

Roots

Botanic Gardens Conservation International Education Review

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**Education and
technology:**
Responding to a
global pandemic



**BOTANIC
GARDENS**
CONSERVATION
INTERNATIONAL

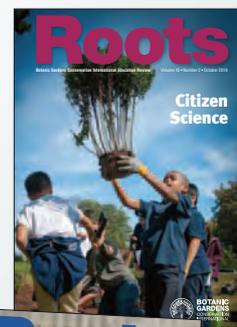
CONTRIBUTE TO THE NEXT ISSUE OF ROOTS

The next issue of Roots is about climate change. Time is of the essence. The latest IPCC report predicts that we have less than 10 years to significantly reduce carbon emissions if we are to avoid the worse consequences of climate change.

Consequences that would have a devastating impact on both humans and biodiversity. This means that we must engage as many people as possible, as quickly as possible, worldwide to address this effort. Botanic gardens as centres of plant conservation and public engagement have a key role to play in this effort. How are you incorporating climate change engagement into your education programmes? Have you developed a new and innovative way of engaging your visitors with climate change? Are you using climate change to engage a wider audience with the work of your garden? Are you supporting your visitors to contribute to climate change action?

We are currently looking for a variety of contributions including articles and education resources.

To contribute, please send a 100 word abstract to helen.miller@bgci.org by 15th January 2021



BGCI'S DIRECTORY OF EXPERTISE

BGCI's new Directory of Expertise is designed to enable experts within botanic gardens to promote their skills and knowledge and, if possible, help them to solve a problem or challenge related to botanic gardens or plant conservation. As a membership benefit exclusively for BGCI Institutional Members, staff associated with these institutions can apply to be listed in the Directory.

The Directory currently includes 11 areas of expertise including Public Engagement. BGCI's purpose in creating this Directory is twofold: firstly, to share the knowledge and skills in the botanic garden community with broader society to solve problems or save plant species, and secondly to give staff of BGCI Institutional Members opportunities to broaden their experience and make a contribution that might not come their way in day to day work.

For more information or to be listed as an expert visit:

<https://www.bgci.org/resources/bgci-databases/directory-of-expertise/>.

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Forthcoming Issue

Volume 18 Number 1: Climate change

Cover Photo: A family interacts with a DBG instructor during a live virtual program (Denver Botanic Gardens/Scott Dressel-Martin)

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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.

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FIRST WORD

EDUCATION AND TECHNOLOGY: RESPONDING TO A GLOBAL PANDEMIC

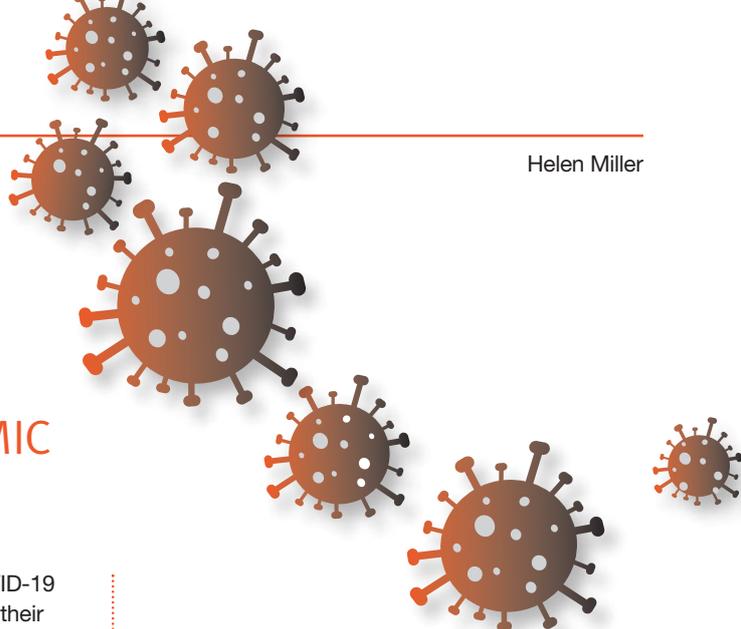
On 23rd March 2020, the UK went into lockdown, as a result of the COVID-19 pandemic. Shops, bars, restaurants were shut, people were confined to their homes except for essential trips, and working from home became the new normal – for those lucky enough to be able to work from home of course. No matter where in the world you are, I am sure you have your own “lockdown date” and a similar experience as this pandemic has swept the globe. Like many other sectors, the botanic garden community has been severely impacted, with most botanic gardens being required to close their doors to visitors for at least part of 2020.

Visitors are a fundamental part of a botanic garden and most gardens rely on entrance fees as their main source of income. This has therefore been a very challenging time for our community. In addition to the economic barriers, the situation has posed a number of interesting questions for those in education and engagement roles – how do we maintain the interest and enthusiasm of our visitors if they cannot visit the garden? Can planned activities and events be delivered virtually? How do we support families, schools, and interested individuals through virtual education? And as gardens re-open – how can we welcome visitors back to the garden in a safe and socially distanced environment?

In this issue, we explore some of these questions and look at the way in which gardens have responded to the COVID-19 pandemic. Technology is playing an ever bigger role in the way that we engage but as outdoor green spaces this can often feel at odds with our core missions – to connect people with plants and plant conservation. However, these difficult times have forced us all to try new things and embrace the virtual world as a way of maintaining connections with visitors, trialling new forms of engagement and in many instances reaching out to new audiences.

With schools unable to access the garden and many children being home-schooled, some gardens have been developing digital learning programmes to support these audiences. Learn about Marley’s School of Magic and other education content developed by Royal Botanic Garden Edinburgh on page 13. Denver Botanic Garden have been providing online distance-learning programmes for schools since 2016, but the garden had to respond to an increased demand due to COVID-19, learn more on page 39. The University of Alcalá Botanic Garden offers an Agroforestry course for university students – due to COVID-19 restrictions student plots could not be accessed and a virtual vegetable garden had to be created instead (page 10). At Vytautas Magnus University Botanical Garden a range of digital education programmes for a variety of ages have been developed, this has included specialised tours and virtual laboratories, learn more on page 51.

Many botanic gardens also deliver training and learning programmes to other audiences. At Morton Arboretum, the Learning and Engagement team have been developing digital resources to engage their various constituents, and share insights into challenges, lessons learnt and the way in which these offerings have allowed the Arboretum to reach new audiences. Learn more on page 26.



↑ *Virtual specialized tours prepared according to university programmes ©Indrė Sekevičienė*

Some gardens have developed creative and innovative ways of engaging their visitors with events and exhibitions in the garden. Shanghai Botanical Garden developed a series of events to help people maintain the connection with nature, including virtual garden tours, an online tree adoption, and virtual exhibitions, learn more on page 36. Shanghai Chenshan Botanical Garden had to cancel their planned series of events to celebrate their 10th anniversary, but instead developed a virtual programme, including an online tour of the garden with a celebrity – which was watched by half a million people (page 17).

Social media platforms have also been a great way for gardens to engage with their visitors during the pandemic and share news and updates. At Peter the Great Botanical Garden, the team have been using social media to run botanic marathons – creative competitions to engage visitors. Learn more on page 30. At Fundação de Parques Municipais e Zoobotânica, the team have set up their own YouTube channel and have been producing a series of short videos about the work of the garden. Read more on page 33. Hangzhou Botanical Garden have been exploring the use of social media methods such as WeChat and TikTok to create new content for their visitors. This has included an online plum appreciation forum, a “cloud live broadcast” about spring flowers, and an online painting exhibition. Read more on page 48.

Augmented reality and gamification are exciting new techniques that many gardens are now starting to explore. As part of the E-Mo.Ve! project, the Museo Orto Botanico, Università di Bari have been developing interactive computer games as part of an evolution exhibition. During the pandemic the garden was able to use these games to engage with visitors remotely. Learn more on page 45. Botanical Garden of Medellín have been engaging younger visitors and virtual audiences through augmented reality and have launched the “Colombian Flora Expedition: an augmented reality experience in Botanical Garden of Medellín”. Learn more on page 23.

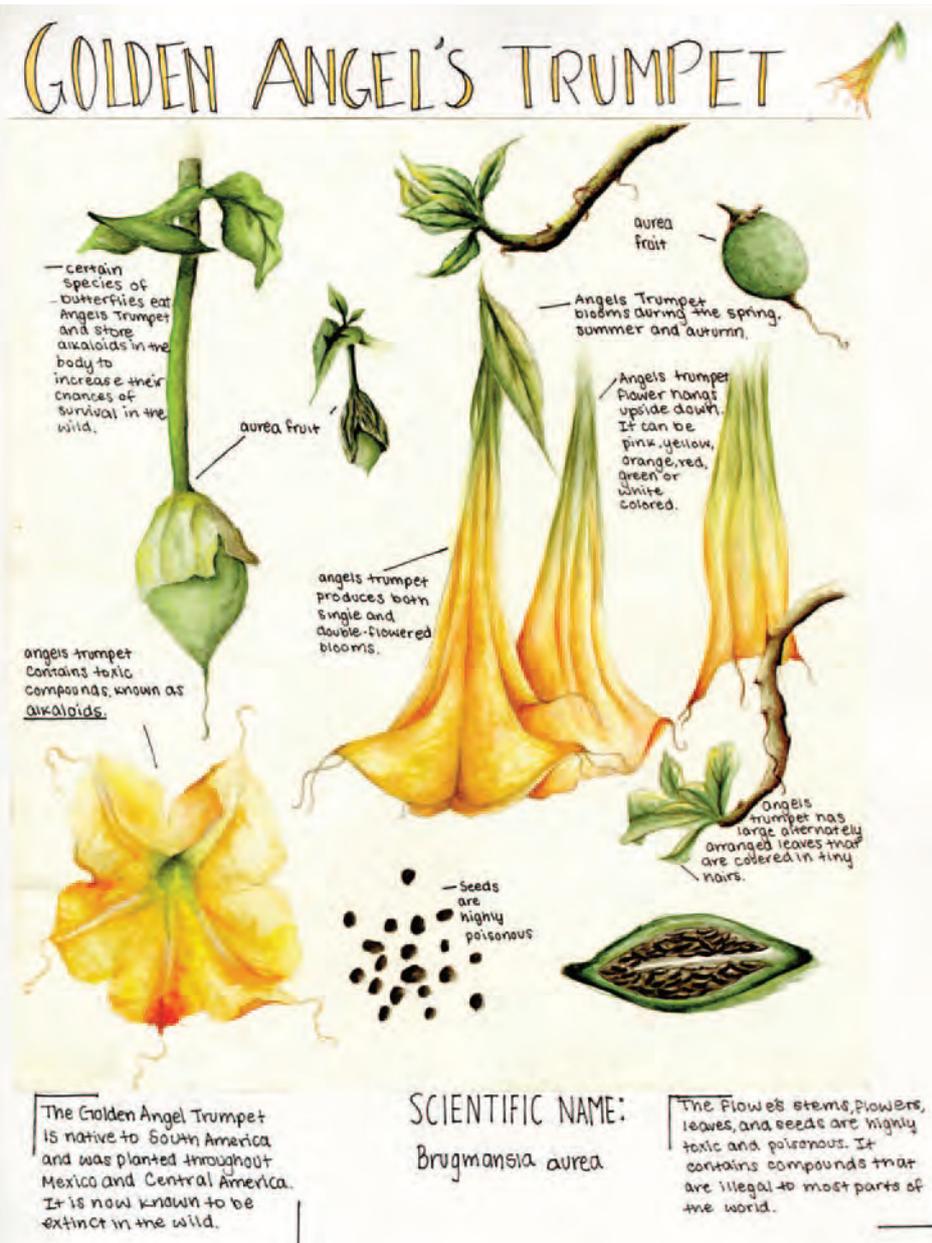
Across Australia and New Zealand, gardens have been developing a range of ideas to connect with visitors, including virtual tours, social streaming of live video, online education offering and adapting school holiday programmes. Read more on page 19.

Finally as gardens begin to open up and welcome back visitors we need to find creative ideas and activities that can support this new socially distanced visitor experience. At Gardens by the Bay, as well as creating a range of online content, the garden has launched a new all-in-one mobile app allowing visitors to buy and scan their tickets to the attractions, pre-book their visiting time slots, perform Safe Entry check-in and check-out, and get real-time updates on crowd levels in selected areas in the garden. Learn more on page 42.

In this issue, I am also pleased to share two articles about pioneers in public engagement, showcasing the amazing work of botanic garden educators and volunteers. On page 54 read about Di Southwell of Bundaberg Botanic Gardens and on page 55 we look at the role of Friends of Groups and how they have adapted to this new normal.

This is another bumper issue, full of creative and innovative ideas that I hope you will take some inspiration from. I think we can all agree that 2020 has been a year of challenges and unsettling times, but it has also forced us as botanic garden educators, to try new things, to think outside of the box, and reflect on how we can continue to offer engaging and exciting content in a changing world.





Fairchild Tropical Botanic Garden, located in Miami, FL (USA), serves a majority-minority community. The garden's award winning environmental science program, The Fairchild Challenge (FC), begins its 19th year by reflecting on its diversity, equity and inclusion guiding principles and practices. This article highlights how the FC is intent on addressing and achieving key issues of infrastructure access, literacy and community acceptance. In partnership with the Botanic Gardens Conservation International, the FC launches the global challenge "Unsung Plant Scientists – Their Journey and Legacy" which will help students see themselves in science and connect to the rich legacy of past and present plant scientists that have impacted the world.

← Gabriella Gomez, Minseo Kim, Younseo Kim, Dana Leidecker, and Maya Wilke
From South Miami Middle School
Winning entry from the 2019-2020
"Fairchild's Rare Plant" Challenge where middle school students created an informative sign highlighting the rare plants at Fairchild Tropical Botanic Garden. This Challenge included an optional student workshop for students to tour Fairchild and learn about our efforts to manage and conserve IUCN Red List plants.

