Botanic Gardens Conservation International Education Review

roots

Volume 12 • Number 2 • October 2015

Room to Grow: Learning spaces in Botanic Gardens

- Propagating awareness about conservation with a greenhouse
- Growing a Learning Campus for children
- The Ecological Garden
- Informal learning spaces for deliberation on science

BGCI
Plants for the Planet

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TIME FOR TREES: CONNECTING PEOPLE WITH THE MAJESTY OF TREES

4-6 November 2015
The National Arboretum, Westonbirt

This year's congress will focus on the relationship between people and trees, with a fantastic line-up of talks and activities. Session leaders and speakers from the Woodland Trust, Royal Botanic Garden Edinburgh, the Sylva Foundation and Citizen Science, as well as many more, will be there to offer their knowledge and expertise.

The three day event looks set to be action packed and full of excitement.

For more information and to book visit:
http://bgen.org.uk/trainingdays/conferences/2015-conference-at-national-arboretum-westonbirt/

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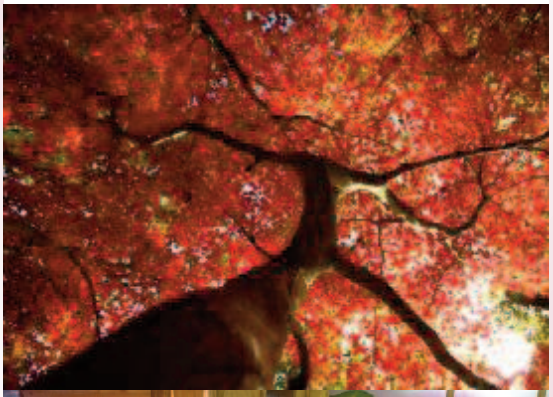

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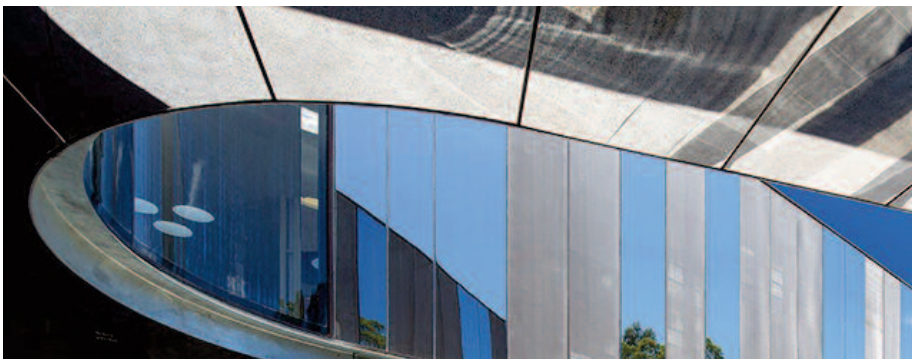

Forthcoming Issue
Volume 13 Number 1:
Science Communication

Cover Photo: Lichen garden at PlantBank
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Design: John Morgan, www.seascapedesign.co.uk

BGCI would like to thank the co-editors for their work in the production of Roots

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Roots is published by **Botanic Gardens Conservation International (BGCI)**. It is published twice a year. Membership is open to all interested individuals, institutions and organisations that support the aims of BGCI.

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BGCI is a worldwide membership organisation established in 1987. Its mission is to mobilise botanic gardens and engage partners in securing plant diversity for the well-being of people and the planet. BGCI is an independent organisation registered in the United Kingdom as a charity (Charity Reg No 1098834) and a company limited by guarantee, No 4673175. BGCI is a tax-exempt 501(c)(3) non-profit organisation in the USA and is a registered non-profit organisation in Russia.

Liliana Derewnicka

FIRST WORD
THE CHALLENGE OF LINKING LEARNING TO SPACE

The wealth of landscapes possessed by botanic gardens, like Phipps Conservatory an Botanical Gardens, can all be considered spaces where learning takes place. ©Banko Media, Inc

Although potentially a point of contention, learning can be defined as "a process which leads to the modification of behaviour or the acquisition of new abilities or responses, and which is additional to natural development by growth or maturation" (Oxford English Dictionary, 2015). The inherent scope and flexibility in this statement offers up a myriad of possibilities to the botanic garden educator. Yet, it also presents a challenge: how do we design a garden to best suit the learning of all our many visitors?

"The environment in which we construct new knowledge has an impact on what and how we learn" (Clore Duffield Foundation, 2015, p.5) and so to ensure a garden's messages are communicated effectively, learning spaces within them need to be fit for purpose. Achieving this is no mean feat. It requires considerations of both a practical and theoretical nature.

Does the space offer a physically comfortable environment? i.e. To ensure visitors can learn in a pleasant and appealing environment lighting, acoustics, heating and ventilation must be carefully planned (*ibid*.).

Is the design of the space conducive to learning from a sociological and psychological perspective? i.e. A space should possess inherent flexibility to offer a variety of experiences that cater for different learning styles and pedagogies (Blackmore *et al*, n.d.). Design should consider accepted, contemporary learning theories and relate them to the space (Guney and Al, 2012).

"A learning space should be able to motivate learners and promote learning as an activity, support collaborative as well as formal practice, provide a personalised and inclusive environment, and be flexible in the face of changing needs" *(HEFC, 2006, p.3)*

Furthermore, Malone (2004, p.62) considers botanic gardens to be "environmental holding environments". She suggests that, in an increasingly urbanised world, botanic gardens provide a rare, nurturing space for the free exploration of nature that should result in the learning about and connection with the natural world (ibid.). From this perspective it is important that the whole site be constructed with learning in mind. This includes not only classrooms and laboratories, but also displays, entrances, walkways, eateries, anywhere where the visitor will be piecing together the bits of their ever expanding understanding of the world. And what of a garden's online environment? In the 21st century garden, audiences are not only restricted to those who physically visit the site.

Maximising the learning of visitors to a garden is a challenge indeed. Yet it is one that the botanic garden education community is in no doubt fit to face. In this jam-packed issue of Roots we feature inspirational leaning spaces, approaches to design and cautionary tales from around the world.

Case studies of inspirational formal learning space development come from Phipps conservatory, who took a collaborative approach to the design of their SEED Classroom. Giving a large scale example is the Australian PlantBank, where technology and innovative design have been combined to develop new spaces and new ways for the teaching of science and plant conservation. Their work here involves engaging students with the practicalities of plant science which is also the case for *Carl Zeiss Microscopy Centre* at the Museum für Naturkunde Berlin.

Taking advantage of social areas: Bedgebury National Pinetum have devoted a new space in their atrium to interpretation about pines. Again, with more of a focus on informal learning, the Cadereyta Regional Botanic Garden and Nanjing Botanic Garden showcase how displays in glasshouses can be used to tell stories about the importance of plants

Yet, much of a botanic gardens is outside space and the design of this is no less important. In what follows we hear from Nairobi Botanic Garden about their grass garden. Jardin des Plantes of Muséum national d'Histoire naturelle explain the redevelopment of their Ecological garden. Taking to the trees, the University of British Columbia Botanical Garden share their approach to encouraging sustainable behaviours through a suspended walkway. The Chicago Botanic Garden also share lessons they are learning through the development of their ambitious Learning Campus, which seeks to offer children the opportunity to interact with nature.

Understanding science is also about having the opportunity to develop views on the ethics of different avenues of research. To this end, we hear about Opinion Lab which will provide spaces that allow children to explore their opinions on controversial subjects.

Developing and maintaining effective outdoor and indoor spaces that encourage learning requires input from individuals with expertise on many different areas. Finally, Andrew Vovides offers us a cautionary tale that highlights the importance of collaboration and communication when it comes to botanic garden development.

Lastly, we would like to thank those of you who took part in our recent survey about redesigning Roots. We have considered all of your helpful comments and catered our features accordingly. We hope that Roots now offers you what you want and need to enhance your practice. We have also informed the lucky winner of the prize draw!

Liliana Derewnicka
Botanic Gardens Conservation International

Effective learning spaces have flexibility to host a range of activities. Here, children are told botanical stories at the Nanjing Botanic Garden ©Li Mei

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Authors: Emily A. Kalnicky, Stacy Smedley, Richard V. Piacentini

Children taking part in an activity in the SEED Classroom at Phipps conservatory ©Banko Media, Inc.

THE **SEED** CLASSROOM

The SEED Collaborative was developed to design an innovative modular SEED classroom that would meet the Living Building Challenge and provide a safe and nurturing space to learn in. The authors will discuss the learning theories employed in the classroom's development as well as the collaborative and participatory approach used in developing the building and a curriculum for programs that utilize the sustainability aspects of the building.

INTRODUCTION

Children are the most vulnerable members of our society yet, quite often, we put them in some of the worst buildings in which to learn. These buildings often have poor access to natural light and ventilation and they expose children to many different toxic chemicals. These conditions are exacerbated when the classrooms are modular buildings. What if every child had access to an inspiring, healthy, and restorative learning environment? What if this space also created hands-on experiential learning opportunities for the children and teachers who learned and taught in it? And what if this space was self-sustaining and could be transported anywhere, could be a temporary or permanent space solution and was also modular and scale-able?

"The SEED Classroom has given us an opportunity to start a conversation in our community about what healthy learning spaces look like for children"
Richard Piacentini

↑ *Interior of the SEED Classroom, showing the exposed features of the building that are utilized in education activities ©Banko Media, Inc.*

The SEED collaborative was founded to address these issues, designing a modular SEED classroom that would also meet the Living Building Challenge. The classroom itself is an important tool in educating children about climate change and the impact of lifestyle choices on energy, pollution, materials and water.

DEVELOPMENT

Building specifications

The SEED Classroom is a hands-on sustainable learning space built to Living Building Challenge (LBC) standards. This means that the classroom is designed to be net-zero energy and water, is made of non-toxic materials, includes daylighting, urban agriculture and equity components, and creates a space that fosters inspiration, education and beauty. The SEED classroom is meant to address a school or institution's need for temporary or permanent additional teaching space. It is built to last up to 100 years and sits on a foundation system that allows it to have little impact on its site as well as making it easy to move in the future. The classroom is modular, and the base design is the same dimension as a standard portable classroom, totalling 83 m^2.

Co-Creative Design

Before the building process begins the designers work with students and teachers to co-design their classroom space. The students are challenged to imagine features that would make a "living" classroom. The most innovative features come from student designs: hand pumped water, a river in the floor and a swing in the classroom. Student designers are always brilliant and inspiring and many of these features are incorporated into the final design for the spaces. In this way, these classrooms are truly designed for and by students and teachers, specific to the space and place they will be used. This creates an environment suited to inspire and engage the people who will be learning and playing there.

COLLABORATIVE LEARNING SPACE

Learning environments should empower students and teachers to engage with the built environment and the ecological systems in which students live, learn and play. More broadly, science literacy is a skill necessary for individuals to develop and be informed citizens. The National Research Council (1996, pg. 22) defines a scientifically literate individual as someone able to "ask, find, or determine answers to questions derived from curiosity about everyday experiences. It means the person has the ability to

"My time as a teen SEED docent at Phipps Conservatory, has been exquisite to say the least. The people that come in to explore the SEED Classroom, show a genuine interest in the health of the next generation, and in the environment. Working in the SEED evokes a sense of pride knowing that Phipps, and the Pittsburgh community of are changing helping to change the perspective of Pittsburgh from the dirty smokey city, to a healthy greener city."
Aaron Sledge, SciTech Academy Senior in Highschool, Phipps intern

↑ *Exposed water pipes within the SEED Classroom that are used as educational aids for the teaching of water security ©Banko Media, Inc.*

"What a great place for the teens to live and learn about environmental issues"
High school internship evaluator

describe, explain, and predict natural phenomena." Unfortunately, the National Science Board (2014) indicated that the general public's understanding of basic scientific concepts and the process of scientific inquiry may be at a level insufficient to make informed scientific decisions.

The SEED classroom is a living laboratory that provides a portal to understanding the interdisciplinary nature of science, thereby enabling project-based and applied-learning opportunities that inherently include the mastery of STEAM (Science, Technology, Engineering, Arts, and Mathematics) and social studies. When students are able to apply new learning to real-world projects, they develop essential, systems-level, critical thinking capabilities. The quality and features of the SEED classroom enable this multidisciplinary and hands-on learning experience, with a focus on experimentation and creativity. Inside the SEED classroom, all of the building systems and components are intentionally left exposed so students can see and understand how the classroom functions and meets stringent Living Building requirements. Energy and water meters and hand-pump faucets allow student to engage directly with the functions of the building, fostering an understanding of how the student's actions impact the building, as well as an appreciation of how much energy is expended moving water and creating a comfortable space.

