Raising Standards Through Inquiry:

Professional Development in the Natural Environment

Royal Botanic Gardens, Kew

9-10 July 2013

ABSTRACTS

Supported by

SEVENTH FRAMEWORK PROGRAMME

Tuesday 9 July

09:50-10:25 KEYNOTE

Chestnut Room

PROFESSOR JUSTIN DILLON, KING'S COLLEGE, LONDON, UK

Outdoor science: developing scientific literacy through inquiry

Substantial evidence exists to indicate that outdoor science education, properly conceived, adequately planned, well taught and effectively followed up, offers learners opportunities to develop their knowledge and skills in ways that add value to their everyday experiences in the classroom. In this talk some examples of activities that are 'properly conceived' and 'adequately planned' will be presented including some which are inquiry-based. The contribution the activities make to developing scientific literacy will be examined with a focus on developing a critical understanding of the role of science in society. While many students are given opportunities to experience outdoor science, others are not. Some of the barriers that are commonly said to exist will be presented and challenged. The talk will draw on examples of effective science education from around the world.

10:25-10:45 KEYNOTE

ASSISTANT PROFESSOR, SUZANNE KAPELARI, UNIVERSITY OF INNSBRUCK, AUSTRIA

INQUIRE for all: what have we achieved and where are we going?

Over the past few years a consensus has emerged that teacher quality is one of the most if not the most significant factor in students' achievement and educational improvement. In addition mounting evidence reveals that structured, non-school science programmes can feed or stimulate the interest of adults and children in science and may positively influence their academic achievement. Thus the main goal of the INQUIRE project was to support teachers and Botanic Garden and Natural History Museum educators to improve their inquiry-based science teachings skills and combine learning in class and at botanic gardens to support students learning effectively about topics such as biodiversity loss and climate change. As professionals in their field, teachers and educators continuously need to increase their knowledge and their ability to work autonomously and to rely on their own judgement when it comes to scaffolding students' learning. The INQUIRE project focused on establishing long term communities of inquiry, not only among the teachers and educators participating in the 60 hour INQUIRE training courses run in 11 European countries but also among the 17 partners institutions of the INQUIRE consortium. Over 350 teachers and educators and 40 consortium members set out on a joint venture to investigate inquiry based science education (IBSE) inside and outside the classroom. IBSE was not only put into practice but evidence was collected and experiences shared to improve individual as well as institutional capacity in science teaching. Thirteen train the trainer courses were organised to motivate other Botanic Gardens and Natural History Museums to give IBSE a try and to join the INQUIRE community and offer INQUIRE training courses themselves. INQUIRE is spreading and will hopefully engender change not only in science teaching inside and outside the classroom but in students' understanding of how humans have an impact on biodiversity loss and climate change.

12:00-13:00 SESSION 1 - POSTERS

Ash Room

The Botanic Garden of Sóller as an educational tool for introducing environmental education in the formal ambit of Spanish Secondary education

José Luis Frontera Colom, Sóller Botanic Garden, Mallorca, Spain

The majority of adolescents don't know much about the environment. Most of them don't think about the future of the Planet, just in there their day-to-day life. In the field of education, there are many ways to make students aware of the need to change attitudes towards nature and their own lifestyles.
One of the problems in the schools is that the conservation of plant life gets much less attention than the animal life. The Botanic Garden of Sóller (JBS) is dedicated the study, research and conservation of the Balearic Flora. A field trip to a Botanic Garden helps stimulate interest and awareness in the plant world and its problems. Field trips need preparation before and after. These are more than just a visit to a research center. Teachers must foster the spirit of the student researcher and wondering why things happen.
My work consists of analyzing the educational programmers run by JBS for the last four academic years. I analyze the use as an educational tool for JBS activities and moreover, if the activities proposed by JBS correspond to the students' school curriculum. Once analyzed, I create a educational proposal where students can learn about the problems of Balearic Flora through the work done by JBS.

An adventure back to the Cambrium

Jorunn Karlsen, Botanic Garden of Oslo, Norway

The adventure took place in 4th grade (10 year old pupils).To find the answer to this question we used the science lessons and inquiry based methods to investigate. The pupils worked together in groups, had conversations, used different senses, wrote and looked at a film about the planet Earths history. They met an environment in the classroom with plants and plastic dinosaurs. We talked about the first plant types on dry land. We were curious about the plants and how incredible it is that the same plant types the dinosaurs ate still exists in forests today. Examples: Wood horsetail, fern and club moss. The final and most exiting part of the investigation was the visit in the Botanic garden of Oslo. There the children looked for the spesific plants in the evolution room. They got pictures to help them, dated the plants and put it on a time line. This visualised the planet Earths history. It was a surprise for the children seeing how little space on the time line was occupied. With plants, animals and people. The lesson plans were made with inspiration from the inquiry based course I attended in Oslo Botanic garden. It was great fun to lead my class on this exciting adventure.

An illustration story on plants evolution: a transdiciplinary BOTANIC GARDEN educative activity

Joana Gonçalves, Cristina Tavares, University of Coimbra Botanic Garden, Portugal

As a Botanic Garden of the University of Coimbra (BGUC) educator, Joana Gonçalves has been performing the story "The algae who wanted to be a flower" with children outside classroom since 2010.
This "story" is an educative activity about the evolution of plants produced by Cristina Tavares, a biologist of the BGUC educative service. By a first 'hands-on' direct contact to the five main plants groups examples, this activity is often and since a long time developed in the cold greenhouse of the Botanic Garden.
Extending the scope of this educational activity and crossing with other teaching-learning methodologies, as Inquire Based Scientific Education (IBSE) advocates, children were provoked and motivated to perform and

compose songs on this story and they also prepared visual arts even making the props for a theater in the garden.
In result of the success of the story and the enthusiasm of the children and being professionally a graphic designer, Joana Gonçalves started to make illustrations and designs upon the story so constructing a book, with the support and guidance of the biologist Cristina Tavares.
Considering that this educative book project matches with the objectives of the Inquire project on IBSE outdoors educative activities case studies, we would like to present a poster at the INQUIRE Conference with some of the "The algae who wanted to be a flower" book illustrations.
In reality, we think this is a case-study focusing on how professional learning communities develop and grow in the context of education in natural environments and that teachers and educators working collaboratively can lead to improvements in practice over time.

"From the Polar Regions to the schools" - Approaching polar sciences with IBSE
Maddalena Macario, University of Camerino, Italy

In the last few years science education moved forward rapidly by connecting the expertise and enthusiasm of polar educators worldwide. In fact, the Polar Regions represent one of the best natural environments where students can investigate directly on global changes. In this sense, our project promotes the arrangement of instructional resources based on IBSE activities as well as on real data coming from the research world.
In this way, the project aims to develop innovative teaching resources and practices designed to bring the importance of the Polar Regions closer to home. Consequently, polar sciences could become a focus point in the new national school curricula.
In particular, the activity consists of a teaching tool package including a dozen of full lesson plans based on multimedia tools (images, smart board lessons and videos of lab experiments) as well as on hands-on labs.
The package includes also an App for tablet named CLAST (CLimate in Antartica from Sediments and Tectonics), freely downloadable from App Store. This App, which has been designed by a team including polar scientists, focuses on the dynamic of the Ross Sea Ice shelf, in Antarctica, that is directly linked to temperature variation. Working with CLAST, students are engaged in inquiry-based and interactive learning experiences, which show the response of the Antarctic glacial system to climatic forcing in the last 150,000 years. Moreover, students handle the same key data used by geologists to constrain the paleo-environmental reconstructions with glacial-interglacial scenarios. Finally, the students obtain evidence on the role of temperature in causing advance and retreat of ice sheet that are strictly related to global sea level and climate.

Acquirement of scientific terms and vocabulary in IBSE (inquiry-based science education)
Petra Bucher-Spielmann, Pedagogical University Tirol, Austria

Dealing with biological, or scientific topics in general, requires to a certain extent the use of scientific terms and vocabulary. This vocabulary eases and enables the understanding and communication of processes and facts. Children and teenagers are continuously introduced into this scientific terminology during their school career. But how does this introduction work if teenagers (aged between 10 to 13) research items and processes on their own without having previous knowledge of the terminology needed?
Observations during the Pilot INQUIRE Course in Innsbruck "IBSE - Flowers and their pollinators" revealed that teenagers try to paraphrase items and processes of which they lack the correct terminology. They seemed very aware of their deficiencies in this respect and it seemed to make them feel uncomfortable.
Teachers and experts use scientific terms regularly and rarely ask their students if they are familiar with these terms. The teenagers mostly reproduced these terms without any further questions and improved their skills in

this way. With knowing more terms and vocabulary about a specific topic the teenagers raised more questions and behaved more self-confident.

Rectangle, triangle, square? Looking for shapes at Nature

Dolores López Bautista, Programa de enriquecimento educativo para alumnus con altas capacidades de la Comunidad de Madrid, Spain

Do you know why bees build hexagonal panels? Have you ever thought that Nature prefers number 5 and that is the most frequent number of flower petals? Have you ever seen the hexagonal shape of snowflakes? And what about the spirals of the young fiddleheads?

Spirals, hexagons… are only just some samples of the shapes that Nature is able of creating without using rules, nor calculators or compasses. Analyzing these statements is one of the objects of this activity that has been realized inside the Inquire Project which has been developed with gifted students who assist to an extra-curricular program that the Community of Madrid, Spain, includes as a specific measure for children with high results in Intelligence Tests, and characteristics such as perseverance, together with an important degree of creativity.

The activity proposed with our students was based on inquiring and relating Nature and mathematical shapes. The season started with questions that took students to reflect and relate elements from Science and Mathematics, transferring data and establishing connections between these two curricular subjects. After a short time for questioning, the learners had to find similarities between geometrical and elements of Nature shapes. Through activities inside and outside the class the students had the opportunity to review their knowledge and to develop their creativity. Drawing, predicting, taking pictures, comparing… were some of the tasks for the children to do, and attending to the results, I can conclude that giving opportunities for inquiring and looking for new relationships among elements are constituted as good tools for the learning process.

A Green Laboratory in School Yard

Diana Koleva, "Vassil Aprilov" School, Sofia, Bulgaria

- Problem situation (current practice):
  - Reducing classes in natural sciences -> theoretical information, no time for practice and revision -> formal memorizing instead of understanding
  - Clumsy procedure of taking students out of school -> limited outdoor activities -> difficulty in developing skills to operate in natural environment
  - Large number of students per class -> difficulties in organizing space for active learning -> rare or no IBSE implementation

- Description of the idea:

Establishing a spot called ‘Green Laboratory’ in the school yard where IBSE lessons will be carried out in the open. The aim is to create accessible environment where the kids are to work as scientists.

The garden in the school yard should be well integrated both in the yard area and in the school process in order to become part of school life.