THE FAIRCHILD CHALLENGE: REFLECTIONS ON OUR SOCIAL ROLE

For more than a decade botanic gardens have reflected, recognized, and redefined their social role to remain relevant in their communities. As one of four selected case study sites in Dodd and Jones' (2010) novel research on the social role of botanic gardens, Fairchild Tropical Botanic Garden's Fairchild Challenge program was highlighted for its ambitious, large-scale education programming. For informal science education museums and centers like botanic gardens, Dawson (2014) proposed a three-part framework for access, equity, and inclusion. Using key issues of infrastructure access, literacy, and community acceptance, this article will outline guiding principles The Fairchild Challenge has implemented to respond to practices of social inclusion and responsibility.

In partnership with the Botanic Gardens Conservation International, the FC launches the global challenge "Unsung Plant Scientists – Their Journey and Legacy".



The largest and most impactful education program at Fairchild Tropical Botanic Garden (Fairchild) is The Fairchild Challenge (FC), an environmental science competition. Aligning itself with Florida state educational standards, this program includes an array of interdisciplinary environmental science and STEM projects to enhance Pre-K-12th student learning and achievement. Integrated STEM education requires a complex combination of content and pedagogy, which can support a more diverse group of students. Embedded in the Miami-Dade County Public Schools (MDCPS) district pacing guides as well as remediation programs for schools receiving a rating of “C” or below, the FC is offered free of charge to all schools in MDCPS. Established in 2002, the program has been recognized as a benchmark for exceptional STEM education and for empowering Pre-K – 12th grade students to become the next generation of scientists, researchers, educated voters, and policy makers.

INFRASTRUCTURE ACCESS

The FC serves more than 125,000 students each year locally, nationally, and internationally. The FC annual competition is comprised of several “Challenges” designed to engage students of diverse interests, abilities, talents, and backgrounds to explore the natural world. Miami-Dade County (MDC) ranks as the fifth poorest metropolitan area in the US. MDCPS is the fourth largest district in the nation with more than 350,000 students that make up a majority-minority: 71.5% Hispanic, 20.1% Black, 6.7% white, 1.8% other (as per Dade Schools Statistical Highlights April 2019). The FC model has risen to this unique opportunity to serve and engage its majority-minority community and create a pipeline for students in STEM.

Because of the diversity of the MDC population, Fairchild is uniquely positioned to combat the ethnic and socioeconomic disparity in STEM education and careers. Often cited barriers to participation and entry into spaces of informal STEM learning include the cost of participation and lack of awareness about informal STEM learning opportunities (Bruyere et al. 2009, Alper 2020). In light of this, the FC team works diligently to ensure that all programming remains free to local participating schools (See Table 1 Theme 1). To assure that FC programming is accessible and useful for participating teachers, the FC team intentionally maintains an open line of communication with participants, and gathers constant feedback to improve this informal STEM learning opportunity. Facilitating this space for co-creation and trust building between organizers and practitioners has been a crucial component to the success of the FC.

← Julian Moise from Maritime and Science Technology Academy
Winning entry from the 2019-2020
“Conservation Photography” Challenge. In
partnership with the National Wildlife Federation,
middle and high school students submitted a
photograph that featured a South Florida
environmental issue.

The Fairchild Challenge is driven by a commitment to address these historical patterns of exclusion and foster an inclusive space for learning and science education.

The FC is intentional about ensuring that absolutely any student and teacher in our community who wants to be involved can be.



↑ 2nd-5th Grade Students from
La Scuola – Cutler Bay
Entry from the 2019-2020
“Shade Our Schools” Challenge where students
measure leaf temperature as it related to leaf color,
shape, and size. In partnership with the University of
Miami elementary school students collected data and
created an illustrated field journal documenting their
observations.

Oncidium ensatum; Florida Oncidium or Dancing Lady

LITERACY

Since its inception, the Challenges have focused on STEM content. However, more recently FC's programming has grown exponentially to provide innovative, authentic research experiences at all grade levels. Through Fairchild's real-world STEM projects, students gain scientific literacy and skills, and increase their interest and excitement towards botany and science (See Table 1, Theme 2). Two projects that exemplify these goals are The Million Orchid Project (MOP) and Growing Beyond Earth (GBE). At its core, MOP is a massive science experiment that allows scientists to make important discoveries about how native, endangered South Florida orchids grow and aims to restore their historical abundance in neighborhood tree canopies. Led by Fairchild's Orchid Biologist, Dr. Jason Downing, students conduct research to reintroduce rare native orchids into the local urban landscapes.

GBE is a school-based STEM education program in partnership with NASA's Exploration Research and Technology Programs, where middle and high school students conduct a series of experiments to identify edible plant varieties for long-distance space travel. GBE is unique in its focus on real scientific research, enabling student "citizen scientists" to contribute data toward NASA mission planning. Through this project, more than 140 varieties of edible plant germination rates, growth habits and edible biomass production have been tested. To date 10 student-tested varieties have been selected by NASA researchers to be ground tested at Kennedy Space Center's GreenLab and in 2019, two of those varieties were tested aboard the International Space Station.

Finally, one of Fairchild's newest partnerships is with researchers at the University of Memphis. The FC will help validate an assessment called the Plant Awareness Disparity Index (PADI) to measure plant awareness disparity (Parsley 2020), formerly known as "Plant Blindness." The PADI will provide insight on how well students recognize and appreciate the presence of plants in their environment, and their important ecological role (Wandersee and Schussler 1999). This information can be used to inform future engagement practices and enhance STEM inclusion.

By promoting these inter-organizational collaborations, the FC has empowered students with not only hands on experience with scientific data collection but the opportunity to reflect on the impacts of their personal contributions to these cutting edge scientific endeavors.

COMMUNITY ACCEPTANCE: THE NEED FOR A COMMUNITY OF USERS TO ACCEPT THOSE FORMERLY EXCLUDED

At Fairchild, Challenges are critically adapted to actively anticipate and address barriers to inclusion. The FC is intentional about ensuring that absolutely any student and teacher in our community who wants to be involved can be. This commitment has generated a truly inclusive community wherein anyone who is committed to the mission of environmental education is welcome and accepted (See Table 1, Theme 3).

In partnership with Botanic Gardens Conservation International (BGCI), the FC is launching "Global Challenge – Unsung Plant Scientists – Their Journey and Legacy". Throughout history, plant scientists have played a critical role in breaking social barriers and influencing scientific thinking that impacts our daily lives. However, representation in the botanical sciences has often been limited. To achieve the United Nation's Sustainable Development Goals, a global community must be built on values of inclusion, diversity, and equity. To celebrate the existing diversity in botany, students will create trading cards that showcase their life and inspiring work.



↑ Jose Caballin, Griselia Cruz, Kendri Diaz, Erika Dominguez, Leah Gil, Lilliana Guillot, Rodoandy Hernandez, Karen Pineda, Lazaro Pino, Mathew Ramos, and Justin Sanchez from iMater Preparatory Academy Winning entries from the 2018-2019 "Million Orchid Project" Challenge, where high school students designed a brochure detailing how to care for The Dancing Lady Orchid, *Oncidium ensatum*.



↑ Anderson Spencer from Kendall Christian School Entry from the 2018-2019 "Growing Beyond Earth" Challenge where students were asked to create a new design for growing plants in space.



This Challenge is a unique opportunity for our diverse local student body and global participants to "see themselves" in science and identify with plant scientists who look like them. Through the BGCI network, these trading cards will be shared to provide a global voice of innovative plant scientists that have spurred positive change.

Learn more about the global challenge at <https://www.bgci.org/our-work/projects-and-case-studies/the-fairchild-global-challenge/>

THE ROLE OF THE BOTANIC GARDEN

Botanic gardens worldwide are concerned about broadening and welcoming new audiences (Dodd and Jones 2010) and are working to combat the image that they are exclusive to white, older adults. To address this, botanic gardens are celebrating the accomplishments and contributions from diverse botanists, often associated with a heritage month (e.g., Black history). Botanic gardens are also recognizing their colonial past including addressing their collections rooted in imperialism.

The Fairchild Challenge is driven by a commitment to address these historical patterns of exclusion and foster an inclusive space for learning and science education. By doing so, we can create a new paradigm of botanical sciences, embracing diversity and equity as tools of scientific progress.

Theme Number	Theme	Quotes from participating teachers
1	Access	"Increased interest in scientific processes, thinking, and issues. Students may realize science is accessible to EVERYONE."
2	Literacy	"A greater literacy in my students about plants and their relevance to the students' lives"
		"I expect student interest to increase when they can take ownership of their learning"
3	Community Acceptance	"Fairchild Challenges help me connect better with my students and the community. It helps my students evolve through time as scientists. It makes my students excited!"
		"I want my students to do hands on activities that are memorable and involve them in science. I also want them to know about the beautiful place that is Fairchild"

Table 1: What impact(s) do you expect from participation in the Fairchild Challenge?

← High school students from Florida Christian School Entry from the 2019-2020 "Green Cuisine Challenge" where students created a dish inspired by the cultural diversity on board the International Space Station.

This Challenge is a unique opportunity for our diverse local student body and global participants to "see themselves" in science and identify with plant scientists who look like them.

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In February 2020, Alcalá's Royal Botanic Garden began teaching Agroecology in partnership with the University of Alcalá. The aim was for students to learn the principles and practices of biointensive agriculture by cultivating plots at the botanic garden. However, shortly after the students had completed the hardest tasks and prepared the plots, the arrival of the lockdown (due to COVID-19) made further work impossible. This led to the creation of virtual vegetable gardens.

The enthusiasm, imagination, and commitment shown by participants produced astonishing, widely participatory, and highly encouraging results.

A VIRTUAL VEGETABLE GARDEN: AN ENCOURAGING EXPERIENCE IN ALCALÁ BOTANIC GARDENS

The Agroecology course that the University of Alcalá's Royal Botanic Garden teaches to University of Alcalá (UAH) students is now in its second year. The subject is part of the university syllabus and this year was taken by 29 students (25 Environmental Science undergraduates and 4 Life Sciences undergraduates). The course was led by 4 UAH lecturers and 5 botanic garden staff members.

The aim of the subject is for students to learn the principles and practices of biointensive agriculture by cultivating plots at the botanic garden. It comprises four hours' on-site work at the botanic garden per week plus additional research time at home. However, the conditions imposed by the COVID-19 pandemic forced us to alter the initial course structure and divide it into two phases: on-site work at the Royal Botanic Garden (4 February to 12 March) and remote work in the virtual vegetable garden (13 March to 31 May).

The on-site work began with preparation of the ground. The students were divided into five groups to prepare five plots, each measuring 1.20 x 0.80 m. They dug the soil until they had achieved the right texture and structure, and then added organic fertiliser. Next, they installed the irrigation system, protected the plots against animals (especially wild rabbits), and made compost bins. Once those stages were completed, they started to plan their crops.



↑ Protecting the plot against animals ©María Torija
↪ A student's private vegetable garden during the lockdown ©Mercedes Torija



← General view of the plots ©César Martínez

“I was so inspired by the course that I’m going to try to convince my residents’ association to set up a vegetable garden on our communal land.”

Student taking part in course

On 12 March, just when everything was ready for sowing and planting, the lockdown was announced. Widespread despondency swiftly set in and several students even considered dropping the subject. Having completed the hardest tasks, the students could no longer work in the garden and were prevented from enjoying the most gratifying and productive part of the course. They had only managed to plant a few onions, strawberries, and cabbages, either provided by our gardeners or retained from the previous year's crops.

In light of the situation, it was suggested that the students should continue their coursework by, on the one hand, creating a virtual vegetable garden and, on the other, returning to their plots in 2021 — even though the course would have finished — to get the pleasure of growing their own non-virtual vegetables. The idea behind the virtual vegetable garden was for the students to do the research at home and set out what their vegetable gardens would have been like if it had not been for the lockdown.

The group communicated via an online platform (the UAH's Aula Virtual) and set up a blog on which students, lecturers, and botanic garden staff shared information, ideas and pictures, allowing everyone to follow developments on the plots week by week.

The students drew encouragement from one another and began to organise the tasks. They sowed seeds on cotton pads and in plastic bottles to watch them germinate, they recycled all kinds of household containers as pots, and they cultivated plants at home in gardens, or on window sills and balconies, to learn how to care for the growing plants. In addition, they continued searching for and sharing information online with their classmates and the other student groups.

Thus, throughout April and May we used the blog to communicate with one another, answer students’ queries, show how the students’ plants were growing at the botanic garden (a skeleton crew continued to work there), and continuously encourage participants. As we had a very wet spring, the crops grew vigorously and the pictures we shared strongly motivated the participants to continue working.

At the end of May, we held a four-hour video conference on the Aula Virtual platform so that the students could exhibit the produce of their virtual vegetable gardens and all the participants could interact. It was an emotive experience for all of us. Later, the students were evaluated by their lecturers. None of the students dropped out and all of them achieved particularly good final marks.



↑ A student digging the soil ©María Torija



↑ Planting kale ©María Torija

The disadvantages of creating a virtual vegetable garden were clear to all of us from the start. The lack of personal contact among participants (students, gardeners, lecturers and botanic garden staff); not working the soil with a hoe, rake or spade; missing watching the plants grow; not doing any physical exercise; not seeing the different kinds of animal life attracted to the site as the plants grew; not directly seeing pests and diseases appear in the vegetable garden; not being able to compare the crops in the students' vegetable gardens with those in the botanic garden; and not being able to harvest lettuces, tomatoes or peppers in summer, to name just a few.

However, the advantages of setting up the virtual vegetable garden were unimaginable for most of us until we experienced it. Collaboration between participants was much closer in the virtual vegetable garden than in the real one; the feeling of being part of a group was more intense; links between the university community and the botanic garden were strengthened; and the feeling of confronting and overcoming a major challenge together (the impact of COVID-19) generated a lot of enthusiasm and drove participants to work harder and more effectively.

The lessons learned from the experience are as follows:

- Student support by lecturers and botanic garden staff was crucial to the success of the course.
- Students placed greater value on self-criticism after completing the course.
- Taking the subject improved students' capacity to work as a team.
- Working together allowed the students to become better acquainted and brought students from different faculties into contact with one another.
- Information and communication technologies allowed students to share a lot, draw encouragement from one another, and achieve better end results than when working independently.
- Students said that the experience increased their understanding of the benefits of vegetable gardens to health and social well-being.
- Students said that the course brought them closer to the botanic garden and its staff.
- The subject must be continued in coming years.