In addition to the collaborative learning occurring inside, the SEED classroom is designed to foster collaborative learning among teachers and administrators using the spaces for their classes. All SEED classrooms are connected to each other through an online system, SEED patch. Students and teachers can share lesson plans and stories about their experience in their SEED classroom as well as compare data collected.

SEED IN PRACTICE

In April, 2015 Phipps Conservatory and Botanical Gardens in Pittsburgh, PA became the second location in the US to host a SEED classroom. The SEED classroom is in addition to a classroom housed in the Center for Sustainable Landscapes, which is one of the greenest buildings in the world, achieving Living Building Challenge status, LEED® Platinum, Four Stars SITES™, and WELL Building Platinum certifications.

Energy and water meters and hand-pump faucets allow students to engage directly with the functions of the SEED classroom, fostering an understanding of how the student's actions impact their surroundings.

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↓ The SEED Classroom at Phipps Conservatory and Botanical Gardens ©Banko Media, Inc.

Phipps provides on-site formal educational programming annually to more than 4,500 school children and 1,110 adults, as well as outreach programming to an additional 3,700 middle and high school students. All of the educational programs focus on using a hands-on, inquiry-based approach, connecting kids and adults to the natural world, as well as providing the necessary tools to act sustainably. With the addition of the SEED classroom Phipps is launching fun and educational programs that showcase the features of the new SEED classroom as a great learning tool.

All lessons involve a multi-disciplinary and hands-on approach, focused on collaborative learning enabling "deeper learning" by all students involved, which is developmentally appropriate and comes from early childhood educators' needs to reach these deeper topics with their early learners. The NRC defines "deeper learning' as "the process through which an individual becomes capable of taking what was learned in one situation and applying it to a new situation (i.e. transfer). The product of deeper learning is transferable knowledge, including content knowledge in a domain and knowledge of how, why, and when to apply this knowledge to answer questions and solve problems. This blend of both knowledge and skills is referred to as '21st century competencies'" (National Research Council, 2012) and the benefit is greatest when starting young.

Additionally, for over 15 years Phipps has offered a high-school internship program focused on horticulture. New in 2015, as an extension of this program, we trained and hired our previous teen interns as SEED docents. Every Saturday from 11 am to 3 pm, 2 high school teens act as experts on Phipps' SEED classroom, focused on the energy, water, and ventilation systems. The teens guide our guests through the space and will continue to receive career development skills throughout the school year.

With its mission on sustainability and the connection between human and environmental health, Phipps is continuing to expand their programming from teacher professional development opportunities, to research opportunities for faculty and graduate students at their new Phipps Research Institute for Biophilia and Science Engagement and especially welcomes the opportunity to continue to collaborate with future SEED classroom educators and students. It is through these types of creative and collaborative learning spaces we can continue to inspire and engage learners and allow for creative solutions to some of the most pressing environmental issues.

↑ The SEED Classroom offers a safe and attractive location for children to learn in ©Banko Media, Inc.

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PROPAGATING AWARENESS ABOUT CONSERVATION WITH A GREENHOUSE

The Cadereyta Regional Botanic Garden is located in the semi-desert zone of Queretaro, Mexico. Its main education focus is communicating the value of native flora. The greenhouse has been adapted for visitors. Children and adults learn about reproductive processes, practicing the steps involved in plant propagation and investigating the principles that allow plants to grow. The communication of these principles is done through various activities, ranging from conversations with staff, to long term courses. The greenhouse raises awareness of the importance of nature and native flora and inspires people to join efforts for its conservation.

↑ *Students are taught about the cultivation of young cacti and succulents ©CRBG*

INTRODUCTION

The horticulture and propagation of wild plants for the development and maintenance of botanical collections (*ex situ* conservation), is now well recognized as a complementary part of *in situ* conservation. Megadiverse countries, such as Mexico, have the blessing and responsibility of being home to marvelous species; their plants are natural capital. However, it must be recognised that this involves demanding work to ensure the healthy function of ecological systems. The conscience of the Mexican people, plays a critical role in the conservation of Mexico's native plants; therefore their ecological awareness needs to increase. The Global

The Cadereyta Regional Botanical Garden greenhouse facilities have been visited by nearly 100,000 people in recent years (2010-2015); many of them are children from poor communities in the State of Queretaro.

← *A guide giving a public tour around Cadereyta Regional Botanic Garden ©CRBG*

Strategy for Plant Conservation 2011-2020 and the Mexican Strategy for Plant Conservation 2012-2030 both highlight this. The Cadereyta Regional Botanic Garden (CRBG), consistent with this, has carried out educational activities that promote the use of the flora of the region under the principles of sustainable use.

ORIGIN AND PURPOSE OF THE GREENHOUSE

The development of protocols for the propagation of wild species for their conservation is one of the pillars of the work of the CRBG. Our motto is: "to propagate is to conserve". One of the purposes of this activity is to exhibit a model that allows the sustainable use of the plant resources in the region. With this in mind, and in order to share these ideas with our visitors, the CRBG developed procedures for engaging the public with the use of plant material in 2011. Various instruments of public engagement have been implemented. These range from guided tours, workshops and courses on the propagation of wild species. In particular, the guided tours have been a great success. The content of the tours seeks to be comprehensive. The learner is led through a narrative of the Semi-desert, whose flora is represented in the CRBG collection. During the tour, the role of plant species as key elements for maintaining the equilibrium of ecosystems is highlighted, as well the economic and cultural importance of these species. The tour culminates in the 'Unit of Propagation of Wild Plants' (UPWP): a greenhouse that summarizes the propagation of our native plants. The greenhouse encourages our visitors to reflect on our natural capital (the blessing and responsibility that this implies) with the aim of inspiring respect for the natural world and recognition of the potential of plants as a natural resource.

AN INVESTIGATIVE SPACE FOR THE PUBLIC TO LEARN ABOUT PROPAGATION

The UPWP is a successful space because it conveys the principles of conservation through investigative actions engaging, both emotional and cognitive learning. The workshops and courses that are taught in this unit are carried out in one or more sessions and delivered primarily to school children. Its content utilizes a design that inspires the development of environmental and natural knowledge (Armstrong, 2002). This starts with creating an emotional experience or reaction towards plants, highlighting their beauty, their intrinsic mechanisms for survival and their usefulness to man; as well as providing a scientific and rational experience. Propagation occurs in 3 stages: germination, initial development and completion.

We cultivate more than 110 species of native plants in the greenhouse; 40% are species at risk of extinction.

↑ *Visitors investigate a huge barrel cactus in the Cadereyta Regional Botanic Garden ©CRBG*

The greenhouse encourages our visitors to reflect on the meaning of our natural capital with the aim of inspiring closeness towards the natural world.

↑ *Students are shown the propagation of cacti and succulents behind the scenes at the glasshouse in Cadereyta Regional Botanic Garden ©CRBG*

During the workshops or courses, each phase is linked with higher educational goals:

1. Recognition of the value of the local plant diversity as an important factor in the survival and quality of life for local human populations.
2. Understanding of the process of propagation as an essential mechanism in the recovery of species at risk of extinction.
3. Inspiring and mobilizing people to participate or start projects for the recovery of endangered species.

THE SATISFACTION IN CONSERVATION

The observation of the developmental process of seedlings, from their germination to their establishment is, without doubt, a method of experiential learning which is ideal for acquiring knowledge that can be applied to conservation. Likewise, the "souvenir" offered at the end of the guided tours, invites our visitors to adopt a plant: a cactus, an agave or a native tree. In this way the visitor, in addition to a bit of knowledge, brings with them an element that commemorates their experience at the CRBG.

Utilising the greenhouse as a system for public engagement has proven to be, in general, a success with visitors. They acquire an admiration for plant diversity and the elegance of natural processes. It is also important to mention, however, that there are situations in which the visitors cannot connect totally with this experience. This can be case for people whose core values are in an urban life style, yet, we must believe that if their relationship with the CRBG and their experience with the plants is extended to more than one visit, some of our messages will be communicated and perhaps, in time, it will get them closer to appreciating the natural world. So, it can be said, that like the propagation procedure, our educational processes require an element of patience: it takes patience when observing and encouraging the development of plants and the same can be said for education, especially when complicated messages are being conveyed to a disengaged audience.

CONCLUSION

There is no doubt that botanic gardens are spaces that should be encouraged. Unfortunately, it is also important to recognize that in Mexico there is a requirement for more sites of this type, sites that are conducive to the conservation of the goods of nature. Greenhouses offer a space, open to visitors, that can enhance engagement with the principles and processes propagation. They can also aid the development of knowledge and sensitivity to conserve nature and endangered species, even in people who are disengaged from the natural world.

"[the greenhouse was] a unique experience. It is good that the botanical garden cares for endangered species".
Noemi Gonzalez, August, 2015.

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← *A group photo in front of some of the gardens stunning cacti after a great day in the gardens ©CRBG*

Author: Cath Weeks

BEDGEBURY ATRIUM -
DESIGNING A VISITOR INTERPRETATION SPACE

The record breaking conifers wall is a big hit with visitors to Bedgebury's National Pinetum ©Forestry Commission

Conifers have a bad name in the UK. So how do you inspire visitors to one of the world's most complete conifer collections to care about such pariahs? The newly-redeveloped atrium of Bedgebury's visitor centre employs record breakers, plant hunters and an enormous dinosaur to do just that. We transformed a dingy, draughty undercover area into an interpretation space that brings out the 'wow factor' of these fantastic trees. Now we're hoping to use the atrium as inspiration for updating the rest of the pinetum's interpretation so that the appearance and contents all links together.

THE CHALLENGE... AND OUR BIG CHANCE

The bad press around conifers is misleading; there's more to them than out-of-control garden hedges and disputes between neighbours. These trees are actually rather wonderful: the tallest, biggest and oldest living things in the world are all conifers. They come in a variety of shapes, sizes and colours and we all depend directly on them for much of our everyday life.

Despite how often we see them in gardens, a third of all conifers are close to extinction in the wild. That's where the National Pinetum at Bedgebury comes in. It's a Forestry Commission-owned site in the South East of England containing one of the most comprehensive collections of conifers anywhere in the world. We also work in partnership across the globe to help save these trees.

Limited resources, time and the need for interpretation to be 'stick whackable' meant we opted for scale and durability over high tech.

← *Plant hunters emerged as a favourite topic in the thematic planning process ©Forestry Commission*

"...the engaging and well presented interpretation is excellent, especially the wall paintings and information on the tallest trees, plant hunters and the essential work carried out at Bedgebury."
Comments on Bedgebury atrium interpretation from VisitEngland report, April 2015.

The Global Strategy for Plant Conservation (GSPC) is a key document that sets the direction for the pinetum's work. Target 14, (communicating the importance of plant diversity and the need for its conservation) sets out an important part of our duty as a tree collection: to tell people what we do and why (CBD, n.d).

The National Pinetum is part of a bigger, complicated site that also includes a timber forest containing bike tracks and an adventure playground. In fact, until spring 2015 many of Bedgebury's visitors probably never knew the pinetum was there, much less what it was – there was nothing interpreting the tree collection at the visitor centre at all.

Putting it bluntly, we were missing a trick.

In 2014 we had an opportunity to redevelop Bedgebury's visitor centre, extending the café and creating an enclosed space out of what had previously been a dark, draughty undercover area. This new 'atrium' would be an eating area, full of a captive audience for interpretation about the pinetum, and the first Forestry Commission eating area to get this kind of treatment.

This was our chance: it was now or never.

STICK-WHACKABLE AND WOW

The process started with the Bedgebury Management Team agreeing the parameters for the interpretation. First of all, it had to be durable (one person coined the phrase 'stick-whackable') in order to survive the attentions of some of our younger visitors. It also had to be low-maintenance, relatively low cost, and its production time had to coincide with that of the redevelopment build (i.e. fast.). High tech was not an option.

We decided to develop the project in-house, using the Forestry Commission's internal Design and Creative team as well as the expertise of Bedgebury staff.

Most importantly, the Management Team agreed the objectives for the interpretation: what we wanted visitors to know, having seen it, and what we wanted them to do. We were aiming to raise the awareness of the pinetum, its work and the importance of conifers. We also wanted to inspire visitors to take action to help. We were clear about how we wanted visitors to feel when they saw the interpretation too, in a word, 'wow'. We also pinned down the main audiences for the interpretation (families and 'empty nesters' – those aged 45-65 with no children in the household).