- Expectations:
  - IBSE – in an informal environment: discussions and conclusions regarding the necessity of a lab for outdoor learning

- IBSE in practice: active participation on the part of the students and teachers in the building and maintenance activities
- Integration of disadvantaged young people and of children with special educational needs
- Self-affirmation: the belief in one's own capabilities resulting from the actual building of the spot
- Strategic thinking: the students develop a plan on the maintenance and use of the lab on their own

- Challenges
  - A large number of children want to participate compared to the capacity of the activities planned under the project.
  - Inclusion of children with special educational needs
  - Apprehension of the idea by teachers and students in connection with the sustainable development of the project.

- Coping strategies. Reflection

- Promoting good practices among other schools for the creation of green laboratories in school yards.

The good Earth, a case study of IBSE in the fourth grade of a primary school

Renata Attolini, Primary School De Gaspari, Trento, Italy

This poster illustrates a laboratory activity related to vegetable gardens, implemented to meet a strong demand in this sense by young children, and to involve in a collaborative way all classes of the primary school. This activity is part of a larger project called 'all similar and yet different' related to the difference between individuals within the same species. As a prerequisite participants need to know the difference between living organisms and non living things, the essential elements necessary for life: light, water, air, nourishment, understand the importance of soil for plantlife.

IBSE is effectively used in this activity, taking the moves from a constructivist approach that is used from the early classes in the primary schools, that takes into account the pre-existing knowledge and conceptual change, moving from common sense to correct concepts, in a process where the teacher acts as a facilitator asking questions rather than providing answers.

The vegetable garden is a lab where students sow seeds and observe whether germination and growth takes place or not, consequently reflecting on the different outcomes, considering the different factors affecting germination (e.g. same seeds, sowing day, sowing technique, etc.). Among the possible explanations (e.g. sunlight, water, cold weather, soil, etc.), the discussion is steered towards soil, analysing in detail soil composition (e.g. water, organic nutrients, mineral nutrients, earthworms and other smaller animals, etc.), looking for differences that can significantly influence germination and growth.

Working in groups, students are stimulated to express their opinion in balanced and respectful discussions, respecting other people opinions, they work in a cooperative way carrying out further investigations and eventually drawing conclusions and presenting them to the class, highlighting the unresolved points and the new aspects to take into consideration and actively investigate (e.g. light levels and temperature).

IBSE: Fresh Impetus for Professional Development and Devising New Lessons

Svetlana Mirontseva, State-funded educational establishment of the City of Moscow, Secondary School, Russia

Classical methods of teaching biology put students off the subject. Life should be studied through living objects, by teaching children to observe, examine processes and conduct simple experiments. This enables them to acquire knowledge while also learning through personal experiences. IBSE is a collection for tools for engaging the students' interest. I use it to organize lessons in such a way that the students stay behind afterwards to continue studying what cannot be squeezed into a 45-minute class.

The students adore their lessons in the Botanic Garden, where they can see extinct species, travel with plants around the planet and understand what makes them like they are. These lessons instil an interest in plant diversity and the importance of studying plant habitats in order to preserve them. Learning the secrets of keeping plants at home and working with them in the Botanic Garden gives the students experiences that will inform their future choice of profession and educate them in environmental issues.

The INQUIRE course and materials helped me not only to apply new techniques in school, but also to develop my own IBSE lessons. Activities such as floristic studies, identifying invasive species, the "Black Book", and studying the biodiversity of indoors plants are particularly popular, as well as comparing the seeds of gymnosperms and angiosperms, modelling flowers, and creating seed collections.

One important outcome of IBSE teaching is the fact that many pupils are now choosing professions related to biology, including that of biology teacher (7 last year alone).

A botanical garden as natural laboratory

Réjane Limet, Botanical Garden of Bordeaux, France

Awareness of future generations of the need to preserve our environment can be done in several steps:

1. to observe,
2. to know,
3. to interrogate,
4. to understand,
5. and finally, to protect.

To achieve this final step, IBSE is the most appropriate method and Botanic Gardens one of the most relevant tool. These scientific and educational spaces, as other natural environment locations, are privileged sites, kind of natural open laboratories.

Three systems of young public reception exist in Botanical Garden of Bordeaux (BGB):

- first, total immersion during a week and two days, out of town, in a park and a forest of 150 ha, for two classes.
- Then, 5 classes of 5 schools in the district of the BGB take the same annual project,
- Finally, children of a social centre neighbouring cultivate a plot in BGB for a year.

In these 3 cases, teachers or educators are masters of their project. BGB is positioned as a reception site where a team can accompany and support them over a long period. Thus, it offers:

- to put on, to accompany and to evaluate the project with teacher or educator, while favouring IBSE,
- activities in relation to the project,
- experimental open site, with living collections,
- meetings or exchanges with experts and scientists,
- bibliographic resources,
- a place where students can communicate to the public results of their researches.

Evaluations of these projects are generally positive for children and teachers or educators. Students develop progressively key scientific ideas through learning how to investigate and they are building their knowledge and understanding of the world around.

Explaining the concept of Inquire Based Science Education through the activity how seeds are dispersed?

Marina Ferrer Canal, Irene Fernandez de Tejada, María Bellet, Alicia Fernández Rodriguez, Blanca Olivé de la Puente, Real Jardín Botánico, Madrid, Spain

The activity How seeds are dispersed? has been delivered in the last two INQUIRE courses (one aimed at educators and one at teachers) by the partners of the project Real Jardín Botánico, CSIC and Real Jardín Botánico Juan Carlos I, UAH (both located in Spain, Community of Madrid) which have been working together to run the courses.

This activity has been used in order to explain what Inquire Based Science Education (IBSE) is. The activity itself is aimed at 9-13 years old students and its main objective is to teach the different ways that fruits or seeds can be dispersed.

The group was divided into three small groups and within each one we use a different approach to face our objective (to teach how seeds and fruits can be dispersed) in order to compare afterwards the three different ways:

- Traditional approach: the group received a master lecture with pictures about fruits, seeds and dispersal. They teacher is the main actor and the students receive all the explanations needed
- Guided "hands-on" activity approach: this group experiences hands-on activities and a quick visit to the garden but it is still an activity leaded by the teacher,
- IBSE approach: these students are encouraged from the beginning to raise their hypothesis and to discover how seeds disperse on their own, collecting seeds and using some materials available as a teddy bear, a bowl with water, a fan… (These materials are used to imitate an animal, the sea or a river, wind…) in their own way.

The activity is finished by a group discussion where the three methodologies could be compared. Conclusions were quite satisfactory as most of the teachers could understand the main keys of IBSE

IBSE as a Platform for Joint Creativity by Teachers and Students

Svetlana Buldygina, State-funded educational establishment of the City of Moscow Lyceum, Russia

Life in today's world requires new teaching techniques focused on individual development, creative initiative and the ability to use information to resolve issues arising in personal and professional life. Our lyceum teaches gifted children with an interest in science and technology and has a particular focus on developing their research abilities. In this context, IBSE has given me a platform to make my lessons more interesting and take a fresh look at the process of teaching biology and building relationships with students.

Since attending the INQUIRE course I have expanded the range of lesson topics, made broader use of reflective practice by the students themselves and organized my teaching around scientific research, in which the teacher and students work together in a shared creative process of seeking the truth. Due to a lack of specialized equipment I have devoted much of my lessons to debating, gathering and evaluating facts, planning experiments and constructing hypotheses. I have begun suggesting that students conduct independent research as part of their homework, including tasks such as observation, planning experiments, problem analysis , preparation of questions for debate and creative work (such as writing scenarios, stories, crosswords and presentations).

In addition to developing intellectual skills, IBSE is helping to nurture personal qualities such as communication skills and an ability to assess one's own work and that of others.
One of the main impacts of IBSE has been the creation within the lyceum of an atmosphere of scientific quest and joint creativity by teachers and students. This is helping students to form moral values, to acquire the skills of scientific organization and public speaking, and even guiding their career choices. This is reflected in their active participation in the school's young scientists' community.

A Pathway to Inquiry-Based (digital) Teaching
Franz X. Bogner, University of Bayreuth, Germany

The objective of the three-year European PATHWAY-project with its 25 partner organisations is to set a pathway toward a standard-based approach to teaching science by inquiry. The project aims to (i) support the adoption of inquiry teaching by demonstrating ways to reduce the constrains presented by teachers and school organisations, (ii) demonstrate and disseminate methods and exemplary cases of both effective introduction of inquiry to science classrooms and professional development programmes, as well as to (iii) deliver a set of guidelines for the educational community to further explore and exploit the unique benefits of the proposed approach in science teaching. In this way the project team aims to facilitate the development of communities of practitioners of inquiry that will enable teachers to learn from each other.
The Pathway project selected a framework for selecting Best Practice Examples within the science education in classrooms. The partners have chosen within their field of specialisation 50 Best Practices, one of which, for instance, is the InQuiBidT, an approach of "Inquiry-based Biodiversity Teaching" in pre-service teacher education (see the following presentation). Another one, for instance, is an approach labelled Natural Europe which is digitally linking museums and school classrooms. An impressive abundance of high quality digital content available in Natural History Museums around Europe still remains largely unexploited due to a number of barriers. A third example is the GenLab, where high school students learn within an outreach lab hands-on experience innovative basics in genetics and gene-technology. Finally, as last example, the interdisciplinary "Hearing of Sound" is highlighted, consisting of 4 interdisciplinary (biology-physics) learning stations about sound and the ear by inquiry. The approach includes to wonder about sound and hearing. to investigate the questions raised in the learning at stations as well as to confront their ideas and findings with scientific insights.

Why is there no population of fish in the river?
Majken Korsager, Norwegian Centre for Science Education, Oslo, Norway

In this poster we present a way of structuring inquiry-based science teaching using the 5E instructional model (Bybee et al., 2006). We show an example of how ecology teaching can be structured and conducted with focus on the five phases in the 5E model: engagement, exploration, explanation, elaboration, and evaluation. By using the 5E model, the science concept of a lesson is "invented" during the lesson rather than defined at the outset of the lesson, as in the traditional approach. This might support teachers to specify the purpose and evaluate the effectiveness of inquiry-based tasks focusing on students' learning. In this example 30 students invest why there no population of fish in the local river by engaging in fieldwork were they collect and further analyze data. During their practical work, they continuously report and discuss their findings with peers in a collaborative wiki and in the classroom. The classroom teacher guides and helps the students to c!
onduct fieldwork, interpret data and to navigate and find relevant reliable information on the World Wide Web. The focus of teaching is on supporting the students when they interpret their own collected data, using evidence to support their scientific claims and knowledge about ecology and environmental issues.

Oak Room

Workshop

Inquiry-Based Science Education in Practice

Do we really know what we eat?