This experience shows that motivation can provide the greatest impetus to act in adverse circumstances, making us more imaginative and more supportive of one another, and allowing us to achieve better outcomes. The Royal Botanic Garden, in partnership with UAH lecturers, is already planning the Agroecology course for the 2020/2021 academic year and is more enthusiastic than ever.



↑ A plot during the lockdown ©César Martínez

“When the lecturers suggested setting up a virtual vegetable garden, I thought they must be kidding, but now we’re all fully engaged and have learnt a lot.”
Student taking part in course



↑ Planting strawberries ©Cristina Pérez

← Students selecting seeds ©Guadalupe Ramos

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USING TECHNOLOGY TO ENGAGE RBGE'S AUDIENCE DURING THE PANDEMIC

In March 2020, the COVID-19 pandemic shut down the whole of the UK. Overnight, schools closed their doors and parents became home educators. People found themselves on a work break (furloughed) or were made redundant from their job - suddenly they had time available and looked to online learning to upskill or fill their newfound leisure time.

The Royal Botanic Garden Edinburgh has a wide-ranging education and community programme, which we had to adapt and find new ways to deliver. Our experienced teams who deliver on-site learning, community programmes and online learning pulled together to respond to this challenge.

INTRODUCTION

The Royal Botanic Garden Edinburgh (RBGE), comprising 4 gardens in Scotland, UK, was shut for three months because of the COVID-19 pandemic. During this time, we found other ways for people to experience the gardens and continue to engage with us. Our responses ranged from 'opening' the gardens up with a 'Virtual Spring'¹ using footage taken by lockdown staff - to additional online delivery of our horticulture, botany and arts programmes.

ONLINE LEARNING

At RBGE, we have been offering a range of online courses for six years. These are delivered using PropaGate Learning², our online learning environment, which uses Moodle open source software. A team of three technologists/designers manage the site and courses, design and develop resources and support the students and tutors.

↑ Enjoying 'Expedition Dandelion' ©Lynsey Wilson



Celebrating
350 years
1670-2020

Royal Botanic Garden Edinburgh



PropaGate
Learning



Though we were in this fortunate position of having previous experience in online delivery, the lockdown still brought us many challenges! These included quickly converting some of our attended courses to online delivery, developing an online schools' presence, and supporting many new students - all while we sustained our established online courses, adapted to working from home, and learned new skills.

ADULT LEARNING

At the start of lockdown, we took the decision to offer courses at half price to enable people to learn more about botany and horticulture from home. The high uptake of these courses saw student numbers multiply more than six times compared with last year, and we welcomed over a thousand new online students, 20% from outside the UK. We have been encouraged by the positive feedback received from students so far.

The main challenges were: upskilling to develop and edit videos; delivering live classes and tutorials online; learning new software; and supporting students throughout the lockdown. So far, we have found that delivering 'live' online is demanding - preparation, practice, and support during the session have proved to be key factors for success.

Two new developments for the team have been creating a new schools' online area and moving our MSc course to online delivery. In both cases, we were starting from scratch, so this was a steep learning curve for tutors new to online learning and extra development work for the online learning team. Online resources for both areas had been under discussion; however, the COVID-19 pandemic became the driver to facilitate these, faster than we had planned.

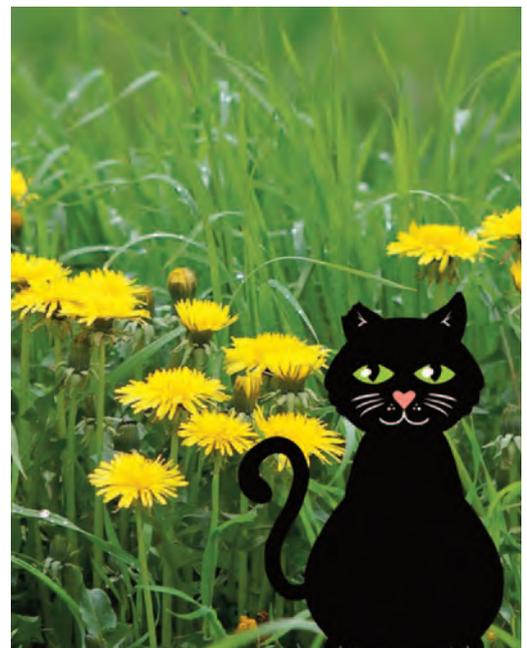
SCHOOLS ONLINE

We developed and launched 'Marley's School of Garden Magic' containing curriculum-linked online interactive lessons, activities, and expeditions. These can be viewed at home and were used on 'lockdown' walks to explore the environment. These resources support teachers and parents with outdoor learning. We adapted topics from our existing on-site programmes, and we plan to use these new resources in the future. To date, two thousand visitors have accessed these activities.

Our Schools' Gardening Project groups (supported by Gannochy Trust), had started planting their vegetable plots at the garden so we decided to capture some of our practical activities and to produce a library of short videos and mini-lessons that can be used by children, teachers, or parents.

↑ Learning about snails online ©Dr Greg Kenicer

"I have really enjoyed the course. The content, presentations, PropaGate Learning platform and tutor feedback have been fantastic and pitched at the right level. Being able to do it at your own pace really helped. It has been one positive of the pandemic..." RBGE Student



↑ Marley's (the Botanics' cat) School of Garden Magic started with learning about dandelions ©RBGE



This work was rolled out quickly in response to changing circumstances so we were unable to consult teachers in advance as we would normally. We used our years of experience to adapt resources, and we will follow up with evaluation to capture lessons learned and support further improvements. Activities were designed to be stand-alone, whilst also being available as additional resources for pre/post school visits to the garden when visits resume.

In order to ensure the inclusivity we pride ourselves on in 'normal' circumstances, we were keen to make these resources available to as many people as possible online and offline. For this reason we worked with a local foodbank to include paper copies of activities with their deliveries.

Explore Marley's School of Garden Magic at propagatelearning.rbge.ac.uk by logging in as a guest.

COMMUNITY PROGRAMMES (supported by People's Postcode Lottery)

At lockdown, the community programmes on-site suddenly ceased. We had to adapt quickly and use on-line video conferencing to continue reaching out to our community.

Edible Garden Project Zoom meetups

Unable to welcome regular gardening groups to the garden, we delivered informal virtual workshops for those who could be online through their community groups.

For adult groups, we found that 20-minute sessions based on a question and answer format worked well. Each session had a theme, e.g. pests and diseases, seed sowing, composting. For family groups that include children, the virtual sessions have been based around a simple practical activity. For example, with Adopt UK (an adoption charity) we ran a seed sowing activity where participants were each sent a packet of pea shoot seeds and seed sowing compost. In our first Zoom session, we set up mini-growing experiments together. Two weeks later, we met up on Zoom again and thankfully all their pea shoots had germinated so we showed them how to harvest their pea shoots and eat them.

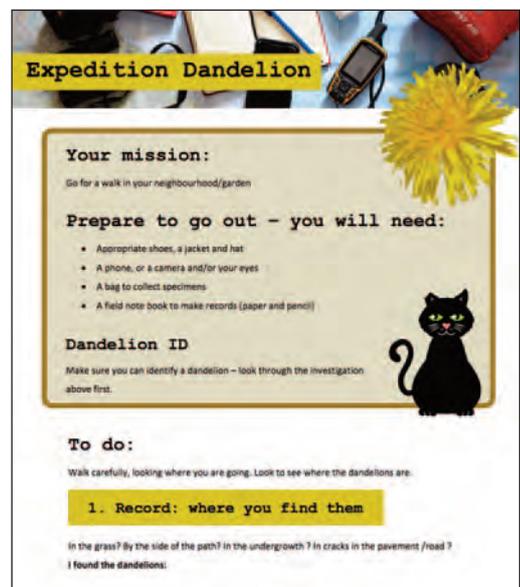
Other community programmes

For our other groups, like Cook Club, our volunteers and staff wrote blogs, which also included activities.³ We wanted to remain inclusive to our audience, however this proved challenging as many of our regular visitors do not have access to the internet or a digital device.

← A screenshot of links to 'The Undergrowth' activities in Marley's School of Garden Magic ©RBGE

"We developed the activities in an online accessible format, but also distributed paper copies through a local foodbank. We issued 1,000 copies of 'Expedition Dandelion' to provide much needed outreach to children with the least access to technology."

*Jane Robertson,
Online Learning Manager*



↑ 'Expedition Dandelion' ©RBGE

"Thanks so much for posting the interesting information about the gardens. The DVD has been a tremendous hit. We've watched it very very many times. Mum is absolutely engaged. Lots of smiling & saying 'look at the lovely flowers!'"
Garden Social (dementia friendly) participant



For people who could not participate in video conferencing, e.g. some participants in our Garden Socials (which are dementia friendly meetings), we sent out electronic copies of blogs. We also sent out DVDs of the 'Virtual Spring' film footage so that as many people as possible could enjoy the therapeutic value of our gardens. To keep in touch, we made phone calls, sent hand-written letters, and used social media such as Twitter.⁴ We are now planning a virtual harvest festival and traditional Halloween trail.

REFLECTIONS – SUMMARY

Looking back, we have the following reflections on our experiences:

- Online resources can enrich people's experiences when they can't physically visit your garden. They can continue learning and engaging with the garden from home.
- Working online enables you to reach people beyond your usual geographical catchment.
- Delivering learning online can be inclusive in that you can provide multiple accessible formats e.g. video with audio and captions, written text and easy to read documents. However, your participants do need access to a computer and internet connection.
- We couldn't address what has been called 'digital poverty' (the lack of access to technology in the home), which has been highlighted during lockdown.⁵
- Developing resources online has cost and resource implications: software, hardware, and staff time.
- Be aware of legislation in your country including accessibility, copyright, safeguarding, and data protection. Do not underestimate the amount of time required to address these important issues.
- Ideally, do some research on what your audiences want and will find useful before you start and include feedback mechanisms.
- Focus on the mission of your organisation and find your own voice and way of branding your online offer.
- Try to make access to materials as easy as possible.
- Use a method of engagement that best suits the needs of your participants.
- Finally, start small, and celebrate your successes!

↑ *Making snails outside* ©Lynsey Wilson

REFERENCES LINKS

¹ Virtual Spring:

<https://www.rbge.org.uk/visit/virtual-summer/virtual-summer-at-edinburgh/>

² PropaGate Learning site:

<https://propagatelearning.rbge.ac.uk>

³ <https://stories.rbge.org.uk/archives/33638>

⁴ <https://twitter.com/RowanAlba/status/1273688460449243140>

⁵ Digital poverty:

<https://www.bbc.co.uk/news/education-52399589>

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Just like other botanical gardens in the world, Shanghai Chenshan Botanical Garden was impacted by COVID-19 and the reduction in visitors that this resulted in. However, we found ways to overcome the challenge, using online broadcasts to promote botanical garden events, such as blooming flowers, a music festival, and educational activities.

THE CHALLENGES AND OPPORTUNITIES CAUSED BY COVID-19

When news of COVID-19 broke in China, it was the Chinese traditional Spring Festival. Usually, people would visit Shanghai Chenshan Botanical Garden with their family members and friends to enjoy blooming flowers and outdoor green space as one of their recreational activities. However, the botanical garden had to be closed and people were required to stay inside this time.

But spring was still coming.

Hundreds of Oriental Cherries were blooming in the garden - an attractive scene but not many people had the opportunity to see them. At the same time, people across the country felt frustrated at this unexpected incident.



↑ Chenshan Meadow Music Festival ©Shen Qiyi
↖ Director Hu Yonghong is introducing the garden during a live broadcast ©Shen Qiyi

Shanghai Chenshan Botanical Garden realized that the blooming Oriental Cherries could be a good symbol to inspire people to feel hopeful and happy, just like plants usually do. We posted some pictures of blooming Oriental Cherries on Weibo (known as Chinese Twitter). The pictures were so attractive and popular that many people re-posted them and had their comments below the pictures. Xinhua News Agency, the biggest national news agency, paid attention to it. They sent a professional team to film the flowers and released a short video from their official Weibo account. Surprisingly, the video was viewed 685,000,000 times. The topic #Blooming Oriental Cherry in Shanghai was clicked on 3,000,000,000 times and more than 50,000 people wrote comments on it. These numbers broke records in Chenshan's history. We found that the new media was a good way of promoting the botanical garden in such a difficult time.

Chenshan Botanical Garden has a well-known event called the Chenshan Meadow Music Festival, which takes place in May each year. It is the biggest outdoor classic music festival in China. Usually, tickets sell out a couple weeks in advance of the festival. The year 2020 was the 250th anniversary of Beethoven's birthday. Because of COVID-19, many commemorative activities were cancelled and/or postponed worldwide. Since China has had some success at controlling COVID-19, with the permission of the government, Chenshan Botanical Garden put on a Meadow Music Festival for a special audience. We invited heroes of the COVID-19 crisis, such as doctors, police officers, volunteers, social workers, cleaning workers, and their families to attend the festival. At the same time, the music was broadcast live by many APPs. Hundreds of thousands of people listened to the music online. When the melody of Symphonie No.3 Op.55 and Symphonie No.5 Op.67 played, people had a strong emotional reaction to it, due to their COVID-19 experiences.

On June 26th 2020, Shanghai Chenshan Botanical Garden was planning to celebrate its 10th anniversary. Because of the pandemic, all traditional ceremony events had to be cancelled. However, special online events were organised instead and attracted a lot of attention.

We made a series of short videos about the Garden, including greetings from Paul Smith, Secretary General of BGCI, Richard Deverell, Director of Royal Botanic Gardens, Kew, and Peter Wyse Jackson, President of the Missouri Botanical Garden. The videos were uploaded onto Xinhua News Agency's APP and more than 230,000 people watched the videos in a day. We were so proud to be a member of a global botanic garden family.

Working with Tencent, a famous high-tech company, we organised a one hour online tour with an internet celebrity to show blooming flowers, such as roses, and unique landscapes in the garden. Half a million people followed the tour.

