Biological Diversity” (in which the author is participating) has produced a paper, which we refer to in chapter 3 of this article.

In addition, outstanding projects, which are good examples of education for sustainable development, may be awarded status as “Official Decade Projects” (Figure 2).

![Logo of the UN Decade (left) and logo of awarded “Official Decade Projects” in Germany (right).](image)

**Figure 2:** Logo of the UN Decade (left) and logo of awarded “Official Decade Projects” in Germany (right).

### 1.3 Milestones in the history of CBD

The Convention on Biological Diversity (CBD) was also signed during the Rio Earth Summit 1992 – in addition to the above-mentioned Agenda 21, the Statement of Forest Principles and the Convention on Climate Change. The CBD includes three main objectives (www.cbd.int):
1. Conservation of biological diversity.
2. Use of biodiversity in a sustainable fashion.
3. Sharing the benefits of biological diversity fairly and equitably.
In Germany, a National Strategy on Biological Diversity was developed in a participatory process and adopted by the federal cabinet in 1997 (Küchler et al. 1997). A set of indicators was developed to report regularly (each period) on implementation of measures and achievement of targets.

The role of education is specified in Article 13 of CBD. The contracting parties are to include the topic in educational programmes and develop educational and public awareness programmes with respect to conservation and sustainable use of biological diversity. CEPA, a global initiative on “Communication, Education and Public Awareness“ was also started. One aim was to support the UN Decade of ESD. As all relevant dimensions of sustainability were incorporated, conservation of biodiversity becomes a central issue in the context of sustainable development.

2 CHALLENGES IN TEACHING BIODIVERSITY

Education for sustainable development is (of course) mainly an educational process (Sterling 2001, Groß et al. 2009). In a learning process the learner’s understandings and misunderstandings are key factors for the success of teaching processes (Kattmann et al. 1997, Groß et al. 2009). The model of Kattmann et al. (1997) focussed on three analytical components related to teaching lessons: scientific understanding, learners’ understanding and the resulting approach for teaching.

Research has been conducted on learners’ understanding of the German term “biologische Vielfalt” (biological diversity). It showed that the term is widely known: 90 % state that they are familiar with it and 75 % could give at least one correct explanation. But mainly, the term is reduced to a single meaning: the variety of species (Figure 3). The meanings of genetic diversity and diversity of ecosystems are rarely offered as explanations. The term is thus not completely understood.

11 % of the students gave wrong explanations, such as:

- “... are the different subject areas in biology science (like zoology, botany).”
- “... describes the fact that biology is an interdisciplinary science.”
- “... is the use of different words for one term.”

(university students; 1-4 year, translated, Lude 2008; unpubl.)

As the quotations show, the misunderstandings probably were due to students’ direct and literal interpretation of the German terms “biologisch” (biological) and “Vielfalt” (diversity). Other studies show that “biologische Vielfalt” is also a confusing term for school students (Menzel & Bögeholz 2009).

Reasons for and consequences of biodiversity loss are complex issues involving all dimensions of sustainable development (social, economic, ecological). A typical resource dilemma occurs when a common, open access resource is (over)
used, consequences are delayed in time, and individual advantages result in commonly borne disadvantages (Ernst & Spada 1993). The answers of school students (Menzel & Bögeholz 2009) and university students (Lude 2008, unpubl.) show that biodiversity is a difficult issue as “bio” signals only the ecological dimension. This way, an understanding of the global and complex nature of the issues is hindered.

3 THEMES AND TOPICS FOR TEACHING BIODIVERSITY IN THE SEGMENT OF ESD

In “Biological Diversity” working group of the Round Table (see chapter 1.2.2), key themes for teaching biodiversity have been selected (www.bne-portal.de). Criteria for choosing the themes were:

• actuality in science and politics
• relevance for daily life
• connection to CBD and ESD (addressing questions of justice, benefit sharing, ...)

Figure 3: Student’s understanding of the German term “biologische Vielfalt” (biological diversity). Lude (2008, unpublished survey: n = 110 students 1-4 year at University of Kassel).
The following four key themes focus on various aspects of biodiversity. The first focuses on an object (ecosystems), the second targets the benefits of biodiversity to humans, the third theme is climate change and especially relevant to future and the last one deals with consumption and individual behaviour. These key themes provide a framework within which specific tangible topics for teaching can be designed.

3.4 Key theme: Diversity of ecosystems

70 % of our Earth is covered by water and the remaining 30 % by land. Diverse landforms have fostered an even greater diversity of ecosystems. Humankind has altered and impacted the ecosystems, creating a spectrum ranging from natural, nearly undisturbed ecosystems to ecosystems highly affected by humans. People live in unnatural and constructed megacities, but they subconsciously seek with the rest of life and this deep affiliation with nature might be rooted in our biology (biophilia hypothesis by Wilson 1993). It has been shown (Kaplan & Kaplan 1989) that people recover faster from illness in nature or behind a window with a view outside to nature. Attractive landscapes also play an important role in recreation and holidays, as tourism in national parks and nature areas shows.

3.4.1 Areas of wilderness

In Germany, less then 1 % of the national territory is currently in wilderness. According to the National Strategy on Biological Diversity (Küchler-Krischun et al. 1997), a goal of at least 2 % by 2020 should be set. To accomplish this, remaining residues of natural ecosystems must stay exempt from human influence and areas where human use has been discontinued should be developed into “new wilderness” for the future.

3.4.2 Cultivated landscapes

In Middle Europe, large expanses of ecosystems have been formed by agriculture, forestry, hunting and fisheries. Species richness peaked in the 19th century and has declining afterwards due to introduction of techniques for intensified land use. The strong local connections between production, culture and consumption, which were the rule in former times, have now been globalized. This had serious impacts on biodiversity as modern agricultural landscapes became less diverse.
3.4.3 Urban landscapes

One third of the world population lives in urban areas today, and they will become more and more important in the future. Some animals (so-called synanthropes) follow humans and use cities as substitute habitats. BioFrankfurt is an initiative to promote the biodiversity of the city of Frankfurt (www.biofrankfurt.de).

This example shows, that biodiversity is also found in areas influenced by human beings, but this cannot justify altering or destroying untouched areas. It must be taken into account that only some species will profit and are capable of living in areas influenced by humans. Many specialized species cannot. Thus it is not sufficient to equate biodiversity with species richness, as richness alone does not account for the specific character of the biodiversity (i.e. kinds of species).

3.5 Key theme: Ecosystem services

Ecosystems provide many essentials for humankind such as water, soil, air, food and building materials. Additional benefits are cleaning processes, especially the self-cleaning of water and air.

At the Heiligendamm Summit in 2007, the G8+5 leaders endorsed a global study to analyse the global economic benefit of biological diversity, the cost of its loss and the cost of failure to take protective measures compared to the cost of effective conservation. This study, named “The Economics of Ecosystems and Biodiversity – TEEB”, is led by Pavan Sukhdev (www.teebweb.org). The final results will be presented at the 10th meeting of the Conference of the Parties of CBD in 2010.

In the field of bionics, natural innovations are used to develop new products and natural achievements are used as inspiration or blueprints. The negative side is biopiracy, in which industry uses genetic resources, traditional knowledge or technologies in production, but withholds the benefits from local people.

Table 1 shows the results of a study in which students were asked to indicate their preference for various arguments for preserving biodiversity. The results show that students do not only put economic values on biodiversity. Three groups characterized by different argumentation schemes could be identified. The usefulness of biodiversity for human benefit is a possible starting point in teaching. But as the results of the survey show, preservation of biodiversity doesn’t have to be motivated exclusively by benefit to humans. Non-economic benefits as aesthetic value, biocentric or holistic relevance should also be included.
3.6 Key theme: Climate change and the future

Climate change will have worldwide impacts on ecosystems (IPCC 2007). An increase in the average temperature will not only result in the melting of poles and glaciers and in an increase of the sea surface level, but also will alter species composition in ecosystems. On land, desertification and droughts will threaten humans in Africa. In Middle Europe extreme weather situations will increase in number, a change of seasonal rhythms will effect biocoenoses, and tropical diseases could spread wherever it happens to get warmer.

Students know more about the effects of climate change in areas far away (e.g. Arctic, Africa) than about the influence on ecosystems in Germany. This is probably because examples such as polar bears have become very prominent icons in mass media communication.

Philipp (13 years): “The polar bears do not have anything they could stand on. That’s why they will die out. (...) Because it will get too hot for them.” (translated; from a study by Mörchen 2009)

Within the theme “climate change” topics for discussing personal impacts and possible activities can be developed. Calculation of the individual carbon footprint
could provide direct links between activities and climate change (www.carbonfootprint.com) and students could be encouraged to develop own ideas, communicate them and work locally in projects to reduce CO$_2$ emissions (www.co2nnect.org).

### 3.7 Key theme: Consumption and behaviour

Consumption is the final step in a sequence: production, processing, transport and finally trading. All steps are relevant to the preservation of biodiversity and involve all three dimensions of sustainability – ecology, economy and social/culture. As it doesn’t stop with consumption, many people therefore talk about a circle for the resources.

Key areas of consumption are food, clothes, health and energy (including mobility, tourism and housing). Daily consumption for some means more than satisfying one’s basic needs; it is an important part of lifestyle, esteem and status in society. Competencies for a more sustainable life style must be promoted without ignoring the psychological functions of consumption. One possible tool for initiating discussions about consumption and the concept of a sustainable lifestyle is calculation of an “ecological footprint” (William Rees and Mathis Wackernagel, www.footprintnetwork.org).

### 4 METHODS FOR TEACHING

All the topics of biodiversity are highly complex in contents and they cannot be reduced without oversimplifying the issues and introducing inaccuracy. Therefore, they pose a challenge for teaching. Complexity is an attribute of key themes of sustainable development, and it must not be reduced but rather adequately explored and illustrated. In this way complexity is made understandable. This can be done by working with case studies and presenting the most important connections in a stakeholder analysis (e.g. posters, mind maps, concept maps, role playing). These kinds of methods can help prevent students from getting demotivated and help them think through complex issues.

Another challenge is to develop realistic perspectives for behaviour for single persons and groups. People often feel that they cannot influence anything; they believe that an individual’s effect is too small to have an impact. Showing positive examples of how customers have influenced production can be motivating in this respect. Lack of time and money is often also commonly viewed as an obstacle to sustainable behaviour. But sustainable activities need not be necessarily be linked to financial or temporal resources. Low cost activities can be a first and easy step into
a more sustainable life style. As a motivating factor, reward systems could be used. One example is “fifty-fifty-projects” in which 50% of the money saved on school energy consumption is returned back to the school classes (www.fiftyfiftyplus.de).

In conclusion, there are many ways to teach biodiversity while contributing actively to a sustainable future. Thus, environmental education is advancing toward education for sustainable development.

5 REFERENCES

The Spirit of Teaching ESD – Biodiversity in Educational Projects


30     Armin Lude
Biodiversity is defined in the spirit of The United Nations Earth Summit in Rio de Janeiro (1992): the variability among living organisms within species, between species and of ecosystems. This definition is adopted by the United Nations Convention on Biological Diversity, which was signed by 150 governments at the 1992 Rio Earth Summit and is dedicated to promoting sustainable development. The Convention recognizes that “biological diversity is about more than plants, animals and micro organisms and their ecosystems – it is about people and our need for food security, medicines, fresh air and water, shelter and a clean and healthy environment in which we live”.

Biodiversity is the invisible basis for human existence. Increasingly settled in urban settings, the global community is largely unaware of the extend to which their economic, social and cultural well-being is founded on strong, resilient ecosystems, landscapes and seascapes, which are themselves buttressed by rich diversity of genes and species. The lack of awareness leads to practices that overexploit natural resources and harm biodiversity. Raising awareness of the critical role that biodiversity plays in ensuring environmental sustainability, economic prosperity and social and cultural well being, will contribute to the enhancement and /or the development of sustainable development actions, including ways of organizing thoughtful consumption and production behaviors that are sustainable from local to global levels.
Human interaction with the environment has been termed as “ecologically sustainable development”. The main aims of ESD are to integrate environmental, social and economic concepts over a long time, adopt a precautionary approach and recognize the importance of biodiversity and ecosystem processes.

A sustainable relationship between human communities and the biodiversity upon which they rely, is the cornerstone of a sustainable future.

That means that ESD is a holistic concept. The study and protection of biodiversity are equal and independent from:

a) the social aspects (human rights, peace and human security, gender equity, health and good governance);

b) the cultural aspects (cultural and linguistic diversity (racism, refugees etc), Intercultural and interfaith understanding, cultural heritage, cultural goods and services and indigenous knowledge (knowledge of flora, fauna, water use, etc);

c) the environmental aspects (natural heritage and resources – water, energy, agriculture, biodiversity, climate change, rural development, sustainable urbanization and disaster prevention and migration);

d) the economic aspects (poverty reduction, corporate responsibility and accountability, market economy).

So mainstreaming biodiversity into education and learning progress requires that students begin to recognize the relationship between biodiversity and human well being and reflect on how this is exemplified in every day life.

**BIODIVERSITY EDUCATION IN AND OUT OF THE CLASSROOM**

The world is facing a biodiversity crisis. A concern for the loss of biodiversity and the ethical issues surrounding its sustainable use, remains central to ESD.

Teachers prepare students to face the real life issues they will routinely encounter in efforts to sustainable manage the biosphere and integrate biodiversity conservation with other societal goals.

Traditional lecture – based teaching does not adequately provide students with opportunities to develop critical thinking skills, apply knowledge to practical problems and contexts, and develop process skills, such as communication, problem solving and collaboration on group work.

ESD is a holistic concept that goes beyond formal education in including sustainable development imperatives by affecting a paradigm shift in collective thinking. The schools aim to offer students a context for developing active citizenship
and participation, embarrassing the complexity of the combined social, economic, political and environmental dimensions of sustainable development.

In the classroom, the teacher should use presentation to introduce and discuss topics and then apply exercises. Students work on the problems and then discuss the results in the class.

To improve critical thinking students work with power relations and conflicting interest e.g. in the local situation, between countries, between present and future generations. Students are encouraged to look at things from different perspectives and give arguments for different positions. Also students are encouraged to look for examples of what is useful and fruitful in other situation, in order to imagine new possibilities and alternative actions.

Conservation of biodiversity, is a field of study, that is values – based. So changing the attitudes, behaviors and beliefs of students is very important. So the outdoor classroom provides a link between theoretical aspects of biodiversity and issues which affect our homes, communities and the world around us. Students overcome mutual ignorance and misunderstanding, such as those between rural and urban areas.

Out of the classroom, working in groups can have a huge influence on how students develop socially. Fieldwork is an essential tool to observe, collect and process data on species and habitats. Observation of the real world, leads to questions hypothesis, predictions and experiments. Students and generally people, learn from observing others.

Also the learning outcomes for the visit should include reference to wider aspects, such as cultural context, historical implications or environmental issues, which are relevant to the student. The children should be actively involved and not just listening to the leader talk.

Fieldwork could be divided in three sections:

• Pre-visit work in the classroom (planning, administration, preparation and discussion)

• The visit itself (fieldwork in teams, such as measurements etc, visit of places with animals and different species of plants, observation, perform a research – questions to local people, read a poem in the countryside, etc.)

• Post-visit work in the classroom. This work should offer opportunities to extend beyond the one off visit and work, towards the experience being seen as part of an integrated work program anticipated, planned and used consequently back to school. The visit should not be seen in isolation from other work at school.

Finally, evaluation of the scheme by participants is an integral part of the process that insures high quality.
SCHOOL – RESEARCH COLLABORATION

A partnership between schools and higher education institutions and research networks in ESD provides a model for the powerful interaction of a school system and Science resource. The interaction provides a direct pipeline for current research to enter the classroom and engage students and teachers.

Main aim is to encourage and enhance scientific excellence, research and new knowledge development in ESD.

Students, even from two or three schools from different countries are encouraged to engage in research based project design (with similar objectives), data collection, analysis and comparisons. So they have the opportunity to introduce current research, new technologies, and pedagogy that enhance student engagement and teacher professional development.

Collaborative teaching of biodiversity, which means cross institutional teaching, should be student centered, and be an extensive resource-base including reading lists and Web-based resources. So students develop transferable skills and enrich their knowledge of biodiversity.

Seminars and discussions in schools could also contribute to distributed education.

ICT AND FORUMS IN BIODIVERSITY EDUCATION

Biodiversity is in danger in the rapidly changing world. Biodiversity education has strong interrelationship with Environmental Education and Education for Sustainable Development. Learning processes are nowadays better understood from individual level to the level of the whole humankind.

Thinking of Environmental Education and ESD, it is extremely important that the whole humankind can learn, thanks to modern Information and Communication Technology (ITC).

It should be mentioned that ICT does not stand for ‘computer’ but for ‘communication’, since Education is not possible without communication. It includes communication in a classroom as well as Internet Communication.

The use of ICT, is the most equitable and pluralistic development in education, aiming to expand the knowledge base about the issues. Through the use of ITC, different views may be harmonized. Also, new knowledge is created, distributed and used.

The use of new ICT tools, collaborative sites and blocks, platforms like Face book and Twitter, video conferencing and mobile tools, is a preferable way of learning.

The benefits of ICT are obvious as they are location independent and improve access for many groups. Libraries are online and there are vast data centers like Google.
Forums give the opportunity to develop knowledge through ESD networking. Forums provide an opportunity to teachers to discuss current issues and to hear about developments.

Also seminars are designed to provide a forum with a focus on the student experience.

Teachers using e-learning and distance learning techniques can share and discuss their experiences with other interested staff.

The Youth Forums are designed to provide both teachers and students with the opportunity to explore the myriad of environmental sustainability issues facilitated by various community volunteers, such as school councils, parents and community members, who play a valuable role in education system and help to shape our schools and communities.

On line discussion forums provide the medium for students discussions, planning and production of project reports, therefore developing an effective on-line, cross-cultural, learning community.

All these practices are focusing on:

• building natural habitats and green spaces
• developing partnerships for environmental programs and projects
• engaging students in research, monitoring and measurement
• hardening the competitive spirit as a motivational tool
• empowering students to effect positive change
• building leadership
• building relationships in the community

Students can use resources such as government websites related to the environment, a sampling of programs and organizations that provide environmental connections for school boards, locally developed courses or specialists.

**BEST PRACTICE EXAMPLE**

An open class lesson, which means lesson in class and out of the classroom, could be one of the best practice examples. Theory can be taught through motivating practical experiences and students will reflect on how ESD is a key approach for the promotion of the conservation and sustainable use of biodiversity.