Blanca Olivé, Real Jardín Botánico Juan Carlos I, University of Alcalá, Spain

The aim of the activity is to understand the importance of the scientific work, technology developments and its application in our daily life.
The activity starts with the teacher asking to students: who likes honey? And a discussion about who produces honey, what is the work of the bees, which plants are visited by bees, what they get in the flowers and so on.
Outdoors in the garden and working in pairs, the students get a jar of honey and a toolkit to investigate it. They have to design their own investigation and find out if their jar of honey has inside the type of honey that the label says (For example: Rosemary honey or False Acacia honey) or if there is a fraud.
The information given in the label is about the type of honey and the place of Spain from the honey comes. Students will compare this information with their own conclusions after their investigations. So, they start with the question: Do I know if this honey is really Rosemary honey?, for example. Their hypothesis can be that the jar of honey is a fraud or not.
For the investigation they can do a pollen test (with simulations of optical microscope pollen samples), they can investigate bees, plants and flowers and they can taste, smell or see the color of their honey. In the garden the plants selected for this activity have a sign showing some useful information as the areas in Spain where the plant grows or the type of honey that the plant produces.
Students have to share their conclusions to the rest of the class. Then, all together can highlight the value of the scientific knowledge, technology developments and their applications of science in our daily lives and our food safety.

Beech Room

Workshop

Reflective Practice

Improving Reflection skills: a new approach

Ljuba Pencheva, University of Sofia, Bulgary

Every activity based on communication provides a feedback about ourselves as it reflects the way people see us and act. So what does the skill of performing reflection mean? It is the ability to read properly the signals of people we associate with. Moreover – reflection can be regarded as the ability to put our ego aside and, as if we are in a magical space, to see ourselves from an outsider's perspective. In the beginning of last century J.L.Moreno - a doctor and sociologist, spent time to focus on a study of the processes of interaction within different social groups. Following many years of practice he developed methods for the improvement of

communication in social communities and beyond – for therapeutic activity of wide application. Today, his approach is known as psychodrama and is characterized by different situations actually played out with the cooperation of a group in which the sharing of experience between the participants has a paramount role. This workshop offers application of the methods of the group psychodrama in the meetings of practicing teachers and educators. By presenting real situations that are related to professional challenges, difficulties in the introduction of new techniques in teaching and so forth, the participants can go through, share and build upon their experience. The real essence of the process of reflection relates to restructuring our experience and knowledge aimed at coping with our tasks in a more qualitative quick and professional way or in other words we should raise our competency. The workshop is designed for practitioners who are curious to look to their practice from aside, to hear from different "points of view" and to experiment new approaches. Each skill develops through experience. We also need practice to improve our reflecting skills.

Rowan Room

Workshop

Inquiry-Based Science Education in Practice

Kolibri seeks Bromelia – sparkling IBSE activities

Doris Elster, Sonja Eilers, Yvonne Matzick, Institute of Biology Education, University of Bremen, Germany

How can we promote the fascination of plants? In this workshop we invite the participants to bring with them IBSE materials and share with us their experiences with remarkable IBSE activities. In addition, we will present some of the most sparkling activities developed and conducted within the "INQUIRE for Student Course Bremen". We invite participants to test some of them hands-on and/or minds-on and to discuss their further development. We start with the IBSE activity "Climate and Ice" and invite participants to build hypotheses about the Ice-Albedo-Interdependence and how the polar ice may influence the sea streams. The experiment "Gulf stream in the aquarium" allows testing the hypotheses. A further IBSE activity is called "Expedition to the Mount Kinabalu". This is a prominent mountain and with 4.095 metres above sea level and the highest peak in Borneo. The mountain is among the most important hotspots in the world, with between 5000 and 6000 species of plants. We invite participants to walk with us through the Malaysian rain forests and to explore the different adaptation of plants in their struggle of light and mineral nutriment. Examples include different epiphytes like Orchid spp., ferns, and the symbioses of Nepenthes sp. with mammalians. What traces of climate change can we recognize during our hike to the peak? Then we move to Middle America and Costa Rica. The IBSE Activity "Kolibri seeks Bromelia" is a sparkling activity in the context of pollination. Why are some of the Bromelia species green and other grey? Why do they have such colorful blossoms? What makes Bromeliceae so successful in their adaptation on a changing climate? At last the IBSE activity "It's my choice" focuses on the Wild Tabac plant, a generalist and winner of climate change, and its fascinating strategy to choose between butterflies (Sphingidae) and birds (kolibris) as pollinators to protect itself against predators.

Sycamore Room

Workshop

Inquiry-Based Science Education in Practice

Object exploration as a process of scientific inquiry

Emily Dutton, University of Cambridge, Cambridge, UK, *Abigail Hinton*, Horniman Museum, London, UK

This hands-on workshop explores object-based learning as tool for supporting IBSE learning. Developed to train teachers and education professionals working in a range of different LOtC settings, the approach can be used with diverse audiences including primary and secondary school students, adult learners, people with special educational needs and community groups.

Participants are placed in a teacher-as-learner role as they work through and reflect on a series fun, fast-paced activities designed to encourage inquiry learning. The activities particularly focus on:

- Asking and answering questions
- Analysing and weighing up evidence
- Developing creative and critical thinking
- Communicating ideas
- Close observation

A key learning outcome for the session is to understand that objects, as pieces of evidence of the world and of the past, can be used nudge learners down avenues of research and observation based on the evidence before them.

The aims of the workshop are to:

1. Provide hands-on, practical examples of how to use objects for inquiry based science learning.
2. Demonstrate the effectiveness of an inquiry-based learning approach for teaching in LoTC settings.
3. Inspire practitioners to develop their own site-specific object-based learning activities.

The maximum group size for this activity is 25 participants. Ideally it requires large enough space for five table islands to be set up to facilitate as a circus of five hands-on activities with a maximum of five participants per group.

Chestnut Room

Papers

Inquiry-Based Science Education Outdoors

How much IBSE is possible during a class visit to a Botanical Garden?

Jutta Kleber, National Botanic Garden of Belgium, Meise, Belgium

When teachers work out IBSE activities, they mostly often think of experiments that can be done in a classroom. These experiments are related a subject taught this time in class and they can take a certain time, if needed.

Educators who organise workshops for children in our Botanic Gardens start from a completely different situation. They often have only a few hours, and a group of children wanting to see as much as possible of the marvels of a Garden.

How can IBSE work in this kind of situations? Is it even suited for these settings?

First of all, we would like to investigate how the educators of our Botanical Garden who participated in the Inquire Course implemented what they learned in the workshops they give. What kind of possibilities and difficulties to they see? How did the course changed their way of working?
Furthermore, we would like to investigate some examples from educators who work at other places, from our partners in other countries and also we would like to add some examples we worked out and tested ourselves in our Garden.
As a conclusion, we would like to make some recommandations on how to implement IBSE during a visit to a Botanical Garden.

How can LOtC provide a change in teaching methodology to promote students' engagement in natural sciences? The Lisbon Botanic Garden as a case study

Martins-Loução MA., Gaio-Oliveira G., Barata R., Carvalho N., Museu Nacional de História Natural e da Ciência - Museus da Universidade de Lisboa, Jardim Botânico, Portugal, *Zoccoli M.,* CED Nª Srª da Conceição, Lisboa, Portugal

This paper points out the role of Lisbon Botanic Garden (BG-NMNHS) within the INQUIRE project. We followed three specific goals: 1) to disseminate IBSE as a pedagogical practice within the teacher's community; 2) to link formal and non-formal education to teach Biodiversity and Climate Change and 3) to use the BG as a LOtC institution in promoting students engagement in natural sciences.
The teacher course consisted of a 60-hours accredited program, involving 40 teachers coming from South and Centre of Portugal. The teachers were invited to develop their own lesson plans, and practice in their classrooms the IBSE method applied to the themes of biodiversity and climate change. A reflection practice was promoted to discuss the advantages, limitations, breakthroughs and challenges of teachers at national context. Also, a 2 open workshop's days was organized in November where 30 other teachers participated.
We were able to develop teacher's knowledge and skills in IBSE methods and to make them effective in applying it within their scholar curriculum. With this they were able to raise students' motivation and interest towards science that went beyond this simple experience. Furthermore, teachers learned how to use the Botanic Garden, how to interact with educators and scientists as a way of contact with real natural contexts and to engage students in the creation of scientifically oriented questions, emphasizing the importance in linking formal and non-formal education. Also, the challenge of using a LOtC as the BG-NHMNS to discuss in situ like researchers, do make them feel important, keen in learning and able to motivate their families in their school programs.
As a whole we can say that Lisbon Botanic Garden presents itself as a good bridge on the promotion of formal and non-formal education institutions. Our experience also showed that any young person should experience the world beyond the classroom as an essential part of learning and personal development, able to remain afterwards as a lighthouse of our Garden.

Processionary caterpillars in January …?

Fernanda Filipe, Escola Secundária de Figueiró dos Vinhos, Portugal/ University of Coimbra Botanic Garden, Portugal

My Natural Sciences 8th year pupils (ages 13-14) developed a project to research which abiotic factors could influence the life cycle of the processionary caterpillar (Thaumetopoea pityocampa).
The early appearance of processionary caterpillars around the school (January 2012 instead of March) had attracted my pupils' attention.

This was the starting point for an Inquiry Based Science Education (IBSE) case study, stimulating interest within the biodiversity and climatic changes curricular program, as well as identifying my project as an INQUIRE course trainee at the University of Coimbra Botanic Garden.
The pupils then developed it, in conjunction with other practical activities inside and outside the classroom, using observation and questioning to answer the initial question proposed by the pupils themselves:
“Why are caterpillars already processing in January?”
The study comprised the conception, planning, implementation and evaluation of an educational intervention using the IBSE active learning method and was framed within the "Ecosystems- Living-Environment interactions" curricular teaching unit:
1. The pupils designed the study in the classroom.
2. Next, they examined pines within the school grounds, in working groups of three and using documents already prepared in class, to find and survey the caterpillars.
3. They related their findings and debated these together in plenary session.
They concluded that caterpillars had processed earlier because of the unusually warmer and drier weather in January 2012.
Later, they developed a poster and a report describing the project, their findings and their learning outcomes.
The pupils reported that they had enjoyed this way of active learning and they felt they had had a stimulating learning experience.
I felt this project was an enriching teaching experience, demonstrating how IBSE can inspire pupils in science and help to address biodiversity and climate change. As a Natural Sciences teacher, I am now a convert to the IBSE teaching-learning methodology.

Pine Room

Papers

Inquiry-Based Science Education Outdoors

What does it look like? Looking at Nature with mathematical eyes

Dolores López Bautista, Programa de enriquecimento educativo, Alcalá de Henares, Spain

Learning is a global process where many elements take place. One of the main teachers’ purposes focuses on encouraging children and involving them in their own knowledge acquisition. Inquire becomes so an efficient methodology which stimulates thinking and offers intellectual challenge.
The activity realized inside the Inquire Project has been developed with gifted students who assist to an extra-curricular program that the Community of Madrid, Spain, includes as a specific measure for children with high results in Intelligence Tests, and characteristics such as perseverance together with an important degree of creativity.
One of the signals that can report parents and teachers information about their children or students’ giftedness is the great deal of questions that they ask since very young. Almost when they start speaking they inquire about everything, mainly when the objects are linked to their own interests. Inquire becomes then one of their main source of knowledge, and it is through inquiring that they get more and more information.
Another feature of some gifted students is their ability for transferring knowledge; as a general rule they usually establish original and creative relations among different events or elements.
Taking into account these aspects, the activity proposed with our students was based on inquiring and relating tasks. The season started with questions that took students to reflect and relate elements from Science and Mathematics, transferring data and establishing connections between these two curricular subjects. After a

short time for questioning, the learners had to find similarities between geometrical and elements of Nature shapes.
Through activities inside and outside the class students had the opportunity to review their knowledge and develop their creativity.
Looking at the results I can conclude that inquiring is the perfect methodology for born inquiring students.