A key element of the atrium would be a sponsorship wall for the Friends of Bedgebury Pinetum, the charity who support us and who generously paid for the interpretation. We needed something visually stunning which allowed for the sponsorship of at least 500 elements. (In the end the designers outdid themselves and gave us 700).

↑ *A 4m tall Brachiosaurus dinosaur in the front windows illustrates the ancient nature of conifers - They apparently were partial to the odd conifer. ©Forestry Commission*

"The thematic planning was really successful. It meant that we could target topics that were universal and appealed to a range of visitors"
Pete Maxwell, Designer, Forestry Commission England Design and Creative Team.

Setting clear objectives up front proved extremely useful in the stages to come, to help us keep the project on track.

POST-IT FUN

The next stage was a first for me: thematic planning with the Design and Creative team. Much more fun than it sounds! Bedgebury staff and the designers met up and scribbled down every theme that we could possibly cover on post-it notes, using the interpretation objectives as a guide. It wasn't long before a white board was completely covered with post-its.

We couldn't cover every idea on the board; we had to narrow them down. To do this, the designers used their knowledge of what would appeal to the target audiences and what would work graphically, and the Bedgebury team used their site and subject knowledge, as well as referring to the objectives as a steer. The process was a 'conversation' which led to a mutually agreed set of topics that appealed to a wide range of visitors.

COULD YOU JUST MEASURE THAT AGAIN?

We didn't have long for the development and production of the panels, which made up the interpretation, so we decided to keep the technology simple and use a tried and tested material: Dibond. However, we did opt for one innovation: we decided to make the panels the full size of the entire walls in the atrium, some over 4m high, so that the space would effectively be clad in interpretation from floor to ceiling.

This wasn't without its challenges: the walls were uneven, complicated shapes which were extremely difficult to measure. After the third or fourth set of measurements (all different!) we opted for templates. The production company used these to produce the final panels, a bit like a dressmaker cutting round a pattern. This was more expensive but proved more successful: the final panels fitted perfectly, to our relief.

WATCH THIS SPACE...

Predictably the most innovative element, the sponsorship wall, has taken the longest to produce. Rather than opting for something off the shelf, the design team have created something beautiful using botanical artwork from Bedgebury's Florilegium Society on engraved wooden plaques of varying timbers and thicknesses. The technical difficulties involved have delayed final production, but we're confident that doing something a bit different will result in a stunning, and lucrative, piece of wall art.

A TERRIBLE CONFESSION

The reality of being a learning manager covering the East of England is that other priorities took over as soon as the atrium installation was complete. So I confess I have not had time to do a formal evaluation of the atrium interpretation yet. However the panels have already drawn praise from public and peers alike, and the consensus is that the atrium is now a vastly improved internal space. Hopefully evaluation will prove that the project has achieved its objectives too.

Have you ever painted a room at home and then realised that the rest of the house looks tatty? We're in the same boat: now that the atrium's finished, we need to update the remaining interpretation in the pinetum to bring it up to the same standard. However, that's been the beauty of this project for me: it has raised the bar for the whole pinetum, and it will inspire the look and content of new interpretations on the site for years to come.

"Did you know? Coniferous ('boreal') forests in the northern hemisphere store the same weight of carbon as 1.6 billion blue whales. Conifers play a large part in shaping the world's climate."
(Just one of the messages from the atrium interpretation.)

THANK YOU

Thank you to: all the Bedgebury staff involved, the Forestry Commission Design and Creative team, BAF Graphics and – last but not least - the Friends of Bedgebury Pinetum for their generous sponsorship of the atrium interpretation.

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Author: Agnes Lusweti

A lone reader at amphitheater in the Grass garden (figure 1.) ©A.M Lusweti

APPRECIATING GRASS: THE FORGOTTEN FLOWER

The Grass Garden and 80-seater amphitheatre were established at Nairobi Botanic Garden between 2009 and 2011, through partnership with the Finnish embassy. The garden seeks to demystify grasses and help conserve rare, endemic and endangered Kenyan species (monocots in the family Poaceae). It has two sections: decorative display and education. The display exhibits ornamental, lawn, economic and decorative grasses. The garden design and layout exploits the versatile character of grasses, displaying their morphology, variable sizes and inflorescence. This learning space is used to: disentangle true grasses from 'grass' in horticulture, contextualise grass ecology and underscore the economic importance.

INTRODUCTION

Grasses are the world's most abundant plant (Ibrahim & Kabuye, 1987), occupying over 30% of the world's total land area. Botanically, grasses belong to the families Graminae and Poaceae, the fourth largest plant family worldwide with over 11,000 taxa (Antieau, 2013). Ecologically, grass grows in a wide range of habitats, altitudes and climates including deserts, savanna woodlands, alpine zones, forests, forest glades, saline and fresh water zones. It encompasses cereals like maize, rice, wheat, sorghum, barley and millet among others; and is the staple food for most of the world's population. Grasses are also the world most important pasture and fodder, supporting the majority of grazing herbivorous animals.

↑ *Visitors can discover a variety of different grass species at the Grass Garden ©A.M. Lusweti*

← *Grass is Sweet interpretation panel in the gardens ©A.M. Lusweti*

They also provide industrial raw materials, directly supporting the production of drinks including alcohol. According to Ibrahim and Kabuye (1987), Kenya is home to some 587 grass species in 142 genera, growing in different habitats. Despite their importance and abundance, few people appreciate grass species.

Everyone interacts with grasses: in the wild; in sports, homes and living spaces as lawns; in agriculture as weeds; in the kitchen as food and used as materials in art and design (Lewington, 1990; Anon., 2008). 'Grass' conjures up thoughts of lawns, food, meadows, prairies, savannas, and pastures among others, depending on personal inclination. Grasses also reveal dramatic stories of evolution and innovation, self-defense, efficiency and adaptation (Attenborough, 1995; Antieau, 2013). In horticulture 'grass' includes all true grasses and sedges (Cyperaceae), rushes (Juncaceae) and Reedmace (Typhaceae) (Schoenaich, 1995). Like other plants, their versatility, durability and beauty, even when dead, means they can be integrated into any garden design (Von Schoenaich, 1995) or floral arrangement.

A GARDEN FOR GRASSES

The three objectives for the Grass Garden were: to display the diversity of grasses; to display common lawn grasses and to help conserve the rare grasses of Kenya (Maunder & Gohler, 1995). The site, previously a rough meadow with old trees and young regrowth, with a large degree of sloping (over 45% slope), was deemed to be ideal. The steep slope over basal rock provided the base for the rugged stone ampi-theatre; and the opportunity for soil erosion control which both became important educational aspects.

ELEMENTS OF THE GRASS GARDEN

The grass garden has two main sections; the decorative display area and the informative educational area including the amphitheatre. The decorative area displays both indigenous and exotic species of common lawn grasses as well as decorative grasses, as proposed by Maunder and Gohler (1995). Lawn grasses include *Pennisetum* spp. (Kikuyu and Durban grass), *Cynodon* spp. (Maadi River) and *Paspalum notgatum* spp. (Bahia grass). This allows visitors to closely interact with and learn about the growth characteristics, textures and colours of different lawn species. The decorative grasses include perennials such as *Phormium* cultivars, *Miscanthus* spp., *Festuca* spp. and cultivars of *Pennisetum* spp. (fountain grass). In addition there are indigenous grasses such as *Sorghum arundinaceum* (Birds millet), to attract seed-eating birds to the garden. The informative and educational area is dedicated to the diversity of grass, especially rare and economically important grasses as proposed in (Maunder & Gohler, 1995). The seasonal displays feature cereals grown in Kenya such as maize, rice, wheat, barley, sorghum, millet and oats. Perennials include sugarcane, Pennisetum giganteum (elephant grass), bamboo, pampas grass and Rhodes grass. Information on grass is particularly important; hence interpretation is included for visitors.

The grass garden design and layout exploits the versatile character of grasses, morphology, variable sizes and inflorescence.

↑ *Guided tours give more information about grasses ©A.M. Lusweti*

After observation, the students deduce and interpret the information gathered; the aim is that they will appreciate the variation demonstrated by the grass species displayed at the site.

In nature, grasses give character to the landscape and identity to locations and this is communicated by the planting and supporting interpretation at the grass garden.

← *A beautiful Ensete taking center stage ©A.M. Lusweti*

LEARNING ABOUT GRASS

Visual literacy involves deriving meaning by observing an object (Friedlaender & Friedlaender, 2013). It is developed by being exposed to the unfamiliar. Differentiating grasses requires good observational skills, or visual literacy, in conjunction with other senses. Observation is used for all learning levels, especially younger learners. Friedlaender & Friedlaender (2013) describe remarkable results, using observation of paintings with students of medicine. Since grasses closely resemble each other, accurate descriptions are important. In the grass identification class, students are encouraged to list descriptive words, which they later interpret further. The learners may initially note that grass has green leaves but, the specific green colour, texture, markings and surface characteristics vary (Anon., 2008). Some grasses have rough leaf-blades (Attenborough, 1995). Leaves may be ribbed, veined, keeled or tapered (Anon., 2008). The tops of leaves may be smooth, jagged, glossy, dull or a combination (Anon., 2008). The roots of some grasses may be modified into stolons or rhizomes (Attenborough, 1995). After observation, the students deduce and interpret the information gathered; the aim is that they will appreciate the variation demonstrated by the grass species displayed at the site. Students can also collect grass and create murals and montages (Figure 2).

Observation improves one's focus, deepens precision and objectivity, and helps the learner improve their associated vocabulary. Consequently, the instructor also achieves the other intended outcome, of enhancing students' communication skills (Friedlaender & Friedlaender, 2013). At a tertiary level, surveying, collecting, curating, mounting and construction of identification keys comprise a practical lesson taught at the grass garden. The garden allows for other learning approaches including lecture, discussion, demonstration, storytelling or music at the amphitheatre, as well as presenting a wide variety of grass species to offer students the opportunity to make direct comparisons between the morphology of different species. Therefore, there is no limit to the educational uses and benefits of grasses and the grass garden and amphitheatre, themselves.

CONCLUSION

Visiting the grass garden greatly improves one's appreciation of grasses. In nature, grasses give character to the landscape and identity to locations and this is communicated by the planting and supporting interpretation at the Grass Garden. Grasses are a socially important species: They form the basis of diets; they provide raw materials for beverage production, alcoholic drinks and biofuels; In Kenya, bamboo is important in both the food and building industry. Therefore, it is important that the public appreciate this. The Grass Garden offers a space for people to learn about these special species to appreciate their characteristics and lifecycle as well as their uses and significance.

In the grass identification class, students are encouraged to only use descriptive words. Since grasses resemble each other remarkably, accurate descriptions are important.

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ENGAGING LEARNING SPACES AT THE AUSTRALIAN PLANTBANK

A student exploring one of the forty features of the Diversity Wall, the main feature of the PlantBank, situated in its center ©Australian Botanic Garden Mount Annan

The new Australian PlantBank building and its encompassing landscape is transforming learning experiences for Australian students and the wider public. The innovative design of the building, its award winning interpretation, adaptive learning spaces and the incorporation of technology have led to new ways of teaching science and plant conservation to students all over Australia.

When the team working at the Australian Botanic Garden Mount Annan put together their plan for a new building to house their seed bank facility, they took a holistic approach to designing, de novo, a building that would not only house scientific research but would also be a unique learning space. Having few constraints, the design team were able to have free rein to work with receptive architects to develop a multi-level learning space. Opened in late 2013, a variety of formal and informal spaces within and surrounding PlantBank have enabled a variety of lessons to be designed to suit different ages, learning styles and student and teacher needs.

The botanic garden took a holistic approach to designing a building that would not only house scientific research but would also be a unique learning space accessible to students and the public.

Within PlantBank glass-walled working laboratories enable observation of scientists at work. Interpretative graphics, images and text demystify the science on view, and at the heart of PlantBank, a stunning interactive exhibition, *The Diversity Wall*, explores the wonders of plant-life. The landscape enveloping the built structure has been designed as part of the interior experience; wherever you look you can see into the garden or the critically endangered Cumberland Plain Woodland.

The design of the building and its surrounds creates a sense of wonder for those that visit. People can engage passively or actively with this facility and be immersed in the science of the building. This provides new opportunities to engage with students and visitors and has allowed the transformation of learning at this garden. Lessons utilise the rich content of PlantBank's interpretation to create unique and inspiring learning experiences for primary and secondary students.