Before and after June 26th, we also organized other online activities. Dr. Hu Yonghong, Director of Chenshan Botanical Garden, was interviewed by Oriental Broadcast Station, a Shanghai-based news agency talking about the history of botanical gardens and the role of a botanical garden like Chenshan BG in Shanghai in this changing world. Staff from the education, horticulture, and research teams led online tours for Rose, Iris, and Chinese herbaceous peonies with different news agencies and new media APPs.

COVID-19 has changed a lot of things. Even now, people prefer to stay at home and reduce their field trips. The number of visitors is reduced dramatically, which poses a serious financial problem for the garden. Many botanic gardens around the world are or will face similar situations. However, as a family member of the global botanic garden community, we are strongly confident that we can overcome any difficulties and challenges with the support from other botanical gardens worldwide.



↑ Educator is talking about roses in a live broadcast
©Shen Qiyl

The video of blooming Oriental Cherries was viewed 685,000,000 times on Weibo.

The topic #Blooming Oriental Cherry in Shanghai was clicked on 3,000,000,000 times and more than 50,000 people wrote comments on it.

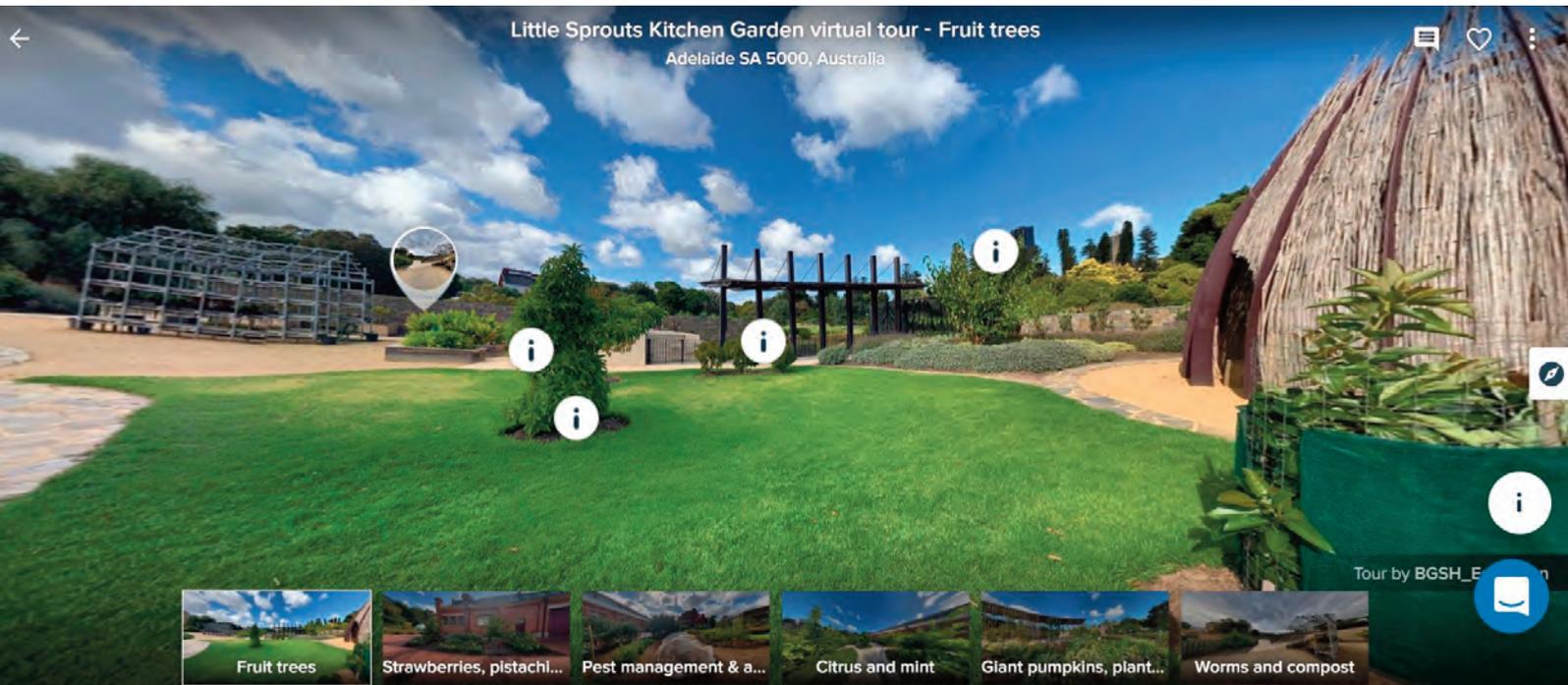


↑ Chenshan Botanical Staff making a celebratory picture with their bodies for the 10th anniversary of Chenshan's birthday ©Shen Qiyl

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CLOSE ENCOUNTERS OF THE DIGITAL KIND: STAYING SOCIALLY CONNECTED WHEN WE MUST STAY PHYSICALLY DISTANCED



Botanic gardens across the world have been catapulted into a new era of engagement by the challenges presented by the COVID-19 pandemic. In this article, you'll find ideas and inspiration from botanic gardens in Australia and New Zealand that you can reconceive and use in your engagement programmes. As Austin Kleon, artist and author, says of creativity "Steal like an artist. Nothing is original, so embrace influence, school yourself through the work of others, remix and reimagine to discover your own path".

Over the past six months, botanic gardens have quickly designed and implemented a variety of ideas on connecting with our audiences when our gardens are closed or visitor contact is restricted. In this article, I'll cover several successful ways botanic gardens in Australasia have pivoted during the COVID-19 pandemic, and stayed in touch with their audiences no matter the level of restriction. As the convenor for the Botanic Gardens Engagement Network (BGEN, part of Botanic Gardens Australia New Zealand, BGANZ) I have the privilege of witnessing a wide range of fantastic programmes from the talented engagement professionals across these two countries. My hope is that you get ideas from some of these programmes that you can adapt and use in your own work.

VIRTUAL 360-DEGREE TOURS

Have you ever wanted to visit the Gardens of Versailles? Or tour a faraway botanic garden? Now you can thanks to 360-degree tours.

↑ *The Little Sprouts Kitchen Garden 360-degree virtual tour at the Adelaide Botanic Garden*
©Adelaide Botanic Garden

While digital technology is a fantastic tool, it is important to recognise that digital equity is not evenly distributed across communities and this needs to be considered when planning engagement programmes.



Virtual 360-degree tours take your audiences on visual journeys from the comfort of their homes. Botanic gardens globally have been creating 360-degree tours to great effect, and now more than ever they are useful tools if your garden is closed or under severe restrictions because they can connect your audience directly to your garden experience.

At Adelaide Botanic Garden in South Australia, the education team has put together a 360-degree tour of their Little Sprouts Kitchen Garden, a garden developed to inspire a sense of wonder in children about where their food comes from. The virtual tour enables viewers from around the world to step straight into the garden and be surrounded by its beauty, no matter the weather conditions, time of day, or whether the garden is closed or not. If your garden is open, it facilitates trip planning for schools and groups before they even meet you.

Aaron Harrison, education officer at the Adelaide Botanic Garden, says, “Our 360-degree tour of the Little Sprouts Kitchen Garden is perfect for home learning, remote area schools, or those not able to make it to Adelaide Botanic Garden”. They have also created a worksheet to go hand in hand with the experience.

These types of tours are simple to create using online platforms, and once you’ve created a 360-degree tour you’ve got it for as long as you need it. Put it on your website, share it on social media, and invite the world into your garden.

SOCIAL STREAMING OF LIVE VIDEO

Nothing replaces face-to-face interaction, but real-time broadcasts of live video on your social platforms can help audiences feel connected to you and your garden especially at a time they may be feeling socially isolated due to physical distancing or facility closures.

Multiple platforms support live video and make it easy to connect with your audiences. Some of the most popular include Periscope, Instagram Live, Twitter, Facebook Live, YouTube, and LinkedIn.

↑ Young students enjoying the Little Sprouts Kitchen Garden at the Adelaide Botanic Garden
©Adelaide Botanic Garden

A tip with live video if you're going to embed it into your website or reuse it later, is to create 'evergreen' content that will remain relevant no matter when or where it is shared.

Taking education offerings on-line has the dual effect of not just engaging with schools if your garden is closed, but also reaching further across your state and country to engage with schools who may not have been able to visit even if the garden was open.



At the Auckland Botanic Gardens in New Zealand, we successfully harnessed live video with our weekly Garden Advice sessions via our Facebook page while our gardens were closed. Our audiences sent in their garden questions ahead of time to be answered live by our expert staff. Our staff filmed this in their home gardens while the Auckland Botanic Gardens were closed, and as restrictions eased, we continued the weekly Garden Advice but filmed it live from our botanic garden. Our audiences connected with us in a new way and the videos reached thousands of people, including internationally, and a raft of gardening questions were answered.

Live videos can continue to provide engagement value for long periods because they can be recorded, shared and embedded in websites. A tip with live video if you're going to embed it into your website or reuse it later, is to create 'evergreen' content that will remain relevant no matter when or where it is shared. Recorded video from live broadcasts can also be reused in various formats - for example, we have used these videos in our garden trail app.

Pre-recorded videos work well but there is something special about being connected to your audience live and face-to-face (or face to garden). Create it once and share it many times.

TAKING YOUR EDUCATION OFFERING ON-LINE

Curriculum-based education programmes at botanic gardens are at the heart of our work and inspire the next generation of nature-loving citizens. However when the garden is closed or restrictions are in place, it's vital to be able to keep running these programmes.

The Royal Botanic Gardens Victoria in Melbourne Australia (RBGVic) has experienced multiple openings and closings in response to varying virus levels during the COVID-19 pandemic. To stay in touch with schools while the garden is closed, learning staff across the organisation have developed Digital Garden Experiences, online versions of 14 of their most popular learning programmes. Each of these includes a live digital session with a RBGVic educator, access to a range of specially selected learning resources for students to explore, and a student challenge that can be completed at school or home.

↑ Facebook live Garden Advice video with manager Jack Hobbs at the Auckland Botanic Gardens ©Auckland Botanic Gardens

Once you've created a 360-degree virtual tour you've got it for as long as you need it. Put it on your website, share it on social media and invite the world into your garden.



↑ The Royal Botanic Gardens in Victoria Melbourne have both live digital sessions and face to face options for 14 of their most popular learning programmes ©Royal Botanic Gardens Victoria

Ben Liu, Creative Producer - Learning and Participation at RBGVic says, "Our situation in Melbourne has been up and down – with restrictions likely to be in place for the foreseeable future. The development of our Digital Garden Experiences has meant that we're still able to support teachers across the state and in a number of cases has allowed us to engage with students who had previously never participated in our programmes."

Taking education offerings on-line has the dual effect of not just engaging with schools if your garden is closed, but also reaching further across your state and country to engage with schools who may not have been able to visit even if the garden was open.

While digital technology is a fantastic tool, it is important to recognize that digital equity is not evenly distributed across communities and this needs to be considered when planning engagement programmes. One example of addressing this is from the Community Greening programme at the Royal Botanic Gardens in Sydney, Australia, which promotes communal greening projects. The team incorporated, printed, and delivered newsletters to their communities while they were in lockdown to ensure they remained connected no matter the individual level of access to online technology.

ADAPTING SCHOOL HOLIDAY PROGRAMMES

School holiday programmes are a valuable engagement tool for botanic gardens but typically involve physical interaction and printed materials. When restrictions such as physical distancing and hygiene protocols are in place, school holiday programmes can be acutely impacted. Creative thinking is needed so programmes can continue no matter the level of restrictions.

Wollongong Botanic Garden in New South Wales Australia has placed more emphasis on theatrical performance, and replaced the art and crafts portion of their school holiday programmes with a simple, reduced-contact plant propagation activity. They perform a theatrical play with an engaging theme, which visitors can enjoy in a safe outdoor environment while remaining physically distanced. Themes have ranged from Captain Compost and Gardens of the Galaxy, to Captain Cook's Botanical Adventures, and The Tree Musketeers.

The play is then followed by a fun adventure trail on the same theme for visitors to enjoy. Traditionally trails require printed maps but Wollongong has turned the trail maps into visual clues along the way, and posters of maps interspersed on the trail so visitors can check their progress. Michael Connor, Education Officer at Wollongong Botanic Garden says, "Replacing the arts and crafts activities has had the additional benefit of connecting our visitors with nature in new ways – we've had a lot of great feedback from both staff and visitors". The play can also be filmed for future use.

While not every team has the tools or skills for creating theatrical plays, this is just one example of creative thinking to inspire you that results in fun and engaging ways to connect our visitors with nature.

CONCLUSION

Our botanic gardens are special places that allow us to directly connect our visitors with nature. However, when our gardens are shut or there are restrictions in place, we need to think creatively about how to stay socially connected while we must stay physically apart. While there are multiple aspects of engagement that could not be covered in the space of this article (such as engaging with volunteers), the principles can be applied across our audiences. Digital technology is a valuable tool that has been successfully harnessed across the world of botanic gardens, and new ways of activating our sites are being developed every day by talented engagement staff.



↑ Educator Michael Connor at the Wollongong Botanic Garden re-enacts the botanical adventures of Sir Joseph Banks in a theatrical play during their school holiday programmes ©Wollongong Botanic Garden

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EDUCATING TO CONSERVE NATURE: AN AUGMENTED REALITY EXPERIENCE IN BOTANICAL GARDEN OF MEDELLÍN



Botanic gardens are facing new challenges due to the increased interest in virtual learning environments. For example, children and teenagers are accustomed to new educational strategies mediated by video games. By designing and implementing a game-based initiative, the Botanical Garden of Medellín seeks to engage the youngest on plant conservation. This initiative focuses on five critically endangered plant species in Colombia, which are part of the living collections of the Botanical Garden of Medellín. To date, over 60,000 people have interacted with this initiative. The App has been online since July 2020.