Students from the 1st Lykion of Ag. Paraskevi, in Athens, Greece, had during the school year 2007-2008, the opportunity to participate to an open class lesson.

In the classroom we discussed the topic biodiversity and how it is influenced by climate change and human activities. Fieldwork was planned, information were gathered, sorted and filtered, potential outcomes and consequences were predicted and discussed.
During the visit, students did fieldwork in teams, (measurements of temperature and CO$_2$ levels, questioner was answered by local population, visited a meteorological station, observed places with animals and different species of plants, read a poem in the forest, etc.)

Teamwork, cooperation, interaction, partnership, environmental integrity, joined the team and had a wonderful time.

Back in school after the visit, all collected data was analyzed showed in graphical expressions and interpreted.

This experience has been seen as part of an integrated work program anticipated, planned and used consequently back to school. The visit has not be seen in isolation from other work at school.

Students realized how man-made activities as well as the global climate change lead to biodiversity loss and in some cases to desertification.

Greece is a country which has “Mediterranean climate”. This means, that winters are calm and summers hot and dry. So, fire is one of the main problems caused by accident or by man-made activities.

We visited an mountainous area in Central Greece where mainly grows the hybrid *Abies cefallonica* X *Abies alba* (Christmas tree). In the area you find *Pinus nigra* in great populations, *Platanus orientalis* and *Oxycedrus*.

It should be mentioned, that in Greece the hybrid *Abies cefallonica* X *Abies alba* grows in areas which are 800m – 1800 m above the sea level.

The students, measured air, water and soil temperature and performed an experiment, by measuring CO2 levels in the area. According to local scientists, they realized that year by year, the Christmas tree forest “moves” to higher levels (900m or 1000m above the sea level), where the temperature cooler is. So, within a century it is expected that the “Christmas tree” forest will not exist in that area (since it can not move and grow above 1800m) and it will be replaced by *Pinus nigra*.

We also visited a part of the forest which was burned some years ago. The place was not protected and was overgrazed by goats. Erosion was encouraged by wind and water. Local people unawareness and poor land management, lead to desertification of this area. The major impact of desertification was biodiversity loss (flora and fauna).

Students realized also, that desertification is both an environmental and development problem because it affects local environments and populations ways of life. They held and questioner and found out that local economy depends on that forest.

Finally all agreed, that desertification effects, however, have more global ramifications concerning biodiversity, climatic change and water resources. The degradation of terrain is directly linked to human activity and constitutes both one of the consequences of poor development and a major obstacle to the sustainable development of south zones.
CONCLUSION

Proper management of biodiversity is more than an aesthetic desire, it is a life supporting need. It may or not be seen as a moral obligation to our environment, but it is most certainly a moral obligation to ourselves and to future generation. Effective, optimal management of biodiversity will require appropriate individual and collective behavior of world citizens. The means to achieve that behavior is Education for Sustainable Development.

Also, through education and life long learning, we can achieve lifestyles based on economic and social justice, food security, ecological integrity sustainable livelihoods, respect for all life forms and strong values that foster social cession, democracy and collective action. Education for sustainable development is immediately necessary for securing sustainable life chances, aspirations and futures for young people.

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Inter-institutional Collaborative Teaching in the Virtual School of Biodiversity [http://www10.org/cdrom/posters/1091.pdf]


This is a short paper with a short message.

Our current approach to biodiversity education is excellent at helping young people to understand how natural systems work and their importance for the survival of humankind. This kind of learning encourages a care for, preservation and wise use for the natural world as the provider of all the resources and services needed for life on earth. This approach to biodiversity education can be called “learning about nature” and is a necessary component of any effective education for sustainability programme.

However, this paper proposes that biodiversity education should have an added dimension. Young people should not just be learning “about” nature, but they should also be learning “from” nature” and it is this “learning from nature” that offers a greater scope and opportunity for considering how to organise our economy and society in the future for sustainability.

This “learning from nature” can take place on two scales, one that we are familiar with and one that perhaps is less familiar. The familiar is biomimicry or looking at how particular plants and animals work and learning from them in the design of products that we use each day. The web site http://asknature.org/ has plenty of examples of how the products and processes we design can benefit from how nature works, whether it is learning from spiders how to create hugely strong glues or threads or from desert beetles on how to collect water in dry ecosystems or from plants on how to design surfaces to repel excess water. Biomimicry is an incredibly powerful way of learning from nature and because the solutions to problems come from nature, they avoid some of the pitfalls, unplanned and unforeseen
consequences of so many human solutions. http://www.biomimicryinstitute.org/ is the web site of the Biomimicry Institute and contains a wealth of information, resources and ideas all relevant for teachers.

The larger scale learning is something that we are less familiar with and involves looking at the characteristics of natural systems as a whole and learning from them. One of the problems of all our current systems, whether they be systems for producing goods or systems for providing services is that they are nearly linear in design as illustrated in Figure 1. Many cannot even have been said to have been designed at all but evolved in a rather haphazard fashion. They nearly all look like the diagram below with the main product of many of these systems being waste – and much of it toxic waste at that. The increasingly popular cartoon found at http://www.storyofstuff.com/ illustrates the point brilliantly.

Many of those involved in education for sustainability are beginning to think that it is this system, linked with the desire for constant economic growth that is at the heart of our unsustainable world. The challenge we face is not just that this system is the possibly cause of our unsustainability, but that much of our ESD seem to think that this system can be “fixed” or improved to make it work more effectively. Whilst improvement is obviously possible through increasing resource
efficiency and reducing waste, there is an increasing body of opinion that says that what is needed is a new system. The old linear “take, make and waste” system is simply unmendable and even if it could be improved would not lead to the justly needed improvement in the quality of life for everyone on the planet.

And this is where learning from nature or biodiversity comes into play. Nature’s systems are built around a completely different set of principles to our human systems. As one pair of authors, McDonough and Braungart put it in their seminal book “Cradle to Cradle” – consider how a cherry tree works and imagine what the world would be like if all human systems could work this way, based on nature’s principles.

- There is no waste or waste equals food
- Only current solar income is used – and none is wasted
- Air, water, and soil are purified
- Valuable materials fare retained or perpetual, productive reuse
- No regulation is required
- An abundance of cultural and biological diversity is celebrated
- Nature’s capacity to thrive is enhanced
- Health, wealth, and useful resources all grow
- There is value and opportunity for all
- Systems are robust but flexible

Whilst applying these principles to human systems might seem an ambitious dream some business people are taking them and making efforts to put them into practice through developing business systems that followed nature’s “closed loop principles” rather than a linear economy model. Figure 2 summarises a closed loop approach to thinking.

The joy of basing economic systems on nature is that nature and biodiversity are protected not through special regulations, protected areas and so on, but through better ways of doing things modeled on nature itself. For example, imagine what a world would look like where waste was actually designed out of every system and where a system that produces nothing that cannot either be composted or used as food for another part of a system just does not exist. We are a long way applying these ideas from nature on a scale needed to bring about real sustainable development, but there are examples out there, some of them just small drops in the business ocean such as the raincoat made out of potatoes shown on Figure 3 and others much bigger such as Interface Flor carpets, the world’s third largest carpet manufacturer.

What if you could toss old items of clothing into the dirt in good conscience? You can--if you have Equilicuá’s Spud Raincoat. The waterproof coat, made of
Figure 2: A circular economy.

Figure 3: A Coat made from potatoes.
potato starch-derived bioplastics, is entirely biodegradable and compostable. That means it can go into the ground at the end of its life. The coat, a local product of Spain, sources its materials entirely from the European Union. It’s produced in Spain with German bioplastics made out of French potatoes. The coat costs 21 EURO. The coat educates every by-passer on bioplastics by telling them “I was a potato”. But the Spud Raincoat isn’t just biodegradable. It also contains a small clay ball that houses seeds for Mediterranean herbs, flowers, bushes and trees. You can planet your coat when you have finished with it! The Spud Raincoat reinforces the concept of closing the loop, by not only returning entirely to the biosphere, but by also nourishing the seeds to grow into new plants. http://www.equilibria.com/

So here is a new direction for biodiversity education – to build on the current learning about nature and encourage more learning from nature. The two together will enable young decision makers and business and social leaders of the future to create systems and ways of living that match with nature and nature’s capital rather than competing against it.

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TOWARDS A SUSTAINABLE SCHOOL –
THE ROLE OF BIODIVERSITY

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SUMMARY

The project explores teaching and learning resources that can help analyse the role of global climate change and in particular biodiversity, within the concept of a ‘Zero-Carbon’ school. It addresses the relationship between the UK government’s initiative to rebuild and renew secondary schools and the requirement for improved education for sustainable development. It looks at developing the ‘biodiversity of the outdoor classroom’, to provide teachers and other practitioners with support to share ideas and learn from experts to provide a broad based situational response to this learning challenge.

INTRODUCTION

The UK Building Schools for the Future (BSF) initiative is a national programme which aims to use building design to support 21st Century education. The programme will rebuild and renew every secondary school in England, with the aim to increase standards of education and has the opportunity to greatly reduce energy use, by developing carbon neutral schools. Since the BSF programme was announced, the Government set a target for all new schools to be “carbon neutral” by 2016. (DCSF 2008).
The work focuses on one aspect of a larger project “Engaging pupils, teachers and governors in the science, engineering and technology of ‘carbon neutral’ schools” led by De Montfort University and funded by Engineering and Physical Sciences Research Council (EPSRC) under the Partnerships for Public Engagement Programme. The project partners are the schools in Leicester City, the Leicester Miller Education Company, the Association for Science Education (ASE), the Centre for Alternative Technology, (CAT), the British Council for School Environments, (BCSE), Leicester City Council’s Energy, Environment and Building Schools for the Future Teams, the City Learning Centres and the Department for Children Schools and Families (DCSF). The main aim of the EPSRC the project is to increase the knowledge of pupils, teachers and governors in the science and engineering of “sustainable energy”. This is being achieved through discussions on the design and operation of their new schools and includes two specific types of engagement event. Firstly between the pupils and the “building energy experts” (i.e. explaining the results of relevant EPSRC and other research findings) and secondly between the pupils and the decision makers (explaining to the decision makers the key aspects of a carbon neutral school). It aims to stimulate young peoples’ interest in sustainable development, in particular a future low carbon society.

The approach is to inspire pupils through “hands on” experience of sustainable energy projects so that they can explain the role of more sustainable school design to policy makers. It also specifically targets the school leaders since both DCSF and OfSTED have recognised the need for effective school leadership in order to implement education for sustainable development and enable it to become more effectively embedded into the school curriculum.

Based on this larger project, support was received from the East Midlands Network for Global Perspectives in Schools (EMNGPS). This new project focuses specifically on the role of biodiversity in education for sustainable development in the schools and is producing teaching resources for these practical workshops.

BACKGROUND

Previous work with BSF schools and sustainable development (IESD 2006) identified the need to involve young people in the development of their new schools. However, a major concern surrounding education is that pupils are no longer finding scientific subjects interesting. Although there is great potential, school science fails to convey the extent to which science is related to everyday life and affects all of us (Planet science 2003). The National Curriculum states that real-world applications of science are an important part of the brief to enrich students’ curriculum experience. Science is therefore not restricted to the laboratory, but is highly
relevant to life outside school and the world of work in particular, (National Curriculum in Action website, 2009).

The majority of individuals do not believe that they are responsible for or can engage in any actions that will be environmentally efficacious (Uzzell, 2000). Therefore removing pupils from their common learning environment to expose them to ways in which climate change and environmental issues are directly affecting them and their own communities may be a way of raising environmental awareness. Scott (2002) agrees suggesting that institutions such as schools need to be free to take up and explore with learners what sustainable development might be in ways that make contingent and contextual sense. He goes onto to prescribe four kinds of responsibilities that educators have to learners regarding education for sustainable development:

1) to help learners understand why the idea of sustainable development ought to be of interest to them
2) to help learners gain plural perspectives on issues from a range of cultural stances
3) to provide opportunities for an active consideration of issues through appropriate pedagogies which, for example, might begin from learners and teachers different interests, helping pupils to understand what they are learning and its significance
4) to encourage pupils to continue to think about what to do, individually and socially, and to keep their own and other people’s options open.

The Department for Children, Schools and Families (DCSF) agree, stating that in addition to our own actions to improve our sustainability, we need to empower young people with the skills, knowledge and freedom to voice their opinions and to make a difference (DCSF, 2008). Therefore educating them to make their own decisions and communicate these to appropriate decision makers and designers within the context of low-carbon schools. It is important to stimulate without prescribing and to encourage pupils to see conceptual frameworks as scaffolding to build learning around, rather than as barriers to new ideas, (Scott, 2002).

In terms of Biodiversity there has been debate about the effectiveness of the United Kingdom sustainable schools framework regarding this theme. This has 8 doorways; food and drink, energy and water, travel and traffic, purchasing and waste, buildings and grounds, inclusion and participation, local wellbeing, and the global dimension. (the doorways) are discrete entry points or places where schools can establish or develop their sustainability practices. Each of the doorways draws its inspiration from a range of Government policies concerning sustainable development and quality of life. There are opportunities and recommendations for schools in relation to each of the doorways (Sustainable schools 2009).
The views of practitioners in this field, to the omission of biodiversity as a ‘discrete doorway’, were detailed in the DfES action plan. (DfES 2006) This plan, responded to their wide ranging consultation exercise on the ‘Sustainable Schools’ programme. These complex arguments and the proposals to address these concerns have been summarised by Scott in a briefing paper for the Secondary Schools and Academies Trust. (Scott 2007)

Firstly some regretted the lack of a doorway specifically focused on biology and ecological systems, as it is ‘ecological quality that underpins all human existence through the provision of goods and services from the environment’. The second argument finds that there is a lack of a clear focus on biodiversity which therefore marginalises a significant section of the curriculum (biology). Furthermore they assert that the existing doorways, for example, food and drink, cannot adequately represent the important set of ideas around ecology. Scott describes how, the DfES, addressed this by naming Biodiversity as one of the ten ‘cross cutting issues’. He rightly summarises the situation by stating that the role of Biodiversity should be more than a focus on teaching but also that it is

‘about supporting and enhancing it both in the school grounds and in the local community, and hence making a small, but definite, contribution’

Since then a number of other major programmes have been launched that support ‘Biodiversity, for example the Learning Outside the Classroom Manifesto (2009) and the Growing Schools programme. (2009)

Schools are now increasingly using their school grounds for learning, for example the Sutton Schools annual school environmental survey (EcoLocal, 2007) found that 98% use school grounds for curriculum work. This was a 10% rise on the previous year.

However other recent reports, summarised by the UK Sustainability and Environmental Education charity (SEEd 2009) point to issues in the implementation of all aspects of the sustainable schools agenda, including Biodiversity. They describe the lack of time and space needed for long term thinking (Cheadle 2004, DEA 2008), few opportunities for professional development (Cheadle 2004). One of the most worrying concerns is that teachers find that there are too many initiatives and this is confusing, overwhelming and often not connected to whole school, Local Authority and national priorities (Global action Plan 2007, NESPSS 2006, The Environmental Audit Committee 2005). The latter found 17 packs on school wildlife habitats alone.

THE BIODIVERSITY PROJECT

Although the scope of the project is limited, it hopes to address the issues described above by signposting good practice and giving teachers the time and space
to reflect on their work. The first stage was the establishment of a working group of practitioners and biodiversity experts. This group has set the framework for the teaching material to be developed. It was thought that the following topics would have most relevance to these schools as they undergo their school design engagement projects

1. The school grounds and management
   - Issues relating to design – siting of trees etc.
   - School grounds in other cultures.
   - School wildlife areas
2. Food –
   - Growing their own!
   - Global food issues
   - Fair-trade
   - Carbon impact of different diets
   - Land use – locally and globally as related to ‘food production’
3. Phenology
   - Creating the links between phenology, climate change and school design. This is the study of recurring natural phenomena (for example the arrival of the first daffodils) which is carried out by monitoring the arrival and departure of species in our environment. This can be used as a piece of long term action research, using web 2.0 technologies to share information cross the globe.

The project also hopes to make teachers in these schools aware of opportunities to share best practice with others locally nationally and internationally. Already one member of the working group has attended a workshop on ESD and Biodiversity hosted by the Support Comenius network programme. The Comenius network “Partnership and Participation for a Sustainable Tomorrow”, SUPPORT, consists of over 40 partners and members from over 20 countries (http://support-edu.org). The overall objective of SUPPORT is to promote and enhance the quality of education for sustainable development (ESD).

Based on the outcomes of the working groups, these resources will underpin the student workshop engagement events. Finally there will be a launch of the resources with participants making their own bread and pizza in a mobile wood fired oven and displays such as the award winning C-Change exhibition http://www.switchonswithcoff.org and the British Council North South East West Exhibition http://www.britishcouncil.org/usa-science-projectszerocarboncity-nsew.htm will be on show.

The work will be evaluated by both quantitative and qualitative methods. Questionnaires will be administered to pupils before they take part in the workshops and
then after the workshops have been delivered and qualitative data will be gathered at the workshops events.

**ACKNOWLEDGEMENTS**

The work is being undertaken with support from the Engineering and Physical Sciences Research Council, Partnerships for public engagement Programme reference number EP/G020043/1 and from the East Midlands Network for Global Perspectives in Schools partnership. http://www.emngps.org.uk

We would also like thank the school pupils and teachers who are participating in this project.

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BEAGLE is an online free biodiversity project open to all schools in Europe. BEAGLE is a COMENIUS project within the EU’s Lifelong Learning Programme. The name BEAGLE is an acronym for Biodiversity Education and Awareness to Grow a Living Environment.

Our pedagogical approach is to create motivating, meaningful and relevant learning experiences for young people. Our project will have a large impact on the quality of learning resulting in more motivated students with the capacity to relate school based learning with real life decision making, especially in the area of sustainable development and biodiversity protection.

The overall goal of our BEAGLE biodiversity project is to improve the quality of learning outside the classroom and enhance students motivation to learn, so that the capacity of people to live sustainable lifestyles and bring about a more sustainable environment is strengthened. To achieve this our partnership of six organizations, all involved in teacher training, from six countries developed a training programme for teachers and then provide the opportunity for teachers and students to take part in a pan European Biodiversity Observation Project (BOP) which will be based on monitoring phenology of trees across Europe. The results of observation (bud burst, flowering, and other phenological events) will be uploaded by project participants into the project website: www.beagleproject.org.

The monitoring will be based on observation of bud burst, flowering, leaves unfurling, and leaves shed for six common in Europe trees: *Fagus sylvatica* (Beech), *Betula* sp. (Birch), *Quercus* sp. (Oak), *Sorbus aucuparia* (Rowan), *Aesculus hippocastanum*
(Horse Chestnut), *Tilia sp.* (Lime). The results of monitoring can be uploaded in form of pictures on the BEAGLE website www.beagleproject.org. The website’s instruments allow users to compare findings and to see how different stages of tree life cycles take place across Europe throughout the year.