Climate change: good or bad?

Catarina Loureiro, Geology Center of the University of Oporto/University of Minho, Portugal/
University of Coimbra Botanic Garden, Portugal

As an educator-trainee from the Coimbra Botanic Garden INQUIRE Project course my project concerned an 'hands-on' activity using Inquire Based Scientific education (IBSE) methodology conducted at Trigal S. Maria School Garden, Braga, Portugal.
Crossing scholar curricula, a seventeen 5th grade students group (ages 10 to 12) explored the importance of abiotic factors to biodiversity through an investigative activity at school natural grounds, discovering the relationships within an ecosystem – trees and the environment.
The project had three stages. Firstly, we confronted our students with a question-problem: "Is climate change good or bad?" They started debating the possible implications of changes in climate upon plants and began preparing the second stage – investigation at the school garden. Here, students autonomously explored the garden natural resources and learned 'hands-on' about the role of plants in an ecosystem: their importance to its equilibrium and the importance of abiotic factors to their survival. Afterwards they returned to the classroom for project stage three, debating and sharing their discoveries to reach an answer to our question-problem.
Ending the project, students showed a better understanding of the trees role in an ecosystem, comprehending that trees need carbon dioxide, water and soil to survive, also serving as support and shelter for soil, plants and animals. Moreover students debated possible scenarios, proposing solutions to minimize climate change effects and naturally the answer to the question-problem emerged: : Climate change can be considered both good and bad, depending…
Several educational materials were developed: notebooks, posters, field guides, both supporting and engaging tools. To systematize out experiences, we created an interactive e-book about climate change including activities suitable for ages 10 to 12 students.
IBSE methodology proved successful as students were engaged, attentive and excited about their discoveries,allowing me, as an educator, to engage them more deeply, while exploring a wider range of subjects.

The SBZH Module "Plant and Climate" in teacher training and school

Dagmar Schlemm, Jörg Ledderbogen, Steinhude Secondary School / School Biology Centre Hannover, Germany

In the SBZH plants from all over the world are cultivated. „Plant deliveries" for certain topics are offered and can be ordered by all types of school during the year.
The SBZH developed an INQUIRE-module and plant delivery "Plants and Climate" with plants of special adaptation, typical for their original habitats in all climate zones.
The IBSE-use of that plant delivery was introduced during the INQUIRE-teacher training course. The plants were compared, sorted according to self-created and given criteria. Morphology and anatomical structures were explored and hypotheses about the plants´ abiotic needs were discussed and tried to be verified with

various scientific methods. Due to the results, the plants were related to corresponding outlying climate diagrams and the climate zone of their origin. Finally, a cultivation plan was developed for each plant.
The module was tried out, amongst others, with a 7th grade class in Secondary School Steinhude. The students made hypotheses about the reasons for adaptation of plant structures. They were focussing on the factor water and its transport, the transpiration and evaporation of plants and developed their own experiments to give evidence to their hypotheses. The success of the module will be presented by its evaluation.

16:00-17:15 SESSION 3 – WORLD CAFÉ

Workshop

Developing Training Courses in LOtC

World Café: engaging the participants into an INQUIRE course

Serena Dorigotti, Costantino Bonomi, Marina Galetto, MUSE, Trento, Italy

Round Coffee tables seating 4, comfortable chairs, paper tablecloth where you can take notes, colour pencils and naturally tea, coffee and cookies to enjoy. These are the basic ingredients of a World Café workshop, besides the facilitators of course! A simple and effective way to promote a lively discussion in small groups in a relaxed atmosphere where even shy participants can feel comfortable to express their opinion, sharing ideas and developing new concepts. There are many variation on the basic format, each table can debate the same topic or different aspects of a similar topics, progressing into 2 or 3 rounds of discussion, participants change table at each round and move the discussion forward into progressing steps. A facilitator sits at each table welcoming participants, making sure the timing is respected and the discussion progress towards the final aim of the workshop. Participants are encouraged to leave notes and comments on the tablecloth and facilitators eventually reports the outcomes of the rounds of discussion to the final plenary.
During the Italian edition of the Inquire course, this format was used twice, a first time to facilitate the creative process where participants were stimulated to develop ideas for a new IBSE activity, the workshop was used to discuss and debate in small groups a possible topic, to select the level of inquiry to use, and to structure the activity into the different IBSE stages. At the end of the course, another world café was used to collect the participant feedback on the course, simulating the evaluation of the course analysing strength and weakness to improve.
Today's world cafe will try to assess what you think of IBSE and the opportunities and challenges connected it, asking you if, why and how you could run an Inquire course in your local context.

Wednesday 10 July

09:00-10:00 KEYNOTE

Chestnut Room

PROFESSOR DORIS JORDE, NORWEGIAN CENTRE FOR SCIENCE COMMUNICATION, OSLO, NORWAY.

What is this thing called inquiry, and why is it so important for teaching and learning science?

Doris Jorde is Professor of Science Education at the University of Oslo and is currently Director of the Norwegian Centre for Science Education. She was the leader of the "Mind the Gap" EU project and participated as scientific advisor for the EU S-TEAM project- both exploring ideas of IBST in teaching and learning. She is a past president of the European Science Education Research Association from 2003-2007.

10:00-11:15 WORKSHOP AND PAPERS

Rowan Room

Workshop

Inquiry-Based Science Education in Practice

"Will there be any sea level rise because of climate change?" Experiments and inspirations - Working like a scientist

Anke Malethan, Jörg Ledderbogen, Regine Leo, School Biology Centre Hannover, Germany

In students´ discussions about various effects of climate change on sea level rise a lot of questions and hypotheses are coming up. On this background students create experiments to explore their hypotheses.
Performing different experiments, they will understand how many factors have to be considered if the relation of climate change and sea level rise is concerned.
During the workshop, participants can do alike and investigate their own hypotheses with the prepared equipment and, maybe, they develop new experiments to investigate and reflect on the relationship between global warming, the global distribution of ice masses, on climate warming, the effects on the melting of the global ice masses and the significance to shelter the global ice masses.
When the participants perform some prepared experiments about the relation of sea level rise and climate warming, these should not be taken as imperative recipes: They are only meant to be a guideline to start.
Many experiments will give unsatisfying results – but why?
What did we do wrong? How can we improve our scientific approach? One question still remains: Can hands-on experiments reflect the real world?
And this is what INQUIRE wants to show…this is the reality of science

Sycamore Room

Workshop

Inquiry-Based Science Education Outdoors

What we can Learn by Measuring Plants and Mobile Application for Assessing Asymmetry Fluctuation in Tree Leaves

Ivan Smirnov, Alla Andreeva, Moscow State Center for Youth, Russia

We plan to introduce IBSE activities, as taught in the INQUIRE course run by the Botanical Garden of Moscow State University ("Aptekarskiy Ogorod"). The activities are based on comparative measurements of, for example, annual shoot growth, leaf asymmetry and leaf surface areas in various species of trees and bushes. The measurements performed by students teach them to identify plants, to compare data and to analyze the

reasons for any differences they observe. Students also construct hypotheses on differences in growing conditions and examine how global or local factors (including climate) may impact growth and development. The measurements are compared against weather and other data to enable students to draw conclusions and develop forecasts of how measurements may change in the future under various scenarios, which can then be modelled.
These ideas, which were presented during the INQUIRY courses at the Botanical Garden of Moscow State University, are being further developed through the creation of a mobile application for assessing environmental impacts on the symmetry of tree leaves. This will be available as a free application for mobile devices using the Android operating system. Thanks to modern technology it is possible to automate a number of processes, such as photographing leaves, image analysis, calculation of the fluctuating asymmetry index, and correlation of the data with GPS coordinates. The program will simplify the process of collecting information and help to create a network of students involved in nature studies.
Two groups of students - biologists (led by 11th-grade student Vitaliy Ryzhov) and programmers (IT-group) have conducted a field study during Research School of Moscow State Center for Youth (http://interschool.redu.ru/). They are currently developing an application with the working name of Symleaf, which will soon be available for downloading.

Beech Room

Inquiry-Based Science Education Outdoors

Sow, see, smell, taste and cooperate
Kristina Bjureke, Natural History Museum, University of Oslo, Norway

In this work shop we will perform parts of an inquire based lesson plan developed at the Natural History Museum in Oslo. It has been tested by teachers, educators from other museums and school children. Continuous evaluations have changed and developed the content. The main topics are: what is a fruits and what is a seed, what are fruits and what are vegetables, different types of fruit, and how a scientist and gardener work. All senses will be stimulated: to think, look, smell, taste, work with your hands and explain.
We will perform a small part of the pre-work, the exercise in the Botanical Garden, and the post-work. The pre-work is a series of questions and answers created by the preceding questions. As there is no space for a greenhouse in the classroom, the students creates mini greenhouses of empty soda bottles during the visit in the Botanic Garden. The bottles are taken back to school and kept in the window. The students are trained to make observations and write a log (like all scientists). In addition the post-work includes practical work as making a fruit salad, and geography â€“ by mapping where in the world the fruits grow originally and as cultivated.

Outdoor

Workshop

Inquiry-Based Science Education Outdoors

Inquiry and Assessment. Are they mutually exclusive? How can inquiry based learning meet the needs of teaching to an assessment and examiners mark scheme?
Sue Hunt, Royal Botanic Gardens, Kew, UK

Many teachers place the problem of having to teach to a prescribed curriculum, syllabus, or examination mark scheme as reasons for not being able to teach using inquiry based methods. This outdoor workshop will show how using 'questioning' will allow students to draw out the required knowledge necessary for developing a methodology and understanding of fieldwork sampling sufficient for examination at 16 and 18 year old level. The activity also demonstrates how the facilitator uses equipment to maintain the required focus without the need for further instruction or limiting student direction. A truly inquiry based outdoor activity which forms the basis of factual data gathering needed to assess impact on species distribution brought about by climate change or other environmental pressures. The closing part of the session considers assessment requirements, good scientific practice and follow on student interest led further work.

This hands-on, practical, outdoor workshop will take place even in inclement weather, so do come dressed appropriately for the weather of the day, as field sampling isn't only for balmy sunny days.