Biodiversity is declining globally. Over one million species are facing an extremely high risk of disappearing from Earth (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services - IPBES, 2019). Plants, an essential source for human life, are one of the most critically endangered groups due to their biological and ecological attributes such as long reproductive processes, specific interactions with animals, restricted distribution ranges, overexploitation, and climate change vulnerability, among others (Kotiaho *et al.*, 2005; Feeley and Silman, 2009, 2010). Colombia, the world's second most biodiverse country on Earth, harbours over 28,000 plant species which corresponds to 12% of the global plant diversity (Bernal *et al.*, 2019). However, its extraordinary plant species diversity is critically endangered and declining at an unprecedented rate due to changes in land-use and habitat loss. Anthropogenic factors such as cattle ranching, illegal logging, mining, extension of the agricultural frontier, among others, are the main drivers of nature declination (Armenteras *et al.*, 2013; Cabrera *et al.*, 2019). National extinction assessments indicate that there are over 2,000 plant species classified as endangered (SiB, 2020), in particular, species of highly endemic plant groups such as cycads, hardwood trees, magnolias, orchids, and palms.

↳ *Isidodendron's avatar inspired by the species Isidodendron tripterocarpum*
©Medellin Botanical Garden

The goal is to explore different conservation challenges through five threatened plant species, mainly restricted to Colombia, and beautifully depicted as avatars.

During its first year, this initiative reached more than 60,000 people.



As one of the oldest and most inspiring botanical gardens in Colombia, Botanical Garden of Medellín (BGM) is committed to plant conservation, especially those species that are critically endangered. The BGM maintains a living collection of 1,200 native species from which more than one hundred are threatened with extinction. Receiving over two million visitors annually, with a free entrance, and reaching a potential audience of more than 100,000 people via social networks (Facebook, Instagram, and Twitter), BGM plays a key role in raising social awareness of plant conservation and sustainability in Medellín, the second-largest city in Colombia.

A large proportion of BGM's visitors come looking for a green space in the city. This postmodern world gives us the opportunity to be stimulated and to learn through different ways. That also affects our scope of attention and makes it harder to appropriate knowledge, since stimulus can come simultaneously from different sources competing for attention. Although BGM is equipped with signage, we have identified that is not enough for our audiences to be captivated, especially the youngest (children and teenagers), who tend to have a poor connection and appropriation of this type of communication. In addition, it is difficult to measure its impact on visitors and, at the same time, this kind of material deteriorates faster since it is located in an open-air museum. With this background, we developed a proposal that was granted in 2018 by MinCiencias (Colombian Science Ministry), allowing us to create an innovative way to engage younger visitors and virtual audiences through a natural experience of augmented reality and the implementation of a transmedia storytelling: "Colombian Flora Expedition: an augmented reality experience in Botanical Garden of Medellín".

This proposal is presented through an augmented reality game, available at app stores. The goal is to explore different conservation challenges through five threatened plant species, mainly restricted to Colombia, and beautifully depicted as avatars. Avatars face challenges like overexploitation, forest loss, dispersal limitations, and pollinator decline. Selected species were specially chosen and exemplify specific causes of extinction. These are hardwood trees *Isidodendron tripterocarpum*, *Magnolia jardinensis*, and *Dipteryx oleifera*, the palm *Ceroxylon quindiuense*, and the cycad *Zamia tolimensis*. These plants are dramatically threatened by overexploitation, pollination decline and habitat loss in Colombia (Galeano and Bernal, 2005; Calderon *et al.*, 2007; Cárdenas and Salinas, 2007; Zapata *et al.*, 2013), and are also part of the living collection of BGM, linking virtuality with reality.



↑ *Zamias's living collection at BGM*

©Medellin Botanical Garden

← *Panoramic view of Botanical Garden of Medellín - BGM* ©Medellin Botanical Garden

Colombia, the world's second most biodiverse country on Earth, harbours over 28,000 plant species which corresponds to 12% of the global plant diversity

Using augmented reality games to promote vivid experiences in botanical gardens, brings new opportunities and awareness about plant species diversity, their key role in sustainable livelihoods and their importance for all life on Earth.

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During 2019 and 2020, the transmedia storytelling has been focused on announcing the game development and presenting the avatars with mindful messages using social media. Additionally videos on YouTube have been used to highlight national specialists of plant systematics and conservation, showcasing their knowledge and efforts. During its first year, this initiative reached more than 60,000 people. To live the experience, users download a free augmented reality app, geolocated with BGM's map, developed by Experience Steam®. Three options are available, (1) self-explorations, with science-based communication signage located in strategic points next to plant species in the BGM's living collection that allow the users to independently discover the garden, (2) face to face guided tours, and (3) a version without augmented reality that can be played anywhere with a tablet or a smartphone. The App (Jardín Botánico Extinction 6) has been online since July 2020 and tours will be accessible by the end of September of 2020. This experience is available in Spanish.

Due to the pandemic Colombians entered a confinement from March to August. During this time, the BGM Networks grew significantly with more than 22,000 new followers in its social networks (7,000 more than the same period in 2019). This time represents an opportunity to migrate face-to-face contents to virtuality, and to promote the strategy of "Jardín Botánico Extinction 6" which focuses on delivering live events via YouTube, which have been seen by more than 600 people.

Using augmented reality games to promote vivid experiences in botanical gardens, brings new opportunities and awareness about plant species diversity, their key role in sustainable livelihoods, and their importance for all life on Earth. At the same time, these tools also engage young people who may be involved in plant conservation action in the future. Although, achieving successful communication and dissemination of science is challenging, it is clear that if the connection with the public is achieved, effective conservation actions can be promoted. In our case, mobilizing citizen participation in environmental issues is fundamental to safeguarding nature for present and future generations. As generations pass by, botanical gardens need to understand and create different mechanisms that will allow them to mobilize educational and conservation action. Game-based learning represents a promising opportunity to save plants, as it creates environments that can enhance the experience around biodiversity, promote a more democratic learning experience, and lead to conservation commitment. We want to share our experience with botanical gardens worldwide.



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← *Zamia's avatar inspired by the species Zamia tolimensis* ©Medellin Botanical Garden

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EMBRACING UNCERTAINTY: ENGAGING THE MORTON ARBORETUM'S AUDIENCES DURING THE PANDEMIC

In response to the coronavirus pandemic in the United States and a stay-at-home order by the State of Illinois that took effect on March 21, 2020, The Morton Arboretum either cancelled in-person programs or reimagined them as digital experiences. Building from a strong foundation of producing online content, the Arboretum's division of Learning and Engagement quickly pivoted to offering digital resources to engage its various constituents. This article describes some of the many digital programs developed to connect with audiences even while the grounds were closed, as well as the institutional strategies that emerged as a result of new ways of working.

On March 16, after only two weeks as the new Vice President of Learning and Engagement at The Morton Arboretum, I and most of my colleagues started working from home, as the uncertainty of a new health crisis engulfed the nation. Countries across the globe were already at a standstill, and the coronavirus pandemic that had besieged parts of Asia and Europe inevitably overwhelmed the United States as well. Illinois' stay-at-home order went into effect on March 21, but the Arboretum, an outdoor tree museum located in Lisle, Illinois, a western suburb of Chicago, stayed open as a permitted outdoor recreation space until eventually closing on April 2.

The week prior to the effective date of the Arboretum's work-from-home directive was a flurry of activity and rapid-fire decision-making, made exponentially more challenging by uncertainty about the virus and confusing information from federal and state officials. I had only met my team members during those first two weeks in March, and this unprecedented situation enabled me to get to know them in a way that I don't believe I could have done so under more normal circumstances.

✦ Youth Volunteer Annie and her brother Toby made leaf rubbings as part of a "Nature Play" activity that Annie created while volunteering remotely
©The Morton Arboretum

The Arboretum's collaborative culture had to be somehow reinvented while we worked from home. It was essential to re-establish and fortify lines of communication that had been diminished by the loss of in-person proximity.



I was impressed by their commitment to engaging the Arboretum's audiences and their ability to nimbly reimagine audience engagement during a period of constant change. I knew I could rely on them to provide a chronicle of efforts and programs as we began, and continue, to work remotely.

NEW WAYS OF WORKING TOGETHER

We immediately recognized the challenges presented by this unfamiliar mode of remote working, and this preparation proved key to our success in our virtual engagement efforts. For a large organization whose work is so profoundly linked to its physical site, the transition to all digital programming presented significant difficulties. Indeed, the Arboretum's collaborative culture had to be somehow reinvented while we worked from home.

It was essential to re-establish and fortify lines of communication that had been diminished by the loss of in-person proximity. One effort toward this end was the creation of an online engagement task force, which consists of staff from the Development, Learning and Engagement, Marketing and Communications, Science and Conservation, and Special Events departments. This task force meets once a week to coordinate a range of virtual outreach and programmatic efforts that keep our audiences attuned to Arboretum activities. The group discusses issues around scheduling and promotion, as well as shares resources, outcomes, and institutional updates. As a result, the Arboretum has avoided potential conflicts in scheduling, enhanced internal communication, and increased awareness about operational shifts, as we adapt to an ever-changing environment.

The Arboretum's Knowledge Management (KM) team, a group within the Arboretum's Learning and Engagement Department, also identified the need to boost staff proficiency in remote working. The team held multiple training sessions on using Zoom, Slack, Google Meet, and other online collaboration platforms to support employees' use of these tools. Over half of the Arboretum's staff took advantage of these sessions. In addition to these sessions, KM produced a number of intranet posts, job aids, and guidelines to ensure ongoing staff support. As more departments organized webinars and large meetings for external groups, KM provided host-specific training for these various platforms.

↑ ©The Morton Arboretum

Virtual engagement with nature proved to be a welcome and viable alternative to in-person programs.

Interactive classes such as garden design and nature writing transitioned well to digital formats.



↑ Youth Volunteer Parnitha created this maple leaf drawing during a virtual demonstration of botanical illustration ©The Morton Arboretum



ENGAGING AUDIENCES DURING THE PANDEMIC

Although several departments at the Arboretum produce programs, I will focus here on the Education Department's work. Since mid-March, education programs have attracted a sizable audience, with more than 60 digital offerings and resources.

Interactive classes such as garden design and nature writing transitioned well to digital formats. Arboretum Yoga, offered live through Zoom, doubled in average attendance compared to the in-person experience. This response encouraged staff to provide offerings that helped to alleviate pressures precipitated by the shutdown; a June in-person retreat was reimagined as a virtual Week of Wellness.

Digital classes that can be taken at the participant's own pace were particularly successful. Enrollment in these programs have more than doubled compared to the same period in 2019. A new class, Basic Tree ID, was an immediate hit with Arboretum audiences, engaging more than 160 participants. A few months later, Illinois' Wild and Wonderful Wildflowers program was attended by over 360 participants.

Education staff also held virtual Summer Science Camps for children ages 4-12. Content for 10 weeks of digital camp was developed using the free e-learning platform, SeeSaw. Virtual camps engaged nearly 50 kids in the course of eight weeks. The Early Childhood team also developed Family Nature Adventure, a free digital resource that featured a new theme each week and included elements of adventure play, creative craft, exploration, and reading suggestions.

LESSONS LEARNED: THE ARBORETUM'S YOUTH VOLUNTEER PROGRAM

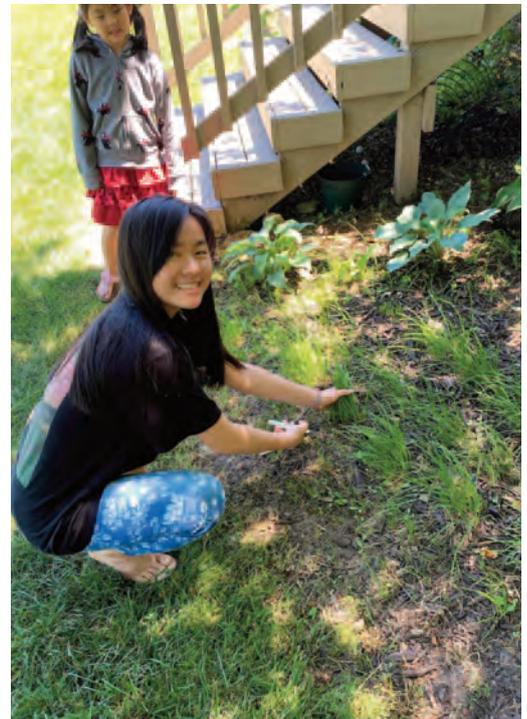
I end with a discussion of the Arboretum's Youth Volunteer Program because I believe what we learned in converting this program to a digital format applies to many of the virtual offerings in the past months.

The Youth Volunteer Program is the backbone of the Arboretum's STEM engagement efforts, aimed at sparking the curiosity in science and nature of a future generation of green professionals. In the transition to virtual, volunteers spent a summer of service focused on their backyards and immediate surroundings rather than on work they would have done at the Arboretum. Many participants were disappointed at first, but the consensus has been that digital engagement was better than outright cancellation. Indeed, despite the virtual format, participants connected with nature in meaningful ways. Although a critical social dimension was lost this summer, some volunteers found that synchronous, albeit remote, projects helped address this to an extent. Some of the volunteers indicated that they gained a better understanding of their immediate surroundings and found real-world applications of assignments while going about their day.

← Youth Volunteer Arnav and his father dug out and planted a new bed of vegetables for his "remote" Victory Garden ©The Morton Arboretum

Engaging audiences effectively while working remotely, and amid uncertainty, presented unexpected challenges. Understanding and addressing these challenges early into the pivot to online engagement helped to resolve capacity issues, and provided staff with a solid logistical and technological platform on which to present a variety of programs.

I now understand how valuable it was to acknowledge then that we had entered unfamiliar territory; recognizing this reality enabled remarkable experimentation and innovation to occur.



↑ Youth Volunteer Kailani and her sister harvested Chinese chives to make dumplings for a garden-to-table project ©The Morton Arboretum

While some activities could not occur, such as site-specific interactions with Arboretum staff, the program inspired participants to apply their newfound knowledge to their daily lives and succeeded in stimulating participants' interest in exploring STEM and green careers. These are some of the same outcomes we would have hoped to achieve during a normal year.

Not all offerings engaged participants as deeply as this program, but virtual engagement with nature proved to be a welcome and viable alternative to in-person offerings. The Youth Volunteer Program illustrates the importance of good program design that intentionally addresses the interests and needs of targeted audiences. Relevant and stimulating content is even more critical when presented digitally.