INTERACTIVE LEARNING PROGRAM

With generous support from HSBC Bank Australia, a Principal Partner of the garden, the education team launched the Interactive Learning Program in November 2013 from the Australian PlantBank. This three year support is for both the Australian Botanic Garden Mount Annan and the Royal Botanic Gardens Sydney to provide resources for children who are unable to come to the gardens. They learn about the beauty and diversity of plants through the video conferencing of lessons. This support has enabled the education team to employ a part-time teacher to coordinate the program and purchase essential equipment to run virtual lessons and enhance in situ lessons.

REAL SCIENCE IN A SCIENCE LAB

The Persoonia Learning Laboratory within PlantBank is a well-resourced multi-purpose wet science lab funded with support from Foundation and Friends of the Botanic Gardens. It is designed as an extension of the working laboratory spaces. With one adjacent glass wall it places students inside the science of the building and enables them to experience learning within a real science laboratory. The students combine getting dirty with using technologies, digital microscopes and plant models to learn about plants. They enjoy looking through the wall into the labs and feel inspired about plants and their conservation.

↑ *The impressive exterior of the new PlantBank structure ©Australian Botanic Garden Mount Annan*

"The video conferencing session was one of the best we have been involved in ... all of us agreed that it was fantastic!"
Lancaster Primary School – Aboriginal People and Plants VC.

↑ *One of the PlantLab education staff conducting a lesson by video conference to class at a remote school ©Australian Botanic Garden Mount Annan*

We have succeeded in engaging with new audiences, have become more creative and flexible, and use more technology and real science in our garden-wide lessons and programs.

VIDEO CONFERENCES BEYOND THE WALLS

Being able to transform the Persoonia Learning Laboratory into a well-resourced live laboratory to deliver video conference lessons to remote schools has changed our teaching practice and enabled the gardens to reach audiences beyond its walls. This gives teachers access to expert knowledge that is difficult to access in their classroom, particularly those in rural or remote areas.

Live plant material delivered to participating schools has enabled increased student engagement in video conferencing. During our "Aboriginal People and Plants" session for example, our Aboriginal educators have delivered cultural information on plants, whilst in the remote classroom the students are touching and smelling relevant plant materials that have been mailed to their classroom.

It was not all plain sailing - as it took six months to work through the firewall barrier and establish video conference links outside the organisation's network. Once conquered, video conferences have engaged with audiences as far afield as Lord Howe Island, remote one teacher schools in Victoria and New South Wales and even as far as China.

SCIENCE SYNERGY

The synergy of working with scientists within this unique space has enabled education staff to source relevant plant material and unique and accurate scientific information. Scientists have also been able to join our lessons and talk directly to students in remote locations and answer their questions. The nursery adjacent to PlantBank has enabled the use of Australian plants to demonstrate their unique features.

DIVERSITY WALL

At the centre of the building is an interactive exhibition, the Diversity Wall, that presents over forty cabinets, drawers, stories and graphic panels exploring the wonders of plant-life. The engaging presentation of this wall has an appeal to young children as well as older visitors. Having such a large resource of material available has meant that the wall is an integral element of most lessons at PlantBank. The creative potential to incorporate more aspects of this wall in education programs is exciting.

↑ *Students taking part in a seedling activity in the specially designed Persoonia Learning Laboratory ©Australian Botanic Garden Mount Annan*

"It was great interacting with the scientists. The students really enjoyed this and couldn't wait to do their own experiments."
Lake Charm Primary School, Victoria – Experiments VC.

↑ *The Living Laboratory, which forms the outdoors section of the Plant Bank, where students take part in activities such as plant identification. ©Australian Botanic Garden Mount Annan*

We have succeeded in engaging with new audiences, have become more creative and flexible, and use more technology and real science in our garden-wide lessons and programs.

COLLABORATIVE TECHNOLOGY

Incorporation of innovative technologies such as the use of iPads in lessons has enabled new creative learning opportunities for students. Group project work on aspects of the endangered Cumberland Woodland has students using iPads to research, take photos and then use apps to create scientific posters. Such opportunities can really engage students and empower them as creators and collaborators.

LIVING LABORATORY

An extension of the PlantBank surrounds is the 'Living Laboratory' research garden, which uses a collection of plants from the remnant Cumberland Plain Woodland, a critically endangered ecological community of the region. The interpretation of this garden provides a focus point for learning and outdoor experiences and has been based on themes such as *Plants and People, Plants and the Environment, Plants and Science*, and *Plants and Animals* which fits well with curriculum focuses. In the future the garden will be used for more outdoor learning experiences as it grows and develops.

IN CONCLUSION

Since the opening of The Australian PlantBank we have incorporated the new teaching laboratory into our lesson programs which had previously focused solely on outdoor learning in large natural learning spaces and themed gardens. We have succeeded in engaging with new audiences, have become more creative and flexible, and use more technology and real science in our garden-wide lessons and programs.

Whilst we have successfully engaged young audiences and older students in a variety of education programs we are still developing simple and innovative communication techniques to engage early childhood audiences with complex plant science content. Overall, students have reacted extremely positively to the building and the hands-on learning experiences at PlantBank.

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↓ School children exploring the Living Laboratory with the use of iPads, during a group activity.
©Australian Botanic Garden Mount Annan

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SUSPENDED WALKWAYS AND SUSTAINABILITY

Field School team including students, faculty and staff exploring the 308 m long walkway up in British Columbian forest canopy. ©Tara Moreau

Forest canopies are hailed as one of the last biological frontiers and a surprising source of species diversity. Nestled in the temperate rainforest at the University of British Columbia Botanical Garden, the Sustainable Communities Field School is an educational program taking root that aims to increase the number of Vancouver businesses and organizations greening their operations. A 310-m-long tree-top canopy walkway forms an innovative, nature-immersive learning space where participants explore connections between forests and water, biodiversity and climate change, and communities and nature.

SUSPENDED WALKWAYS AND SUSTAINABILITY

Field schools are schools without walls. They allow learners to engage with the natural world using all of their senses. Field schools have a proven track record. The idea was borrowed from the United Nations Food and Agriculture Organization (FAO), which developed the concept in South East Asia (SEA) in the early 1990's. Pesticide use among farmers in SEA was increasing, even though concerns about their negative effects were widespread. When individuals were brought together for Farmer Field Schools, behaviors were altered and pesticide use decreased (Settle *et al*., 2014).

↑ *The Field School conducts many different environmental talks, one of which is how forest canopies filter light which causes diversity in lower organisms. ©Tara Moreau*

← *A corporate group visiting the Field School, taking part in nature based team building activitie. ©Tara Moreau*

In Vancouver, the concept of a field school was further developed by Dr. Tara Moreau who, as part of her postdoctoral research with the Pacific Institute for Climate Solutions, designed and launched the Urban Farmer Field School (UFFS) in Vancouver, endorsed by the Society Promoting Environmental Conservation (SPEC, 2015). Now in its 4th year, UFFS focuses on education around urban agriculture, food systems and climate change.

UBC Botanical Garden is situated in a temperate rainforest on Point Grey, on land directly overlooking the Pacific Ocean. The climate allows for significant diversity and the botanical garden's collection consists of more than 50,000 accessioned plants representing over 7,000 taxa. As Canada's oldest university-based botanical garden, applied research and education connect the garden to academic work within the UBC Faculty of Science.

Botanical gardens, beautiful environments with a strong community presence, are uniquely positioned to engage visitors in learning about biodiversity, climate change solutions and international policies that affect those issues. They provide researchers, educators and the public documented, well maintained plant collections and education programs. This contributes to global biodiversity and conservation objectives, such as those described in the Convention on Biological Diversity (CBD). The CBD's stated objectives include improving the public's "education and awareness about plant diversity, its role in sustainable livelihoods, and importance to all life on Earth" (CBD Secretariat, 2015).

The Field School at UBC Botanical Garden is a non-profit collaborative program managed by the garden, UBC Department of Psychology and SPEC. The Field School team is developing interactive methods to engage the employees of local businesses in stimulating experiences in nature that, among other things, will help Vancouver achieve its Greenest City Action Plan (City of Vancouver, 2015). Central to the Field School's pedagogy is the Greenheart Canopy Walkway, a 308-metre long, cable bridge system that is itself a model for sustainability. Using 'tree hugger' cable systems and 'kissing bar' stabilizers, the innovative engineering design allows visitors to experience the canopy with minimal impact on the trees and surrounding ecosystems.

Currently in its pilot phase, participants in the Field School report experiencing an adrenaline rush as they climb the suspended bridge system into the forest canopy. High above the forest floor, standing on tree platforms participants discover how red alders (Alnus rubra) fix nitrogen to help regenerate forests devastated by wildfires. They learn how forest canopies filter light, allowing a diversity of smaller plants and other

Through engaging exercises and immersive experiences, paired with local knowledge and best practices, the Field School aims to positively affect the environmental attitudes of visitors.

↑ *The field school aims to improve attitudes to nature and sustainability by providing opportunities for the public to engage in with nature through a hands on experience ©Tara Moreau*

Central to the Field School's pedagogy is the Greenheart Canopy Walkway ... the innovative engineering design allows visitors to experience the canopy with minimal impact on the trees and surrounding ecosystems.

↑ *An example of the 'tree hugger' system that means the walkway causes as little impact as possible to the trees. ©Tara Moreau*

organisms to flourish in the soils below, and how forests protect local watersheds by regulating water flow through absorption and filtering processes. In Vancouver and much of western North America, water conservation was an especially relevant issue in the summer of 2015 as reservoirs were extremely diminished and water restrictions widespread.

The Field School aims to not only change attitudes towards the natural environment, but ultimately to better understand the psychology of sustainable behavior change. Recent research by Williams et. al. (2015) demonstrated how botanic gardens can alter attitudes. Using the framework of the New Ecological Paradigm, these researchers presented quantitative evidence demonstrating how informal education at botanic gardens can positively affect the environmental attitudes of visitors. Through engaging exercises and immersive experiences, paired with local knowledge and best practices, the Field School is building on this research, as well as the work of the FAO, and the experience of the SPEC Urban Farmer Field School. As part of this project, the team will measure the effect the Field School and its Greenheart Canopy Walkway have on changing sustainability behaviors. Initial results of the 2015 pilot project will be used to refine programming and define metrics and activities for the years to come.

← The canopy walkway offers the opportunity to get up and personal with the trees at UBC Botanical Garden ©Tara Moreau

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← A group take to the trees along the Greenheart Canopy Walkway ©Tara Moreau

Author: Alexandra Moormann & Astrid Faber

THE CARL ZEISS MICROSCOPY CENTER-
A TEACHING AND LEARNING LABORATORY

A student attending the project "Experiments with Heart" investigates the circulation of invertebrates ©The Carl Zeiss Microscopy Center

The *Carl Zeiss Microscopy Centre* is a place that invites visitors to participate in research activities. Together with scientists and educators, students can explore the wonderful world of water drops, or investigate criminal biologists in a project called "CSI fly". The centre was founded by nine of the museums' scientists to offer microscopy courses for children, based on their own research questions. In the future, the goal will be to develop specific activities for adolescents and adults in order to increase their participation and thus nurture inclusive learning for all visitors.

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Today the microscopy centre is an established learning laboratory with more than 10,000 supervised visitors a year.

The Carl Zeiss Microscopy Centre (CZM), a learning laboratory at the Museum für Naturkunde Berlin, is situated in the middle of the museum's exhibitions. This unique lab is a place where children, adolescents and adults can gain an understanding of natural history through hands-on experience and experiments. The educational approach offers visitors of all ages, with diverse educational backgrounds, an authentic insight into scientific research at a natural history museum that houses more than 90 scientists and over 30 million objects.

The microscopy centre was founded in 2006 by nine of the museum's scientists. Their main objective was to pass on their own enthusiasm for their scientific work. The idea was to deliver microscopy courses especially for children, based on the scientists' research topics. The microscopy centre's motto can be described as "the best way to understand science is to do science", and hence promotes scientific literacy (Hodson, 1992). Today the CZM is a part of the education department where it sees, museum educators and scientists to work together to develop new educational programs which integrate current research topics. While in the beginning the CZM was solely funded by a third-party, its financing is now also part of the museum's budget. The centre's equipment consists of twenty high quality stereo microscopes and sixteen stereo microscopes as well as lab equipment such as pipettes and petri dishes, aquariums and terrariums.

Today the centre sees more than 10,000 supervised visitors a year and is used by various groups and organisations including teachers, students and citizen scientists, schools, universities and associations. These groups visit the CZM for a variety of purposes. On the one hand, school classes come to the CZM to attend introduction and advanced courses, whereas, associations use the microscopy centre for meetings. For example, the entomological association, ORION - a group of amateurs who want to share their enthusiasm for entomology - meet at the CZM once a week.