BEAGLE website has been launched 15 February 2010, and it will be available as a school resource for the next 5 years. The website is available in all six partner languages.

To enable teachers carrying out the phenological observations and further exploring the results with students supporting materials and a teacher manual have been developed.

What is the advantage in taking part in that project? BEAGLE project participants will

- Explore ecosystems first hand
- Share and compare experience with schools across Europe
- Understand human impacts on the natural environment
- Take actions to improve the natural environment
- Connect local investigations to global issues such as climate change
- Engage in real science and learn from real scientists
- To meet curricular demands in biology, science, geography and digital learning.

Who is behind

BEAGLE is a consortium of six partners from six countries:

- Poland (University of Warsaw – Centre for Environmental Studies)
- Great Britain (The Field Studies Council)
- Hungary (Hungarian Society of Environmental Education)

![Figure 1: BEAGLE logo. Drawing by Maja Kiss.](image-url)
Our consortium has a number of strengths

- Each of the partners has worked with at least one other partner on a previous project.
- All the partners in the consortium have worked on a variety of transnational projects.
- Each organization has a national reputation for education projects and/or biodiversity education work.
- Some members of our Development Team are recognized as leading experts in Europe on work outside the classroom.
- The partners have areas of common biodiversity experience. For example, all partners are involved in the development and delivery of out-of-classroom activities.
- Each partner has a specific expertise to enrich the BEAGLE project, and roles within the consortium have been allocated on the basis of specific areas.

THE FUTURE

Research has shown that learning out of the classroom can provide motivating and relevant learning experiences for school students. This research has also identified that because of a lack of teacher training, practical curriculum based out of classroom opportunities and resources, many of the current out of classroom programmes do not result in high quality learning. Our project will have a large impact on the quality of learning resulting in more motivated students with the capacity to relate school based learning with real life decision making, especially in the area of sustainable development and biodiversity protection. Our project impact is sustainable and will also be exploited through the dissemination of supporting materials and the guaranteed sustainability of the BEAGLE website on www.beagleproject.org.

We are open to any other country to take part in the BEAGLE project.
INTERNET
COMMUNICATION
TOOLS
Right now we are living in the decade of biodiversity. 2010 has been designated to be a special year of biodiversity. Biodiversity is one of the most important things when we think our life and the future of the planet Earth. But how many of us understand what it means? We are talking a lot about biodiversity, but do people really understand, recognize or notice it? Biodiversity education is very important and the most important reason that we really should teach and learn about species.

**Biodiversity and Education — Why We Should Recognize Species?**

Biodiversity is an essential part of our life. We people get our oxygen, food, materials etc. from nature. We are part of nature and very dependent on it. Without

**Picture 1.** Biodiversity is beautiful. Photos: Jouko Lehmuskallio www.naturegate.net
biodiversity there is no life. Biodiversity is formed by species. Species and their networks build ecosystems. Ecosystems can be very complex and there are many networks of interaction within and between ecosystems. Any species could be very important in the complex systems of nature. We have to protect every species because we do not know what happens if some species disappear. We have to recognize species, if we want to perceive and protect biodiversity and if we want to understand how ecosystems work.

Ecology includes the study of the distribution and abundance of species and helps us to understand networks of interaction within and among ecosystems. If we want to understand how nature works, we have to understand ecology. We need to recognize species and biodiversity and understand the networks of interaction among species and ecosystems. Ecological understanding is necessary if we are to face current environmental and societal problems such as climate change and invasive plant species. These are few of the most important reasons why we have to be able to recognize species. Then we can see biodiversity in our nature.

When we recognize species, we use our cognitive skills, such as perception, classification, memory and naming. Plant species recognition, for example, helps us to improve these skills. Species recognition helps us create a holistic view of nature and environment. Plant species or other species recognition may give us joy and happiness. It is one thing which helps us attain a good quality of life.

**PLANT BLINDNESS – IS IT REAL?**

Do people recognize plant species, what do they know about species? My doctoral thesis research (Kaasinen 2009) aimed to determine how well Finnish pupils and students of different ages recognize plant species. I also sought variables that could explain recognition skills, investigated what plants and nature mean to the subjects and proposed how plant species identification should be taught in general education in Finland. I tested the plant recognition skills of pupils from every class level of general education (Table 1). Students from universities (from the department of teacher education), classroom teachers and teachers from universities were also included. I also interviewed experts from the fields of botany and education. A total of 883 people took part in the research.

Both quantitative and qualitative research methods were used (Table 2). The quantitative methods were: a) plant species recognition test, where 70 plant species photos were shown to subjects and b) an experiment in which three experimental groups were given a plant recognition test on the nature trail and the three comparison groups were tested on recognition of the same species in the classroom. The testing materials consisted of 31 real plants outdoors and 31 photos taken of these
real plant species that were shown to primary school pupils in the fourth, fifth and sixth classes (grade levels). The qualitative methods were a) a questionnaire administered to elementary school pupils, high school students, students from the department of teacher education and teachers from university and b) interviews of the 3–5 pupils and students with the best or worst results in the species recognition test were selected to be interviewed and c) interviews of classroom teachers from primary school and experts.

The research results showed, on average, inadequate plant species recognition by pupils at every level of education. On average, Finnish pupils and students (ages 6-19) recognized 25 plant species of 70 plant species shown to them. Some teachers did not recognize plant species very well either. The species recognized also varied. Pupils recognized berries and trees well, but many common flowers were not very well known, for example. Pupils recognized raspberry (Rubus idaeus), pine (Pinus sylvestris), spruce (Picea abies) and bilberry (Vaccinium myrtillus) rather well, but they didn’t recognize Queen-of-the-meadow (Filipendula ulmaria) or Common Toad-flax (Linaria vulgaris). Botanical concepts were also hard for many pupils to understand, such as identification marks can be found on plants and the role of plants in the ecology of the Earth.

Species recognition skills improved from primary school to university teachers. Sex and place of residence were among the factors that could explain species recognition skills; girls and pupils from rural areas knew plant species significantly better than boys or pupil from cities.

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Number of subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary schools: every class level (grades 1-6)</td>
<td>481</td>
</tr>
<tr>
<td>Lower secondary school (grades 7-9)</td>
<td>139</td>
</tr>
<tr>
<td>High school (grades I-II)</td>
<td>137</td>
</tr>
<tr>
<td>University department of teacher education</td>
<td>103</td>
</tr>
<tr>
<td>Classroom teachers</td>
<td>6</td>
</tr>
<tr>
<td>Teachers from university involved with environmental teaching and also experts from education and botany</td>
<td>17</td>
</tr>
<tr>
<td>Total</td>
<td>883</td>
</tr>
</tbody>
</table>

Table 1. Overview of general education participants in the study (n= 883).

<table>
<thead>
<tr>
<th>Quantitative</th>
<th>Qualitative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant species recognition test</td>
<td>Questionnaire</td>
</tr>
<tr>
<td>Experimental test</td>
<td>Interviews</td>
</tr>
</tbody>
</table>

Table 2. Both quantitative and qualitative research methods were used.
Almost every pupil and student, and all classroom teachers, wanted to recognize plant species better. Many pupils mentioned that a motivating teaching method would be to go outdoors and investigate the plant species themselves. University teachers and experts also mentioned that the best and most efficient learning and teaching method for species recognition skills is to practice in nature. That is why we should teach plant species in nature, using many senses and teaching methods. New technology could also be used in teaching species recognition skills. Whereas one traditional teaching method is to collect plant species, dry them and make a herbarium, nowadays you can also take photos and make a digital herbarium. In Finland we have a long history of using this method in schools. Plant species recognition is also mentioned in the curriculum; every pupil must collect plants from nature and make a herbarium. The best way to learn species, ecosystems, biodiversity and ecology, is to go to nature, but many teachers are afraid to go to nature with their pupils. Teachers need assistance, materials, supplemental education and motivation. One very good tool to assist teachers is the NatureGate website.

**NATUREGATE GIVES TO YOU AN OPPORTUNITY TO UNDERSTAND BIODIVERSITY BETTER**

NatureGate is a free online website which opened in autumn 2008. It is based on the lifelong work of Eija and Jouko Lehmuskallio. photographing plants and other organisms for about 20 years. The material in NatureGate currently consists of Finnish plant species, butterflies, birds and views. Invertebrates, fishes, mammals and other organisms are being added to widen the offering. A future plan is not only to look at the different kinds of organisms and species, but also to look at nature at the ecosystem level. In the future food chains will also be shown: first a plant, then a butterfly, then a bird comes and eats it, etc.

One very important part of NatureGate is a unique species identification tool. Plant species (currently flowers, trees and shrubs are supported) can be identified using a key to their characteristics. This innovation is very up-to-date, taking into account that concepts about botany are difficult to understand for many pupils and teachers, and that people prefer easy and quick tools. It is also suitable for those who cannot read or don’t understand what they are reading, including autistic people/pupils. Let us say that you have been walking in nature and have seen the plant shown below in picture 3. You haven’t recognized it, but you really would like to know something about it. You can try to remember it, or you can take a photo with your digital camera or cell phone. After that you can try to solve the problem with the identification tool. NatureGate website also works in cell phones.
First you can choose which identification mark you would like to use. You would probably look at the flower and the color of it first. So then you can click flower, then color and after that, color red.

Then the tool gives us 183 identity candidates. It is still too much, so you have to choose more identification marks and click on them. For example you can click shape of corolla. This flower is bell-shape as you can see from photo 3.

Now the tool narrows down the list of candidates to 25. This is better, but you could still add new identification marks, for example leaves. In this case the shape of leaves is round, kidney-shaped.

Now the tool gives you only 4 alternatives. Now we probably can already recognize what plant species you have seen in nature. It is a Twin flower, Linnaea borealis. Now you can read much more about this plant species and see many more photos of it. This is the way the identification tool works. The same kind of tool will be available for every organism shown on the NatureGate website.

Finnish species are on the website now, and species from other countries will be added soon. Several language versions are also available, so you can probably read the NatureGate website in your own language. There is also an online news section, where you can read news and articles. In the future there will also be a
special area for schools, pupils and teachers. Education will be the priority number one in NatureGate. Today there are many pilot schools in Finland who use the NatureGate websites. We are collaborating with these schools to make learning and teaching materials. There are three main focus points behind NatureGate: 1) nature, biodiversity and species, 2) practice/education and 3) research. These three dimensions bring biodiversity closer to people so that they can appreciate and understand how important nature and the sustainable use of nature are. Development continues and something new is always coming. We are also looking for partners and pilot schools from all over the world.

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[www.naturegate.net]
CO$_2$NNECT: CAN AN INTERNET TOOL CATALYSE HIGH QUALITY ESD?

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DESCRIPTION

The internet-based ESD tool “CO$_2$Nnect: CO$_2$ on the way to school” was launched in spring 2009 as part of the EU Comenius Lifelong Learning network project “SUPPORT: Partnership and participation for a sustainable tomorrow”. SUPPORT is EU funded from 2007-2010. The long term goal of CO$_2$Nnect is to further the understanding and practice of high quality ESD. CO$_2$Nnect offers schools an international, internet-based learning activity and guidance materials about ESD. Schools, researchers and actors in the local community collaborate on the theme of reducing CO$_2$ emissions from local transportation. CO$_2$Nnect is intended to help teachers to provide high quality ESD without taking ownership of the educational activities from them. Rather than providing a “ready teaching package,” the tool is meant to help teachers with their work of constructing educational arenas and activities for (and with) their pupils. CO$_2$Nnect was opened for use March 2009 and will be available for at least two more years. It includes a calculator for CO$_2$ from transport, a database for the results, analysis tools, pupil questionnaires, more than 50 pages of guidance materials for teachers and an evaluation module. A few features such as “ask an expert” have a more limited time frame. Key pages are translated into 17 languages.
RESULTS AND CHALLENGES

CO₂nect has been successful in terms of the breadth of participation by schools and pupils. This is significant both educationally and as a contribution to sustainable development. More than 50,000 pupils in 30 countries have registered their CO₂ emissions from school transport and many have carried out local projects on sustainable transport (Fig. 1). Approximately 300 teachers have submitted an online evaluation. They assessed the various parts of the activity and the extent to which the goals were achieved at pupil and school level. The results are predominantly positive. The CO₂nect activities are flexible, allowing a variety of approaches in different countries, institutional and curricular contexts and cultures. Implementation has been enhanced in several countries by offering schools additional support and guidance to supplement the internet site. Within the SUPPORT partnership we see examples of effective school support by national or regional education authorities, NGOs, educational development projects and teacher training institutions.

Figure 1: More than 50,000 pupils from 30 countries have registered data.
One dilemma that arises is the apparent trade-off between classroom activities that are quick and easy to do (which teachers often seem to be looking for) and more demanding activities such as local project work in partnership with others. The former is perhaps more attractive, but the latter is more likely to succeed in effectively developing pupil competencies and the school’s capacity to deliver high quality ESD. Recognising the great pressure many teachers are under, CO₂nect deliberately combines these two approaches. The simple activity of registering CO₂ emissions is a starting point that every school and teacher can do. Schools can then go on to develop more advanced local projects using the results.

We expect that learning results for pupils, teachers and schools will reflect the way the project has been implemented locally. Active and creative use of the CO₂nect tool and reflection on what has been learned will produce stronger learning outcomes. More passive implementation focussing on “just doing the activity” is not likely to produce the competencies to the same extent. This applies especially the competencies related to understanding complexity, skills and attitudes, which are central for high quality ESD.

REFERENCES

CO₂-Website: [http://www.co2nnect.org]
SUPPORT-Website: [http://www.support-edu.org]
LEARNING WHILE BUILDING AN INTERNATIONAL ENCYCLOPEDIA OF LIFE

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Abstract

The Encyclopedia of Life (EOL; http://www.eol.org) was established to make comprehensive, authenticated information about the world’s biodiversity freely available over the internet. Encyclopedia of Life’s portal is currently being developed and includes more than 180,000 authenticated species pages, another 1.4 million base pages that still need information and links to over 26 million pages of digitized biodiversity literature. The content on EOL and contributions from scientists, students and the public increases everyday and the features available on the EOL portal make participation possible by everyone. Users including students, scientists and members of the public can contribute photos and videos via the EOL Flickr Group, apply tags to images, provide comments on the content and add new text to species pages.

In addition, Regional EOLs are a key feature of EOL. They will typically serve species pages for the flora and fauna from a specific geographic area, in languages used in the region, making this valuable information much more accessible.

The EOL provides an engaging and informative learning platform where students and others can work together to help build this global resource and learn about biological diversity worldwide.
The Encyclopedia of Life (EOL; http://www.eol.org) has been called a “Biological Moonshot” for its vision to create a centralized Web portal with a page for every living organism on Earth – and – for succeeding in demonstrating proof of concept with the project well underway since the site went live in February 2008. “Like flying to the moon, making one encyclopedia of all life is an old idea that technology might finally make possible.” (Milius 2008)

As its user base grows, EOL continues to engage people everywhere with a greater number of enhanced species pages and is developing a comprehensive set of knowledge tools to navigate and mine EOL’s increasingly rich content. The content and tools allow new applications of EOL for different end-users from educators and students to conservation scientists and the general public.
The newest version of EOL’s portal was unveiled in early 2009. In addition to new features, EOL now serves more than 180,000 authenticated species pages covering a greater breadth of biodiversity. While there are approximately 1.9 million known and named species today, scientists estimate another 10 to 30 million species yet to be discovered and named, and eventually added to EOL. Because of the enormous nature of the project and the desire to have international participation and knowledge in building the EOL, the project has focused on building participatory and collaborative web tools for diverse audiences of all ages to contribute to this global resource.

Information, images, videos and other content coming into EOL from various audiences is differentiated so the end-users know the source of the information and whether or not it has been authenticated by the scientific community. If a user chooses to see all information, they will notice that unauthenticated information is distinguished from authenticated information on each species page with a yellow background for photos and text. Users can choose whether to view unauthenticated content by selecting it on any species page or through the preferences menu on the top.

**LEARNING WHILE BUILDING**

EOL can be incorporated into learning activities across ages and skill sets, while at the same time contributing to this global biodiversity initiative. Activities and resources for students, educators and nature enthusiasts can be found on the Learning and Education section of the EOL site (http://eol.education.org).

The EOL can be used as a reliable reference for a wide range of information about species, including but not limited to life history, molecular biology and genetics and current conservation status and threats. All content and multi-media resources are provided through EOL is either in the public domain or is served under a Creative Commons License (see http://creativecommons.org/). In nearly all cases, mate-
rial available through EOL can be freely used by anyone, although in some instances the data partner will need to be contacted if one wishes to re-use the material for commercial purposes. These freely available resources can help increase learners’ knowledge and understanding of particular species, provide exposure to various analytical methodologies and the process of scientific discovery. The EOL also provides access to an ever-expanding repository of information, including primary literature through our partnership with the Biodiversity Heritage Library (http://biodiversitylibrary.org) and Biodiversity Heritage Library Europe (http://www.bhl-europe.eu/).

Through the participatory capabilities, such as uploading images and videos, commenting and tagging data objects and adding text, EOL can serve as an interactive platform to better engage audiences to learn about biodiversity and to hone 21st century skills.

Users are invited to join the EOL Flickr Group (http://www.flickr.com/groups/encyclopedia_of_life) and post photos and videos to be served on the species pages. There are more than 1,600 members from around the world and more than 40,000 images and 300 videos posted. In addition to posting to the Flickr Group, users can also help identify images with the correct species names. This matching of images will allow the display of the photos on corresponding EOL species pages and help add content to EOL.

The EOL Learning and Education group has begun an initiative in which university students write species page descriptions under the direction of their professors. To date, positive responses have been received about this activity from both students and professors, with indications that contributing to a global endeavor, such as EOL, is highly motivating (http://www.eol.org/content/page/undergrad_init). EOL works with its content partners Mushroom Observer (http://mushroomobserver.org/), Animal Diversity Web (http://animaldiversity.ummz.umich.edu) and AmphibiaWeb (http://amphibiaweb.org/) for this project and also provides its own tool, the Education LifeDesk (http://www.edulifedesks.org) that are being used internationally to develop species pages. More than 300 pages have been written by students since September 2008. EOL will continue to develop features and tools such as field guides to further support this endeavor and welcomes new participants to join at any time.