Pine Room

Workshop

Inquiry-Based Science Education in Practice

IBSE activity on textile plants and fabrics

Francesca Pugni, Bergamo Botanical Garden "L.Rota", Italy"

The activity is conceived for Primary School Students and it deals with textile plants. The activity has different goals: to let the children discover that what they usually dress in everyday life partially comes from plants and to let them discover, by an active learning process, the distinction between what comes from plants (the textile fibre) and what is embellished by men (the fabric). Plants are very important for our lives and they are more present than we expect in our wardrobe and in our homes. The activity takes about two hours, and it can be run either in Botanical Garden, either in schools or in informal learning settings.
Fabrics hide important and different stories: they can come from plants (such as cotton and flax), but from animals or oil as well. In groups, students will investigate the origin of one ball of thread, provided by the teacher: cotton, flax, wool, synthetic fibre.
"Where does this thread come from?" is the scientifically oriented question, which should stimulate the children investigation. Each group will receive one "stimulating bag" (the cotton bag, the linen bag, the wool bag and the synthetic fabric bag) provided by the teacher and containing different materials: fabrics, objects, pictures, instruments. Students will be asked to analyse what they find into the bags and by the help of written guidelines they will be asked to cooperate, to connect information and to investigate about the origin of their single fabric.
By explaining their findings and listening to the other groups, students will focus on the importance of plants in our lives. The Botanical Garden setting could foster the investigation of other textile plants structuring the learning process by the direct experience with plants.

Chestnut Room

Papers

Inquiry-based Biodiversity Teaching in pre-service teacher education - a contemporary approach using mobile devices to support location-based learning

Steffen Schaal, Ludwigsburg University of Education, Germany

Biodiversity is part of secondary school curricula and contemporary teaching strategies are crucial for the development of students' knowledge and attitudes towards its protection. In contrast, pre-service teachers do not feel competent enough to teach about complex issues like biodiversity. Biodiversity education needs to draw connections to students' every-day life and interests that could be attained using authentic learning environments and multiple methods. Combining active, participatory and collaborative learning methods with outdoors experiences seems to be promising to improve biodiversity knowledge and attitudes. But during their instruction pre-service teachers often do not encounter instructional approaches like this in their university education.

The study presents an approach of "Inquiry-based Biodiversity Teaching" (InQuiBidT) in pre-service teacher education based on a comprehensive framework for inquiry-based science education developed within the EU-FP7-project PATHWAY. The InQuiBidT-approach (workload 3 ECTS) uses mobile technology to support self-determined location-based learning to enhance contextual learning about local biodiversity. This approach comprises three stages: (1) Introductory stage: Basic concepts of botany/zoology and biodiversity are taught using computer-supported cooperative learning strategies which is consolidated in a botanic garden. (2) Preparatory stage: Student groups inquire a habitat and create materials for a web-based repository accessible with mobile devices. (3) Exploratory stage: Students explore the habitats of the other groups using geocaching tools like GPS, hidden QR codes and other game-like activities to access the materials. All students summarize the information (photo, location) about species they found in their digital herbarium (examples at http://wikis.zum.de/inquibidt).

The study is based on a previous work (Schaal, Grübmeyer, Matt, 2012) investigating the cognitive, motivational and attitudinal effects of the InQuiBiDT approach. Compared to other formats of teaching (N = 64 pre-service teachers), InQuiBidT students (N = 90) showed higher cognitive achievement, motivational and attitudinal effects indicate slight advantages for the InQuiBidT-approach, further details will be discussed.

Developing on-line communities of practice via subject oriented resource gateways, e-forums & social media

Costantino Bonomi and Matteo Cattadori, MUSE, Trento, Italy

MUSE is a science museum based in NE Italy fully committed to support teaches and educators in their professional development in nature and science topics. MUSE endeavours to use at its best the many free tools ad opportunities made available through IT technologies and the world wide web to develop an effective on-line community of practice.

Since 2010 MUSE developed an information gateway of earth system science educational resources called I-CLEEN (inquiry on climate and energy - www.icleen.museum), to support Italian science teachers in setting up Earth science student-centred lessons. The gateway adopts a bottom up approach to resource development that relies on strong cooperation between science teachers and professional researchers (who also act as resource referees); it is subject–oriented and enhances the multi-and interdisciplinary traits, it embraces the concept of open source, through the technological tools (LifeRay) used and copyright policies adopted.

Since 2011, during the Inquire project the course participants, both teachers and educators were encouraged to use free tools such as e-forums and on-line file storage drives (e.g. dropbox, google documents) to share and discuss the course products (e.g lesson plans, ideas, additional resources). The

community is regularly briefed and updated through a mix of free tools such as mailing lists (e.g. freelists) and social media (e.g. facebook, twitter).

GreeNET - Towards the Formation of a Teachers' Network on Environmental Education through Inquiry and Technology

Vassiliki Markaki, Ellinogermaniki Agogi, Greece

Around the world, the awareness that we live on a planet with limited resources signals an educational crisis, among others, that calls for support to these key competences necessary for active citizenship and social cohesion, as well as a turn towards green professions (Orr, 1992). What is more, teachers often lack the skills needed to enhance students' key reflective problem-solvers, a fact that derives from the limited range of learning activities that demonstrate specific pedagogic approaches (inquiry-based learning) and innovative use of ICT tools. The role of specially trained teachers to effectively carry out environmental education, increase expertise and ensure sustainability (Ariansingam, n.d.) is particularly stressed out by the European Commission (Stokes et al, 2001). This paper will focus on the GreeNET project, an initiative that corresponds to this increasing recognition through the development of a teachers' network that strengthens the connection between environmental sciences education and the respective labor market. The paper will explain how the network is formed, motivated through specific educational actions to develop the competencies necessary in order to properly educate their students according to cutting-edge approaches in environmental education, and finally trained to operate in an independent way. The focus is on obtaining the skills necessary to be actively involved in the green jobs market (United Nations Environment Programme, 2009). Ultimately, the work of GreeNET is in line with the European Commission's High Level Expert Group on Science Education Renewal point that to render "teachers are key players… being part of a network allows them to improve the quality of their teaching and support their motivation".

11:45-13:00 SESSION 5 – PRESENTATIONS

Rowan Room

Reflective Practice

How and What to Teach about Biodiversity?

Alla Andreeva, M. V. Lomonosov Moscow State University Botanic Garden, Russia

To try to answer this question and understand the role the Botanic Garden can play, I would like to share some shocking conclusions of an evaluation of what our children know about biodiversity (before they start having lessons in the Garden).

Our children do not know how many plants species there are in the world. But, after analyzing the situation, we realized that not all school educators know the answer to the question….nor do they know how many species there are in our regional flora…

The next point is the importance of asking how to conserve plants. For this, it's important to talk about the role played by botanic gardens in preserving biodiversity (preserving the genofond, creating seed banks etcetera). We have to teach them that it's impossible to save plants without preserving their natural habitats and - most

importantly – without preserving the soils. Soil is a vital ecological factor for any plant. Plants grown in other conditions lose their properties…
Another important conclusion that I reached during the evaluation is that teachers know nothing about the problem of invasive species. They aren't even aware of the phenomenon and the term "invasive species"… and while our school and university curricula are being updated to incorporate these concepts the situation could get out of control.
Botanical gardens can take on a vital teaching role and become powerful educational spaces for the application of various techniques and approaches. In 2011 - 2013 the Project participants designed and delivered a teacher training pilot course that demonstrated the relevance of this approach and of IBSE techniques. The next step is to promote closer interaction between gardens and schools, transforming botanic gardens into a major component of contemporary school education for learning about biodiversity and plant conservation.

Investigation around the pollen

Claudine Pierre, Collège François-Truffaut, Saint-Martin de Seignanx, France

Twice a week, 16 pupils, from 11 to 15 years old, all volunteers, got involved in an investigating approach around pollen and climate. By beginning with the observation of the biodiversity of the school, the pupils asked questions on vegetables, bees and climate. The questions were all written. A person coming from outside the school gave several answers concerning the changing look of the plants: the pupils have discovered phenology. Later, we saw the questions and experiments on climate. Our school librarian proposed the creation of an alphabet primer: it was a very creative, enriching activity and the meeting with a beekeeper answered questions concerning pollen and bees.

Pollens balls are a perfect tool for an investigation and a lot of experiments. Their biodiversity made us discover a science: palynology. Fossilized pollen gives a lot of clues to different scientists and allows the re-creation of former climate! Alphabet primer, dried flowers, flower model, exchanges with others pupils, concept cartoon, video and internet sites have been realized. A visit to the Museum d'Histoire Naturelle closed the year.

There are a lot of positive aspects in the investigating approach: pupils ask questions, proceed by trial and error to find the answers. They explore the point of view of a question at their own pace. Pupils to different standards work and help each other, which knits the group together. The big difference in standards among the pupils could be dealt through a sharing of the activities.

The INQUIRE project really helped us to involve better our pupils by intensifying the moments of listening, of exchange and of assessment. We also adapted our activities and our aims to our pupils. Teachers and pupils discovered new techniques, new methods of learning and now everybody's got a better knowledge on pollen.

IBSE as an approach to reduce the gap between young people and green world: an Italian experience.

Francesca Pugni, Gabriele Rinaldi, Bergamo Botanical Garden "L.Rota", Italy

Bergamo Botanical Garden has always been interested in conducting visitor surveys. In 2012, we implemented a new survey among students from Elementary school to University in the city of Bergamo and its nearby districts by means of different questionnaires filled in by 3000 students. The survey had different, but interconnected goals: understanding if young people in their spare time regularly attend botanical gardens and other green areas such as public gardens, countryside, mountains; investigating what they do when they play

outdoor, the amount of time they spend in front of a screen and their knowledge about plants; discovering how the green world is present in young people's everyday life.
Survey findings reveal an increasing gap between young generations and green world. Moreover, the Italian school systems is highly based on frontal lessons and this frontal approach seems to foster discontinuity between what students learn in school and outside, with special reference to the gap between plants and their common use in everyday life and between botany knowledge and experience.
The research aims to show that IBSE methodology and outdoor IBSE activities in Botanical Gardens can be regarded as a new approach to overcome the frontal lesson and to reduce the gap between young people and the natural environment.

Beech Room

Students' Perspectives on IBSE

The pedagogical value of genuine inquiry.

Dominik Katterfeldt, Botanical Garden University Würzburg, Germany

Modern education takes place in a seemingly conflicting area between learning like a machine and understanding principles. This seems to apply especially in scientific disciplines. Science education needs both, facts and the ability to apply the knowledge. Problem is that we do not function like an input-memory machine. Much effort has been spent therefore to inspire pupils to learning. Problem-based learning basically aims at activating learners to look into a subject. Interestingly, those approaches disregard the common constructivist view. Prepared questions or problems are not necessarily the ones pupils learn most of. The intrinsic/extrinsic motivation ratio then is unfavourable regarding lasting education. One hint for that is the fact that pupils after an instructed conceptual change often switch back to their previous understanding.
Learners need to formulate their own questions regarding the subject. Thus they are literally involved. In this paper we show that questions aiming directly at nothing than answers mostly are not adequate for learning processes of complex scientific matters. We propose a mode of education that animates genuine unanticipated questions. Based on experience in philosophizing with children in context of "Jaspers' Club" we demonstrate why outdoor learning experiences are highly suited for this enquiry within education. With this reasoning enquiry learners will be enabled to understand better and more sustainable.