WATERFLEAS, CRIME INVESTIGATIONS AND EXPERIMENTS WITH HEART

The school's courses are based on particular curricular and national standards for science education and allow pupils to familiarise themselves with scientific research methods, such as scientific drawing. The use of drawings caters to individual learner differences (Ainsworth, Prain & Tytler, 2011). A basic instructional course for primary school classes (pupils age 9 to 11) is an "introduction to microscopy". Pupils acquaint themselves with the structure and functionality of a microscope by examining micro-organisms like water fleas (*Daphnia*) and by experimenting on their own. The development of practical skills, such as the ability to focus a microscope, is one of the aims of practical work in science education that fosters scientific literacy (Abrahams, Reiss & Sharpe, 2013).

An exciting course for secondary school students aged 14 and up is the workshop, "CSI fly". The students slip into the role of a crime scene investigator (CSI) and learn what the fly larvae, located on or in a dead body, betray about the location or time of death. In the practical part of this course, students solve a criminal case by investigating different larvae and adopting the knowledge they learned beforehand in the theoretical part.

← *Pupils collect water samples on a fieldtrip to a protected landscape. The next day they analyse and identify the samples ©The Carl Zeiss Microscopy Center*

The unique microscopy center is a place where visitors can gain an understanding of natural history through hands-on experience and experiments. The educational approach offers an authentic insight into scientific research.

↑ *A group of scientifically-minded youngsters investigate different issues in a biweekly workshop conducted by two teachers ©The Carl Zeiss Microscopy Center*

The microscopy center offers visitors of all ages an authentic insight into scientific research at a natural history museum that houses more than 90 scientists and over 30 million collection items.

Aside from biological issues, the CZM is mandated to investigate the geological sciences, e.g. mineralogy. Students work together with scientists and education officers to marvel at the mysterious beauty of thin sections of stones and minerals, even meteorites from outer space. In the course "What am I" students (from age 10) view stones and minerals under a microscope, and identify them by determining the density, abrasiveness and formation of the samples.

NOT ONLY FOR PUPILS – NETWORKING, PUBLIC EVENTS, TEACHER TRAINING AND SCIENCE WORKSHOPS FOR ADULTS

Together with fourteen other school labs, the microscopy centre belongs to the GenaU association, a network of learning laboratories at universities and scientific institutes in Berlin and Brandenburg. In cooperation with these partners, the team at the CZM develops teacher training, new concepts and courses for classes. One example is the project "Experiments with Heart", an unusual set of experimental sessions which gives students particular insight into the heart as a research subject.

At a national level, the microscopy centre operates in close exchange with the German association of learning labs. Together with this association, categories for learning labs were created, by which learning laboratories can be subdivided, e.g.: classic learning laboratories, research centres for students, or teaching and learning laboratories (Skiebe-Corrette, Seidler, Fandrich, Faber, Schulz & Vorst, 2014). According to this classification the CZM is a teaching and learning laboratory, because, not only do students and interested visitors experiment in the CZM, aspiring teachers regularly visit the centre to learn how to teach science (subject didactics) and deepen their scientific knowledge. The University of Potsdam also uses the CZM for teacher education every semester, holding week-long compact courses in "botany, the ecology of flowers" and "food".

The "bio-inspiration" workshop is a creative workshop for adults, established in 2014, and created with the Biomimicry Germany association. Participants cover ideas such as: How nature can inspire solutions to the urgent challenges of our time; strategies that have evolved in biological systems to harvest energy, clean water, design buildings, and regulate temperature. In this inspiring workshop the attendees learn about intelligent mechanisms and strategies from nature, and how biomimicry and its methodology enable creative solutions. The most important part of this workshop is that participants create their own ideas and discuss them with the other participants.

In addition to these special programs, the microscopy centre is also open to the public once a week and during events (e.g. museum lates, researchers' night, day of biodiversity etc.). At these events visitors are given the opportunity to operate microscopes by themselves and to learn more about the topics investigated by the museum's resident scientists.

SUMMARY

Looking ahead, we will continue to expand the CZM as a place of active participation. In particular, we wish to strengthen projects in which participants can develop broader scientific research skills and create their own ideas in a collaborative and co-creative way (Simon,2010). In the future we will enhance our programmes for school groups, adults and tourists with more innovative formats, like biomimicry. By providing an innovative space with up-to-date scientific equipment, the CZM continues to help foster scientific literacy regardless of the age, educational background and offers inclusive learning for all visitors.

↑ Participants join the museum's scientists, as well as members of Biomimicry Germany association, in the multi-faceted "bio-inspiration" workshop to develop their own creative ideas ©The Carl Zeiss Microscopy Center

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GROWING A LEARNING CAMPUS FOR CHILDREN

One of our summer camp members hard at work in the Growing Garden ©Chicago Botanic Garden

Chicago Botanic Garden is developing a Learning Campus dedicated to the needs of those participating in our education programs. We have completed the first three elements of the Regenstein Foundation Learning Campus—an entry drive, a children's growing garden, and an aquatic discovery area. The remaining two, an education center to house youth and adult programming, as well as a nature play garden, are scheduled for completion in 2016. The finished spaces have transformed the educational programming offered at the garden, and their successes have influenced the facilities still under development.

Several years ago, Chicago Botanic Garden began plans for a new space to centralize the operations of programming for children. As the concept of a "learning campus" developed, the space morphed from one for children, to one serving a broader public. Though general outlines for the entire campus were developed at the outset, fiscally conservative operating plans meant that the campus was fleshed out and built in stages as funding was secured. The staged rollout allowed us to take advantage of lessons learned during each step.

The finished, children's growing garden and aquatic discovery area, have transformed the educational programming offered at the garden.

← *Children in our summer camp program digging in the soil sandbox at the Grunsfeld Children's Growing Garden ©Chicago Botanic Garden*

In 2013, 5,066 visitors stopped by the Cove for drop-ins. In 2014, that number rose to 5,797 – a 9% rise from the previous year. Many visitors returned week after week to see which program was in rotation and the facilitator bonded with the repeat families.

↑ *Children get an up-close view of aquatic habitats at the Kleinman Family Cove ©Chicago Botanic Garden*

The Grunsfeld Children's Growing Garden began life in 2011 and opened in June of 2012, as a center of gardening activity for children. It features: planting beds, compost bins, a tool shed and potting shed powered by solar panels, habitats for native mason bees, a water pump, and underground rain collection tanks used to water the garden. The garden provided, for the first time, a dedicated space for program participants to get their hands in the soil and to experience the joy of nurturing plants. The original concept was a space for guided programs but, as plans developed, so did the audience. Our challenge became accommodating various types of visitors, for example: grandparents with their grandchildren, a group of 6- and 7-year olds enrolled in a summer camp, and adults enjoying a bike ride in search of a rest stop. We created different levels of engagement which ensured that fee-based programs offered special experiences worth the cost, such as planting and harvesting. In order to provide ample choice during visits, we offered daily, free, drop-in programming led by staff and volunteers, to complement the continually growing menu of self-guided nature play experiences. In addition to watering, children can creep under a bean trellis tunnel, explore paths through butterfly weed, and use real tools to dig in a soil sandbox. These new activities have increased visitation and, more importantly, young children and their families are now spending extended periods of time engaged in open-ended nature play, which is valuable for child development and nurturing an appreciation for the natural world. (Sobel, 1996)

Near the end of construction of the Growing Garden, work on the Kleinman Family Cove began. The Cove, an aquatic garden, provides an ideal space to teach visitors about the importance of water and water conservation. It is a beautiful and peaceful destination that also enables educators to teach children about aquatic habitats in a meaningful way. This garden features a covered outdoor amphitheatre, a boardwalk that extends over the water, and a gradually deepening shoreline to illustrate the diversity of plant and animal life at varying water depths. It even includes an enclosed wading area for supervised, up-close, discovery of aquatic organisms. Children in programs are truly immersed—collecting water samples, evaluating quality and discovering insect life cycles as they explore the many aquatic creatures that live underwater. As with the Growing Garden, the layering of experience is echoed at the Cove: in addition to structured programming, drop-in programs allow family groups on weekends to touch the plants growing at the water's edge as they hop along rocks, examine specimens with magnifiers, and search for native water birds.

The success of these self-guided experiences and the desire to expand upon them helped shape the design of the Nature Play Garden. The new garden meets guidelines established by nature play experts, offering a variety of ways to engage with plants and stimulating a child's curiosity about nature. (Moore, 2014) It includes a willow tunnel for children to run through, a shallow stream for dipping fingers and toes, and small hills to climb and roll down. Children will be encouraged to express their imagination using the "loose parts" that nature provides – seeds, nuts, leaves, twigs, and stones. Not only do these experiences attract visitors, they provide a safe space to address "nature deficit disorder" and aid in whole child development—physical, social, emotional, and cognitive. (Louv, 2005)

The Education Center will house guided and facilitated programs, orient the public, and establish the Learning Campus as a center of activity for youth, families and adults. Specific elements in the design will support the programmatic needs we have established as vital to our successes in environmental education. In order to make connections to the natural world, all classrooms have large windows that view landscapes designed to enhance learning activities. Select classrooms have doors that lead out into outdoor classrooms. Among the 12 indoor classrooms, three particularly provide immersive experiences similar to those in the Growing Garden, Cove, and Nature Play Garden. These include the ITW Kitchen Classroom for foods programming, a Nature Laboratory for intensive planting programs and animal observation, and two early childhood classrooms for a nature preschool. The nature preschool program, particularly, utilizes lessons learned throughout the development of the campus as it is a program where all of the child's senses are immersed in the natural world.

The design, construction, and implementation process of each space has, at times, felt long and disconnected. Looking back on the experience -the opportunity to use completed elements to test programming that would inform the centerpieces of the Regenstein Foundation Learning Campus (the Nature Play Garden and Education Center) - allowed us to ensure these new spaces would continue to provide high quality, meaningful learning spaces and experiences that foster an appreciation for plant, nature, and the environment in children as well as in secondary audiences.

↑ *Older pupils conducting investigatory activities in the aquatic discovery are in the Kleinman family Cove ©Chicago Botanic Garden*

We created different levels of engagement which ensured that fee-based programs offered special experiences worth the cost such as planting and harvesting, while drop-in visitors could borrow a spray bottle to water plants.

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OPINION LAB –
TOWARDS INFORMAL LEARNING SPACES FOR DELIBERATION ON SCIENCE

↑ *A schematic visualization of what the eventual Opinion Lab will look like, from a bird's eye view. (figure 1) ©Marjoleine van der Meij*

In the future, more science and society dialogues are likely to take place. Therefore, citizens need to feel equipped to engage in processes of deliberation on science. Informal science learning spaces can take a role in preparing young people for this 'deliberative citizenship'. But what should 'new' informal science learning environments look like? In this article we describe the Opinion Lab (OL), a playful informal learning space about synthetic biology that was tested in NEMO (Amsterdam) in spring 2015. We present a narrative that describes the OL learning experience and explain its design principles for science deliberation, enriched by preliminary findings of our prototype test sessions.

"Have you ever heard of 'synthetic biology'?", I ask a boy. *"Nope"*, he says shyly. *"Maybe biology?"* I try. *"Uhmm, plants, humans…. Freek Vonk?"* he says. I smile. *"True! Biologists study humans, animals and plants; they also study small parts that we are made of, named cells"* I say, *"Have you ever heard of the word 'cells'?"…"Hmm….DNA?"* says the kid. *"True, cells 'contain' DNA. Now what does 'synthetic' mean, you think?"* I ask. *"Do you mean 'made by humans'?"* gently interjects his father. *"Yes, things 'made by humans' are called 'synthetic'. So 'synthetic biology' basically means 'cells made by humans'"* I summarize.

I grab a wooden puzzle (figure 3): *"Now let's play synthetic biologist!"*, I say. The puzzle represents a nucleus with a little piece of 'unfinished DNA'. *"This is a cell. Can you finish the DNA of this cell?"* After a couple of tries, the boy puts the DNA in a sequence that makes sense to him (figure 4). I celebrate his achievement: *"Good work! Now let's see what you have made……. its a plant!"* I say, while showing him a visualization. I continue: *"This plant is a special one. The DNA that you have just made gives the plant a special property: it takes its 'food' from the air! Therefore it needs no soil."* I give the boy and the father time to observe the drawing (figure 5).