**EOL AROUND THE WORLD: MAKING REGIONAL AND GLOBAL RESOURCES ACCESSIBLE**

**Regional EOLs**

EOL continues to cultivate global partnerships by developing regional versions of EOL. Regional EOLs are a key feature of EOL’s global outreach. They will typi-
cally serve species pages for the flora and fauna from a specific geographic area, in languages used in the region. Encyclopedia of Life is in various stages of discussion and development with representatives of countries wishing to establish their own EOLs, including The Netherlands, Central America and China.

Naturalis, the National Museum of Natural History in The Netherlands, has partnered with EOL to create the first regional EOL. It will serve species pages on more than 35,000 native species of Dutch flora and fauna in the Dutch language. Hundreds of scientists at Naturalis and partner organizations are compiling species information, images and trend graphs into the Dutch Species Catalogue. This information will also be shared through the central EOL portal in English (http://www.nederlandsesoorten.nl).

Costa Rica’s national biodiversity institute, INBio (http://www.inbio.ac.cr/), is taking the initial steps to start an education-based regional EOL for Central America. INBio is exploring how their program, Cyberhives (Cibercolmenas in Spanish), can be expanded for use in other Central American countries. Cyberhives is a methodology based on virtual communities of learning. It promotes the innovative use of science and information technology in the classroom, in Costa Rica’s wild protected areas and in cyberspace to generate experiences and projects that stimulate students to learn and build knowledge about their local biodiversity.

In June 2009, EOL representatives signed a Memorandum of Understanding with members of the Chinese Academy of Sciences, who expressed their enthusiastic desire to work with EOL and engage in exchange visits of personnel. They are developing a Chinese regional EOL to serve information and literature about Chinese species. They are also planning to host a full EOL mirror site for Asia and translate the entire EOL into Chinese. They have begun significant high-quality digitizing of Chinese language biodiversity literature and are taking steps to join the Biodiversity Heritage Library consortium.

EOL will continue to expand its global partnerships, which will increase its ability to deliver and receive biodiversity information and allow learning and educational activities worldwide.

**Scanning and digitization: accessing biodiversity literature**

Accessibility to primary literature and accurate, detailed images are critical to support educational activities across informal and formal science learning audiences. Biodiversity literature and images are made possible through EOL from the collections of the contributing libraries of the Biodiversity Heritage Library (BHL) (http://www.biodiversitylibrary.org). More than 400,000 EOL species pages are linked to portions of these numerous texts.
BHL Europe (http://www.bhl-europe.eu/) was launched in May 2009 and involves 28 major natural history museums, botanical gardens and other cooperating institutions. The objective of the BHL-Europe project is to make available Europe’s biodiversity information to everyone by improving the interoperability of European biodiversity digital libraries. This partner project will add significant biodiversity content and continue to make EOL more relevant on a global scale.

Celebrating the International Year of Biodiversity

EOL looks forward to collaborating with institutions and individuals around the world to celebrate the International Year of Biodiversity in 2010. Through multiple efforts, EOL resources and tools to participate and access biodiversity content will continue to grow.

Please let us know about how you use EOL in your learning activities or what you need in order to get started.

Please contact us at education@eol.org or post a comment on our forum (https://eol.uservoice.com) under the Education section.

REFERENCES

OBJECTIVES

Current education and leisure patterns lead to ongoing distraction of young people from nature. As their free time is taken up by computers, games, television and other multimedia, nature plays a minor role in daily life of the younger people. They spend increasingly more time in front of TVs and computers: In 2009 63% of 12 to 19 year old German students watched TV daily, 65% searched daily in the internet for more than 2 hrs in average. Home availability of computers increased from 57% in 2005 to 75% in 2009. Whereas 35% had access to the internet in 2005, 54% of students had personal computers with internet connection in 2009 (MPFS 2005, MPFS 2009).

Subjects related to nature education had low priority in school curricula for many years. Formal education is in many cases still focused on subject-specific and theoretical contents. Students often learn about a wide range of biological topics, from assimilation and digestion to the components of the nucleus, but biodiversity education is mostly lacking.

We are facing the risk of bringing up a generation that does not care about the conservation of animals, plants, and landscapes. Scientists, teachers, and politicians have the duty to join forces in teaching young people to understand and appreciate biological diversity. New concepts and contents have to be created that have the potential to develop core competencies such as global responsibility, critical thinking, acquisition of scientific knowledge, and evaluation of complex processes.
As early as in 1992, the International Convention on Biological Diversity (CBD) emphasized the global commitment to the conservation of nature and it underpinned biodiversity in the fields of environmental education. Biodiversity education should form an essential component of the education for sustainable development (ESD). The importance of addressing the issues of natural resources must be highlighted as part of its broader agenda. In particular, ESD should encourage new behaviours to protect the world’s natural resources.

**CHALLENGE AND RESPONSIBILITY FOR SCIENTISTS**

The implementation of new concepts and contents into the educational system requires activities from policy, science, and society. We should realise that inaction inevitably will lead to a lack of interest in biodiversity conservation. Scientists have the responsibility to communicate the problem to politicians and policy makers to also initiate top-down processes. On the other hand, bottom-up activities are necessary for which scientists and teachers should take the initiative to work together. Close cooperation should be based on the awareness that high-quality science education is required not only for sustaining a lively scientific community that is able to address global problems like global change and biodiversity loss, but also to bring about and maintain a high level of scientific literacy in the younger generations. There is no doubt that effective education is the basis for enabling future decision-makers to solve global problems.

In this contribution we present the educational project PRONAS, where scientists are making efforts to share and transfer knowledge to school students and their teachers. Moreover, pupils, teachers, environmental educators, and pedagogical scientists are intensively involved in the project (Fig. 1).

![Figure 1: Components contributing to the educational software PRONAS (www.pronas.ufz.de)](image-url)
The challenges we face are:
- Linking the new educational tools with the school curricula
- Didactic reduction of complex contents
- Selection of appropriate scientific contents
- Create background stories that fit “students’ language”
- Explaining threats to biodiversity while drawing not too pessimistic pictures
- Motivate students to individual actions for biodiversity conservation.

The scientific content for PRONAS has been mainly derived from the biodiversity research project ALARM (Assessing LArge-scale environmental Risks for biodiversity with tested Methods; Settele et al. 2005, 2010) which was an Integrated Project (IP) within the 6th Framework Programme of the European Commission (short: ‘Commission’ or EC).

**ALARM FOR BIODIVERSITY**

The ultimate aim of the ALARM project was to develop and test methods and protocols for the assessment of large-scale environmental risks for biodiversity. To do so, ALARM has integrated the research results of more than 250 scientists of 68 institutions from 35 countries. Their analyses added to constant scientific knowledge improvement and formed the basis for policy recommendations, in an attempt to strengthen evidence based decision making on biodiversity relevant issues.

**PROJECT OBJECTIVES AND SUMMARY**

Based on a better understanding of terrestrial and freshwater biodiversity and ecosystem functioning, ALARM developed and tested methods and protocols for the assessment of large scale environmental risks for biodiversity in order to minimise negative direct and indirect human impacts. Research focused on assessment and forecast of changes particularly in biodiversity but also in structure, function, and dynamics of ecosystems. This related to ecosystem services and included the relationship between society, economy and biodiversity. In particular, risks arising from climate change, environmental chemicals, biological invasions and pollinator loss in the context of current and future European land use patterns have been assessed. There is an improved understanding on how these environmental risks subsequent to each of these impacts act individually and affect living systems. Whereas the knowledge on how they act in concert is poor and ALARM was the first research initiative with the critical mass needed to deal with such aspects of combined impacts and their consequences.
Risk assessments in ALARM were hierarchical and examined a range of organisational (genes, species, ecosystems), temporal (seasonal, annual, decadal) and spatial scales (habitat, region, continent) determined by the appropriate resolution of current case studies and databases. Socio-economics as a cross-cutting theme centrally contributed to the integration of driver-specific risk assessment tools and methods and developed instruments to communicate risks to biodiversity to end users, and to indicate policy options to mitigate such risks.

**ALARM APPROACH**

The four modular environmental pressures studied within ALARM were climate (and land use) change, environmental chemicals, biological invasions and pollinator loss. The impacted biodiversity was classified in a nested way from genes via populations or species to ecosystems. Indicators of Environmental impacts are on the genetic (e.g. hybridisation due to cross-breeding with invasive species), populations or species (e.g. decline of species numbers or abundance), and on the ecosystem level (e.g. change in species composition). To quantify the impacts of the pressures ALARM used combined risk likelihood and risk consequences scores throughout to identify low, medium or high risks consequent on the respective pressure(s). This approach was used for single as well as multiple pressures. Scenarios have been applied to simulate future environmental threats and to quantify risks subsequent on these (Spangenberg 2007).

ALARM provides coherent scenarios of socio-economic, climate, land use and other biodiversity-relevant trends, exploring the framework conditions for biodiversity pressures. An innovative element will be the combination of long term trend and short term shock scenarios, allowing a sensitivity analysis of currently predominating trend projections.

The three basic scenarios are: SEDG – Sustainable European Development Goal, BAMBU – Business-As-Might-Be-Usual and GRAS - GRowth Applied Strategy.

Results of the different risk assessment approaches have been communicated to stakeholders as tested methods for broader application. Socio-economics as a cross-cutting theme contributed to the integration of driver-specific risk assessment tools and methods and developed instruments to communicate risks to biodiversity to end users, and indicate policy options to mitigate such risks.

In the context of ALARM large scale risk assessment refers to processes which have an impact on a large scale, but could affect biodiversity and ecosystems from a local to a continental scale. This includes natural processes as well as anthropogenically triggered change or direct impacts of socio-economic systems in the EU and globally.
HIGHLIGHTS OF RESULTS

ALARM has been successful at gaining the attention of key stakeholders and in general of raising awareness of threats to biodiversity in Europe.

Until early 2009 ALARM has contributed to more than 1000 scientific publications, with a number of papers which may well develop into citation classics and which might shape the way science is conducted in the future. Results of the different risk assessment approaches have been and shall be communicated to stakeholders as tested methods for broader application – e.g. through the ALARM Risk Assessment Toolkit (Marion et al. 2010) the scenarios (Spangenberg 2007), the development of decision support software and the integration of driver-specific risk assessments. These methods and instruments are to be used to communicate risks to biodiversity to end users, and indicate policy options to mitigate such risks. The project PRONAS has been initiated for communicating ALARM results to the education sector.

PRONAS: PROJECTIONS OF NATURE FOR SCHOOLS (WWW.PRONAS.UFZ.DE)

In the PRONAS network, biodiversity researchers collaborate with teachers, environmental educators, and pedagogical scientists. 15 to 17 year old students are involved to discuss and evaluate content and design in the course of software development. The education software PRONAS aims at improving biodiversity literacy among school students and their teachers, but also of the wide public. The main target group are students from 12 to 19 years. The overarching objective of PRONAS is to provide users an understanding of risks for biodiversity and the impacts of climate and land use. Students will gain core competencies and skills in the sense of Education for Sustainable Development. They will be enabled to derive and develop own activities for biodiversity conservation.

PRONAS provides settings to develop specific competencies such as

Ø Applying expert knowledge through
   o discussion of complex tasks,
   o reducing them to the essential aspects and,
   o building structures and systems

As an example, the scenarios SEDG, BAMBU and GRAS (derived within the ALARM project) provide an integrated view on socio-economic and political processes. Understanding of this basic principle should make the presented projections of future geographical distributions of selected species clear.
Ø Acquiring scientific knowledge - adoption of interdisciplinary methodologies and modelling approaches

An example is the concept of climatic niche modelling. Simulation interfaces are available for this modelling approach.

Ø Communication - handling different media (internet, software programs, journals, DVD etc.), present and discuss own positions

On many pages of the PRONAS-software, links to websites are provided for detailed information, literature is cited for further studies; worksheets are available for download and presentation.

Ø Evaluation of peoples’ behaviour of in relation to others and to the environment.

As a result of better understanding biodiversity subjects, students may reflect their own behaviour, appreciate intact nature, and perceive the significance of sustainable development. Through a series of exercises students achieve scores which help them to evaluate their learning success.

**STRUCTURE OF PRONAS**

The software consists of several chapters which are connected by a storyline.

*Storyline:* In this storyline, school students want to learn about biodiversity and how their environment will look like in 20 or 50 years. The “virtual” students visit scientists and environmental educators who are revealed as real persons (e.g. the authors of this paper) at the end. The following sections describe the main chapters of the software.

*Introduction:* Fundamental topics of biodiversity and ESD are described. Video clips show the beauty of nature and emphasize the threats endangering this beauty: Destruction and mitigation of habitats due to climate change and changes in land use.

*Scenarios:* Managing change faces the challenge of the intrinsic uncertainties of future. Scenarios are alternative, dynamic stories that capture key ingredients of our uncertainty about the future of a study system. Rather than predictive frames, scenarios are regarded as tools for preparing societal and individual responses to plausible futures. Three basic scenarios SEDG, BAMBU and GRAS are explained as storylines for “possible future worlds”.
The scenario GRAS (GRowth Applied Strategy) describes a future world based on economic imperatives like primacy of the market, free trade, and globalisation. Deregulation (with certain limits) is a key means, and economic growth a key objective of politics actively pursued by governments. Environmental policy will focus on damage repair (supported by liability legislation) and some preventive action which is based on cost-benefit calculations and thus limited in scale and scope. Mean temperature is assumed to increase by 4,1 °C.

BAMBU is the acronym for the Business-As-Might-Be-Usual scenario which describes a continuation into the future of currently known and foreseeable socio-economic and policy trajectories. Policy decisions already made are implemented and enforced. At the national level, deregulation and privatisation continue except in “strategic areas”. Internationally, there is free trade. Environmental policy is perceived as another technological challenge, tackled by innovation, market incentives and some legal regulation. The result is a rather mixed bag of market liberalism and socio-environmental sustainability policy. In this scenario, mean temperature increases by 3,1°C.

SEDG - the Sustainable Europe Development Goal - describes a policy primacy scenario focused on the achievement of a socially, environmentally and economically sustainable development. It includes attempts to enhance the sustainability of societal developments by integrating economic, social and environment policies. Aims actively pursued include a competitive economy, a healthy environment, social justice, gender equity and international cooperation. As a normative backcasting scenario, policies are derived from the imperative of stabilising atmospheric Greenhouse gas concentrations and ending biodiversity loss. Mean temperature increases by 2,4 °C.

Projections. Based on the scenarios, geographical distributions of species and species groups throughout Europe, but also of vegetation zones and land use types are presented. The projections demonstrate which area could be lost for a species as a consequence of climate change. It is also shown which new regions could be occupied by the species in the case it is able to disperse there. An example for a typical “loser” of climate change is the Scarce Copper *Lycaena virgaureae* – one of our most beautiful butterflies (Fig. 2). As shown on Figure 3, the Scarce Copper is expected to lose a significant part of its territory in Europe until 2080 even if the sustainable scenario SEDG is assumed (Settele et al. 2008).

Virtual field trips: Three excursions provide frames for discussing the impact of climate change on species living in lowland meadows, in mountainous regions (with an altitude of about 700 m), and in the foothills of the Alps. Species are “discovered” and “monitored” on these trips. With the “time machine” the user is transferred to the year 2050 or 2080 where he gets informed about possible
Figure 2: The Scarce Copper *Lycaena virgaureae* will lose large habitats due to climate change. Photo: Albert Vliegenthart, taken from Settele et al. 2008).

Figure 3: Projected habitats for the Scarce Copper *Lycaena virgaureae* for the year 2080. (a) SEDG; (b) GRAS. Orange: occupied areas, grey: lost areas, brown: gained areas under the assumption of full dispersal. Source: Settele et al. (2008).

area gains or losses of the species for each of the scenarios. Project partners from environmental centres located in the described regions contribute to the virtual field trips with valuable information and experience. These partners (all from Germany) are the Historisch-Ökologische Bildungsstätte Papenburg (www.hoeb.de),
Species gallery: For applications of the software, we have to select a reasonable number of species out of a database which contains many hundreds of plants and animals. For this purpose, we asked more than 100 students which species they wished to be included in PRONAS. Evaluations resulted in a significant interest for butterflies (though the knowledge on particular species was very low). The highest ranked amphibian was the Fire Salamander *Salamandra salamandra*, the most popular tree species was the German Oak *Quercus robur*. High scores also were received by the Big Nettle *Urtica dioica* and the Poppy *Papaver rhoeas*. Species such as the nettle (which is a common food plant for butterflies) are of particular importance for education purposes as they allow the analysis of species-species interactions.

Simulations: Potential distributions of the butterfly Titania’s Fritillary (*Boloria titania*) and its food plant Common Bistort (*Polygonum bistorta*) up to the year 2100 can be simulated with time steps of one year. Occupied, lost and newly gained areas are shown under the assumptions of the scenarios SEDG, BAMBU and GRAS. The butterfly is limited both by climate and host plant. Recent studies indicate that there will be an increasing spatial mismatch over time regarding the niches of plant and butterfly (Schweiger et al. 2008). Consequently, the area suitable for the butterfly may decrease significantly.

Students’ projects: Examples of students’ scientific project work are described in a separate software section chapter. Projects such as dendrochronology of pines and spruces are presented by the students themselves. They tell how they experienced that nature is far from boring after all and that the conservation of biodiversity is an important issue.

WHY SHOULD TEACHERS MAKE USE OF PRONAS?

PRONAS provides alternative learning approaches that can encourage a variety of young users – those who are open to new learning techniques and even those who may not respond well to traditional teaching formats. Through provision of scientific information based on current research projects such as ALARM the software supports the development of critical and dynamical thinking and other competencies and skills that are essential for the young generation (see also Ulbrich et al. 2008). In this way, PRONAS offers an opportunity to better understand the effects of human activities, like land-use and climate change, impact biodiversity at local and global levels. It increases the sensitivity of young people concerning their roles and responsibility in these processes.
ACKNOWLEDGEMENTS

We thank the DBU - Deutsche Bundesstiftung Umwelt (AZ 26271-41) for the financial support.

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INTERNET COMMUNICATION TOOLS (ICT)
– HOW TO MAKE THE BEST USE OF THEM? –
THE PLATFORM WWW.SCIENCEACROSS.ORG

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Teaching ethical topics as „the value of biological diversity“ seems to be rather difficult because up to now teachers of science – biology – not only in Germany mostly do focus on the academic content of the subject and not on „science and society“. Textbooks and student workbooks found in our schools are often published some years ago and the changing conditions for man and nature can not be found.

Authentic texts written by students in different countries and societies show what is hot across the world and they are an important factor of motivation.