The use of IBSE for improving science literacy and education at MNHNC

Raquel Barata, Museu Nacional de História Natural e da Ciência - Museus da Universidade de Lisboa, Portugal

The need for improving science literacy has been a central topic for the last decades in Europe and the term Inquiry has a persistent history in characterizing good science education. Innovative learning methods developing skills related to inquiry, decision-making and problem solving must provide young students with real experiences which are meaningful to them. Therefore, new proposals of curricula are inquiry-based, involving new forms of technology and proposing the use of Learning Outside the Classroom (LOtC) contexts. Botanic Gardens and Natural History and Science Museums represent ideal LOtC institutions allowing students to explore on their own and to interact with collection objects related to real contexts, developing their knowledge and skills in ways that add value to their classroom everyday experiences. This paper presents results of two major projects developed by the National Museum of Natural History and Science of Lisbon University bridging non-formal and formal education in order to promote the dissemination of Inquiry Based

Science Education (IBSE) through the use of exhibitions as outdoor opportunities to deliver high quality inquiry activities. The INQUIRE project involved 40 teachers and 10 educators in formation courses about the practice of inquiry for teaching biodiversity and climate change using the Botanic Garden. The teachers' experience during the INQUIRE course resulted in recognizing IBSE and the use of LOtC as an opportunity to engage students, turning them into active problem-solvers and able to motivate their families in their school programs. The Natural Europe project aimed the development of educational pathways with digital contents to help teachers and students to develop inquiry based activities using the Museum exhibitions. These IBSE educational pathways were tested by teachers and their students from 10 to 14 years old and results show that such educational resources may in fact promote the knowledge and awareness about natural sciences contents.

The Garden of Stairs

Anne Birkeland, Department of Outreach Natural History Museum, University of Oslo, Norway, *Annelise Bothner-By,* Departement of Design, Oslo National Academy of the Arts, Norway

The Garden of Stairs' (Trappebakkehagen) was launched in the Botanical Garden of the Natural History Museum in Oslo, summer 2011 as part of the museums educational programme developed for the University of Oslo's 200 years anniversary. The project was concerned with exploring social and spatial experience in exhibitions combined with bodily experiences of geology.
The theme of the educational programme, Forskerspiren (The Budding scientist), is geological research, fieldwork and landscape for 10 years old students. One of the aims of the project was to see how body-centred activities, kinetic experiences and the activation of pre-realized knowledge can be used in geology-education of young students. A second aim was to explore how the spatial design can mediate for relations between people/students in the exhibition space, and how these social experiences relate to, and enrich the theme of the education programme. The result of an explorative design process was the open installation Garden of stairs, consisting of a hill with steps of stairs in a continuous mode of transformation, co-creation and re-creation, and other elements. The project has resulted in new ways of engaging the school, engaging the visitor and new use of the Botanical Garden as museum space.

Chestnut Room

Evaluation of IBSE

Fostering INQUIRE through Evaluation Capacity Building

Fabio Dovigo, Vincenza Rocco, University of Bergamo, Italy

Compared to the great spread of IBSE methods, evaluation of inquiry-based activities still remains rather undeveloped. Many assessments tools for evaluating the quality of IBSE activities and student's skills are currently employed but, since IBSE has proved to be a complex process, there is no "right way" to assess it (Dillon, 2012). As a consequence, despite "Science in Society" projects include program monitoring and formal evaluation to determine whether the intended findings are being achieved, there be a lack of effective program evaluation as well as a lack of confidence among professionals in their ability to use evaluation in their programs (Coyle, 2005). To investigate this issue, we developed an analysis of the INQUIRE's project within the framework of Evaluation Capacity Building theory (ECB). ECB is the intentional work to create and sustain organizational processes that make quality evaluation and its uses routine, involving the supply of technical skills, tools and resources to produce evaluations which become sustainable over time (Stockdill,

Baizerman, Compton, 2002; Preskill, 2008; Fleming, Easton, 2010). To this aim, we examined the activities monitoring process and the assessment instruments implemented by the INQUIRE project to evaluate their ability to provide staff with skills and sufficient resources to conduct rigorous and lasting evaluations. The investigation involved the analysis of documentation (forms, questionnaires, reports, manuals, and lesson plans), research with the stakeholders (interviews, focus groups), and the participation to courses, workshops, and meetings held during the project. The data collected provide an overall picture of the evaluation activities carried out by the project, offering valuable insights into the positive and critical aspects of INQUIRE related to the development of a sound evaluation capacity.

Course INQUIRE for Teacher Students - What is its impact?

Doris Elster, Tanja Barendziak, Frederike Haskamp, Lena Kastenholz, Institute of Biology Education
University of Bremen, Germany

The INQUIRE course is addressed to teacher students and active teachers who are interested in inquiry based learning dealing with the topics biodiversity, biodiversity loss and climate change. The course is performed at the green houses and laboratories of the University Bremen. Visits at the Green Science Center botanika Bremen and the Climate House in Bremerhaven are an essential part of the course which consists of three modules: investigation biodiversity and climate change, planning a school project and conducting the school project.
The evaluation of the training course is conducted using qualitative and quantitative methods with interviews (pre-post), questionnaires (pre-post), research diaries and World Cafes after each meeting. Reflection is encouraged from teacher students (N=17), teachers (N=4), botanic garden educators (N=2) and teacher educators (N=2). In addition a questionnaire survey (pre-post) is conducted.
The focus of the evaluation of the INQUIRE course Bremen lays 1) on the professional growth of all participants regarding their pedagogical content knowledge and 2) on the implementation of the INQUIRE project.
Student teachers as well as teachers report an increase of subject knowledge in the field of biodiversity, biodiversity loss and climate change and an increase of methodological knowledge regarding IBSE. The educators at the biological garden, the botanika and the Climate House are recognized as experts in their specific domain. The flat hierarchy between student teachers, teachers and educators supports a multifaceted mutual learning. The development of an IBSE school project in union promotes the pedagogical content knowledge (PCK) first of all of the participating student teachers (knowledge about the pupilsâ€™ attitudes, knowledge and interest, knowledge about planning and conducting IBSE activities, knowledge about the curriculum, knowledge about assessment techniques like concept cartoons and concept maps).
Student teachers, teachers and educators successfully set up joint goals (especially in planning the IBSE school projects), focused on IBSE learning using checklists and by planning and testing IBSE activities. Student teachers reflected regularly on their experiences during the INQUIRE meetings by research diary writing. The participants understood themselves as learners. The atmosphere during the meetings was inspiring and allowed autonomy and self-efficiency of the participants.
Further results will be presented at the INQUIRE conference.

A case study: “Can children interlink specific modules/activities with each other on the one hand and with the overall/ all-encompassing scientific question on the other hand?”

Elisabeth Carli, Grüne Schule Botanischer Garten Innsbruck, Austria

In Spring 2012 a course on the topic of “Florescence and its pollinators”, which was held based on the method of inquiry based learning, was reviewed at the Botanic Garden of the University of Innsbruck. Children aged between nine and ten years carried out various activities and made observations about florescence construction, nectar and pollen. During the process it was investigated, to which extent the children were able to link those activities with each other and with the all-encompassing scientific question - “Why do insects visit blossoms?” - respectively. In order to answer this research question interviews with children, teachers and garden educators were conducted. In addition to video observations and photographs, children’s’ notes on their hypotheses and observations were analyzed. Analysis of data resulted in the finding, that children were indeed able to link activities with each other quite well, whereas they were quite unable to link the activities to the all-encompassing scientific question. The case study shows that it is important to confront the children with a problem, maybe create a dilemma, so that finding a satisfactory answer to this all-encompassing scientific question remains their main focus. Inquiry based learning cannot be imposed on children. It has to be experienced - maybe even rehearsed. Above all it has become clear, that the children have to know at any given time “what” they are doing and most notably “why” they are doing it, so they can enrich themselves by achievement and acquisition of competencies.

Aftermath of the two editions of INQUIRE training course in IBSE methodology at COIMBRA BOTANIC GARDEN

Cristina Tavares, Coimbra Botanic Garden, FCTUC,Portugal; *Susana Silva*, Research Centre (CEGOT)-Coimbra University, Portugal; *Teresa Bettencourt*, Research Centre (CIDTFF), Aveiro University, Portugal

INQUIRE - a good starting point for any educative and research activity - is an international net-working European Project developed in 11 countries to reinvigorate inquiry-based science education (IBSE). The study of biodiversity and climate change in formal and informal education systems is undertaken using models for training teachers and educators in ‘Learning outside the Classroom’. As one of the 17 partners, the University of Coimbra Botanic Garden (COIBG) accomplished the COInquire training two editions course.

The Coimbra INQUIRE course participants’ needs were supported by the trainers with well-founded design on IBSE methodology and different Biology, Geography and Geology plenary sessions about climatic changes and biodiversity current case-studies presentations. Also best IBSE practice inside and outside the classroom were performed at the COIBG by setting diversified IBSE activities previously tested and well succeeded educative activities, crossing scholar curricula. Following the worksheets guidelines designed for educators and students, outside work in the COIBG was undertaken with the trainees, by implementing the three main lesson planes (Let’s hug the trees; Explorers in the Garden; Scientist-pupils in the Botanic Garden), among other inside and/or outside activities. These enriched the educative examples and the knowledge about the garden resources so involving and encourage the trainees to get inspiration, confidence and skills to achieve a better performance when using the Botanical Garden for educative activities with their students.

By the implementation and evaluation of the training course we concluded that it enhanced competence, participation, interest and motivation of learners whose outcomes presented a good structure and the production of innovative and reproducible projects, using IBSE methodology, with relevant curricular topics, reflected in the trainees’ portfolios.

So the training INQUIRE courses can be considered real education in practice, as replicable educational resources were produced, sustainable models of education directly linked with Natural Science knowledge and understanding.

Pine Room

Professional Learning Communities/Communities of Practice implementing Inquiry Based Science Education (IBSE) in- and outside the classroom

Jakob Egg, Grüne Schule, University of Innsbruck, Austria

Continuous Professional Development (CPD) is essential for a teacher's work. By designing and giving their lessons, teachers heavily influence the learning outcome and success of their students. Especially by implementing various approaches to science teaching and learning, teachers directly influence their students' ability to increase their science competencies and skills. Implementing inquiry-based science education (IBSE) and learning outside the classroom (LOtC) positively affects interest and motivation of students as well as of teachers. Research has shown that fostering the development of „Communities of Practice" (CoP) in CPD courses has a positive impact on teachers' learning outcomes and on their ability to integrate newly-gained knowledge into their everyday teaching. This study analyses the social interaction between learners in heterogeneous groups, which are formed of teachers as well as educators working in LOtC institutions. Preliminary findings show that responsibility, self-initiative and cooperation of the individual participants have been strengthened. These basic changes in the understanding of learning have led to an increasing exchange of knowledge and experience between participants. The participants acknowledged the different experiences of the other participants as a benefit in their CoP and realize its potential for their own professional development. In other words, they have begun to use a valuable learning resource: the heterogeneous composition of the group.