In the context of the pandemic, engaging audiences effectively while working remotely and amid uncertainty presented unexpected challenges. Understanding and addressing these challenges early into the transition to online engagement helped to resolve capacity issues and provided staff with a solid logistical and technological platform on which to present a variety of programs. Although I didn't realize this last March, I now understand how valuable it was to acknowledge that we had entered unfamiliar territory. Recognizing this reality enabled remarkable experimentation and innovation to occur, as demonstrated by the examples above. We also allowed ourselves to be less than perfect, albeit hesitantly.

We started to offer in-person programs again in July, but a segment of our audience still prefers to engage with the Arboretum virtually, which isn't surprising given the precarious circumstances in which we still find ourselves. This hybrid strategy of audience engagement will likely continue in the months ahead. As this crisis continues, Arboretum staff are applying what we learned to improve programs and expand our audience, streamline user experience, and ensure greater accessibility for online learning.

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↓ ©The Morton Arboretum





Lockdown restrictions due to the COVID-19 pandemic led to the creation of new educational forms in Peter the Great Botanical Garden (Russia, Saint Petersburg). Remotely communicating with our visitors from March to July, we had a lot of fun revealing the talents of our young participants. Two botanical marathons using social media were an excellent way to reach out during the isolation. It was exciting! In July, the Garden finally began to receive visitors. Now for parents with children there is a changed format to their ecological excursion - the quest-walk "The Journey of Ant in the Tropics". Participating in it, everyone is happy, both parents and children!

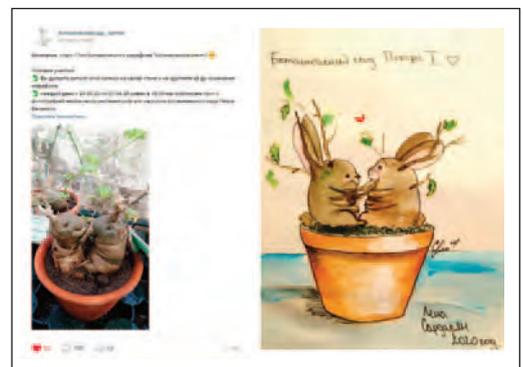
SEARCH FOR OPTIMAL WAYS: NEW HORIZONS FOR CONTACTLESS EDUCATION

Modern botanical gardens are undergoing a change. In the context of the COVID-19 pandemic unprecedented opportunities are created. The motto of specialists implementing new programmes for visitors remains "education throughout life". We have repeatedly turned to the topic of informal learning through social networks and are sure that in such difficult conditions such as these, it is necessary to continue to develop the system of interaction "Garden - Internet - people". This has allowed us to continue to share knowledge about biodiversity remotely and embodies the ideas of the Global Strategy for Plant Conservation.

Before the pandemic, Peter the Great Botanical Garden organized at least 10 festivals, 30 botanical exhibitions, and more than 9000 excursions a year. We also ran 26 specialized children's programmes, interactive excursions, master classes, quests in the arboretum and greenhouses, and inter-museum projects. Engaging with online communities have previously helped us achieve our educational goals. The Garden uses Vkontakte (the Russian equivalent of Facebook) and Instagram to help with daily communication and allows visitors to get acquainted with a large collection of the Garden. However, during the COVID-19 pandemic this area of work became even more relevant.

In 2015, the online community "Botanical garden for children" was created to engage with our younger audience using social media. This "hobby club" attracted regular visitors and formed a strong "fan base" supporting the traditions, culture of communication, and behaviour in the Garden.

↩ Children independently study plants in the quest "The Journey of Ant in the Tropics" ©Larisa Musinova



↑ An example of an ad and response from a child in the 17th and 18th marathons in a children's group on a social network



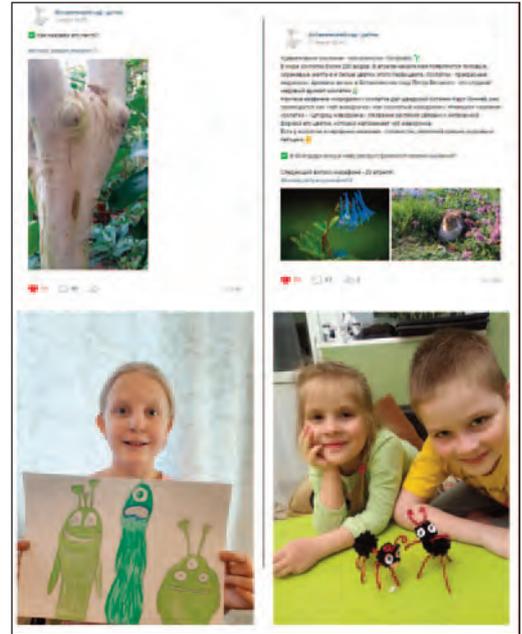
Contests such as “botanical marathons” have become regular events in the community. This “creative” competition is an innovation of the organizers. It attracts large numbers of participants, reveals creative potential, and develops cognitive activities. “Marathons” require serious training of employees, and careful selection of content. They are dedicated to themed holidays or exhibitions in the Garden. Two to three marathons are organized annually. The algorithm is as follows:

1. An announcement about the start and the theme of the "marathon" is made.
2. A request is made to the community members to place an announcement about the "marathon" on their page to promote the competition.
3. A daily announcement about a plant from the Garden collection is posted.
4. A question is posed to community members.
5. Community members post their answers in the comments of each announcement.
6. The team sum up and identify members who answered the question first and those who left the most interesting comments.
7. The winners are awarded.

Invitations to Garden events (festivals and exhibitions) and botanical gifts (plants or seeds) motivate participation. However, the most powerful incentive is the opportunity to excel, stand out and learn new and exciting things.

More than 100 families took part in two such marathons during the pandemic. The 17th «Botanical Thing" marathon, the longest in the history of the community, opened up the creative potential of children. The challenge was to give an unusual plant a capacious name associated with literary, cinematic, animated, or other fantasy characters. Over three weeks, we received about 100 responses every day! Everyone wanted to express an unusual plant with a picture or a word. The development of a child's (and an adult's!) imagination, expressed in memories of books, films, paintings and songs, helped to occupy people and relieve the tension of the first period of quarantine.

During another marathon “The Big Journey of a Little Seed”, participants studied the methods of plant seed dispersal: anemochoria, hydrochoria, zoochoria, endozoochoria, myrmecochory, autochoria and ballistochoria. In the comments to the announcements, we asked participants to supplement the given methods of seed dispersal with plant examples. Children and parents studied the distribution of plant seeds from the Family *Nymphaeaceae* Salisb.; Genera *Corydalis* DC., *Dorstenia* L., *Betula* L., *Quercus* L., *Acer* L., *Prunus* L., *Oxalis* L., and the species *Barringtonia asiatica* (L.) Kurz.



↑ Examples of ads and responses from children in the 17th and 18th marathons in a children's group on a social network

↩ The quest “The Journey of Ant in the Tropics”
©Larisa Musinova

We have repeatedly turned to the topic of informal learning through social networks and are sure that in such difficult conditions it is necessary to continue to develop the system of interaction "Garden - Internet - people" expanding knowledge about biodiversity and embodying the ideas of the Global Strategy for Plant Conservation.



↑ Awarding the first group of participants of the 18th “botanical marathon” ©Larisa Musinova

Child participants engaged with the activity by drawing, sculpting and gluing. Every day we received more than 80 comments supported by video and musical accompaniment, installations, and simulations of various methods of plant propagation. The "competition" was filled with personal experiences and opportunities for self-expression. Some children supplemented the story with melodies performed on musical instruments. The new film company "Nadyafilm" was born here. A twelve-year-old girl, Nadya, made a series of short cartoons about the dispersal of seeds. A guided family walk in the Japanese Garden was her reward after the restrictions were lifted.

The opening of the Garden on July 1 was a welcome event. Before the pandemic visitors could choose from two tour formats, one of which was a group excursion with a guide, and the second one was a walk with consultants working on the route. During the pandemic we completely switched to the second format.

The quest "The Journey of Ant in the Tropics" was created especially for walking along the Tropical route. Any quest is a great way of attracting new visitors and this quest was suitable for children aged six and above. However, in July, we received interest in the quest from more than 300 families.

The quest tasks cover various questions about the interaction between plants and animals, in particular, how representatives of these two kingdoms help each other to exist on the planet. Drawings of plants on the route sheet, and images of an ant placed in greenhouses, were designed to help a child find plants quickly. During the walk-quest families study plants of the *Cactaceae* Juss. and *Fabaceae* Lindl. family, as well as the Genera *Aspidistra* Ker Gawl., *Salvinia* Ség., *Acacia* Mill., *Ficus* L., *Tillandsia* L., *Costus* L., *Monstera* Adans., *Phoenix* L., and *Begonia* L. We used a visual image of an Ant as the main character in the quest for the first time. During the quest, he becomes a friend of children and encourages them to study. Other tricks we used were:

- a sheet of paper with windows for plant names;
- using highlighted letters to determine the main hidden word - "biosphere";
- encrypted plant names in a "grid of letters" next to the plant;
- at the end of the route, a garden specialist checks the responses and adds a stamp;
- the reverse side of the route page is a certificate for «the Best naturalist»;
- interdisciplinary learning process, including both mathematical and grammatical tasks.

The advantages of this format are that it works with social distancing requirements, it motivates and it interests the audience. It supports informal learning by providing both reflection, and the development of a respectful attitude towards nature.

Both engagement forms discussed here have been effective in increasing interest in the study of plants by visitors. The interactions generated by the marathon and the quest-walk, are good examples to build on in future educational programmes.

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↑ The quest "The Journey of Ant in the Tropics"
©Larisa Musinova

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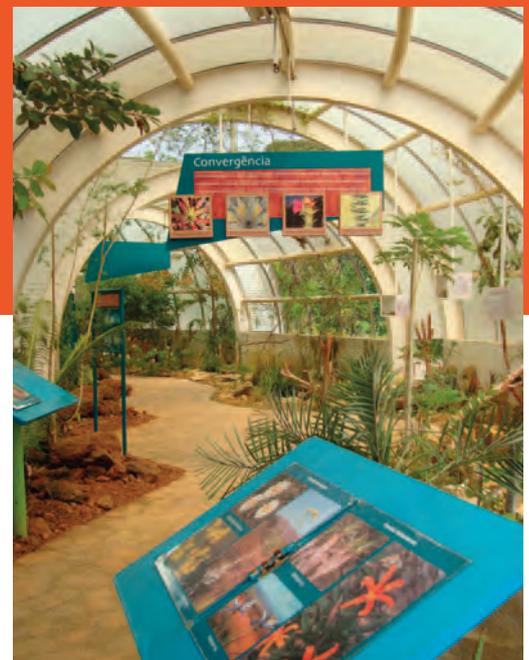
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HOW CAN ENVIRONMENTAL EDUCATION OVERCOME THE CHALLENGES FACED DURING A PANDEMIC?

The Belo Horizonte's Botanical Garden works on research and conservation projects in three Brazilian biomes. It is also responsible for the production of seedlings, and has a visitation area with thematic greenhouses that received around 370,000 visitors in 2019. In March, the increase of COVID-19 cases in Belo Horizonte required the closure of the Belo Horizonte's Botanical Garden to the public. Since closing, the Environmental Education team has been working remotely facing the challenges of reaching our audiences with online activities.

↑ Japanese Garden ©Suziane Fonseca

The Fundação de Parques Municipais e Zoobotânica (FPMZB), located in the city of Belo Horizonte, capital of the Minas Gerais state of Brazil, is a foundation that manages the city's Botanical Garden and the Zoo (both located in the same area), and more than seventy urban parks, agroecological living centers, and cemeteries. Additionally, FPMZB coordinates many *ex situ* and *in situ* conservation projects. The Belo Horizonte's Botanical Garden (BHJB) works on research and conservation projects in three Brazilian biomes: Caatinga, Atlantic Forest, and Cerrado. These last two are conservation hotspots due to their great biodiversity and degree of threat. BHJB has a herbarium, cultivates threatened species, and also maintains a seed bank. In addition, BHJB is responsible for the production of seedlings for afforestation and gardens in public areas of the city and has a visitation area with thematic greenhouses of the biomes Caatinga, Atlantic Forest, and Cerrado, and another that addresses the evolution of plants.



↑ Thematic greenhouse of the Rock fields (biome Cerrado) ©Suziane Fonseca



← Thematic greenhouse of the evolution of plants
©Suziane Fonseca

FPMZB has an Environmental Education (EE) section that includes biologists and educators from different fields of study, engaged to increase the knowledge and enchantment of people in relation to living beings, mainly species of native flora and fauna, providing tools for species conservation and their environments, and for improving quality of life of the community. In 2019, the BHJB (and Zoo) received around 370,000 visitors, mostly composed of students, who were guided by the EE sector.

In March, the increase of COVID-19 cases in Belo Horizonte required the closure of all FPMZB units to the public, and the EE team has been working remotely since. At the beginning, we were optimistic and prepared ourselves for actions already planned for the semester. However, the number of cases is still increasing and the initial plans were cancelled, and new alternatives were proposed to raise public awareness at a distance. Thus, we started to produce and publicize educational material for download from our website (<https://prefeitura.pbh.gov.br/fundacao-de-parques-e-zoobotanica/informacoes/educacao-ambiental/materiais-educativos>). This includes booklets, colouring books, crosswords, word searches, and memory games. Later, we realized that several institutions were doing the same and we received reports from parents who were overloaded with their children's online classes, and that the receptivity for this type of material was starting to decrease. Therefore, we needed to reinvent ourselves, and an obvious alternative would be to use social media. FPMZB does not have its own social media and normally uses those of the Belo Horizonte City Hall, to which it is subordinated. Usually EE social media posts focused on publicizing and inviting people to their events. However, in the context of the COVID-19 pandemic, posts were exclusively dedicated to broadcasting epidemiological bulletins, and preventive measures against the disease. We couldn't be discouraged! Therefore, we sought partnerships with other institutions and, through their social media, our team offered an online course on environmental education for a local college, participated in social media lives and podcasts on topics such as native species and their valuation, and environmental services. We also turned our efforts towards the production of more detailed educational materials that require higher staff investment – something that is not usually possible when the garden is open.