These examples of original experience with monitoring nature, political and economic development are wonderful to motivate students. Last but not least students and teachers get inside information about moral and ethics across the world. In my experience students are also activated to use ICT (video and audio clips) reading examples from partners across the world (Figure 1).

SAW provides communication techniques in a wide range of Languages and gives access to nearly 8000 teachers and their students in 148 countries of our world. The project was built in times when just „snail mail“and fax-machines connected people across the world. A team of teachers from UK, Poland, Germany, Ireland and Italy first talked about what students and teachers need most to ease communication about Science and then developed a range of topics suitable for lessons both in science and humanities and the language department. (Figure 2).
Figure 1.

Figure 2.

Example Exchange Forms for the Biodiversity topic

Susanne Perez and Isabel Muñoz, Colegio Latino Cordillera, Chile.

Ludmila Sukhanova, School No 1129, Russia.

Rita Maria Saraiva de Berros, Colégio Dante Alighieri, Brazil.

Gymnasium Edertalschule, Germany.

Gymnasium Blikova, Slovakia.

Scuola-Vigezzo, Italy.
BIODIVERSITY AROUND THE WORLD – MIGRATION OF SPECIES – PLANTS TOPICS

Climate Change – Global Warming

Teachers and Students in Science and Humanities usually need some support in Foreign Language and Teachers of Language have to enter – step by step – the area of Science.

These are the most important constraints to enter topical communication across the world.
1. Use connectors, ask questions, use students' first language, use visuals....
2. Help students with vocabulary
3. Strategies for supporting reading
4. Strategies for supporting listening
5. Strategies for supporting writing
6. Strategies for supporting student talk

On the other hand, teachers and students in Humanities and Language lessons working on Science topics often need some support to understand the basics of Science topics (Figure 3) and it is not always easy to ask the teacher of

Figure 3.
science (as the marks have been too bad in his lesson). That’s why we provide for each topic specific parts:

- Science Teacher Notes
- Language Teacher Notes
- Student Pages
- Exchange Form in Word Format
- Information Section

As we have provided our material in several languages it is useful for teaching classes with mixed first languages and communication may start with the classroom next door.

**Next step will be starting to exchange your students work (text, pictures, diagrams, audio- and video-files) with students across the world.** Your students will get their individual access to the websites workspace – „my zone“!

- Make use of authentic student texts
- Connect your students to the world
- Offer a „workspace“
- Help students to prepare presentations
- Initiative – Research – Communication

Networking across the world using ICT may also work as an initiative to establish personal exchanges. Comenius projects funded by the European Union and other funding opportunities enable teachers and students to „meet the neighbour“.

![Welcome Support for Language Teachers Ten ways to link languages and science](image)

**Benefiting from flexibility**

1. **Extending an existing topic of work, solely within the Modern Languages department**
   A teacher decides to combine a topic of work on food and daily routine with the topic *What Do You Eat?* The topic of work is lengthened to allow the teacher to give the class extra practice in carrying out surveys. The class carry out a survey in French in every class in their year group and then send off the results back to all
   school in French-speaking Martinique, Senegal, one in Paris and one in the French Alps. The teacher uses the information she receives from the foreign
   plan and resource the same topic in the next academic year.

2. **A vehicle to incorporate ICT into Modern Languages learning across the whole department**
   In advance of teaching a topic of work about the home, they discuss with their ICT co-ordinator, the various ways in which they can help their students the results of their survey. They become familiar with the applications and software themselves, hold sessions in the Information Technology suite at the school, and then use the Renewable Energy topics tasks and resources. The data gathered is then analysed and recorded using ICT before being sent

3. **A Modern Language teacher works collaboratively with a Science teacher within the school**

Figure 4.
WELCOME – TRY IT!

Join the 7,904 teachers in 146 countries where students are collaborating on school science topics.
Find out how and why and then join us now!
www.scienceacross.org

REFERENCE

INTRODUCTION

Sustainability and halting the loss of biodiversity are two central themes (key issues) of the environmental and nature policy of the province of Limburg. To reach set targets Nature and Environment Education (NEE) is used as an important tool. Informing people (especially young people) and giving them insight in the effects of their behaviour on the environment will stimulate them to use natural resources in a sustainable way.

With the project Environmental Care at Schools (EC@S) the province assists schools that wish to develop a Nature and Environmental Education programme (NEE). EC@S is an initiative of the Flemish government, stimulating nursery, primary and secondary schools as well as higher education institutions to develop their own Environmental Care programme in a pedagogically way.

With the project “Municipalities Adopt Limburgian species (MALS)”, the province also tried to halt the loss of biodiversity in the province. The main objective of this project was to assist local governments in designing their own nature protection policies by providing them with a provincial framework and a number of result oriented examples. Every municipality was asked to adopt a plant or an animal species. For every of these adopted species a project office, alongside people in the municipality, wrote an action plan.
We have tried to integrate both provincial initiatives (MALS and EC@S) – so as to develop biodiversity education – by linking the educational activities, described in the MALS-project, to the “nature” theme of the EC@S-project.

**EC@S**

In the EC@S-project, schools are invited to work on one of five themes. Waste (prevention), water, energy, mobility and nature. In Limburg schools are assisted by four EC@S-monitors (promoters), employed by the province, in designing their own EC@S-programme. For each theme and educational level a number of manuals, magazines, practice books and theme kits are developed for the teachers. Schools working on the theme “nature”, are for instance encouraged to create greener school grounds, greener neighbourhoods or classrooms. The children visit nature education centres or nature reserves. Halting the loss of biodiversity also fits this theme. In this project the adopted species (MALS-project) were used as levers for developing sustainable Educational packets for the theme nature.

EC@S-Schools can obtain a logo if they work in the course of one school-year on one or more EC@S-themes. In doing so, (pupil) participation, creation of a wide support base and introduction of environmentally sound behaviour in all segments of the school, have to be taken along. A school can obtain a maximum of three EC@S-logos.

Once schools receive their third logo, they can become members of an international network of “Green Schools”. The EC@S-project encourages schools to remain environmentally and get the “Green Flag of Eco-school”. The EC@S-project is the national operator of the Eco-school programme of the Foundation for Environmental Education (FEE).

**MALS-PROJECT**

The Belgian province of Limburg can be proud of her ‘green image’. A lot of rare and endangered plant and animal species appear mainly or even exclusively in Limburg. We therefore call them “Limburgian Species”.

Although the biodiversity in Limburg is still high, species and their habitat are under pressure. As in other parts of the world, open space is disappearing at an alarming rate. Species have less space to live in and occasionally disappear (i.e. *Salamandra salamandra*, this species disappeared around 2000 in Limburg).

project ‘Municipalities Adopt Limburgian Species’. Each municipality was asked to adopt a plant or animal species, which is typical of its territory. That could be a species which is the ambassador of the typical landscape of the municipality or it could be a species that can almost exclusively be found in that municipality. A species that emphasizes the character of the municipality and for which the municipality wants to make special efforts. In June 2006 each of the 44 municipalities had adopted their own animal or plant. Species such as the weatherfish (Misgurnus fossilis), the tree frog (Hyla arborea), the badger (Meles meles) and the nightjar (Caprimulgus europaeus) all could hope for a brighter future.

For every municipality a ready-to-use action plan was written: Territory actions are the pivot around which everything turns, but the plan also contain guidelines on communication and education. The plan not only stimulates municipalities and citizens, but also schools in the municipality to take action for their adopted species.

To this end the plans contain some general guidelines and a few examples demonstrating what a school can do for the adopted species. Some examples are: preparing a lecture; organizing a role play, have an expert give a presentation; make posters, drawings or songs about the adopted species or help count the animals or plants present in the municipality; visit an educational centre or a nature reserve. Besides this actions, directly benefiting the adopted species, are given such as improving areas inside or near the school for the adopted species (e.g. construction of ponds, planting trees/shrubs, etc.).

**HOW TO INTRODUCE BIODIVERSITY INTO THE CLASSROOM**

The rather abstract concept ‘Biodiversity’ is not easily explained to pupils. Schools wanting to take up this subject under the theme nature need coaching. Nevertheless we stimulated schools via EC@S to take up this subject but coached them in designing their activities. A few primary schools spontaneously worked out actions to help their adopted plant or animal.

The ‘Vrije Basisschool van Smeermaas, ‘Aan de Basis’ worked out for instance a two-week project for their butterfly, the mazarine blue (Polyommatus semiargus). They visited the butterfly greenhouse and insectariums, at the Nature educational Centre “de Lieteberg” and studied butterflies at the petting zoo Pietersheim. Together with the NGO Natuurpunt and Stichting Ark the pupils went in search of the mazarine blue’s home (biotope), in the nature reserve Hochter Bamp. They also planted six shrubs of orange eye (Buddleja davidii) in the school yard, where each classgroup was appointed stewardship of one shrub. Finally all pupils designed a badge with a photo of the mazarine blue and the slogan ‘I will protect the Mazarine Blue’.
In Tongeren, the pupils of the vocational school VIIO, section “wood and metal”, made nest boxes for the little owl (*Athene noctua*), which the environmental council mounted at suitable locations in gardens and orchards of Tongeren’s residents. One teacher of VIIO is willing to present a powerpoint presentation about the little owl in local primary schools. The local art school together with the local environmental movement (Leefmilieu Tongeren) organised a competition and art exhibition with the little owl as main theme.

Learn and play is a good combination, the “Discovery Box: Limburgian Species” illustrates this. This box was developed by the Provincial Nature Centre and a student from the ‘environmental management’ programme of the ‘Katholieke Hogeschool Limburg’. This box contains tips and trips for lectures and a number of ready to use worksheets. But the real eyecatchers in the box are the games, for instance, an adapted Goose and Happy Family card game, featuring the Limburgian species. The Provincial Nature Centre distributed this box to all primary EC@S-schools in the province.

The pupils of the primary school Don Bosco in Gerdingen spent a whole afternoon studying the Limburgian species using this box. The teachers invented a game, using the tools and games in the box in which groups of pupils received game assignments. If the assignment was performed well, the pupil received a card of the Happy Family cardgame. Aim of this game was to collect a complete family (a set of four cards belonging to the same family) as fast as possible. Some assignments were riddles, the answers of which could be found in an art exposition made by the pupils of the last two grades. Each of these pupils was assigned one of the 44 adopted species and was asked to make an informative collage or powerpoint. To collect the necessary information they were allowed to access internet or to use the library on the previous Friday.

The exposition was open for visitors, including parents, pupils from the nearby school from Bree. A local guide received these visitors and gave them a tour explaining the ups and downs of the life of the adopted animals and plants.

These examples are illustrations of the interactive learning process. The concept biodiversity is explained from head (knowledge based education) to heart (experience based education) to hand (hands-on education). The combination of these three formats guarantees that all students have an equal opportunity to master the concept, as not every person learns the same way nor reacts to the same stimuli. We can distinguish four methods of learning, namely: copy, question, experience, and associate. Every person can use all of these methods, but not necessarily in equal proportions. Depending on our character/capacities we will favour certain methods over others.
Biodiversity refers to components (species, genetic variations), but also and maybe even mainly to the ways in which these components, through interactions (ecological processes), create new equilibriums.

Interestingly, this idea of interaction between components has recently also been introduced in orthopedagogy and education (system approach of Engeström). A child is no longer viewed as a separate entity, but as an identity belonging to a number of groups/networks, where it interacts with other persons. This contrasts with the classical approach (formal learning), which aims at changing the attitude of the child only. Children are “submitted” to educative projects – eventually organised by local environmental movements or a nearby nature education centre, without involving for instance, parents or grandparents. In other words, the effects of other people’s behaviour on the child’s behaviour are not taken into account. The child is addressed as “the pupil”, not as (grand) son/(grand) daughter/friend/brother/sister/etc. But if, for instance, the family does not master the techniques needed to correct the child’s behaviour or, even worse, consistently show unsustainable behaviour (as would rather use their car than a bicycle for short trips), the child will soon take up old habits. We believe approaching a child in all its different functions (pupil, friend, brother/sister, grand(child), ..) as well as involving all people that belong to the child’s life circle (i.e. taking into account the child’s home situation), will strongly enhance the effects of nature education. We even advocate using children – our primary target – to change the attitudes of a much larger group of people. In addressing the children – in all their different functions – they become ambassadors for biodiversity in every community they belong to.

To achieve this goal both the formal (in school) and the informal (outside school) circuit should be used. The EC@S-project is well suited to use the system approach, both via formal and informal learning. In school, education concentrates on changing the attitude of the pupils by offering a new set of values (i.e. importance of biodiversity, sustainable behaviour). By involving pupils in the process (planning, organisation, implementation, evaluation), they acquire the essential skills, attitudes, values and knowledge needed to work in a sustainable way and thus preserve biodiversity in their “habitat”. The EC@S-project also stresses the importance of parent involvement, thus creating the possibility to also influence attitudes at the child’s home situation (informal learning circuit).

The MALS-project offers another opportunity for using the informal learning circuit. In this project the child functions as an “inhabitant of the municipality”. The challenge will be to find the most suitable platform to reach the child in this function. It is, for instance better to contact the child via the youth movement – where nature/environment are often promoted as a year theme – than to try to
convince the child via sports clubs. In doing so, the child is repeatedly confronted in a number of different ways with the concept of biodiversity. The adopted species act here as anchor point for the child, both at school and outside school. By using the adopted species, the concept biodiversity also becomes recognizable, concrete and part of the child’s living space. We believe that in doing so, the chances of changing the child’s attitudes improve greatly.

One example of a method to involve youth organisation, and elderly people is the Happy Family card game made by RLLK. On each game card one of the adopted species is presented via an attractive picture and a text summarizing interesting facts of that species. The aim of the game is to bring youngsters and elderly people together and allow them to share their knowledge of the species. As most of the adopted animals and plants were still common several decades ago, they usually are well known by the elderly people, while children have often never seen them. This way the degradation of the environment and the loss of species are made clear to both groups.

When launching the game, announcements were placed in newspapers, regional papers and the e-zones of the three Limburgian Regionale Landschappen. The game was distributed free of charge, but candidates had to write a story or make a poem or a drawing about “nature in the days when grandfather and grandmother were still young”. About 500 drawings, stories and poems were received, which were shown to the public at an exhibition later on. Not only schools, but also retirement homes, scouts, environmental volunteers or cultural heritage group, as well as the different governmental levels, asked for the card game.

The popularity of this card game brought the 44 adopted species to larger public notice in a large part of the province, also to segments that were often only marginally involved in nature protection. This game thus proved to be a valuable tool in creating a support base.

**CONCLUSIONS**

When introducing a new item, such as ‘biodiversity education’, it is wise to use existing and known systems. We used the EC@S-project network as a stepping-stone. To bring the complex and abstract concept ‘biodiversity’ into reach of children we used the Limburgian species and their habitats as levers. The adoption-concept improves involvement, both of the children as pupils, but also as inhabitant of the municipality. The species become their “pets”.

To give ‘biodiversity education’ a chance to develop further, a knowledge base is needed to assist educators both inside and outside the school. The EC@S-monitors and GALS-promoters hold this function in the Province Limburg.
Until recently nature and environmental education – biodiversity education being one theme – was limited to a visit to a nature reserve or an educational centre, accompanied by one or more presentations. With our biodiversity education we like to go further. Children are not only addressed as pupils inside the school, also outside school the child and people living with this child – parents, grandparents, peers in the youth movement or other socio-cultural organisations to which the child belongs – are addressed. This requires new communication methods and tools, as each group has its own requirements.

Different children have different skills and interest. To reach as many children as possible, biodiversity education should be creative and versatile. All senses should be stimulated and hands-on playful techniques used to heighten the involvement.

**ACKNOWLEDGEMENT**

In general we would like to thank Jan Stevens, Peter Baert, and Eric Caers for their support and contributions to this paper.

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DESCRIPTION

Earth’s atmosphere is finite and its capacity to clean itself is limited. A wide array of air pollutants including particles, liquids and gases are being emitted both from natural and anthropogenic sources. Biosphere contributes significantly to the chemical composition of the atmosphere and on the other hand, changes in atmospheric properties have a strong feedback effect on ecosystem functioning and biodiversity. This project’s aim was to explore how Romanian schools can collaborate to create a high quality education in biology and also to make a connection between theory and educational practice. The idea of the project came in February, 2009 when five schools from the municipality of Târgu Mureș, Romania, have decided to collaborate in extracurricular activities. The main objectives of the project were to engage a large number of pupils, to organize activities based on practice, to change attitudes referring to nature and environment and also to induce sensitivity and awareness of the effect of...
pollution on the environment. The project includes the following schools from Tîrgu Mureș: Gimnaziul “Alexandru Ioan Cuza”, Gimnaziul “Liviu Rebreanu”, Liceul Sportiv “Szász Adalbert”, Gimnaziul “Nicolae Bălcescu”, Gimnaziul “Romulus Guga” and engaged a number of 458 active pupils. The schools ensure bilingual teaching, in Hungarian and in Romanian languages. We have collaborated with the following organizations: the Focus Eco Center and the Rotaract Téka Club, two nongovernmental organizations from Tîrgu Mureș, the Healthy Environment Regional Organization and the Environmental Health Center from Cluj Napoca, the Meteorological and Hydrological Center from Tîrgu Mureș and the Mureș County School Inspectorate. Pupils participating in project are from primary and lower secondary level of 9 or 10-14 years old. We carried on six main activities, all with different materials and methods:

“Earth’s Health Is in Our Hands”
Pupils took the initiative to organize an activity in collaboration with other schools and to present their knowledge referring to climate changes, increases in persistent pesticides and trace metals, greenhouse gases, transport and stratospheric ozone-depleting gases. They have elaborated essays and portfolios which were presented in Power point and the well performed ones being rewarded with diplomas. (Fig. 1)

Figure 1: Earth’s Health is in our Hand-Children’s presentation about climate changes
“S.O.S. Nature Needs Help!”
Another activity with involved presentations of pupil’s posters. The topics of the discussions were “The effects of global warming on the biodiversity”, “The deforestation of the tropical forests and its effect on biodiversity”, “Endangered species-2009-The year of the Gorilla”.

All ended by watching together a documentary about the life of the Gorillas by David Attenborough. (as shown on figure 2)

“CO\textsubscript{2}nnect on the Way to School”
Focus Eco Center is a nongovernmental organization from Tîrgu Mureș, Romania, working in the field of environmental protection. We have heard about the CO\textsubscript{2}nnect campaign during a meeting between teachers, organized by them. After the meeting we signed up for the campaign and we presented the goals and activities of CO\textsubscript{2}nnect in our schools. Children completed a short online questionnaire on climate- and transport issues. Schools have carried out the “CO\textsubscript{2}nnect: CO\textsubscript{2} on the way to school” campaign.