Teachers' reflections on the meaning of IBSE: a question of autonomy

Fran Riga, Faculty of Education, University of Cambridge, UK

In this paper, we examine what a group of in-service, secondary school science teachers think about the meaning of IBSE. 32 teachers attending a one-day workshop were asked to work in small groups to describe examples from their classroom practice which they deemed to be instances of inquiry-based activities or tasks. They were then asked to reflect on and develop criteria which they thought would categorize these activities/tasks as being inquiry-based. This was followed by a smaller group of seven teachers (drawn from the initial 32) who then examined the criteria developed by the larger group in more detail. Data in the form of audio-recorded conversations, participant data record sheets (these included a SWOT analysis of the strengths, weaknesses, opportunities and barriers to IBSE), and field notes were collected. The audio-recorded conversations were later fully transcribed and were analysed by using the process of microanalysis (Strauss and Corbin, 1998). We found that teachers' perceptions of what constitutes IBSE tended to be unclear, and varied substantially from one another as well as from publications (such as NRC, 2000) which set out guidelines on what inquiry-based approaches entail. Where some teachers believed that inquiry meant students conducting research-style, project work with full autonomy, and without any notion of what they would find out, others thought recipe-style tasks, where students knew what the expected results would be, and undertaken under the watchful eye of the teacher, were also inquiry-based. Respondents also tended to believe that inquiry meant teachers had to give up teaching content themselves and allow students to find things out for themselves – something they were most reticent to do in the current climate of teacher accountability.

Understanding the Multi-Dimensional Role of Reflection in the Educational Process: the Natural Europe Experience

Vassiliki Markaki, Ellinogermaniki Agogi, Greece

In an era when effective environmental education is an increasingly challenging issue, a pan-European approach called 'Natural Europe' redefines the use of inquiry-based learning (IBL) through the connection of formal and non-formal learning, in a model that consists of three phases: Pre-visit, Visit, Post-Visit. By definition, the IBL model involves reflecting on and critiquing experiments, debating with peers, forming coherent arguments (Linn, Davis, & Bell, 2004). More specifically, Inquiry-based learning refers to a specific, cyclic and nonlinear model of five teaching steps, including reflection about knowledge and the learning process, which leads to new and refined questions - and the process goes on for another cycle. While the Pre-visit phase deals with prior knowledge, research and personal experimentation, the reflection process starts as early as in the Visit phase and is enhanced by the non-formal institution surroundings; it is then that students are expected to come up with results and to discuss them with their peers and reflect on different explanations than the ones initially given. The Post-visit is the concluding step, during which students are asked to work individually or in groups to reflect on the whole experience and create a tangible product to summarize their findings. In this sense, reflection as an active, vital and continuous procedure rather than simply a step of the educational process as it deepens learning and leads students to further reflect on their visit experiences. Overall, the focus is on the qualitative and quantitative enhancement of the participants' educational experience offered in a non-formal context (National Science Education Standards, 1996). This paper will illustrate how the enhancement of the reflection process in an integrative approach in environmental sciences can contribute to the comprehension of major scientific issues and the improvement of innovative and personalized educational experiences that correspond to the learners' individual needs.

14:15-15:30 SESSION 6 - POSTERS

Ash Room

Yesterday, Today and Tomorow
Anabela Magalhães, University of Coimbra Botanic Garden, Portugal

The purpose of this activity is to identify five biomes which are present at Oporto Botanical Garden and focuses on Biodiversity lost or adaptation related with Climate Change. Oporto Botanical Garden provides a range of opportunities to develop this educational activity. It holds a great diversity of native and non native plants that represent 5 world biomes: Boreal Coniferous Forest, Deciduous Temperate Forest, Chaparral, Desert and Tropical Rainforest. The focus questions are: how are plants suited on their biomes? Will biomes be able to walk? The activity consists on the application of 3 'H's (Head-on, Hands-on, Heart-on) and is divided in these following parts: 1st Part - Where are you from? (represents Yesterday); 2nd Part -Who are you? (represents Today) and 3rd Part - Where are you going? (represents Tomorrow). The student will act as an explorer, discovering the garden with the help of coloured arrows which guide him into the 5 biomes. In each biome, near some trees, there will be a poster with animals, biome conditions and localization on world map. In this first part of the activity the student is required to create a biome map. On the second part of the activity there will be plants' adaption clues near trees which represent those biomes. (e.g. Aloe sp. at the Desert : "I´m living in dry and hot climates so I have thick, fleshy leaves to preserve water.") In this part the student will identify plants' adaptation and relate to the biomes' conditions. The first and second part of the activity will occur outdoors. The third part will occur in the classroom. Each student chooses a biome where they would prefer to live. After students collect some material in the garden they will be able to make a maquette that represents the chosen biome. At last, students will play a card game on biomes extinction or adaptation. This activity will occur on Easter Holidays so I don´t have the results yet.

From Reflection to Research

Inessa Voynova, State-funded educational establishment of the City of Moscow Education, Russia

I first visited Moscow University's Aptekarskiy Ogorod Botanic Garden in 2009 and was always inspired by this amazing place in the centre of a major metropolis. Over time, I gradually came to realize that the Garden is not only a place of leisure and visual delight, but also an open air classroom and research laboratory. And in 2012 I attended the pilot INQUIRE course, which helped me to see the Botanic Garden and teaching as a whole in a completely new way.

What is INQUIRE education all about? It's about seeing a problem where apparently there is nothing new to learn…learning to ask questions in a way that motivates students to solve problems…constructing different hypotheses, both scientific and absurd ones… seeking out fascinating information…and conducting experiments. All of these things are the essence of scientific research. It's also about compiling a portfolio …reflecting, assimilating, becoming aware…These are perhaps the most important aspects!

Although I was already familiar with most of these techniques, IBSE is now becoming an integral part of both my teaching and my personality.

Here are some projects we have run since January 2013:

- A Visit to the Herbalist (about different medicinal plants) - a master class for 5th and 6th grade students as part of the school's Traveling with a Rucksack of Knowledge event;
- GM crops – for or against: public dates for 6th-9th grade students;
- Festival of Amazing Science, Technology and Culture – extracurricular activity for primary school pupils run by senior school students

Our next project is about getting children to create an atlas of plants in the Garden's hothouse and using it to train students as tour guides. They will lead tours entitled "Rain Forest Epiphytes", "One Plant Museum: the Cycas"; "How many Species of Liana in the Hothouse" etc.

COInquire Platforms: sustainable approaches for Educative Resources dissemination

Joaquim Santos, Cristina Tavares, University of Coimbra Botanic Garden, Portugal, *Teresa Bettencourt,* Department of Education, University of Aveiro, Portugal

The University of Coimbra Pilot INQUIRE course (COInquire) formed twenty trainees among teachers and educators on Inquire Based Scientific Education (IBSE) methodology. Each of them developed an individual project applying this methodology with their students outside the classroom school environment.

One of the main objectives of the INQUIRE Project is to implement the IBSE teaching methodology and to disseminate the outcomes as educative and innovative new resources. To accomplish this goal and to reinvigorate the methodology IBSE as a more attractive learning sciences methodology, the educative outcomes should be available to a wide-ranging and complete educative community.

Some of the COInquire trainees have developed blogs to publicize the activities, but the Coimbra group considered necessary to centralize all resources. It was therefore developed one platform with various levels of access to facilitate the trainees 'projects availability for an easier trainers assessments and also to promote the trainees sharing and delivery of the entire projects outcomes and to allow a wider sharing of educative resources.

This COInquire Training Course platform is likely to persist after the finalization of the European project - http://sequoia.bot.uc.pt/jardim/inquire - as a dissemination agent on IBSE methodology applied in well succeeded educative resources on climate changes and biodiversity.

Also, the results of the projects resulting from COInquire first edition were spread within FORUM. Plenaries, IBSE activities, workshops, educational resources were performed on sciences education and the program

‘sessions, book of abstracts and other outcomes are available on COInquire Forum platform - http://sequoia.bot.uc.pt/jardim/inquire/forum2012/ - another mediator for INQUIRE Project dissemination of new educative resources.
Continuing after the finalization of the European INQUIRE project, we consider these platforms sustainable approaches for educative resources dissemination, so contributing to effective professional learning communities, also providing their development over time.

Botany at School: Learning to Observe Plants in a School Environment
Jose Pedro Marín, Faculty of Education, University of Murcia, Spain

This practical project is focused towards students that are studying, studying the Primary Education degree at the University of Murcia (Spain). This practice was called ´Botany at School´ and is about learning a methodological way to observe plants in a school environment (school garden, neighborhood gardens and cultivated plants inside the classroom, etc.)
The scenarios chosen for these experiences with students took place in a forest area close to the Faculty of Education. Many specimens from the Mediterranean can be found there, growing spontaneously alongside others that we had planted in recent years. Another scenario used was the recovery of the Botanical Garden of Murcia which vegetation is serving as a tool to teach botany, considering plants that may serve us for future workshops based on the inquire methodology.
These activities were based on experience gained during the ´Inquire course´ developed by the Royal Botanical Garden of Madrid and the Royal Botanic Garden of the University of Alcala in November 2012. We decided to take an approach based on the deductive method with the point of view about nature study outdoors, trying to meet the educational ideal of moving the classroom outdoors and reject the classical lab-practice based on observation of plants collected by the teacher with closed results.

IBSE: New Educational Opportunities and Resources for Students and Teachers
Svetlana Soboleva, State-funded educational establishment of the City of Moscow, Secondary School No.1344 for in-depth study of biology and chemistry, Russia

Participation in the INQUIRE project marks a new phase of collaboration between the school and the Botanic Garden, enabling us to use the Garden as a permanent base for developing research activities by students of all ages. We have seen in practice how lessons in the Garden can motivate children to carry out research. In 2008 our teachers participated in the Gardenâ€™s international SAPS project, learning how to grow fast plants and use them in experiments with pupils in grades 3-6; these techniques still form part of our extracurricular work.
Thanks to the new IBSE techniques we have been able to expand and deepen our collaboration with the Garden. Following lessons in the Garden, students have gone on to study nature in summer camps and nature reserves, producing accomplished research projects.
The INQUIRE course has also given us new opportunities for integration between lessons in the natural sciences (biology, nature studies, geography, chemistry) and in foreign languages. Using the multiple languages and enormous resource and information base of the www.inquirebotany.org website, our students have expanded their understanding of global issues such as biodiversity conservation and climate change in English lessons and in extracurricular activities, selecting interesting articles and publishing translations of them on the website. The problems and issues raised in these articles are then often explored as topics of discussion in biology lessons. The website has therefore become an important information resource for our students.