In June 2020, we set up a YouTube channel and started posting short videos about the work of the Botanical Garden, Zoo, and urban parks (<https://www.youtube.com/user/videospbh/featured>). This project, still in progress, includes videos on the production of seedlings, planting techniques, the work of the seed bank, among others.



↑ Cover and pages Booklet Cordel das Plantas - poetry about a cactus called Mandacaru (*Cereus jamacaru*) from Caatinga biome (in Portuguese)
©Diego Paiva (Text: Ana Romanizio, Arthur Leonel)



↑ Belo Horizonte's Botanical Garden
©Suziane Fonseca

All videos are filmed using masks and respecting the minimal distance between people to ensure the safety of those involved. The production of educational videos is something new and challenging for the team. It took a lot of effort and the team needed to work together to write the script, film, and edit the videos. The first videos were well received and we had a larger number of hits than expected. The comments showed that the videos pleased the audience. Despite the challenges, the results stimulated the team a lot.

In addition, we made new partnerships that allowed us to reach the public more effectively. One of them was the Belo Horizonte Municipal Education Secretariat. Thus, the team recorded online courses for teachers addressing the role of botanical gardens for the conservation of species, strategies for better use of visits with students, ecosystem services in green areas, prevention of forest fires, among others. A part of the course content is based on one of our online publications entitled “Livro Ilustrado da Zoobotânica: um guia para visitas” (Illustrated Book of Zoobotany: a guide for visitors) that was made freely available for teachers and others interested in the content (<https://prefeitura.pbh.gov.br/sites/default/files/estrutura-de-governo/fundacao-de-parques-e-zoobotanica/zoo-botanica/livroilustradozoobotanica-e-book-sem-prefacio-1.pdf>).

Another partnership, involving eighteen institutions including botanical gardens, zoos, museums, and non-governmental organizations, resulted in the offer of an online vacation course on social media aimed at children and teenagers. In Brazil, school holidays take place in July. All institutions involved created daily posts with play activities around the theme of endangered Brazilian primates and their ecosystems (<http://bit.ly/curso-de-ferias-ea>).

Questionnaires (in an online form) were sent to teachers from public schools. This evaluation aimed to identify the impact of the materials produced by the team during social isolation, on teachers, as well as to understand how teachers heard about the content and whether it had been used with their students through remote teaching.

Between the 3rd and the 14th of August, 60 teachers were invited to answer the questionnaire and 22 responses were obtained. The evaluation showed that the videos posted on YouTube had a greater reach when compared to the activities available on social media, Facebook or on the institutional website. Teachers reported that the WhatsApp messaging app proved to be the best way to share information about content and activities. In addition, they preferentially used this means to communicate with students, passing on received content and sending activities based on this content. Until August 2020, remote teaching had not yet been implemented in public schools in Belo Horizonte. Most students do not have a computer at home. Cell phones are more accessible to the majority of the population, which justifies the use of the WhatsApp app to communicate with students. Unfortunately, access to online content is limited for most Brazilian students (Alves & Mamede, 2020). In times of the pandemic, EE could be more effective if everyone had access to technologies that would allow access to online content.

The pandemic has changed the way we live and work. Environmental educators and other professionals have been challenged to innovate in order to achieve their goals. It encourages us to discover new opportunities, new ways of working and interacting at distance. Even with limitations, it is a path of no return. Technologies previously ignored, will be a permanent part of our routine forever. This “new normal” still calls us to master new tools and, even in isolation, to unite and form new partnerships to delight the public with knowledge about biodiversity, supporting species protection, and preservation of their environments.



↑ Videos teaching planting techniques ©Diego Paiva

At the beginning, we were optimistic and prepared ourselves for actions already planned for the semester.

We needed to reinvent ourselves, and an obvious alternative would be to use social media.

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↑ The online “flower viewing” of cherry blossom in the Shanghai Botanical Garden received more than 330,000 clicks through Xinhua News Agency APP
↵ Tourists enjoyed the splendour of spring in Shanghai Botanical Garden ©Li Kai

SHANGHAI BOTANICAL GARDEN'S INNOVATIVE VIRTUAL SCIENCE EDUCATION DURING THE COVID-19 PANDEMIC

From January 24th to March 12th 2020, the Shanghai Botanical Garden was temporarily closed to prevent the COVID-19 pandemic. Although the virus has kept tourists away from the Garden, we have innovated and developed a series of events to help people maintain the connection with nature via the internet, such as virtual garden tours, online tree adoption, and virtual exhibitions. This new mode of science education not only brought hope to citizens who were trapped at home, but also attracted considerable attention from the mainstream media and the public as well.



← The news report of virtual garden tours held on our Garden's official WeChat account by Shanghai TV

The sudden outbreak of the COVID-19 pandemic caught everyone off guard. To help avoid social gatherings, the Shanghai Botanical Garden had to temporarily close its doors to visitors on January 24th. Although the virus has kept tourists away from the Garden, it did not stop the arrival of spring. On February 4th, the beginning of spring, magnolias - also known as the city flower of Shanghai - bloomed in our Garden. The bright and white flowers encouraged our staff and brought hope to the city. To help people enjoy these flowers and continue to connect with nature at home, we planned and hosted a series of virtual events. With creativity and innovation, the Shanghai Botanical Garden developed a new model of science education despite the challenges of a pandemic.

VIRTUAL GARDEN TOURS

Beautiful flowers often bring people to gardens, parks, and out in the wild in springtime. As the tourists were unable to visit the Shanghai Botanical Garden and were about to miss the blooms of the early spring flowers, the staff of the Garden decided to document their blooms with articles, pictures, and short videos, and then share them on our websites, WeChat, and Weibo (MicroBlog). While people could not feel the softness of the young grass or smell the faint fragrance of these delightful flowers, they were still able to experience the vitality of nature. This experience brought people hope and courage during the pandemic. Since January 24th, we have hosted several online exhibitions and "flower-viewing" sessions through our official WeChat account. From February 5th, we also published a series of articles with images and videos, and successfully created virtual tours of the Garden through WeChat. Those virtual exhibitions and tours have attracted considerable attention from the mainstream media and were very well-received. By the end of March, more than 20 news media outlets, including the Xinhua News Agency, Shanghai TV, Guangdong TV, China Flower News etc. had reported those events. Among them, the video about plum blossoms received more than 330,000 hits. As a result, more and more people have become familiar with our Garden and our virtual events through We-Media and increased publicity.

ONLINE TREE ADOPTION

Tree adoption is a traditional, yearly activity held on every Tree Planting Day (March 12th) in the Shanghai Botanical Garden. Many environmentally conscious citizens would come and adopt a tree to support the environmentally and our Garden. As one of the first batch of China's "Internet + national voluntary tree planting" bases, the Shanghai Botanical Garden continued the tree planting activities in this very special spring, and went even further to host an online ecological "banquet" for the public. This "banquet" consisted of four "dishes": Nature trivia, a plant science video exhibition, Nature Notes - the growth of a seed, and tree adoption. Among them, the charitable event "Nature Notes - the growth of a seed" was jointly planned with the Morning News newspaper and integrated with home gardening, nature notes, science education, and other elements.



↑ The young staff of our Garden participated in the online tree adoption event voluntarily ©Li Kai

Despite the challenges of the pandemic, Shanghai Botanical Garden has never ceased to promote knowledge about plants and flowers.



↑ The virtual tour held by Shanghai Botanical Garden and People's Daily Weibo attracted more than 3,500,000 live viewers

The public responded to this activity so enthusiastically that we had to add 500 additional free gifts including calliopsis seeds to the original 500. Even 1000 barely met the demand. As the “main course” of this “banquet” – we put out 200 adoptive trees. In only two days, we received nearly 500 adoption applications. This series of virtual tree planting activities not only complied with the government’s pandemic prevention requirements but also fully embodied the concept of “Internet +”. Because of these, it generated extensive media interest. The Xinhua News Agency reported on it with a video story, which received more than 350,000 clicks. In addition, the in-depth story from the Xinhua News Agency titled “we sow green - report on afforestation in spring from all over the country” featured the case of our Garden and was posted on www.gov.cn.

VIRTUAL EXHIBITIONS

Because of the pandemic, many top-tier flower and horticultural exhibitions have been cancelled or postponed, such as the Hong Kong Flower Show, Myplant & Garden in Italy, Melbourne International Flower & Garden Show, and even the RHS Chelsea Flower Show, which usually attracts global attention, has turned to an online format. The Organizing Committee of Shanghai (International) Flower Show, which aims to create “China’s Chelsea Flower Show”, decided to host the exhibition offline and online synchronously. This decision was made not only to allow citizens and tourists to enjoy the most beautiful spring scenes, but also to boost the confidence of the horticultural and landscaping industry. During the pandemic, the organizers had to make sure that citizens and tourists could enjoy the beauty of gardening and plants, while ensuring the safety of the visitors. The Shanghai Botanical Garden implemented the most stringent prevention and control measures and adopted an “appointment only” method to control visitor flow. At the same time, the Garden greatly enhanced our online presence and outreach, and successively launched various forms of exhibitions and virtual tours. Through collaborations with major media partners including many state-level media, such as CCTV News, Xinhua News Agency, People’s Daily Weibo etc., our live virtual tours were led by professional hosts and representatives of the organizers. The total number of live viewers exceeded 6 million, which is 20 times the average number of tickets sold in previous flower shows. In addition, the Shanghai Botanical Garden also continued to release short videos and visual stories through WeChat, Weibo and other We-Media platforms. The diverse forms of public outreach helped highlight each scenic spot in the flower show, so that people could fully enjoy the show from home.

Although the prevention and control measures of the COVID -19 pandemic have proved to be effective in China, the battle between us and the coronavirus is far from over. There are still significant risks associated with large gatherings. Therefore, the group tours and offline activities of the Shanghai Botanical Garden are still suspended. However, despite these challenges, Shanghai Botanical Garden has never ceased to promote knowledge about plants and flowers. So far, we have successively launched several video tutorials online, such as chrysanthemum planting, mini-penjing (bonsai) repotting, oriental flower arrangement, and natural notes taking. This way, people can participate in gardening activities anytime at home. We also moved our most popular science activities - meeting the night elf – online too. We shot a series of videos of fireflies in the fern garden, unicorn beetles in the herb garden, and epiphyllum in the greenhouse, etc. These videos are particularly popular among children, as they allow them to experience the wonder and beauty of nature through a professional lens.

Whilst these online activities have helped maintain people’s connection to nature to a certain extent, we sincerely hope that when the pandemic is over, they could return to our Garden, embrace nature freely, and appreciate truly the bond between humans and nature.



↑ The beautiful scenery of 2020 Shanghai (International) Flower Show held in our Garden ©Shanghai Botanical Garden

Hosting the 2020 Shanghai (International) Flower Show not only allowed citizens and tourists to enjoy the most beautiful spring sceneries, but also boosted the confidence of the horticultural and landscaping industry.



↑ One of the live virtual tours of the exhibition conducted by Shanghai Botanical Garden and CCTV News together ©Shanghai Botanical Garden

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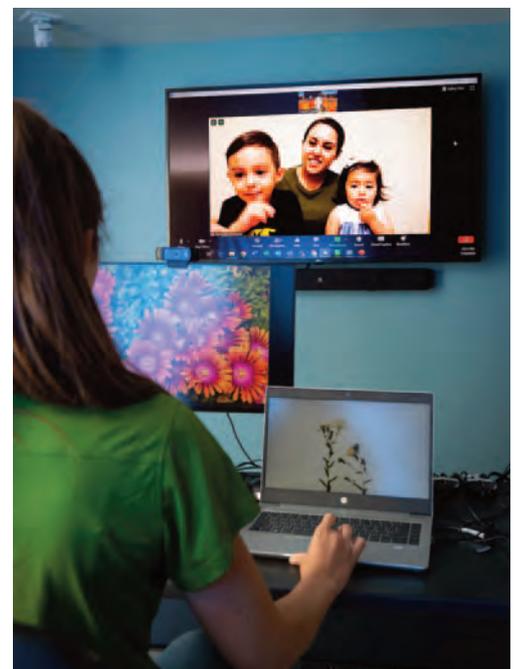
← Prairie Ecology programming at Plains Conservation Center (pre-COVID-19) ©Denver Botanic Gardens/Scott Dressel-Martin

Denver Botanic Gardens has provided online distance-learning programs for schools since 2016. With COVID-19 and changing school models, the demand for these distance learning programs increased significantly, along with unforeseen challenges. Our education and information technology departments forged partnerships to address these challenges, adapting to meet the rapid acceleration of virtual programs in new and creative formats. Denver Botanic Gardens is a multi-site organization, operating school programs out of three locations; our virtual format showcases each unique site while allowing us to serve our local schools and reach new audiences well into the future.

INTERACTIVE DISTANCE LEARNING: ADAPTING SCHOOL PROGRAMS DURING COVID-19

INTRODUCTION

Denver Botanic Gardens typically runs school field trip programs at three different sites in Colorado: at our main horticultural and research location in Denver, at our agricultural, historical and native plant site Chatfield Farms in Littleton, and at Plains Conservation Center in Aurora, a cultural history and prairie conservation partnership site. On-site educational programming highlights the distinctive plants and characteristics of each location. Although Denver Botanic Gardens has offered distance learning since 2016, virtual programs were intended to reach distant audiences rather than replace in-person visits from local schools. When the COVID-19 pandemic hit we were forced to close our sites to field trips, requiring a quick pivot and reallocation of resources and teamwork between the Education and IT departments allowing us to replace cancelled on-site programs with virtual experiences.



↑ A family interacts with a DBG instructor during a live virtual program ©Denver Botanic Gardens/Scott Dressel-Martin



Prior to the pandemic, we offered two virtual school programs: Flower Dissection for primary grades, and Drawing for Scientific Studies for secondary grades. Both were designed for one classroom of students at a time, used Zoom, and required teachers to purchase a grocery store item for use during the live session. Before spring 2020, these virtual programs reached a handful of classrooms each year in several US states and Canada. During spring 2020, we saw a significant increase in local Colorado school participation plus expanded national and global reach with new virtual program participants in Africa, South America, Europe, and Asia. The Gardens currently offers 8 distinct virtual programs in addition to a custom option, with substantial changes to program structure in response to the needs of our audience.