In collaboration with the Focus Eco Center, the Mureș County School Inspectorate and the “Mihai Eminescu” High school from Tîrgu Mureș, we have realized

![Figure 2: “S.O.S. Nature Needs Help!”- Endangered species-2009-The year of the Gorilla](image)
a broad activity which took place in the center of the city “Less CO$_2$! We want fresh air!” (Fig. 3 and 4).

Children from primary and secondary schools made posters and drawings and some of them came by bicycles just too attract attention on CO$_2$ emission from transport and road-traffi

More information:
County’s newspaper-Népújság, year LXI, number 68 (17155.), 24 march, 2009

“The Stratospheric Ozone-Cancer of the Sky”

In our project of collaboration, we have introduced an activity having the goal to inform children about the distribution of the ozone in the stratosphere and ozone holes. The activity was based on discussions and exchanges of views after watching a documentary- “The Ozone-layer”.

“Keep The Planet Clean!”

Co-operating with the Rotaract Club Téka, another nongovernmental organization from Tirgu Mures, regarded worldwide as the youth branch of the Rotary organization, concerned about world peace and good relation between nations, we have organized an action to clean the Mureș River banks and its surroundings. Our action was successful mainly because around 150 students were with us.

Air quality is critical to plants’ health and is a prerequisite for normal gas exchange processes. Plants are important because they keep the atmosphere's composition in normal limits. Therefore we assumed the responsibility to take care of the trees from the Mureș banks. (Fig. 5) More information and picture:
http://www.rotaract-teka.RO/?lang=en&page=project&idproject=28
http://www.acvila.info/doku.php?id=jurnal:2009_05_buteo_igienizare_mures
County’s newspaper-Népújság, year LXI, number 103 (17190), 9 may, 2009

Figure 3: Less CO$_2$! We want fresh air-asphalt drawings

Figure 4: Preparing drawings for the activity “Less CO$_2$! We want fresh air!”
“Pollution monitoring in Tîrgu Mureș with bioindicators and soil”

Study area
During the Geography classes children described the municipality of Tîrgu Mureș and its surroundings. More information: http://www.co2nnect.org/innsendt/pdf/vedlegg/68/4aa7f97102d84/co2report.pdf

Air, soil and water pollution is determined by weather conditions and precipitations. We have studied the temperature, wind intensity and direction, the quantity of the fallen precipitation in year 2005 and 2008. All the information was given by the Meteorological and Hydrological Center from Tîrgu Mureș.

Determining sampling points
The schools involved in the project are located in different neighborhoods. We divided the city’s area in five sites to make easier the student’s work. The sampling points (the total number is 33) contain streets with low and huge traffic, green spaces and a control space where entry by car is forbidden (The Zoological Garden).

Collecting data
Vehicles counting: Students went to the established sampling points in groups of four and counted the number of small, medium and large vehicles for two hours, in the
morning, at noon and in the afternoon. The counting was made in three days of one week: Monday, Wednesday and Saturday, in 2006 and 2009.

Sample collection: The soil samples were collected in 2006 and 2009 from a depth of 15 cm. The lichens Xanthoria parietina and the mosses Brachythecium sale-brosum, Eurhynchium hians and Hylocomium proliferum were investigated for potential use as bioindicators for heavy metals only in 2006. The collection of the samples was made in the same month of the two years, in March.

Calculation of CO$_2$ emissions from transport: The multiplier defines the amount of CO$_2$ emitted per passenger and per kilometer for a given mode of transport. Each mode of transport has a different multiplier. Here are some of the CO$_2$ multipliers: small car-0.11, medium car-0.133, bus-0.069, large car-0.183

The samples treatment and analysis: After the preparation stage (drying, removing extraneous materials or pieces of the bark- and soil subtract, washing in distilled water to remove dust and sand, drying on 100°C, pulverization in mortar and drizzle through a DIN-ISO 125 $\mu$m diameter sieve) we have analyzed the samples with a NITON XL-700. With this device we can measure the concentration of the following chemical elements: As, Ba, Cr, Co, Cu, Fe, Mn, Hg, Mo, Ni, Rh, Sr, Zr, Pb, Ag, Ti, Se, Pd, Cs, Zn, Sn, La and others. The concentration is given in ppm. The analyses were conducted in the Environmental Health Center from Cluj Napoca.

RESULTS

Children introduced the obtained data in computers. In order to find out the results they used the Excel and the SSPS Statistic Programs. The results were presented in figures and tables:

http://www.co2nnect.org/innsendt/pdf/vedlegg/68/4aa7f97102d84/co2report.pdf

This study has tried to assess the relative importance of transport in CO$_2$ and heavy metal emissions. The tables and graphics indicate that the number of the vehicles from our city has grown significantly since 2006. Also the emitted CO$_2$ concentration is higher today than in the year of 2006. The heavy metal emission from transport did not differ significantly in the two years. The replace of the least fuel efficient cars with performing ones and the use of good quality fuels (unleaded petrol) might provide an explanation for a lower concentration of emitted heavy metals in 2009. After the presentation and the discussion of the results obtained from our study, the students proposed some climate ideas or general methods about the reduction of CO$_2$ emission:

Some climate ideas:
- to create fuel from natural fertilizer
• all the vehicles to function with electricity
• to use non polluting modes of transport like bicycles, going by foot
• every man who has a car, to plant a tree
• to use public transport in the city
• the introduction of the trolleybuses
• to create cars that are functioning with wind energy
• the reintroduction of the carts and tractions by horses
• the center of our city to be a place where entry by car is forbidden
• it would be nice to build a road only for bicycles
• it is necessary that schools provide more information about ecology
• Radio and TV to present more information about the negative effect of the transport on nature

What have the children learned during the project?
Most important is that children have learned to collaborate and work in groups. Also they were encouraged to express their climate ideas. Children were aware that nature is in danger. They have enriched their knowledge referring to the emission of the CO$_2$ and the role of CO$_2$ in plant’s life or its effect on the living organisms. Students have achieved new skills in ecological research, in investigation and in solving ecological problems. This project has contributed in the evolution of communication and children made a lot of new friends. All the activities have promoted interdisciplinary learning. This project gave the opportunity for the students to use computers in beneficial purpose. They used the computer and the Internet as an information source for this project also they have learned how to process data in order to find out the results. Children were surprised regarding to the results. According to our calculations, teachers travelling to school by car emitted more CO$_2$ than children using non-polluting transport modes.

“We care about climate changes!”-some of the children’s opinion:

“CO2nnnect, seems to be an ambitious project that helps us to understand how much harm we can do to the environment, without knowing.” (Şandor Bianca Laura, Gimnaziul „Al. I. Cuza”, VII. C)

“I understand that the younger generation should have a greater responsibility to the environment surrounding us.” (Vultur Radu, Gimnaziul „Liviu Rebreanu”, VIII. A)

“Now I understand why people said, walking is half of health.” (Horváth Boglárka, Gimnaziul „Liviu Rebreanu”, VIII D)
The project has encountered some difficulties
It was difficult to manage time, most of the working groups have an afternoon program in school having the classes between 12 a.m. and 18 p.m. The IT office of the schools represented another problem, children worked in most of the cases at home on their own computers. Even so the project has had success especially among the children but also locally, because the participating schools made popular the events. Our collaboration with the schools and organizations will continue in the following years. The developed activities are related to Curriculum Area of Mathematics and Natural Science. They stimulate motivation to protect nature and also these activities are to create beliefs and skills appropriate to students’ involvement in environmental protection.

ACKNOWLEDGEMENTS

The authors wish to thank Focus Eco Center from Tîrgu Mureș, HERO from Cluj Napoca, Kemenes Hajnal, Bíró Ileana and Kádár Noémi from the Gimnaziul “Liviu Rebreanu”, Doczy Melinda Tünde from the Liceul sportiv “Szász Adalbert”, Mátyási Emőke, Szakács Aranka and Cseke Tünde from the Gimnaziul “Alexandru Ioan Cuza”, Német Gyöngyvér from the Gimnaziul “Romulus Guga” and all the participants of this project responsible for collecting the samples and carrying out the activities.

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CO2-Website. [http://www.co2nnect.org]


HÖNTTÄMÄKI SCHOOL AND TIMOSENKOSKI NATURE SCHOOL
Emotions, Environmental education, Education for sustainable development

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Hönttämäki school is situated eight kilometres from the centre of Oulu, surrounded by forest and countryside. The amount of pupils is about 210 (aged 7-12) and 12 teachers. All our pupils come from the area around the school. Environmental education and strengthening the positive relationship between nature and child are some of the main interests in the school. We want to teach children good manners and a sense of responsibility. In our teaching we emphasize active and independent acquiring of knowledge and pupils’ participation. For that purpose we have been developing our school library and the nature school Timosenkoski to serve as learnscapes for our pupils.

ESD IN OUR SCHOOL

We have a sustainable development action plan, which consists of ecological, economical as well as social aspects of sustainability. ESD action plan is made every year as a part of the curriculum of the school. For example, in school year 2009-10 it is realized through our:

• Eco School programme
• Environmental certificate programme
• Electricity and energy management
• Recycling of waste raw material
• Organic food
• Pupils’ participation (student council)
• Pupils’ well-being
• Peer mediation
• Godchild in Togo, Africa
• Unicef walk
• Comenius project
• Member of ENSI/SUPPORT

EDUCATIONAL TRIPS

We have an educational trip program in Hönttämäki School. Its main idea is to strengthen pupils’ positive nature attitude and increase their knowledge of nature. Students will have educational trips at grades 2, 3, 4 and 6. All the trips are closely connected with nature.

Grade 2: Kids have night school in Timosenkoski Nature School. They have outdoor activities and plays in the forest (Fig. 1).

Grade 3: Kids have 15 kilometers cross-mountain biking to Sanginjoen Leirikeskus (camping centre) and back to Hönttämäki. They stay there for one night. They have outdoor games in the surrounding nature for small groups (Fig. 2). They also have an evening snack at campfire.

Figure 1: Adventure at Timosenkoski Nature school.  
Figure 2: The group members need to work together.
Grade 4: The theme of 4th grade camp school is forest. The trip is supported by Metsähallitus (the Finnish forest and park service). We use their camp centre in Taivalkoski, 150 km from the school. During this three-day trip pupils visit a forest working site and käpykaristamo (the place where seeds are shed from cones). They learn the importance of seeds and that a tree is old enough for cutting after 80 -100 years. One day pupils hike to an old forest and make food on campfire. They also get a chance to make tar during the forest days.

Grade 6: This is a wintertime camp school in Kuusamo, 250 km from the school (Fig. 3).

The camp lasts four days. Pupils learn about nature and livelihoods of the eastern part of Finland.

They visit a reindeer farm, Fish Processing centre and Nature centre. Winter highlights are skiing to an old wilderness cottage and spending one day downhill skiing.

**HERBARIUM**

To get to know the most common plants in Oulu area each student collects his own herbarium (21 species) during grades 1-6. In the future we will want the students
also to make digital versions of their herbaria. That will give pupils a new way to look at nature and to learn about it. At the same time they will gain important media skills.

**ECO-SCHOOL**

We got the Green Flag permanent last spring. This year we are having our fifth program with the theme We and Our Common Earth. As a result of our long time work in the area of ESD we got the environmental certificate by the Finnish OKKA-foundation in 2008.

**TIMOSENKOSKI NATURE SCHOOL**

Timosenkoski nature school is part of our school. One of our teachers works there and her students come from all the schools in Oulu. Timosenkoski nature school, situated about half a kilometre from our school, gives pupils in Oulu facilities for learning through memorable first-hand experiences. The activities vary according to the four seasons of the year. In autumn children may explore the nearby marshlands or collect and study water examples from the pond Huutilampi. In winter they can do research work both on and under the snow. In spring bird watching is the most popular activity. [www.timosenkoski.net]
STUDY OF BIODIVERSITY AT THE REGIONAL SCALE BASED UPON THE ACHIEVEMENTS OF THE SANTO2006 EXPEDITION

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Abstract

We currently drive a program of pedagogic accompaniment of scientific expeditions on biodiversity. The goal is to demonstrate the federative capacity of a group of teachers and researchers and help to create a dynamic (networking capacity at national level), and increase their legitimacy in regard to their institutional authorities. The proposal is to reproduce the major steps in the organisation and the development of a scientific mini-expedition, replace it in the local environment, build resources, bibliography, cartography, materials and methods for studying biodiversity through activities where youths will be the core. According to the topics, the teachers and their pupils are be connected with scientific organisations, natural parks, gardens, civil society organisations, industries etc… that are directly involved in the field. These local networks help teachers and their class to deepen their understanding of the domain they are working in and to strengthen their capacities to approach scientific questions related to the socio-environment.

Getting an educational benefit of years devoted to discoveries and scientific personalities, as well as earth and space exploration, is by far nothing new. Implementing media processes to allow mass and school audiences to follow theses ‘adventures’ is a remarkable fact of the past years. It has become one of the communication aspects on them and one of their evaluation criteria.

Karin Ulbrich, Josef Settele & Faye F. Benedict (Eds) 2010
Biodiversity in Education for Sustainable Development – Reflection on School-Research Cooperation, pp. xx-xx.
© Pensoft Publishers, Sofia–Moscow
SANTO2006, AN AMBITIOUS PROJECT

The educational support to scientific events and expeditions project was built by the ACCES (Actualisation Continue des Connaissances pour les Enseignants en Sciences) team of the French National Institute for Educational Research (known as INRP). This project is one option to directly transfer questions from science, methods in use and progress in the knowledge being recorded.

Beyond the media treatment, it is about defining organizational modes to articulate educational follow-ups of a scientific event or expedition with the fundamental interrogations of life and earth sciences. These follow-ups integrate human, scientific and technological dimensions. Fundamental interrogations of life and earth sciences should reflect how these sciences are effectively trained, with their contents, their approach methods and their instrumental preoccupations.

In this respect, the scientific organizers of the international scientific ‘Santo2006’ expedition contacted ACCES.

The expedition took place between the months of August and December 2006 in the Vanuatu archipelago (West Pacific). Around 160 scientists of various specialties were involved to study terrestrial and marine biodiversity in a very rich environment, as well as the consequences of human activities upon the environment. To meet these objectives, a whole set of scientific field laboratories were implemented. They were split into four workshops: marine environment; caves; forests, mountains and rivers; man-modified environment. Each of these workshops represents a real research approach on questioning and assumptions, that requires tools and methods for sampling and collection adapted to the various environments.

With a strong media support, the expedition allowed a large number of short video sequences about its progress, several films to be broadcasted on national networks, several radio reports and numerous articles in general interests magazines. Once analyzed, the outputs of the expedition have progressively been published.

AN ORIGINAL APPROACH

The ACCESS team of the INRP was in charge of the expedition educational support, with the coordination of the French general inspection for national education in life and earth sciences. Associating an education research and development team with scientific mediation appeared to be an original approach.

This support took two different formats.

Some pilot schools were identified in the sectors of Lyons, Nantes and Versailles. A dozen of schools were involved (graduate teacher training institutes aka. IUFM, primary and secondary schools). These schools developed various edu-
cational tools: exchange with some Vanuatu schools; integration of the support approach and the biodiversity topic in training programs; use in specific trainings (scientific workshops, etc.).

Furthermore, three virtual communities associated to the training, namely scientists, trainers and teachers, shared a collaborative Internet website. This site offered scientific content, folders, educational tips, forum and media (http://acces.inrp.fr/santo/).

This educational tool meant to spread a culture of observation and experimentation, allowed students to get acquainted with the world of research and perceive the main realization principles.

THE NATIONAL AND EDUCATIONAL ‘GRAINES D’EXPLORATEURS” PROJECT

Since September 2007, the Santo plan has been reinvested at the educational level, as a project to support the preparation of scientific expeditions.

For the year 2009-10, 42 schools at the national level will implement this project in their classrooms. A few examples are listed in the appendix.

‘Graines d’Explorateurs’ is an educational action aimed towards secondary school students and teachers. It takes place over a full school year. The objective is to allow classes to design and implement, an interdisciplinary scientific expedition linked to local biodiversity. Through its interdisciplinary nature, ‘Young Explorers’ contributes to education towards Sustainable Development. This project is significant in the field of mediation between scientific research and education while it strongly involves external scientific partners (INRA, CNRS, MNHN) and the French local and national educational instances (Inspecteurs d’Académie and Inspecteurs Généraux).

Joint thought management with the education and communication managers of scientific organizations such as the French CNRS, INRA and the Paris Natural History Museum allows common thought interfaces about the method to share scientific knowledge in the areas of Life and Earth Sciences.

The work performed by the ACCES/INRP team in the area of educational support to scientific events and expeditions is used today as a reference for other national projects. The Mozambique-Madagascar 2009-10 project is a perfect example. Sponsored by the Natural History Museum, the objective of this support is to develop a large set of educational tools around this expedition. Teachers will have a free access to online resources on the project website http://www.laplaneterevisitee.org. This will allow them to design classroom activities for their students.

This spin off process is now visible at both the national level (in the sectors) and the international level. At an international level, the tools were presented in
Table 1: Some examples of “Graines d’Explorateurs” projects

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<td>13-14 year old</td>
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<tr>
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<td>11-12 year old  (Students from Lyon)  8-10 year old (Students from Chitré)</td>
<td>Supporting of the setting up of CSCW**</td>
<td>Lyon University + local partner associations + Current scientific Partners seek</td>
</tr>
</tbody>
</table>

* “Graines d’Explorateurs” meaning “Young Explorer”

January 2009 at the ‘In Darwin’s footsteps: effective biodiversity education through the outdoor classroom’ in Shrewsbury, UK and at the ‘Biodiversity workshop’ days in Fuldatal, Germany. Participating and presenting performed work and developed
tools contribute to networking. Networks allow further thinking on a joint approach between research and teaching.

In 2009-10, a project to design a scientific expedition at the local level, using resources from the ACCESS/INRP team is being run between a secondary school in the Lyons sector and a Panama secondary school. The idea is not only to build a comparative study of biodiversity in a humid environment (comparing fauna and flora in the pond and the mangrove) but also to share collected data through a common numeric work interface allowing communication between students and teachers on one side and scientists on the other.

**THE PEDAGOGICAL TOOLS AND ACCOMPANY**

The ACCES team provides several types of educational support for ‘Graines d’Explorateurs’.

Quarterly meeting within a sector and between sectors allow a deep support to teachers. They are also meant to answer their expectations. The administration of the various sectors (rectorats d’académie) also contributes through the financing of scientific practical workshops to implement these projects in classrooms.