↑ *The four voices about synthetic biology, Jack, Liv, Zoë and Dax, respectively an instrumentalist, critic, inventor and 'bionaut' (figure 2) ©Marjoleine van der Meij*

The aim of the Opinion Lab is to provide children with the comfort to 'speak up to science', now or in the future, and stimulate them to embrace a diversity of views.

"What do you think about this plant?" I ask the kid. *"I think it's smart of that plant to do this!"* he says, after a little bit of thinking. He looks at his father, so I ask the father too. *"Well, interesting; maybe we can feed more people with such plants?"*, he says. The kid and father chit-chat for a little while, and I ask questions to unravel differences in their views. The father seems a bit concerned about this new plant. The kid challenges his view by posing several possible applications ('indoor fruit plants').

I give them headphones: *"I have asked other people what they think about this new plant too. Shall we listen to them?"*. They nod and then listen to Jack, Liv, Zoë and Dax (figure 2). It takes two minutes. I based these audio-characters on focus group sessions about synthetic biology (Betten, *et al*, 2015).

To represent diverse views that people have of synthetically designed organisms such as this 'new plant', I scripted four very distinctive opinions (OPL Framework, 2015).

"So what do you think now?" I ask the kid. He says: *"Well, Zoë sounds like me! But what Liv says also makes sense". "In what way?"* I ask. The boy lifts his shoulders, *"Don't know, I just think it was ok"*. The father helps his son *"You mean that it can be a bit dangerous to make completely new plants, right? Especially when you also eat its fruits?"*. The boy agrees.

After conversing more, I pose a 'deeper question': What is nature? I ask their answers to this, question, and then make them listen again to Jack, Liv, Zoë and Dax. We exchange thoughts and then reflect. The boy finally concludes: *"I still think the plant is cool, but I understand that dad thinks differently"*.

Last, I ask them to draw a 'future world' with organisms made from 'new cells'. The kid grabs some pencils. He draws an 'earth' with many smiling stick figures. *"What did you draw?"* I ask. *"Well, if we can feed all people in the world with these plants, we have happy but also loooots of people….!"* says the kid. *"Interesting!"* I say, and we chat a bit more about this world. The kids still speaks enthusiastically of synthetic biology, but notes that it should not be applied 'too much'. I conclude: *"Thanks! Let's stick your drawing to the wall!"*.

THE OPINION LAB

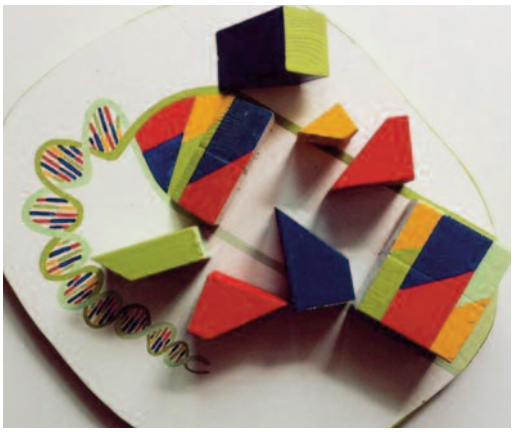
This fictitious dialogue is a typical of conversations in the Opinion Lab (OL), an informal learning environment where kids (and parents) train their science deliberation skills (Boerwinkel, *et al*, 2014) through a three step process:

1. kids and parents are introduced to a new development in science,
2. the kid creates an 'innovation' in relation to the new development,
3. then a conversation starts in which the child and parent reflect on their thoughts about this innovation, inspired by audio-fragments.

The OL is currently just a prototype (OPL, 2015), for which there is a parent-child conversation moderator, but the final design is a 'stand-alone' informal science learning space, suitable for zoos, botanic gardens or science centers (figure 1).

TOWARDS SPACES FOR DELIBERATION

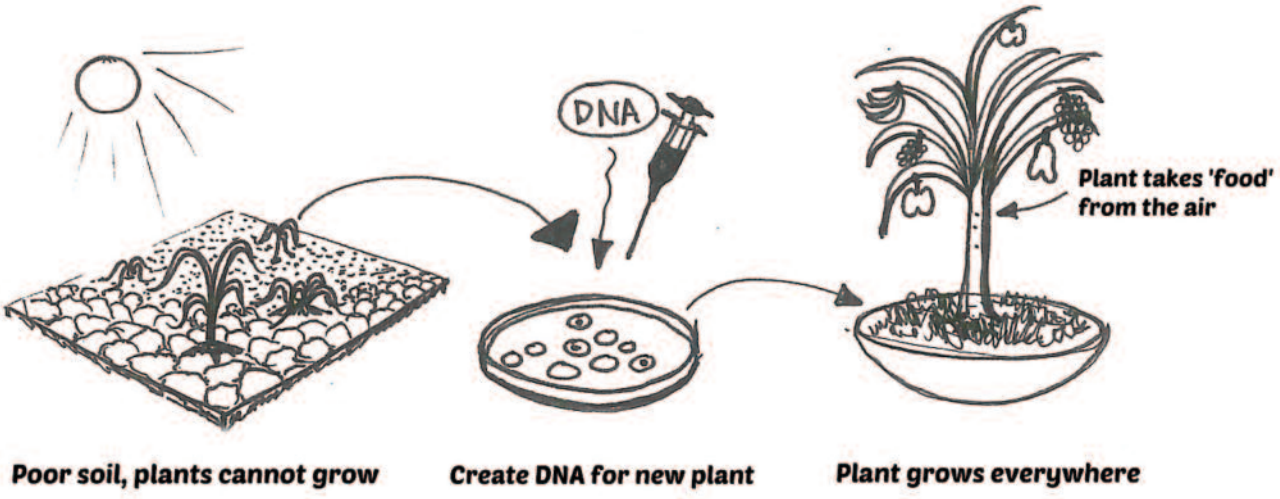
Since research and innovation will impact people's lives in the future, in a way which is often uncertain and indefinable beforehand, it is useful to reflect on purposes of science while 'doing it' (Owen, *et al*, 2012). These days, such reflection on research and innovation is becoming more inclusive, opening up to the societal 'arena'. Therefore it is important to



↑ *The Opinion Lab conversations build upon kids making a fictitious piece of synthetic plant DNA. Kids create the plant by means of this wooden DNA puzzle. (figure 3) ©Marjoleine van der Meij*

↑ *The different possible ways in which kids can configure the DNA puzzle. (figure 4) ©Marjoleine van der Meij*

Many kids started to articulate differences between their own and other views, based upon their interactions within the Opinion Lab environment, e.g. "I think differently; he [father] thinks this is unnatural, but I think it is natural"



prepare kids for such reflection. Informal science education spaces like science centers, zoos and botanic gardens can play a role in training such 'deliberative skills' (Boerwinkel, *et al*, 2014).

Looking at the OL prototype, spaces for training kids in deliberative reflection on science might be different from the usual informal science learning spaces in the following ways:

1. Potentially controversial developments in science are addressed.
2. Embedded visuals are, besides being explanatory, imagination triggers.
3. Different views are provided to support kids in discovering their own position.

The aim of these spaces is to provide children with the skills and confidence to 'speak up to science' and encourage them to embrace a diversity of views (Boerwinkel, *et al*, 2014; Owen, et al, 2012).

Designing informal learning spaces for deliberative thinking asks for openness from designers. No longer do we seek to give 'correct content'. Firstly we have to present science in a balanced manner; we need to encourage everyone to form their own opinions. One way to do that is by providing stories from people in and outside of academia, explicitly mentioning the 'authors' of such views. Secondly all voices should be presented equally to embrace diversity in thinking about science. Therefore we allow every visitor to make sense of the content in his or her own manner, we may have to limit our own definitions of what is to be learned from the exhibit.

Learning impacts of deliberation spaces - findings of OL testing
Preliminary findings from OL prototype test sessions (done with children aged 8-12 at Nemo, Amsterdam, spring 2015), show what learning does occur in deliberation spaces. In general, after kids created a 'synthetic biology application' (with the puzzle, see figure 1), they were initially enthusiastic. However, during the sessions we could see their views broadening; through considering the audio-fragments (figure 4) and discussing with their parents. Sometimes they adopted other views into their own initial view. The drawing exercise showed that most kids eventually formed a clearer version of their own opinion, while accepting the existence of different views. The fictitious dialogue above illustrates that the kid adopted some concerns about synthetic plants ('over-population') besides merely seeing potential opportunities; as he did in the beginning.

WHAT'S NEXT?

Questions remain as to whether these informal learning spaces for science deliberation work without teachers or parents accompanying the kids. Stand-alone spaces require additional tools that incite reflection. Also a challenge occurs when people do not follow the tasks in order. Therefore the re-design will be tested in 2015-2016.

↑ *A visualization of the synthetic plant to trigger the kid's imagination. (figure 5) ©Marjoleine van der Meij*

Designing informal learning spaces for deliberative thinking asks for openness from designers. No longer do we have the task to give 'correct content' about the meaning or purpose of science.

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THE ECOLOGICAL GARDEN:
WILDLIFE SANCTUARY IN THE HEART OF PARIS

The pond in the Ecological Garden in late spring ©MNHN - J.C. Domenech

The Ecological Garden at the Jardin des Plantes of Muséum national d'Histoire naturelle is an enclosed space of 12,000 m², almost wild, landscape in the heart of Paris. It was created in 1932 to present the vegetation of the Paris region. Sadly, it closed to the public in 1960. However, this left the fauna and flora to grow naturally. Then, in 2004, renovations were started to open the garden once more. The garden now hosts guided tours and workshops that allow school children and the general public a taste of wilderness in the city.

The Jardin des Plantes, Paris is a historical botanic garden belonging to the Muséum national d'Histoire naturelle (MNHN). The Ecological Garden was created in 1932 by Pierre Allorge, a professor of botany at the Museum, and Camille Guinet, horticultural engineer at the Jardin des Plantes. They decided to devote a part of the old systematic garden, dating from 1843, to the development of the Ecological Garden. According to historical documents, it seems that caring and maintaining a high diversity of herbaceous and woody formations in a relatively small space proved difficult. The garden deteriorated gradually and by 1960 it was closed to visitors and its activities were abandoned. From 1960 to 2004, it was left to its own devises. In the early 2000's, the question of reopening the space, for both public and scientific interest, arose. This lead to the development of the programme, implemented with scientific support from the Conservatoire Botanique National du Bassin Parisien.

Compared with the 1932 plan, the organization of the garden has been simplified. The various communities have been grouped in larger areas. The forest communities are grouped on one side of the garden, the open and anthropogenic plant communities on the other.

The age of the garden was an advantage, with the presence of mature trees representative of several types of wild forest habitats. Old specimens of exotic trees dating from the previous systematic garden have also been preserved. This has helped us to accentuate the forest ambiance. In

↑ *The insect hotel seen from outside the garden, with the limestone escarpment in the background ©MNHN – B. Jay*

***"The Ecological Garden is a beautiful reserve of wild plants in the heart of Paris!** 3rd year botany student.*

← *Philippe Barré, head of the Ecological Garden, presenting the vineyard vegetation during a guided tour ©Chicago Botanic Garden*

places, depending on the plant communities, soils were changed or amended and different types of rocks were brought in. The formal privet hedge was replaced by natural hedgerows. The paths have been cleared to allow access to all audiences including people with disabilities, but the intervention was deliberately kept to a minimum to preserve the natural quality of the space. A small dedicated team of gardeners are responsible for the garden's upkeep. They are involved minimally: maintaining the equilibrium within plant communities without disturbing wildlife. They have to find a balance between the necessary maintenance, especially for public safety, and the natural cycles of the flora and fauna. For example, dead leaves are not collected, except on certain paths.

Thanks to its special position as a natural enclave within the city; close to the research laboratories of the MNHN and the University, and in an enclosed area protected from public disturbances, the Ecological Garden is increasingly considered as an experimental ground for various biological studies (monitoring of airborne pollen, study of pollinators in the city, bird banding, study of soil microorganisms, etc). These activities have a strong educational potential as a showcase for scientific research at the MNHN.

The Ecological Garden allows us to easily present a number of concepts important for environmental education.
The garden provides a living classroom for teaching about ecosystems, displaying the physical parameters and the interactions between species. It also demonstrates the adaptation of plants and animals to their environments and the concept of biodiversity. Here it is easy to show that diversity of conditions leads to diversity of species. It is also possible to study the interaction between man and nature, for example by comparing the garden's wild dry meadow with a cultivated vineyard. The Ecological Garden houses various devices (composters, nest boxes, etc.) that present the theme of sustainable gardening and explain the role that everyone can exercise to preserve biodiversity in their own garden.