Collaboration among institutions to run teacher training courses

Alicia Fernández, Blanca Olivé, Irene Fernández de Tejada, María Bellet, Marina Ferrer, Real Jardín Botánico Juan Carlos I, Universidad de Alcalá, Spain

Botanic Gardens are Learning Outside the Classroom institutions providing teacher training courses. These courses aim to spread the Inquiry-Based Science Education methodology under the Pan-European INQUIRE Project.
A total of 77 teachers and educators have attended the INQUIRE courses in Spain, learning and increasing their knowledge about inquiry-based science education. They have been able to put it into practice taking their students to the botanic gardens or developing their own lessons at school.
The INQUIRE courses in Spain have been developed by two partners working side by side, The Royal Botanic Garden of Madrid (Consejo Superior de Investigaciones Científicas) has an important researching role and vast historical collections while the Royal Botanic Garden Juan Carlos I (University of Alcalá) occupies a large area with different locations and resources for didactic and researching purposes. These institutions are very different from each other but these differences precisely make work-sharing so rewarding.
Both institutions are located in the same region, therefore, collaboration is more effective than competition in order to run successful IBSE training courses. Besides, the decision of working together was not intended to save time and labour but to enrich the project with ideas and resources as we do with the rest of the Partners.
Opinions and points of view may be different; there is where consensus democracy comes in. Likewise, it is really important to be open minded and understanding to reach agreement. Regardless, the advantages of cooperation are more numerous than the disadvantages: offering different learning environments to the participants is more enriching; snowballing is increased as the dissemination reaches more people and two or more institutions are more powerful in the attempt to deal with the Education Authorities.

Locate the invader

Alfredo Cosculluela, Juan de Valdes, Spain

This paper describes a project ,that using a simple experience, aims to check for invasive species in our surroundings and their effects on biodiversity and the environment in general.
It is specially designed to Students of around 14 years old. It is included inside the curricula of Biology and Geology.
Student will identify native and invasive species in their neighborhood and will elaborate a database and a map.
The main goal is that students learn to appreciate the interest of preserving the native species. The benefits they provide to us and the problems caused by invaders species.

What did the dinosaurs eat?

Gro Hilde Jacobsen, Natural History Museum Oslo, Norway

The Inquire project mainly focuses on botany and IBSE. Botany is a part of the natural sciences, but natural science is not just botany: Plants don't live alone! Nature are deeper understood in a context of several of the disciplines of natural science. At the Natural History Museum in Oslo there are qualified mediators in botany, mycology, geology, paleontology and zoology. Prior to the INQUIRE project each department at the Natural History Museum developed their own lesson plans, even in topics like evolution which all departments teach.
Cross disciplinary cooperation is extremely important in developing lesson plans, particularly in themes like evolution and biodiversity. A Botanical Garden has a great potential by hosting rocks of different origin, birds and insects in combination with the flower collections as well as fungi growing on different substrate. However, at the Natural History Museum in Oslo this potential has not yet been exploited in a large extent.

Early in the INQUIRE project collaboration was established between the educators, inspired by the IBSE way of thinking. This has been a fruitful experience, that will lead to more cross disciplinary work in the post-INQUIRE period, developing new IBSE lesson plans.
The current outcome of this collaboration is a lesson plan for primary school, named “What did the dinosaurs eat? “. The poster will give a short introduction to the lesson plan.

Taking IBSE approach into Italian secondary school: the challenge of innovation
Barbara Scapellato, School of Science and Technology, Geology Division, University of Camerino, Italy

In the last few years several studies on science education in Europe suggest the use of Inquiry-Based Science Education approach (IBSE) to reverse the decline in interest of young people in science. The dissemination of this approach in Italian school is limited by a number of factors, among which the large amount of time necessary to plan and then implement the activities in class, compared to the time available in relation to the curriculum and the forms of student assessment, to the increasingly large class sizes and the lack of laboratories and equipment. This study examines the effects of in-service teacher training about IBSE education on teachers’ confidence regarding IBSE teaching and on teachers’ perceptions of the impact of IBSE learning on the students. It also evaluates the short-term effects of IBSE education on teachers' teaching quality and motivation and the challenge that teachers have to face to introduce IBSE approach in science teaching in Italian secondary schools.The pilot training course started in September 2012, before the beginning of the lessons, and will be over in May 2013. 8 teachers (M=2, F=6) have accepted to participate in this study on a voluntary basis. This study (pre/post-test design) will gather data before, during and after a 30-hours training course by means written reflections of teachers, and of a summative evaluation administered by means of questionnaires and interviews. The preliminary data obtained so far show that: during the training teachers’ confidence in teaching science through IBSE has began to increase; teachers have become more aware of their difficulty in changing their teaching from passive to active learning; teachers think that the implementation of IBSE activities in class have positive effects on students' learning and motivation; teachers think that the use of IBSE approach have improved their teaching quality and motivation.

Watch/Judge/Act in Arboretum Luis Ceballos
Elda Carmona, Felipe Castilla, Arboretum Luis Ceballos, Comunidad de Madrid, Spain

The Arboretum “Luis Ceballos” is a fenced area, which hosts more than 250 species of native Spanish trees and bushes, along with a great number of botanical and animal specimens.
It is located on a mountainside, 60 kilometres NW away from Madrid (Spain).
Outside that fenced area, the landscape is submitted to the pressure of cattle, collectors of branches, pinecones, fungi, flowers and wild fruits…and the excursionists limit its natural diversity. However, within the Arboretum, there is a strict regulation of visitors, walking outside designated roads is forbidden, cows and horses are not allowed to enter, and there are no harvesting activities.
IBSE is being applied through an activity carried on several times with high school students from a nearby school, as part of the “Programme with Local Population” or PLP, consisting in 3 phases (WATCH/JUDGE/ACT). Students carry these actions on a specific area called Arroyo del Arca del Helechal (the Ferns’ Ark Stream), which hosts an important gallery forest. On the WATCH phase, students investigate and discover the differences between the area’s internal and outer features: diversity of species, number of species and state of preservation. On the JUDGE phase, they search for the causes of these differences.
And on the ACT phase, they deduce and discuss behaviours to reduce the deterioration of the environment.
PLP started in 2001. The resulting data –both scientific and

methodological- obtained along more than 10 years, are clearly revealing the existing biodiversity differences between both ecosystems, as well as returning significant results.
The programme has improved gradually due to the inclusion of new techniques such as the investigation/inquiry, the exchange of ideas and discussion, as detected on the subsequent evaluation.

Study of the impact of climatic factors and habitat
Milena Yakimova, University of Sofia, Bulgaria

Large part of the fundamental processes in life is invisible to the naked eye. This makes them both difficult to observe, as well as to understand and give meaning to. An example is the conducting of water and minerals through the stem of the plants. Therefore, we developed a training module that makes it possible for the children to get acquainted with this process by creating a functional model of water moving through plants.

Outcomes:
This activity combines the planning and developing of a model that represents the way the conductive tissue functions. Visualizing the process helps students in realizing the significance of water for the plants on one hand, and to understand the function of the conductive tissue within the nutrition cycle, on the other.
In the botanic garden the children may oserve a diversity of plant species adjusted to survive in different habitats.
The follow up activities are intended to have the children make their research more comprehensive by developing experiments that provide different conditions in the environment (temperature, humidity, nutrients in the soil and, respectively, the interactions between them).
The children summarize their conclusions referring to the impact of the changes in the living conditions on the plants.

The poster will present challenges related to the development and implementation of this activity in the botanic garden. It will reflect the actually used techniques for their overcoming, as well as a critical assessment to this activity.

Analysis: Via this activity the children learn not only about one physiological process, but also they appreciate how strongly the change in the environment impacts the living organisms. They build their hypotheses about life and about the adjustment of different plant species in case of changes in environment conditions, including climate changes resulting from human interference in the ecosystems.

Inquiry by levels in the classroom
Jose Luis Olmo RÃ Squez, Ies Guadiana, Ciudad Real, Spain

Scientific inquiry refers to the activities carried out by students to develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world. To get this end we perform a set of activities based on the methods of inquiry that we join in three levels of complexity: a) Level 1. Activities based on questions. Questions are the key to good teaching and the student must have some interest in the question. An example would be watching a documentary or video in the classroom and students should develop a set of questions with What, Where, Who, When, Why and How. b) Level 2. Activities based on experiments. Laboratory practices or simple experiments are made in the classroom or at home, students

will acquire scientific procedures and clarify their ideas about the nature of science. There are hundreds of examples. One of them (designed by us) is the identification of photosynthetic pigments in order to answer the question 'Do all the leaves of the plants have to be green?' (C) Level 3. Project-based activities. Researching will be performed at the maximum level because with these students will be able to use inquiry to learn to do science and learn about science and its contents. At this level, we include the "mini-projects" and research projects in which we use the scientific method to its fullest extent. Finally, when we work the different levels of inquiry, the results obtained are very positive, both for students and for teachers.

Exploring nature through children-led inquiry
Kamelia Miteva, Bio Games, Sofia, Bulgaria

The effects of children-led inquiry are learning effectively and the most interesting for each individual. This is true for semi-outdoor playful experiential activities in botanic gardens, etc. A facilitator provoked children, who then led her, inquiring about facts of interest to them.

A result of the INQUIRE teacher training - The medicinal plant module
Roland Wozniewski, Annette Reisenweber, Christina Siefert, Botanika, Bremen, Germany

One intention of the INQUIRE teacher training in Bremen (Nov 2011 – May 2012) was to get teachers to create a new IBSE (inquiry based science education) module, in order to build a community of practice. Although all of us are very experienced in our fields we had to figure out what IBSE exactly means in practice. Teaching pupils with IBSE is worthwhile however it can be difficult to transfer all the information we want to. It is still a process we and the pupils are in.
The module was created until May and got tested by several school classes between May and September 2012. New aspects were included in the former lesson after finishing an INQUIRE course for garden educators. From the idea to the actual version it took more than half a year. The result of this process ensures that pupils and educationalists are motivated.
During the module, pupils take the role of medieval monks. Different villages ask for help to find out which plant helps to get rid of their disease. The different illnesses get them to form groups. First they have to figure out with an 'old book' which diseases can potentially get cured by which plants. Afterwards they find out further information in the medicinal plant section of the botanical garden. All necessary information have to be collected in order to write an informative answer to the villagers. After a verbal presentation the pupils change their role. They become villagers and have to find out which plant is described in the letter written by another group. Provided with all information except the name of the most suitable plant the villagers have to find the plant in the medicinal garden to get cured.

Chestnut Room

16:00-16:30 PROFESSOR ANGELA MCFARLANE, ROYAL BOTANIC GARDENS, KEW, UK

Where will our curiosity lead us next?