In order to better help the involved teachers, the ACCESS team of the INRP has set up online tool:

http://acces.inrp.fr/evolution/graines.

The creation of a forum allows teachers to get rapid answers to their scientific and educational questions.

Teachers needing scientific, educational and didactic resources can now access a website with deep educational resources, based upon feedbacks as well as practical memos and biographical files.

Furthermore, the ACCCES team trains teachers to the use of innovating tools (TICE) to improve their practical training skills. We may quote the use of CENTRA (a visio conferencing software) to break the ‘isolation’ of teachers who are far from the scientific partners. Tutorials on the design of hyper-landscapes and numeric shared workspace are also proposed to the teachers.

Another focus is set on the promotion of the joint work with partners, through among other things, participation to local scientific events (Exposciences, etc.).

Students present the outputs to the scientific and educational partners at the end of each year. This ‘students congress’ takes place in emblematic places for the study of biodiversity (Paris Natural History Museum in 2007 and 2009, Lyons Botanical Garden in 2010). It allows the promotion of a complete collaborative work between education and research.
A special briefcase is also available to support teachers. It contains the required supplies to make a scientific expedition at the local level: digital camera, GPS, expedition notebooks, small observation supplies (boxes, magnifying glasses, etc.), etc.

CONCLUSION AND PERSPECTIVES

‘Graines d’Explorateurs’ thus contributes to broaden students vision on the implications and objectives of diversity as this was highlighted during the Biodiversity Workshop in Fuldatal from September 24 to 27, 2009.

Indeed the main pedagogical and civic objectives of these accompaniments are to create good conditions for the educative system to face those kind of democratic demands that concern preservation of biodiversity-environment and sustainable development (socially “hot” questions) and to debate with the pupils on these questions.

Realizing a scientific expedition at the regional level to study biodiversity is a source of motivation for teachers and students. This creates special dynamics made of projects, interactions between classrooms and discussions with specialists.

Partnering with some researchers from the main research organizations (CNRS, INRA, etc.) through class sponsoring, meetings (introducing students to research laboratories, etc.), on-field support to the associated teachers, scientific expertise, gives teachers and students a perception of a scientific approach, which is as close as possible to real life. It is both an opportunity to give young people a sense of scientific jobs and methods and to discover, promote and preserve the natural legacy of their area.

An analysis on the implementation and follow up of these projects is currently taking place in order to translate the support approach into engineering and expertise terms. This will give to these actions a generality that could lead to their application to other operations of similar nature.

ACKNOWLEDGEMENTS

We are grateful to Catherine Foucaud-Scheunemann of the INRA (Institut National de la Recherche Agronomique), Sophie Pons of the MNHN (Museum National d’Histoire Naturelle), Sébastien Buthion of the CNRS (Centre National de la Recherche Scientifique) for scientific support; Alain Pothet, Jean-François Carion, Thierry Lhuillier and Brigitte Mestre who helped us with the coordination of the Graines d’Explorateurs project at the regional level.

This work was supported by a research contract grant NAR from INRP 2007-2009.
We took part in the workshop about biodiversity in September 2009. My school is part of the European project Comenius 1- the school partnership and we use the booklet “The Quality Criteria for ESD-schools”. Furthermore, we are an Eco school and last year we participated in the CO2 champaign which was organised by the network SUPPORT (suppport-edu.org). The topic “Biodiversity in ESD” was highly interesting for my school.

The workshop took place in the beautiful nature school and training centre of Fuldatal. We used the great hall, the library and ICT room. We listened to and discussed about the fauna and flora with the experts from the branches of pedagogy and ecology. When a cooperation between scientists and school exists, then the school can undertake projects in which students get experiences in learning, visit laboratories at the University and prepare the students forum at the University. All this we could see at the workshop. Sabina was talking about a French project. It was great to listen to her. Another excellent experience was to see and to listen to German students from the local High school. They gave an English pesenation about their comprehensive environmental project. They were very skilled in using a foreign language. It was great to see that they can take part in the international project to share their results to other countries. After coming back to Slovakia we have taught two science lesssons in English in Grade 4 on the topic “Space”. It can be found on www.zsjanzh.edu.sk.

People from SUPPORT informed us about their projects. We enjoyed that our school was in the database CO2 champaign. We were in when Reiner was describ-
ing the campaign. And we were in shock when we got the official letter from Support in November 2009. Our school project was highly recommended. You can see our presentation on www.co2nnect.org.

Mary from the Harvard University presented the great encyclopedia EOL. We have used it since we came back from Kassel. Our children entered some nice pictures into EOL. It is the big motivation to be an international student.

In our country there is no similar place like WASSERHAUS – the environmental centre in the nature which we had visited during the workshop. We had watched the fauna and flora of the German region there and we had learnt about physical principles of waste water treatment. We are sure that students must love this place.

We took home many ideas to improve school life, to become a sustainable school.
ÖKOLOG is the first and the main programme for schools at the interface of Environmental Education and school development. It is based on the ENSI approach to ESD taking account the challenges and opportunities of school autonomy and school programme development. Schools define ecological, technical and social conditions of their environment. This is the basis for their concrete activities. Students, teachers and parents should be involved in a participatory way. Collaboration with authorities, business firms and NGOs should be encouraged.

HOW DO SCHOOLS BECOME AN ÖKOLOG SCHOOL:

In Austria there are about 300 ÖKOLOG schools. Schools have to apply to become a member of this network. The application has to be signed by the school team coordinator and by the headmistress or headmaster. It is an internal decision at school to join the network. 10 steps are necessary to become an ÖKOLOG school.

1. Reach an agreement among all partners at school
2. Establish a school team and a coordinator
3. Analyze the state of art
4. Define priorities
5. Formulate aims and objectives
6. Develop an action plan and projects
7. Implement the plan
Control and reflections

Celebrate success to strengthen the team spirit

Transfer the results and experiences in every day routines.

It is very important to require a school consensus and to build up a school team. This school team is a step towards “middle management structure” at school. The members are the main actors and should guarantee further project work. Headmistresses and headmasters play a very important role in the decision to join the network, but also in the future project work. In some cases the heads are not able to convince the teachers to join the programme.

ÖKOLOG schools become active in different topics—such as energy, water, consumption, lifestyle, fair trade, waste, school climate, health. They should show higher environmental engagement than other schools.

ÖKOLOG schools have to report yearly their project work and activities to get their certification. These certificates are printed and signed by the Ministry of Education and signed by the responsible ministerial head of section as well as by the President of the regional school administration. The certificates are handed over to the ÖKOLOG schools in regional celebration meetings.

HOW ÖKOLOG-SCHOOLS ARE SUPPORTED

The Ministry of Education, Science and Culture and Forum Umweltbildung provide the central support. This comprises the co-ordination of the regional teams. The regional teams meet twice a year exchanging their experiences and work out the topic themes.

ÖKOLOG schools are supported by the regional teams. Their major task is to organise further training, promote the exchange of experiences between schools, provide teaching materials and support schools in their project work.

In some provinces the ÖKOLOG regional teams managed to establish a co-operation with the Environment Department of the provincial governments and with NGOs and are able to get some financial support.

As a member of the Carinthian ÖKOLOG regional team I must confess, that we worked very hard and had a lot of meetings to persuade the Carinthian Government of the valuable work of the teachers at the ÖKOLOG Schools. After all we were successful and a small amount was assured to our regional team. Now it is possible to support some schools in their project work. A second financial support where ÖKOLOG schools can apply for is at the Environment and Health Education Fund which has been offering three times a year financial support from € 500 to € 1600 for a school project.
The Carinthian school “Hauptschule 3 Spittal/Drau” has been an ÖKOLOG-school for six years, when the school has been given an area of 1200 m² from the Austrian Government to take care of for a period of 20 years. We established an open-air class consisting of a meadow, a wood, a barbecue place and a water arena as shown on figure 1. This project is embedded in schools subjects and the cross-curricular themes.

One project was dealing with water and the environment of the open air class. This project is called “ACWAVIVA” which means “water” in different languages.

AC. Acqua
WA (Wasser, Water)
VI (Vis)
VA (Van)

The information is available at www.acwaviva.at.

**PROJECT CONTENT**

1. Pupils and teachers should value water and learn about issues surrounding water conversation and pollution. Finding of this work should influence the parents of pupils and the wider community.

![Figure 1: On the banks of the river Drau. (Water arena). Pupils are active and have a lot of fun.](image)
2. Pupils should know about interdependences between animals, plants and humans, as well as other environmental factors in different habitats such as lakes, ponds and rivers. Information is changed between local authorities and environmental agencies.

3. Analyze water as a resource

4. Comparisons are made between uses of water in past and present time. Work will involve consultation with water authorities and older family members.

5. Find out how freshwater networks form landscapes and affect ecosystems.

6. Conduct research into how water has inspired writers and artists.

7. To use modern technology to communicate project work

ACTIVITIES

1. Observation of how water is used and for what purposes, calculating and measuring water use leading to a water-action day as shown on figure 2.

2. Producing leaflets as a part of presentation

Figure 2: An action day. Can you smell nature? Young explorers are defining the aroma of nature.
3. Regenerating river banks to involve planting trees and managing habitats for plants and animals.
4. Investigating water supply and consumption by families, schools, home town.
5. Comparing maps and photographs of landscapes past and present.
6. To collect text, poems, songs, paintings, photographs, films
7. Writing songs and stories, drawing pictures, making posters, acting out plays, producing films
8. Carrying out chemical test and biotic analyses

END PRODUCTS

- Leaflets
- Reports following interviews
- Statistics in form of tables and graphs
- Nature trails with sign posts and notice boards as shown on figure 3.
- Videos
- Posters

Figure 3: Feeling with all senses. Pupils are blindfolded and barelegged. They are guided along the trail of senses.
PARTICIPATING OF PUPILS

Active participation of pupils is to be insured through pupils-centred activities, for example designing logos, carrying out manual work.

Since our school is a member of ÖKOLOG, we want to encourage ecological thinking at school as well as in our community. We want to give our pupils an understanding of our environment and nature.

They should also be able to experience nature in all its beauty with all their senses.

This project has been awarded of one of the UNESCO Decade projects by the Austrian Unesco Commison.

ÖKOLOG- NETWORK CARINTHIA:

The ÖKOLOG - Regional Team of Carinthia consists of four members depending on their function in the network. The coordination is given to the ARGE ÖKOLOG, which is situated at the Pedagogical Institution of Carinthia. This ARGE is closely linked to primary schools and secondary schools and have contact to the regional school boards. The two members also organise the regional in-service training at the Pedagogical Institution. They keep close contacts to the schools and support them in their project work. Contact to NGOs and to mass media (local newspaper, broadcast and TV) are also held. The Pedagogical Institution in Klagenfurt is represented with one member in the Carinthian Regional Team, therefore co-operation between ARGE and Pedagogical Institution works well. The fourth member in the team represents the provincial school administration (Landesschulrat).

The main goal of the network is to get the vocational schools into network. Therefore some meetings with the heads of the vocational schools have already taken place.

Every two years the main topic theme changes. At the moment the concrete theme is energy, so a pilot project has already started. This project called “Energy Detectives” has won the Energy Globe Award 2009 for the Youth in Carinthia and is recommended to get the Austrian Award. Students from the age of 8 to 17 are involved in this project.
Hundreds of wild bee species living in Europe are at risk. However, there is still little knowledge about these wonderful insects in the wide public. A widespread ignorance exists about the threats to bees and even about their importance for humans. Most people don’t know that a large percentage of our food relies on bees. Most plants are pollinated by insects, and bees play a major role. There are the Red Mason Bee, Nordic Leafcutter Bee, Hairy-footed Flower Bee, Wool-Carder Bee and many others. Many of them are often even better pollinators than the well-known Honey Bee. Studies conducted in the ALARM project (www.alarmproject.net) have shown clear evidence of a significant decline in wild bee diversity over the past 25 years (Biesmeijer et al 2006; see Ulbrich, Schweiger and Settele, this book). The scientists also observed that the loss of pollinators is consistent with the loss of bee-pollinated plants. As many crops are directly dependant on insects for their pollination, the reported decline in the bee populations may have severe implications for farming and food production. Crops such as apples, pears and berries are entirely dependent on pollinators for fruit development, while in crops like oilseed rape, sunflowers, peppers and tomatoes, visits by pollinating insects like bees improve the quality and quantity of fruit and seeds produced.

In collaboration of scientists and teachers a nature trail was developed which communicates knowledge about wild bees to students and the wide public. The trail was positioned in the environmental school centre Franzigmark near Halle in Saxony-Anhalt (Germany).
The first panel describes the diversity of bees (Fig.1; more than 500 species occur in Germany). Bees differ in their habitat needs but also in their nesting and reproductive behaviour. Whereas 70% of bee species are constructing nests in soil or sand, the Red Mason bee *Osmia rufa* and several other species use hollow plant stems for nesting. Bees are feeding on diverse plant species – on nettle, dandelion, thyme, bellflower and many others.

Bee habitats are the topic of the second panel (Fig.2). Most bees occur in open landscapes that are rich in structures. Ideal habitats are species-rich, semi-natural areas such as grassland-orchard systems with scattered fruit trees usually mown once or twice a year, flower-rich grasslands, edges of forests with dead wood or rain edges.

Figure 3 shows the morphology of bees at the example of the Red Mason Bee *Osmia rufa*. This bee collects pollen with the brush hairs on its abdomen. In contrast, honey bees and sand bees collect pollen in small baskets on their legs.

The life cycle is described on Figure 4 and 5. Wild bees (with the exception of bumble bees) are named solitary bees because they build individual nests in contrast to the social honey bee. In spring, the males emerge first, feed to gain energy, and then look for females for mating. Once the females have emerged and mated they start building nests. Their short lifetime runs for a few weeks from April to late June. The nests of *Osmia rufa* are cylindrical hollows. The bee uses existing hollows for the nest such as plant stems or abandoned beetle holes. She divides the hollow into several cells – one for each larva – separated from the next by a wall of clay or mud. The female provisions each cell with a pile of pollen, lays an egg on top, then caps off the cell with a wall of mud. She is able to determine the sex of her offspring and puts females at the back of the nest and males at the front. During the summer the larvae eat the pollen, then spin a cocoon and pupate, sitting out the winter in the insulating cocoon as fully developed bees.

Main predators of bees are presented on figure 6 of the nature trail. Among them are birds such as the bee eater, spiders, toads and other insects (e.g. bee beetle). Parasites are mites and ichneumon wasps.

Threats for bees are shown on figure 7. Destruction and mitigation of bee habitats are often the consequence of intensive agriculture, construction of highways and sealing of urban areas.

Figure 8 describes the importance of bees for humans. It is mentioned that bees do an essential job. Without their pollination services many flowers would produce no seeds, and fruit and vegetable yields would suffer. To help bees we all need to find room for bee-friendly plants, many of which are extremely beautiful and look great in the garden throughout the year. Examples are the butterfly bush *Buddleja davidii*, herbs such as thyme and lavender, or Lupin and *Phacelia*. 
Die Vielfalt der Bienen

1 Honigbiene
Apis mellifera
Sie produziert als Haustier des Menschen Honig und Wachs. Über tänzelnde Bewegungen, genannt „Rundtanz“ kommuniziert sie mit ihren Artgenossinnen.

2 Winzige Furchenbiene
Lasioglossum Pauxillum
Diese Biene gräbt Nester, die gut an den „Schornsteinen“ aus Sand zu erkennen sind, die von Wächterbiene bewacht.

3 Erdhummel
Bombus terrestris
Diese Wildbiene nistet in alten Maulwurfsgängen oder in den Erdreich, die bis zu 1,5m Tiefe und ist gut an ihrem weiß behaarten Hinterleib zu erkennen.

4 Gemeine Trauerbiene
Melecta punctata
Diese kleine Kuckucksbiene legt ihre Eier in fremden Nestern ab, bevorzugt bei der Gemeinen Pelzbiene.

5 Glockenblumen Sägehornbiene
Melitta haemorrhoidales
Sie hält sich häufig an Waldrändern auf. Dort sammelt sie ihren Nektar und Pollen ausschließlich von Glockenblumen, die außerdem als Schlafstelle und Platz zur Partnerfindung dienen.

6 Zweifarbige Mauerbiene
Osmia bicolor
Diese Mauerbiene instet in leeren Schneckenhausbauturen, die sie mit einem Steinchen verschließt und danach unter hunderten von Zweigen vor Feinden versteckt.

7 Gemeine Blattschneiderbiene
Megachile analis
Sie schneidet aus Birken- und Eichenblättern runde Stücke heraus, aus denen sie kleine Näpfe formt, die als Nester für ihre Nachkommen dienen.

Lebensraum

Die vielen unterschiedlichen Bienenarten haben sich in Anpassung an ihre Lebensräume entwickelt. Deshalb befinden wir sie sowohl in kühlen Hochmooren als auch auf trockenhaltigen, in Schilfrohrbereichen oder in Schuppenhütten. Wenn die Bedingungen stimmen, kannst du sogar in deinem Hausgarten Bienen antreffen!

Nahrungspflanzen

Die meisten Wildbienen haben sich auf eine Pflanzenart spezialisiert. Andere nutzen das breite Spektrum an Blütenpflanzen, das die Natur ihnen bietet.

Kornblume
Löwenzahn
Thymian
Feuernelke
Linde
Weide
Kirsche
Apfel

Baumaterial


Figure 2: Habitats of wild bees.
Die Biene (Apiformes)

Facettenauge
Bienen besitzen Facettenaugen, die aus vielen einzelnen Miniaugen aufgebaut sind. Damit kann sie Helligkeit, Farben und Schwingungsrichtung des Lichtes bestimmen.

Flügel
Die vier dünnhäutigen Flügel sind von auffälligen Adern durchzogen, welche zu deren Versteifung beitragen. Am Rand der Flügel befinden sich kleine Häkchen genannt Hamuli, sie heften den vorderen und den hinteren Flügel zusammen, um somit eine größere Flächen zu schaffen.

Lebenszyklus der Roten Mauerbiene

1. Die Mutterbiene steckt das Ei in den mit Nektar getränkten Bereich des Pollenvorrates.
2. Einige Tage nach der Eiablage schlüpft die Larve und beginnt ihren Pollenvorrat zu verzehren.
3. In der zweiten Lebenswoche löst sich die Larve und frisst nun liegend ihren Pollenvorrat auf.
5. Schon im August liegt die voll entwickelte Biene in dem Kokon vor. In diesem Kokon überwintert sie auch.
6. Im Frühjahr nagt sich die Biene durch die Kokonwand und den Nestverschluss und verlässt ihre Brutzelle.
7. Nach dem Schlupf aus der Puppe beginnt die Biene, das Nest zu düngen, Pollen zu versammeln, die Brut zu versorgen und zu pflegen. Sie entwickelt sich in den Nestern.
8. Noch im gleichen Jahr, nach einer 4-6wöchigen Flugphase, stirbt die Biene und ihre Nachkommen entwickeln sich in den Nestern.