Several series of explanatory panels are arranged in the garden.
Only a small proportion of plants (mainly trees) are labelled. It is difficult to label plant species that grow in large or dispersed populations; that change location or mix with other species. Furthermore, to preserve the landscape and natural look of the place, labels have been avoided.

Interpretation presents different plant communities and highlights different objects in the garden, e.g. nesting boxes, pollen sensors, compost heap, etc. These panels are displayed along the paths and serve as support for guided tours. Duplicates of some are hung on the fence surrounding the

The Ecological Garden provides a living classroom for teaching about ecosystems, the adaptation of plants and animals to their environments and the concept of biodiversity.

↑ *The oak-chesnut grove at the Ecological Garden in summer, with panels presenting the plant community ©MNHN - P. Barré*

The Ecological Garden presents the theme of sustainable gardening and explains the role that everyone can exercise to preserve biodiversity in their own garden.

↑ *Although in the heart of Paris, visitors have the illusion of walking in the forest ©MNHN - P. Barré*

garden enabling other visitors to grasp elements of what is displayed behind the walls. To reach a wider audience, and at the public's request, we are currently experimenting with a new system of opening up windows in the surrounding hedge and displaying additional panels.

Educational activities are held at the Ecological Garden for three audiences.
For the general public, guided tours are offered presenting themes such as ecology and flora and fauna. The Ecological Garden is also a landmark during various thematic tours through the Jardin des Plantes. For schools, educational team offers workshops for various levels (from kindergarten to high school) which have been developed with the curriculum in mind. University students discover the garden under the guidance of their teachers who use it to illustrate various concepts or to carry out practical work. Thus a partnership was developed with the Master of Ecology and Biodiversity Management MNHN / UPMC. Annually, first year students use the garden as a testing ground for sampling methods to measure the populations of different biological groups. In exchange, reports deliver important information for the monitoring of the Ecological Garden.

The Ecological Garden of the Jardin des Plantes is remarkable for the range of public it can accommodate and the diversity of ideas that visitors can approach there.
It has the advantage to concretely and visually represent to the public the diversity of the natural environment. This is explicit even for people who are not used to observing nature. From a practical position, the garden is useful for Parisian schools, who find it impossible to organize trips to discover such vegetation in the wild.

The public opening of the Ecological Garden has been much discussed. It seems that a consensus has now been reached between educational use and conservation of wildlife. Restricted access to the garden is now seen as a way to promote respect and create an educational advantage: people who access it feel privileged, the calm of the place encourages attention, the wild atmosphere and the feeling of being elsewhere other than in Paris is a cause of amazement for visitors, creating the ideal conditions for learning.

"The Ecological Garden is a small paradise full of life, a harmony of ordinary nature, close to people."
Bernadette Lizet, ethnologist.

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↓ The moor on sandstone slab (foreground) and the vineyard in the Ecological Garden, with large illustrated panels presenting plant communities ©MNHN - F.G Grandin

Author: Andrew P. Vovides

A CALL FOR COMMUNICATION WITHIN INSTITUTIONS

High-level executives or institute CEOs have, at times, an inaccurate idea of what a botanic garden is, and often ignore the mission under which the garden was created. They can confuse the aims of public botanic gardens with agroforestry experimental stations. When directors do not consult garden curatorial staff, horticulturists, scientists and educators - with their expertise public engagement - on changes to displays and learning spaces, it can greatly impact the garden's design, landscaping and the learning experience offered to visitors.

INTRODUCTION

This case study is focused on an established botanic garden which will have been open for 40 years in 2017. It occupies an area with some native forest that has been undergoing ecological restoration for well over 30 years. It is, therefore, among a rare group of botanic gardens that perform on site, *in situ* conservation within a native forest.

The layout and design of the garden was assessed in collaboration with an international botanic garden expert in the late 1970s. Taking into consideration the natural landscape of the area, the sections of the garden were categorized as native forest, arboreta, ornamental garden, pond and ethnobotanical area. These were separated by paths and a pergola for climbers was installed. The more distant areas are devoted to the arboretum with a vista dividing the collections of native and exotic trees and leading the visitor towards them.

↑ *(Left) Labels need to be heavy duty as they are liable to break with wear and tear (Andrew Vovides) (Right) New labels have been placed at a comfortable angle for easy reading ©Andrew Vovides*

It's imperative that communication, respect, understanding and consideration of all staff is nurtured within a garden

This layout and design has been stable, with no more than slight modifications to accommodate new exhibition areas designed by the garden staff. Recently, however, the garden has seen a shift to the agenda that is alien to the garden's mission. This came with the introduction of a new Chief Executive Officer, a non-botanist, for the whole institutions of which the garden is part. This has had a detrimental effect on the garden as a space to engage with the public and encourage them to learn about the plants and habitats which were previously on as well as on its scientific collections.

THE PROBLEM

The garden acquired new areas adjacent to the garden and a public highway for new buildings. These areas were in need of landscaping. Although the garden brought in temporary staff, this caused an increase in the work load of the existing staff, who were also not consulted about design or logistics.

The CEO has seen the garden's vista as an unoccupied area which could be devoted to experimentation to ascertain 'what species of native forest trees would be successful under an urban environment?' Thus, five equidistant rows of 130 saplings were planted throughout the length and breadth of the vista and beyond; some planted within less than 20 cm from large established trees in the arboretum; which can be considered bad horticultural practice.

The garden staff and technicians are internationally certified horticulturists and tree surgeons and their pruning practices are exemplary, yet, their skills have not been taken into consideration. To satisfy the requirements of aeronautical authorities regarding a new heliport on the roof of one of the new buildings, external contractors were brought in to prune and shorted two nearby large mature trees, with detrimental results (Figure.7).

THE IMPACT

The vista and landscaping

There has been negative feedback from members of the public and staff from other botanic gardens and parks who consider the new trees to be "ruining the vista".

Labels and signage

Labelling is often a source of concern in botanic gardens as it requires constant maintenance, due to wear and tear from visitors and the weather. Thus many collections within the garden are now unlabelled or have damaged labels, and some older signage is illegible due to lack of maintenance. Even the name of the botanic garden for some time has been absent from road signage and at the garden entrance. Reasonable maintenance of the collections takes into account the periodic cleaning and replacement of damaged labels but this has gone by the wayside since the garden staff are occupied elsewhere on 'high priority projects'.

Tree pruning

The garden delivers diploma courses in horticulture, upon seeing these horticultural mistakes, the students were dumbfounded and asked, "why do you teach one way to do things, but in practice this is ignored in your own garden?". The poorly pruned trees have left a bad example for students and the public, as well as potential risks to garden staff.

RECOMMENDATIONS AND LESSONS LEARNED

The Vista

To recover the vista, the trees planted there are destined for replanting into a more suitable area. The trees are valuable documented material, some are rare and endangered and therefore, this will be a considerable task. Experiments should be confined to designated areas and should not affect the ambiance of a garden.

↑ *Young trees planted equidistantly in rows along the length of the Garden's vista ©Andrew Vovides*

On seeing the trees planted in the vista: "Why on earth have you planted all these trees here!?"
Former horticulturist at Sir Harold Hiliers Garden

↑ *Young sapling planted with a few centimeters of a mature tree bordering the vista ©Andrew Vovides*

Tree pruning
Removal of the badly pruned trees would have social and political implications. Therefore, these trees will require significant effort from staff since the plan is to selectively remove some and prune suckers to eventually eventually return the trees, despite being shorter, to a point approaching their former glory.

Labels and signage
Labels have been mounted at an angle making them easier to read which will hopefully prevent the public from breaking them. The nailing of labels to trees has been problematic due to the trees lateral growth but has since been solved by using screws and washers that can be unscrewed as the tree grows. Much of the older, illegible signage is being replaced with larger examples.

Landscaping of buildings and public highway
Landscaping, planting and lawn management of buildings and public highway should be contracted out to companies devoted to this work and not be the responsibility of highly skilled botanic garden horticulturists whose expertise should be employed in the garden s collections.

Visitors´ and students´ learning experience
Taking advantage of the undesirable alterations is providing interesting teaching material for the horticulture diploma students by teaching them how not to do things. Nevertheless, the impacts on the public, scientists and students have elicited negative remarks and opinions that will have a lasting effect.

CONCLUSION

There is no immediate solution to unilateral interference from higher authorities other than to turn the tables, as it were, to obtain a workable advantage. Students are often taught not what to do in theory, but giving them concrete real-life examples does drive the message home.

However, it is imperative that communication, respect, understanding and consideration of all staff is nurtured within a garden. It is important that the skills and experience of the whole team are consulted and considered to ensure a botanic garden develops in a way that benefits it as a scientific and educational space. This is a call to botanic garden CEOs to directly involve technical staff and experts in decision-making regarding new areas and new ventures in public botanic gardens.

← *Badly pruned large trees: Platanus sp. (figure 7) ©Andrew Vovides*

Q: "What was the logic and purpose of having planted trees this way? Its seems incongruous to what you have taught us in the course" *Student of horticulture diploma*

A: "This was the best site for planting the trees as an experiment to evaluate their suitability for urban planting." *Garden Manager*

↑ *Landscaping and maintenance of ½ km of public highway borders ©Andrew Vovides*

Several researchers have commented that the time the garden personnel were spending on planting and maintaining the public highway borders resulted in neglect of the scientific collections.

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USING THE TROPICAL PLANT PALACE AS A SPECIAL EDUCATION FACILITY

Inside the Tropical Plant Place at Nanjing Botanic Garden ©Li Mei

The Tropical Plant Palace has been a highlight at Nanjing Botanic Garden since it was open to the public in October, 2007. Covering the area of 12,000 square meters, the 'Palace' is home for over 2,000 taxa of plants from all over the world and offers visitors a unique experience of discovery. As well as displaying the wonder and beauty of the plant kingdom, the 'Palace' has been used as a special classroom to engage the general public, especially young people with the importance of plants in our lives and in the global ecosystem.

It is well accepted that botanic gardens are important centres for education (Willison, 1994). Nanjing Botanic Garden (NBG), the first national botanic garden in China, began its education program in the late 1970s. Ensuring that science is made available to young people, through education, is of paramount importance to the garden. Its Education Programme provides services to elementary schools, middle schools and universities (Li Mei et al, 1992). Since the 1990s, the education programme of NBG has aimed to increase environmental knowledge and awareness and engage the public with the urgent need to conserve plants.

Since its opening, the Tropical Plant Palace has received over 100,000 visitors each year.

← *Inside the Tropical Plant Place at Nanjing Botanic Garden ©Li Mei*

Among all display areas, the Tropical Plant Palace has been a highlight of NBG since it opened. Covering an area of 12,000 square meters, the 'palace' is home to over 2,000 taxa of plants from all over the world, and it offers visitors a unique experience of discovery.

The 'Palace' contains an array of systematically arranged and labelled plants, along with informative signs that are complemented by leaflets and a guidebook. The garden has abundant materials for guided tours and story-telling. These activities are organised into topics such as the 'marvellous natural phenomenon in the tropical rainforest', 'interesting plants', 'plan pollinators', 'special uses for plants' and many more.

In the tropical rainforest section of the 'Palace', there are many interesting thematic narratives to engage the public. For example, 'the blossoming and fruit bearing on old stems' story involves the display of species like *Ficus auriculata* (Roxburgh fig), *Mayodendron igneum* (Tree Jasmine) and *Artocarpus heterophyllus* (Jackfruit). These plants illustrate the phenomenon, arisen as a result of long-term evolutionary adaptations, whereby some tropical plants attract insects to maximize pollination by producing fruit on old branches or even stems near the ground. This is a wonderful example used to reveal to visitors, how plants adapt to the environment and introduces the concept of 'survival of the fittest'. Other vivid examples of adaptation include the pebble-shaped *Lithops pseudotruncatella*, this cute plant is disguised as pebbles to avoid being eaten by animals and the Bottle-like *Brachychiton rupestris* (Queensland bottle tree), native in Australia, which possesses a trunk that can store up to two tons of water during the rainy season, allowing itself to survive the long periods of the dry season.

'plant pllinators' is another interesting narrative displayed in the 'Palace'. Besides bees and butterflies, plants can have other pollinators. For example, *Strelitzia reginae* (Bird of Paradise) is a kind of ornithophilous flower. The delicate structure of its flower seems to be designed specifically for sunbirds and hummingbirds, two of the blue petals are joined together to form an arrow-like nectary, when the sunbirds sit to drink the nectar, the petals open to cover their feet in pollen. As for *Stapelia grandiflora* (Starfish Flower), the rotten-meat odour emitted by the flowers attracts flies.