Jede Tierart dieser Erde ist bemüht, Nachkommen zu produzieren, so wie die Wildbienen. Jede Art hat dabei ihre zutreffende Strategie. Hier steht, wie sich unsere heimische Osmia rufa entwickelt, und welche Stadien sie vom Ei bis hin zur ausgewachsenen Biene durchläuft.

**Figure 4:** The life cycle of the Red Mason bee Osmia rufa.
1 Paarung

2 Baumaterial
Das Bienenweibchen sucht an kleinen, feuchten Lehmgruben nach Material zum Bau der Brutzellen. Hierbei treten zum einen die spezifischen gefärbten Verkleidungen auf, die sich aus dem verarbeiteten Lehm ergeben.

3 Nestbau
Das Weibchen fertigt in Röhren mit 10-12 cm Durchmesser Brutzellen an, welche sie mit einem Pollenvorrat und einem Ei bestückt. Ist das Nest voll besetzt, wird es durch einen besonderen Pfropf aus Speichel und Lehm verschlossen. Unter günstigen Bedingungen kann eine Biene zwei bis drei Brutzellen pro Tag anlegen.

4 Nahrungssuche
Die weibliche Biene sammelt Blütenpollen, mit ihren Bauchbürsten die Pollensäcke und trinkt Nektar zur Aufrechterhaltung ihrer Lebensfunktionen. Der Pollenkuchen in der Brutzelle ist die Nahrungsgrundlage für die Entwicklung der nächsten Bienengeneration.

5 Nestbau

Wenn euch eine Biene begegnet, könnt ihr so gut wie sicher sein, dass sie gerade auf der Suche nach einer Blütenpflanze ist, um Pollen und Nektar zu sammeln. Während ihrer vier bis sechswöchigen Flugphase beschäftigt sich Osmia rufa ausschließlich damit, das Weiterbestehen der Art zu sichern.
Unsere Wildbienen sind in ihrem Lebensraum vielen Gefahren ausgesetzt. Spinnen, Hornissen, Bienenfresser und viele andere Feinde tummeln sich auf der Suche nach ihren Opfern. Schaut euch also genau um und ihr könnt selber sehen, wie gefährlich unsere Bienen leben!

**Figure 6:** Natural predators and parasites: Birds, spiders, other insects.
Der Lebensraum der Wildbienen wird immer mehr durch uns Menschen bedroht. Moderne Formen der Landnutzung nehmen den Bienen die Lebensgrundlagen. Wie lange können Bienen in so einer Umgebung überleben – was meint ihr?

Figure 7: Threats to bees caused by humans.
Bedeutung und Schutz


Gestalte deine Umwelt Bienenfreundlicher!
Leiste einen Beitrag dazu: begründe deine Umwelt, bunte Nistmöglichkeiten, schaffe Freiräume, kläre auf ...
Since the opening in 2007, the bee trail has attracted hundreds of students and their teachers. Most of them told that they became more aware of these endangered insects and their habitat requirements. It has motivated them to initiate and implement conservation activities.

ACKNOWLEDGEMENTS

We thank the DBU – Deutsche Bundesstiftung Umwelt (AZ 22380-41)

REFERENCE

INTRODUCTION

In this chapter we will present ideas emerging from the SUPPORT workshop on biodiversity and school-research collaboration which was held in Fuldatal, near Kassel, Germany, from 24 to 27 September 2009. The workshop was attended by 32 teachers, teacher trainers, education experts, biological diversity experts and programme developers from 13 countries. We also offer some of our own reflections about school-research collaboration and use of ICT tools in biodiversity education.

The primary goal of the workshop was to merge perspectives from various actors to reach a better understanding of how schools and researchers can collaborate to create high quality education on biological diversity and education for sustainable development (ESD). The role of ICT tools to facilitate such collaboration and promote the learning outcomes of ESD was also a central theme of the workshop. Participating teachers and environmental educators were to build their competence to plan and carry out educational activities on the topic of biodiversity.

In the context of the SUPPORT project, biodiversity education is framed in the context of ESD rather than a purely natural sciences or descriptive approach to biodiversity. The competency goals and learning outcomes aspired to by high quality ESD should therefore also be embraced and addressed in biodiversity edu-
cation. In an ESD perspective, pupils should acquire not only a scientific understanding of biodiversity, but also an understanding of the complex interactions of economy and society which impact biodiversity, and the skills and attitudes needed to participate as citizens in the management of biodiversity for sustainable development on the planet.

In an ESD context, biodiversity education would:

• Appeal widely to all kinds of pupils
• Be scientifically sound
• Develop critical thinking
• Use ICT effectively for communication and participation
• Promote understanding of the complexity of biodiversity issues and management choices
• Develop pupils’ understanding of why biodiversity is critical for sustainable development
• Motivate pupils to act to protect and preserve the diversity of nature
• Provide opportunities for pupils to do research and contribute to knowledge about biological diversity

The workshop started with plenary talks by educational and environmental experts providing input and concepts about biodiversity education, school-research collaboration and ESD. Group discussions, hands-on trials of ICT-based tools and a visit to an outdoor centre for environmental education (see Fig. 1) were also on the agenda.

*Figure 1: Visit to the field station “Wasser-Erlebnishaus”.*
Through the workshop, emphasis was placed on experiencing and discussing “state of the art” programmes in school-research collaboration on biodiversity as well as examples of good practice. Ample opportunities for crosspollination of ideas and perspectives were provided. The participants presented successful examples of biodiversity projects from their countries, including “Biodiversity in winter” (Finland), “Collecting olives” (Spain), “Creating an eco-park” (Slovakia), “Year of the Gorilla” (Romania), Bird monitoring (Hungary), biochemical measurements at river sites (Finland) and creation of a nature trail on wild bees (Germany).

The participants’ evaluations of the workshop confirmed that the discussions among people from various spheres of science and education and from different countries had been fruitful. A majority of the participants reported that they had increased their own competence about how schools can collaborate effectively with research to improve ESD, about the potential of ICT-based tools in ESD and about the application of ICT tools in formal and informal education. Many of them planned to use ICT tools more intensively in their educational work in the future. An unexpected outcome was that the ICT presenters also networked and now plan a stronger collaboration. The participants reported that they became more aware of the usefulness of intercultural exchange and established useful contacts with other participants.

**COMPARISON OF ICT TOOLS**

Before attempting to compare and contrast the four ICT tools presented at the workshop, we will briefly recall their main features.

*Example 1: Participatory species database*

**Encyclopedia of Life - EoL (www.eol.org)**

Encyclopedia of Life (EoL) seeks to transform how students learn about biodiversity by providing easy access to authoritative content and by encouraging educators, pupils and scientists to participate by contributing content to the encyclopedia. EOL aspires to create a global community of biodiversity learners and to expand and deepen the collective understanding of species. The ultimate goal is to inspire future generations of scientists and stewards of our living planet.

*Example 2: Species database and identification key*

**NatureGate (www.luontoportti.com/suomi/en/)**

NatureGate is an internet service providing a wealth of information about Finland’s plants, birds and butterflies, including high quality photographs.
The intention is to awaken interest and build pupils’ knowledge about biodiversity in their own location. The tool includes a unique species identification tool based on a visual taxonomic key. The user makes choices and works their way through several levels in the key, shown on the screen. Eventually a list of plant names and images for plants with the chosen features is served. NatureGate is becoming very popular in Finland and is being adapted for application throughout Europe.

**Example 3: ESD campaign on climate and transport**

CO₂nect (www.co2nect.org)

CO₂nect has been developed by the SUPPORT consortium as an international offering to schools on the topic of sustainable transport. The website combines a relatively simple activity (registering pupils’ CO₂ emissions in an international database) with guidance materials for teachers about how they can extend and adapt the activity. Schools are strongly encouraged to analyse and use the results in the international database, develop ideas for reducing emissions and create local projects in collaboration with actors in their community. The website includes a description of intended learning outcomes, a calculator for CO₂ from transport, a database for results, analysis and map tools, pupil questionnaires, guidance materials for teachers and an evaluation module. More than 30,000 pupils in 30 countries have registered CO₂ emissions from school transport and many have carried out local projects on sustainable transport.

**Example 4: Educational simulation software**

PRONAS (www.pronas.ufz.de)

PRONAS stands for Projections of Nature for Schools and consists of free educational software available over the internet. PRONAS was developed with support from the SUPPORT project and in collaboration with researchers, educators, environmental education centres and schools. Building on the results of biodiversity research in the project ALARM (www.alarmproject.net), PRONAS addresses topics of climate change, pollinators, invasive species and environmental chemicals. Modelling software constructs, presents and explains projections of future distribution of hundreds of European species. Three basis scenarios are simulated up to year 2100: SEDG (Sustainable European Development Goal), BAMBUB (Business As Might Be Usual) and GRAS (Growth Applied Strategy). Further development of the tool will include user interfaces for habitat modelling. Learning outcomes for pupils include ecological understanding and critical thinking.
All four ICT tools clearly provide excellent educational opportunities for pupils to acquire scientific knowledge and apply it to practical activities. Some of them (PRONAS, CO₂nnect) aim specifically to develop a deeper understanding of complex ecological interactions and nature-society interactions. Some of them (EoL, CO₂nnect) feature participation in an international network of learners, and thus build communication skills as well as pupils’ attitudes toward their role as an active participant in society. Critical thinking and ability to evaluate alternatives are emphasized in PRONAS and CO₂nnect.

NatureGate and EoL are structured around descriptions and identification of species and thus primarily oriented toward the natural sciences. But they are also, in some sense, broader in scope. EoL includes much information about human impacts and management, while NatureGate has an affective impact through beautiful high quality photography. Pupils’ observation- and cognitive skills are also developed by the NatureGate identification tool. EoL and NatureGate could be used in an interdisciplinary context such as investigation of local ecosystems or development issues. A creative teacher could also combine several tools in a single local project, drawing on the strengths of each tool.

**THE ROLE OF THE TEACHER WHEN USING THE ICT TOOLS**

One common feature of all four ICT tools is that the teacher needs to carefully think through and plan how they are to be used, if they are to become effective instruments for high quality biodiversity education and ESD. The teacher needs to specify what learning outcomes are appropriate for their class, pupils, and curriculum and then apply the tool in the local setting. Pupils as well as any potential partners in the local community should be involved in planning. Thus the teacher, pupils and local collaborators can together make a path “from the computer to nature” and “from the computer to society.”

It is therefore not just the features of the tool itself, but also the way the tool is applied, that will determine the learning outcomes. If the tools are used simply and directly, in an “instrumental” manner, the learning outcomes are likely to be quite limited. Much wider kinds of understanding, skills and attitudes can be acquired by creating a frame of local planning, collaboration and project work. The tools then become “emancipatory.”

Schools may also embed the use of the ICT tool in school development work. An action learning cycle (planning-implementation-evaluation-adaptation) will produce learning at the school organisation level and develop the capacity of the school to change and to create new and high quality educational activities for ESD.
WHERE IS THE COLLABORATION?

What does the school-research collaboration actually consist of in our four ICT tools and in the examples of good practice? What is being contributed by each of the partners, and why is collaboration important for achieving both scientific results and educational results? These are difficult questions, to which the workshop did not provide clear answers. We offer here some post-workshop reflections about these issues.

Collaboration can be conceived as a joint effort by two or more actors toward a shared objective. “Shared objective” means that the partners have the same intents about what they are trying to achieve by doing these activities together. “Shared effort” means that both parts contribute to a common set of activities. Many kinds of relationships between schools and actors outside the school in ESD might not actually constitute a true collaboration in this sense, but rather a less demanding kind of cooperation. Examples of these less committal kinds of relationship include sharing of data, communication of results and provision of information or resources to schools.

Let us consider the four ICT tools in light of these ideas about ESD collaboration and cooperation. In the case of all four ICT tools presented at the workshop (EoL, NatureGate, CO2nnect and PRONAS), a researcher or organisation has developed a tool which they intend to be used by schools. Several kinds of collaboration may be present.

• The tool could have been created in close collaboration with schools, giving both the education system and the developer “ownership” of the tool. School experience was important in the development phase of at least two of the tools (PRONAS and CO2nnect), but we have little information about the details of the school input and the collaborative arrangement.

• Collaboration in all four examples arises between schools/users and the researcher/developer at the point at which the pupils and teachers start using the tool (after its development). The collaboration is then based on the shared educational mission of the developer and the schools using the tool. The collaboration brings resources and quality assured information and scientific methodology to schools. The producer develops the educational offering or product and offers it on the “market” on the internet; each school then chooses whether or not they wish to join. A shared mission, shared activities and mutual benefits are all present, but the level of two-way interaction, mutual commitment and dialogue among the partners is relatively low.

• In the case of EoL and CO2nnect, the shared mission and shared activities go further than the mission of providing high quality education for pupils. The
interaction between the developer and the learner is more dynamic and schools actually contribute to and form the content of the online resource. In EoL the participants contribute as part of a learning community together with the EoL developers to produce the publicly available online resource. In CO₂nnect, the learners are working together with the programme developer SUPPORT to produce a global online community of schools working with the issue of CO2 emissions from school transport and to produce reliable scientific information.

- A perhaps even more important kind of collaboration than the collaboration implicit in the ICT tool itself is the local collaboration that happens when schools apply the ICT tools and create projects in their communities. The examples of good practice in the previous chapter also illustrate various kinds of collaborative arrangements in local and regional projects, without use of an ICT-based programme. Every collaboration will be different, having evolved out of the interests of the school and its pupils and local issues of concern to the collaborators.

Local collaboration may be considered one of the hallmarks of a high quality ESD project. Schools may collaborate with local authorities, businesses, politicians, centres of competence, non-government organisations, citizen groups, parents, and a host of other possible partners in the local community. These relationships may also constitute a school-research collaboration, as many local agencies and organisations are knowledge-based and have strong links to research.

The partner should be involved at an early stage to help develop the shared mission and shared activities that are at the heart of the collaboration. Each partner will also want to consider its motivation to participate and the benefits it expects to receive. To avoid misunderstandings, it is advisable for the school, its pupils and the collaborator to discuss and agree on each participant’s role, activities and contributions during the planning phase.

**FURTHER DEVELOPMENT OF THE TOOLS**

These four ICT tools are all uniquely attractive and appropriate in the context of biodiversity education and ESD. It would be difficult if not impossible to achieve the same learning impact using books or the blackboard. This applies to the photographs and identification key of NatureGate, the experience of being part of an online learning community in EoL, the simulation of nature management choices in PRONAS or the international participation and pupil activities in CO₂nnect.

The four ICT tools presented are good just the way they are, but there is also potential to further develop and improve them and other similar tools to be even
more effective. In particular, developers of such ICT-based tools should be aware of the role of the teacher in adapting and embedding the activities in their local curriculum and project work. Each tool should preferably include teacher guidance materials which can help schools and teachers use them properly. Teachers need to understand that the tools are not intended to be “readymade teaching units,” but rather should be used creatively to produce optimum learning outcomes for both pupils and schools. Ideally, they should be adapted to each educational situation and community in which they are used and embedded in a framework of school development, local project work and collaboration.

A website containing an overview of available ICT-based tools and activities, pointing out their features and strengths and providing advice and examples of how the tools can be used together or separately, would be very useful to teachers.

**WAYS FORWARD IN BIODIVERSITY EDUCATION**

The workshop participants discussed at length how high quality biodiversity education in the context of ESD could be developed in the coming years, and in their own job situation. Based on their own experiences, they (perhaps not surprisingly) identified many barriers facing those who want to develop biodiversity education and ESD:

- Structure of schools and curricula gives little space for biodiversity education
- Unsupportive educational policy framework
- ESD competes with other topics and priorities
- Teachers are pressured
- Lack of money, materials, time
- Going out into nature is a problem for many teachers
- Information is provided in English rather than the national language
- Understanding complex issues (ecological-economic-societal aspects) can be a challenge
- Dealing with conflicting sets of values and norms that affect attitudes and decisions about biodiversity protection
- Poor collaboration with families
- Bureaucracy

Given these barriers, what can a school or teacher do? The workshop participants pointed out a number of opportunities can be exploited to strengthen ESD and biodiversity education in the coming years:
• People can be encouraged to be in touch with nature and recognize their need for nature
• Collaboration and discussion can be encouraged between scientists, teachers, and students
• Teachers can innovate using “out-of-the-box” thinking
• Biodiversity and ESD topics can be integrated into every subject
• The relevance of biodiversity and ESD topics to everyday life can be emphasized
• High motivation can be mobilized, because people really want to do the right thing

Thus, each teacher and school can do something within the existing policy framework. It can be argued, however, that a more favourable policy framework for ESD (including curriculum, teacher training and resources) is a prerequisite for effectively integrating biodiversity education and ESD in education systems over the long term.

WAYS FORWARD IN SCHOOL-RESEARCH COLLABORATION AND USE OF ICT

The workshop participants discussed at length how school-research collaboration could be intensified to support development of biodiversity education and ESD over the coming five years. As in the case of ESD, many “systemic” barriers to a collaborative approach with research were identified. These included low level of knowledge among teachers, language barriers, teachers’ fear of using computers and new technologies, geographic barriers, time management issues, complexity of the issues, funding, scientists’ lack of pedagogical training, teachers’ lack of confidence and low recognition of scientists.

The participants offered several suggestions as to how these barriers could be overcome, for example by creating a system for teachers to find experts, changing the award system for experts, securing support for projects in advance, improving project management, identifying key people responsible in each collaboration, English language training and training in use of new technologies.

Regarding ICT, the participants felt that more intensive use of ICT in biodiversity and ESD was clearly called for, and that higher priority should be given to upgrading and improving computer equipment in schools throughout Europe.
IDEAS FOR PERSONAL AND INSTITUTIONAL ACTION

The workshop participants made action plans telling how they would follow up what they had learned to promote biodiversity education and ESD. The following items extracted from the participants’ action plans convey a high level of engagement and understanding at the end of the workshop:

- Create awareness and engagement about biodiversity in multiple target groups by using new technologies
- Review available biodiversity activities and offerings
- Integrate school research cooperation into university projects
- Adopt a more coordinated approach in science department to teaching ESD and biodiversity
- Embrace a wider and more holistic view of sustainable development, ESD and biodiversity
- Live in a more sustainable way
Figure 3: Discussion on action plans. © Reiner Mathar