One of the garden's most popular activities is storytelling. One parent commented that the experience was very fruitful in instilling their child with a positive attitude towards nature, an influence that they aim to continue.

↑ *One of the interpretation signs siotuated within Tropical Plant Palace, to aid educational visits and tours ©Li Mei*

As well as displaying the wonder and beauty of the plant kingdom, the 'Palace' has been used as a special classroom to teach the general public about the importance of plants in our lives and in the global ecosystem.

↑ *A school group taking part in one of the story telling activities, which focus upon unique and interesting plant species in the Palace ©Mr. Tian Songhu*

← *Volunteer training for junior students of Nanjing Foreign Language School ©Mr. Tian Songhu*

The 'Palace' is used as an outdoor classroom for training volunteer students. Volunteers of different ages, from primary students to graduate students, learn about plants and their habitats as well as vital horticultural skills.

These instances, and many more, not only reveal the unique ways plants use animals to ensure their own survival, but also show the subtle relationships between plants and animals, the mutual benefits and cooperation.

With hundreds of tropical flowers, fruits (like banana, lichee, mango, lemon) and economic plants (tea, cocoa, coffee), the tropical economic plants section directly demonstrates the close links between plants and human beings. Here, visitors can discover that, besides the material resource plants supply for people, they are also important for emotional wellbeing and culture. For instance, *Ficus religiosa* (Sacred Fig), *Plumeria rubra* cv, *Acutifolia* (Frangipani) and *Saraca dives* (Saraca) are plants that feature heavily in Buddhism. Saraca is believed to be the tree under which Buddha was born.

Since the 'Palace' is full of special and interesting plants, it also serves as an ideal place for the pupil-oriented game 'Searching for Green Treasure'. Normally, several groups of primary students are invited to search for dozens of special plants, using a leaflet containing hints, questions and a map. After having found them, they need to answer questions; the group who completes the task quickest and answers the most questions correctly wins. Participants not only have fun, but also get the chance to get close to plants by observing and studying them carefully.

Finally, the 'Palace' is also used as an outdoor classroom for training volunteers. Volunteers of different ages, from primary students to graduate students, learn about plants and their habitats as well as other vital horticultural skills required to work in a garden. After having passed our test successfully, they can become a part-time educator, offering scientific guides for visitors.

As well as displaying the wonder and beauty of the plant kingdom, the 'Palace' has been used as a special classroom to teach the general public, especially young people the importance of plants in our lives and in the global ecosystem, proving how the 'Palace' offers a multifaceted space that inspires the public of all ages and communicates stories about plants to engage and inspire people about these fascinating organisms.

↑ *The pebble shaped Lithop plant, one of the unique species that form the basis of the story telling activities ©Li Mei*

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Mei, L., Li-sheng, W., Yi-cheng, W., (1992), Science for the Public. Roots 5, pp. 14-16.

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PIONEERS IN PUBLIC ENGAGEMENT

YI JIANFANG'S STORY

"Excuse me, can we have Ms. Yi Jianfang as our tour guide?"

Yi Jianfang, is our senior tour guide at Xishuangbanna Tropical Botanical Garden (XTBG), Chinese Academy of Sciences. She is well known as one of the best tour guides in our 50 strong team. Many tourists who have visited the garden have made friends with her and some even re-visit the garden because of her. Not only can she identify any plant of interest around the garden, but she can also tell you stories about them: why it is here, who plated it, its traditional use, etc.

Yi Jianfang has delivered more than 8000 tours for the public, including senior government officials, famous scientists, tourists and kids from the local schools. Although known as the "XTBG Encyclopedia", she was only 17 when she stared in 2002. Yi Jianfang has worked hard to improve her skills and knowledge. She keeps more than 20 note books about plants, insects, birds, garden history and local culture.

Yi Jianfang belongs to Dai, an ethnic minority from Xishuangbanna. The Dai culture has a long history of using native plants. During her tours, she always integrates her indigenous knowledge with modern science to make special connections between plants and people. For example, The Dai people have a traditional food called "Hao Luo Suo", which is made of sticky rice mixed with flowers of *Gmelina arborea Roxb*, a native plant. The food was so popular in the local area because it can be kept for a long time without a fridge, yet the reason for this was unknown. Research has shown that some elements from the flower kill bacteria. Yi Jianfang invites visitors to taste the rice and explains its story from the perspective of local culture and modern science.

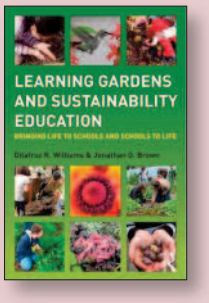
Yi Jianfang's knowledge about plants helps the local community, too. One day, her neighbour told her that the fruits of her Chinese date tree (*Ziziphus jujuba Mill.*) tasted bad so they wanted to cut it down. After investigating the tree, they discovered that some native orchids were living in it. Through her work at the garden, Yi Jianfang has gained knowledge of grafting technology. She helped her neighbor to graft a good date tree to the old one and saved the orchid at the same time.

Working with XTBG has made Yi Jianfang an activist in conservation within the local community. She is always one of the first at conservation events that encourage planting native trees, ecological restoration, reducing plastic trash, etc.

All this and more has made Yi Jianfang a role model to new tour guides to whom she passes on her skills, knowledge and passion.

RESOURCES

BOOKS



Learning Gardens and Sustainability Education: Bringing Life to Schools and Schools to Life

This book highlights the importance of having an interactive learning environment that is designed to achieve specific learning purposes. A unique theoretical and conceptual framework is presented with soil as the focal point. Seven elements (cultivating a sense of place; fostering curiosity and wonder; discovering rhythm and scale; valuing biocultural diversity; embracing practical experience; nurturing interconnectedness) are used as a basis of how to create learning gardens and convey the topic of sustainability. This unique framework manages form a dynamic, new method and language for approaching sustainability education.

Dilafruz Williams & Jonathan Brown
2011, Routledge, London, UK
ISBN-10: 0415899826
ISBN-13: 978-0415899826
Available at: http://www.amazon.co.uk/Learning-Gardens-Sustainability-Education-Bringing/dp/0415899826
http://www.amazon.co.uk/Learning-Gardens-Sustainability-Education-Bringing/dp/0415899826

WEBLINKS

Space for Learning: A Handbook for Education Spaces in Museums, Heritage Sites and Discovery Centres

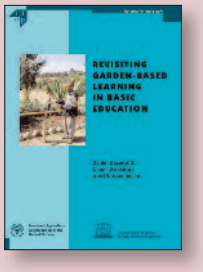
This handbook has been created through collaboration between many key informal education groups in the UK. Its contributors are experienced in providing and securing funding for learning spaces. The handbook seeks to address the current issues with education and education spaces in UK museums, discovery, environmental and heritage sites. It identifies that many sites, such as botanic gardens, are not meeting their potential. The handbook seeks to address this by supplying information to advise and support the development of learning spaces. Advice comes from many different contributors including, Arts Council England, Department for education and skills, heritage lottery fund.

http://www.spaceforlearning.org.uk/

What Learning? What Theory?

Written by Katherine Stewart at the Royal Botanic Gardens Sydney, this paper highlights the fact that students that visit education sites rarely retain the information educators expect. The paper seeks to align the expectations of teachers and the actual learning of students. Considering the study's results in the light of the theory of constructivism the paper concludes that the adopted learning style of botanic gardens should be experienced based. Gardens should focus on making displays interactive, robust and appealing to students.

https://www.bgci.org/education/1659/



Revisiting garden-based learning in basic education

This paper addresses the relationship between garden based learning and basic education. Garden based learning is classified not as a specific discipline but rather a collection of theories that can be moulded to the practitioners' needs. Garden based learning is portrayed as being able to meet educational needs across all locations, subjects and ages.

http://www.fao.org/3/a-aj462e.pdf

Reimagining outdoor learning spaces: Primary capital, co-design and educational transformation

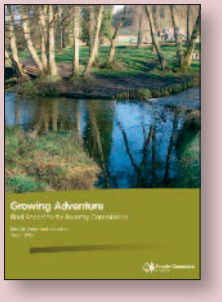
A guide for educators on how to redesign outdoor learning spaces. The handbook champions the involvement of the learner across all aspects of the planning and the creating of learning spaces. The need to have the child involved ensures the most effective learning experience through a sense of attachment to the area, which will encourage their interests in the target learning points of the space.

http://www2.futurelab.org.uk/resources/documents/handbooks/outdoor_learning_spaces2.pdf

Learning Labs in Libraries and Museums: Transformative Spaces for Teens

This report is a summary from a project in the USA that aimed to create learning labs in informal learning spaces to improve education, especially for teens. The project saw collaboration from the main supporters of informal education in the USA, therefore, the report provides a wealth of solid useful information. All the topics that are required for creating a learning lab are covered, including what a learning lab should be, recommended activities and how to successfully evaluate the process.

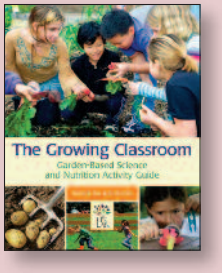
https://www.imls.gov/sites/default/files/legacy/assets/1/AssetManager/LearningLabsReport.pdf



Growing Adventure: Final report to the forestry commission

'Growing Adventure' is a forestry commission project that aimed to encourage nature play within their sites. The report is very useful as it covers the whole project including social and practical topics relating to nature play. How to create nature play areas and activities to conduct in them are covered as well as a conclusive summary of what nature play should be and how important it is. The document also provides a solid evaluation and information on the importance of networking and partnering to ensure the success of projects.

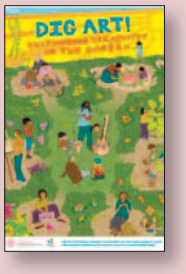
http://www.forestry.gov.uk/pdf/fce-growing-adventure-report.pdf/$FILE/fce-growing-adventure-report.pdf



Cornell Garden-Based Learning Institute

The site has a very generous index of learning resources for educators to use in botanic gardens. There are a large range of topics available that can be targeted at various different subjects. Activities such as, children's garden consultants and seed to salad provide opportunities to get children involved in all aspects of a garden based learning space.

http://gardening.cce.cornell.edu/



Life Lab

Life lab is a non-profit organisation that promotes garden based learning through their workshops and publications. Their program is aimed at both educators and parents to encourage environmental interest in children. The website provides lots of resources and advice on how to create garden based learning spaces such as, how to fund and sustain your garden, how to manage children in the space and what elements to include.

http://www.lifelab.org/

Education Outside

Education Outside converts school gardens into effective garden based learning areas or 'classrooms'. The organisation addresses the issue many educators face when creating learning spaces, of not knowing where to start; the company comes in and creates the area. They can also provide staff that visit into schools to hold classes in these learning areas. The website also provides resources on how to create your own garden learning area as well as activities.

https://www.educationoutside.org/

RHS Campaign for School Gardening

The campaign is mainly directed at schools and focuses on supporting them in providing gardening opportunities to aid classroom learning. The site has an extensive and varied range of resources that can be applied both in and out of school such as, identification activities, mapping classes, germination races and poetry.

https://schoolgardening.rhs.org.uk/about-us

BGCI'S NEW GARDEN TWINNING INITIATIVE

ARE YOU INTERESTED IN GARDEN PARTNERSHIPS AND TWINNING PROGRAMMES?

Based on feedback from the membership survey and the Communities in Nature evaluation, BGCI is looking to develop a twinning programme to aid partnership between botanic gardens. To create such a programme 'minimum standards' are required, standards that we need your guidance upon.

To have your say please complete the short online survey available here:
https://www.surveymonkey.com/r/BG_twinning

Thank you for your help!

BGCI
Plants for the Planet

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ISSN 0965-2574

ROOTS 13:1 SCIENCE COMMUNICATION

HOW DO YOU TELL THE WORLD ABOUT YOUR RESEARCH?

As public facing, scientific institutions, botanic gardens have a responsibility to share their research with their audiences. Since many people who visit are not experts, communicating plant science effectively requires creativity. Science communication activities should be fun, inviting and cater to a range of audiences, interests and levels of prior knowledge.

Science communication comes in different shapes and sizes including activities that showcase current research, tell stories about the history of a site or ask the public to take part. From lectures to citizen science projects; exhibitions to learning labs, the next issue of Roots will look at how botanic gardens are engaging the public with their scientific work. We will take a glance at a variety of activities, from a range of perspectives: educators, directors, scientists, volunteers, etc.

If you have an exciting approach to science communication then let us know!
To feature in issue of Roots contact: **Liliana.Derewnicka@bgci.org**