CHALLENGES, SETBACKS AND SOLUTIONS

Once we began replacing cancelled field trips with virtual programs, our first major hurdle was how to set up our instructors to successfully teach programs from home. Supplied by IT, our at-home setup included a laptop with an embedded webcam, ethernet cord, extra monitor and external microphone. This set up ensured that instructors could see, hear, and present to students with a stable internet connection throughout the program. Setting up directly in front of a blank wall or using a portable green screen allowed instructors to utilize virtual backgrounds via Zoom, projecting scenes from our three physical sites behind them. Concurrently, the IT Department began assembling a socially distant virtual program studio on-site for when staff could safely return to the Gardens.

To better serve our teachers, we set up test meetings via Zoom or Google Meet prior to booking their virtual programs so we could prepare for any challenges on their end. With our students and their teachers at home, we could no longer rely on teachers' physical presence with their class to manage behaviour, pass out materials, and assist with facilitating activities. All virtual school programs were re-designed so that the only required materials for students were a writing implement and blank paper. For example, the existing Flower Dissection program depended on teachers passing out a fresh *Alstroemeria* flower to each student; we could not expect all families to make this purchase for their children, so the dissection was replaced with a flower drawing activity. Although interaction with physical materials decreased, we took advantage of the distance-learning format to connect students directly with online resources and citizen science projects such as phenology data collection through Project Budburst, a tool students can use in any season (Henderson *et al.*, 2012).

The on-site programs we replaced all involved tangible explorations of gardens, sensory experiences with plants, and hands-on activities such as planting seeds. Our programs prioritize immersion in and access to nature, which have been shown to positively impact health, well-being and academic achievement (American Public Health Association, 2013).

↖ Virtual program instructor acts out the life of a plant with young program participants ©Denver Botanic Gardens/Scott Dressel-Martin
 ↑ Virtual program studio setup ©Denver Botanic Gardens/Scott Dressel-Martin



↑ USB microscope and document cameras allow participants to see plant structures, such as trichomes ©Denver Botanic Gardens/Scott Dressel-Martin



↑ Studio setup includes a blue screen for virtual backgrounds, which works well with green items such as plants ©Denver Botanic Gardens/Scott Dressel-Martin

Replacing in-person experiences with virtual ones can still provide the potential benefits of nature, such as decreased stress (Valtchanov, Barton and Ellard, 2010). Some examples of interactive and nature-based experiences we incorporated into virtual programs include:

- Existing photographs and video content: gardens in bloom, time-lapse of certain plants, unique highlights like controlled burn of grassland area, trap camera footage of wildlife, etc.
- Movement and dramatic play for ages 3-8, such as acting out the life of a plant
- Drawing an ecosystem or food web with Colorado species, via Zoom whiteboard
- Instructor interaction with physical objects such as plants or artefacts, using document camera, webcam, or pre-recorded video

Following pilot programs and initial teacher feedback, we addressed the challenge that not all students had access to internet, an appropriate device, or an environment conducive to virtual learning during live programs. One solution that worked well for multiple schools was to pre-record our programs and provide teachers with a password-protected Vimeo link so their students could separately view the program at a time convenient to them. While less interactive, this format ensured more equitable access to our content. Throughout the development of new distance learning activities, our Bilingual Programs Instructor worked to translate each program for live or pre-recorded instruction in Spanish.

We also provided teachers with follow-up activities for their class, such as a prompt to explore nature using a scavenger hunt or sharing a picture of student drawings via email or social media. We had to balance our desire for getting children out into nature and off their screens with mindfulness around their access to a safe space in the outdoors. Knowing that not every child would have a yard or garden at home, we invited students to connect with botanical materials in nearby parks, or through a window, or even in their own kitchens. In several programs, students are taught about plant parts using edible examples and then learn how to grow a garden from leftover food scraps such as carrot tops, potatoes, and garlic cloves. Content like this often drew the most engagement from parents and caregivers, providing a model for future family-oriented programming.

PRESENT USE AND LOOKING TO THE FUTURE:

With increased demand for distance learning and decreased use of our on-site facilities for in-person classes, it made sense to repurpose a classroom as a more permanent virtual studio. Guided by the feedback from instructors, IT staff created a virtual studio including:

- Computer with 2 additional monitors
- Laptop docking station
- External webcam
- External microphone
- Adjustable front lighting
- Document camera
- USB microscope
- Blue screen for virtual backgrounds
- Desk and chair with adjustable height

While many unknowns still await us, our new breadth of virtual program topics and formats sets us up to better meet the needs of not only our school communities, but also other family, adult, and youth groups. The insight and experience we gained continue to inform our creation of new content as we look to extend program longevity and reach wider audiences well into the future.



↑ Children participating in nature and art programming at Denver Botanic Gardens main location (pre-COVID-19) ©Denver Botanic Gardens/Scott Dressel-Martin

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Denver Botanic Gardens



← An idyllic European themed floral display greeted visitors when the Flower Dome reopened to the public on 11th July 2020. Many of the temperate flowers were grown in-house by the Gardens' horticulturists ©Gardens by the Bay

The COVID-19 pandemic has thrown a major curveball to the operations in Gardens by the Bay, shattering the traditional modes of visitor engagement by putting a stop to events – be it floral displays, festivals, or learning journeys for school children - that draw crowds to the Gardens' premises. It requires a united approach by staff from all levels to collectively brainstorm and implement new initiatives, develop new offerings, and communication modes to transform the manner of engagement and outreach to visitors. Being level-headed, innovative, and adaptable are means to survive and thrive in this extraordinary time.

#STAYHOMEWITHGB: BRINGING A PIECE OF THE GARDENS TO VISITORS VIRTUALLY

Nestled in the heart of the Marina Bay New Downtown at the southern tip of Singapore, Gardens by the Bay has wowed Singaporeans and visitors alike with lush outdoor greenery and seasonal floral displays set in a perpetual spring environment since June 2012. Built on reclaimed land, the 101-hectare national garden comprises three interlinked waterfront gardens: Bay South, the largest at 54 hectares; Bay East, at 32 hectares and the site for the future Founders' Memorial; and Bay Central, to be developed at a later phase.

The Gardens has grown in many ways over its eight years of operation. Its deliberate curation of programmes and events is aimed at appealing to a wide spectrum of visitors and has created several widely popular festivals, such as Christmas Wonderland, Mid-Autumn Festival, and the Children's Festival. Its Avatar-like Supertrees and the accompanying Garden Rhapsody light and sound show have created countless magical moments nightly for starry-eyed visitors. The all-weather cooled conservatories - Flower Dome and Cloud Forest - have thrilled visitors with plants from all continents except Antarctica, and presented 57 stunning changing floral displays to date. This progressive People's Garden has indeed blossomed into the beloved pride of Singaporeans and is a widely recognised Singapore icon.



↑ Temperature screening being carried out using a thermal scanner before visitors enter the Flower Dome. Temperature screening is among a slew of safety measures that were implemented to safeguard visitors' wellbeing at the Gardens ©Gardens by the Bay

The Gardens welcomed 2020 with the 5th edition of the Dahlia Dreams floral display, one of the perennial favourites among visitors. However, it was soon apparent that this year was unlike any other year in the past. The emergence and rapid global spread of COVID-19 had brought the world's economic activities and travel to a halt. Just slightly over two months since the first reported case of COVID-19 infection in Singapore, the Government of Singapore had announced that a "circuit breaker", comprising a range of preventive measures to stem the rising number of COVID-19 infections in Singapore would be implemented from 7th April 2020. During this period, Gardens by the Bay closed its popular garden attractions to visitors. This exceptional situation presented a challenge and opportunity for the Gardens to maintain mindshare and engage its visitors in a manner and scale that were not typically done in pre-pandemic days.

The Gardens wasted no time and sprang into action swiftly, taking a whole company approach to plan, develop, and implement a series of online offerings for the general public, visitors, and members during this time. New work streams were formed with staff across departments to work on different projects. The teams brainstormed and identified various e-resources to meet the needs of the public during this period. These included original video series that were produced in-house, such as *Garden Explorer*, which brought visitors on a virtual tour of the Gardens; *Bringing the Gardens Home*, which highlighted some of the plants in the Gardens that could also serve as houseplants, and *Behind the Scenes – Designer Chat*, which provided insights into the conceptualisation and design considerations behind some of the Gardens' past floral displays. Other contents included children's craft activities, original comic strips, and lifestyle and plant articles. A plant doctor initiative was also rolled out as another way of engaging visitors virtually, with the Gardens' horticulturists sharing their expertise in plant maintenance.

The setting up of an eShop was another approach to connect with the public, providing an opportunity for people to bring a slice of the Gardens home. This included terrariums, mini gardens, and bespoke plant arrangements created by the Gardens' horticulturists, a selection of the Gardens' plant collections such as air plants and orchids, as well as seasonal collections like hydrangeas and begonias, along with DIY plant kits, Gardens' merchandise, and gardening supplies.



↑ Local residents enjoying the plant displays in the Flower Dome after the circuit breaker was lifted and Gardens by the Bay obtained approval to reopen its cool conservatories progressively ©Gardens by the Bay

A whole-of-company approach was adopted to plan, develop and implement a series of online offerings for the general public.

In preparation for the Gardens' reopening, a key strategy was to leverage digital transformation to enhance visitor safety and experience as well as to drive productivity.

↓ An elevated view of Bay South Gardens showing the iconic cooled conservatories, Flower Dome and Cloud Forest, the majestic Supertrees as well as one of the Gardens key water bodies, the Dragonfly Lake ©Gardens by the Bay



The Gardens also took the opportunity to highlight some of the positive outcomes in its sustainability endeavours arising from the circuit breaker. In a way, these stories conveyed uplifting messages of resilience and adaptability in the face of difficult situations. A series of experiments was conducted in the cooled conservatories to provide insights into how plants cope with, and adapt to, environmental changes. These trials presented a great opportunity to explore potential solutions to improve operational efficiency in line with the Gardens' sustainability efforts. One example involves increasing the temperatures in the Flower Dome to give a little seasonality to the plants. Much to the horticulturists' delight, the warmer temperatures triggered the deciduous African Baobab (*Adansonia digitata*) to leaf out and flower. Another happy camper was *Stapelia grandiflora*, a South African native that put out spectacular, star-shaped blooms during the trial period. For plants that did not respond favourably to the experiment, in part due to higher humidity that accompanies the elevated temperatures, the horticulturists came up with the idea of introducing strategically-positioned fans to facilitate airflow, and direct cool air to where it was needed most – that is, where the temperature-sensitive plants are – and reduce humidity levels. This not only created a salubrious environment for plants that prefer drier conditions, but also discouraged the growth of pests. Marked improvements were observed in the health of several plants following the deployment of the fans. Certain species even demonstrated the ability to adapt to – and in some cases, prosper in – their new environment! This experiment highlighted the potential of introducing seasonality to the domes to enlarge the Gardens' offerings, and also inspired and challenged the team to seek new ways of doing things.

With most people at home during the circuit breaker, online and social media platforms have become the preferred communication tools. In response to this accelerating trend and to meet the public's evolving needs, the Gardens' social media efforts were augmented to deepen engagement, add value to its branding, and grow the Gardens' mindshare. The curation of meaningful social media content mix that interests the Gardens' audience was undertaken by in-house social media specialists. The increased number of social posts published during this period was matched with higher engagement rates across the board, a signal that more people are interacting on social media platforms in this extraordinary time.

Meanwhile, measures to safeguard visitors' health and safety in preparation for the Gardens' reopening were being developed concurrently. Besides on-site measures like increased frequency in cleaning and disinfection, making hand sanitisers available, safe distancing, and reduced capacity for attractions in the Gardens, a key strategy was to leverage digital transformation to enhance visitor safety and experience as well as to drive productivity. In this regard, a new all-in-one mobile application (app) was developed and launched when the Gardens reopened in phases beginning from 1st July 2020. The app allows visitors to buy and scan their tickets to the attractions, pre-book their visiting time slots, perform Safe Entry check-in and check-out (a national digital check-in system to facilitate contact tracing efforts), and get real-time updates on crowd levels in selected areas in the Gardens.

The COVID-19 pandemic has changed the operandi modus for gardens worldwide, including Gardens by the Bay. One can no longer rely on physical visitation to sustain operations, and the ability to be creative, adaptable and resilient are key to developing new modes of engagement with visitors and to do so in a sustainable manner. The journey continues for the Gardens in exploring new ideas to stay relevant, and providing a green respite to nourish and rejuvenate one's body and soul in the fight against the pandemic.



↑ Mini garden displays, known as the Pocket Gardens Surprise series, are being introduced throughout the Flower Dome to encourage visitors to explore various nooks. The first display under this series is Edible Garden, which is sponsored by private individual Mr John Lo and his family in dedication to Singapore's healthcare and safety enforcement officers ©Gardens by the Bay

With online and social media platforms becoming the preferred communication tools, the Gardens by the Bay's social media efforts were augmented to deepen engagement, add value to its branding, and grow the Gardens' mindshare.



↑ Visitors practising safe distancing while queuing to purchase tickets in March 2020 ©Gardens by the Bay

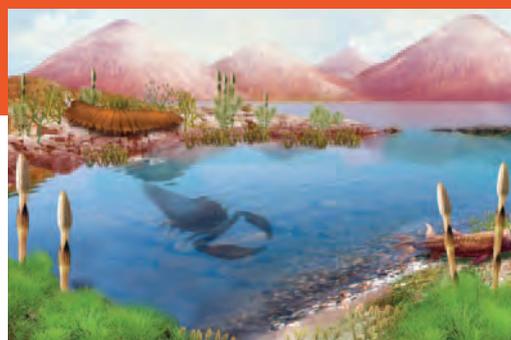
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← Kids playing Game 1 ©Giovanni Signorile

Botany is beautiful, but we need new ways to make it more appealing. Too many names and details that are hard to remember are often discouraging, especially for kids. The best way to overcome this problem is to get acquainted with plants directly in the wild, or in botanic gardens. Alternatively, we can use interactive computer games (serious games) to learn about botany with a bit of fun. Let's play!



↑ Silurian landscape with horsetails
Design: Mario De Tullio, Pooya srl.

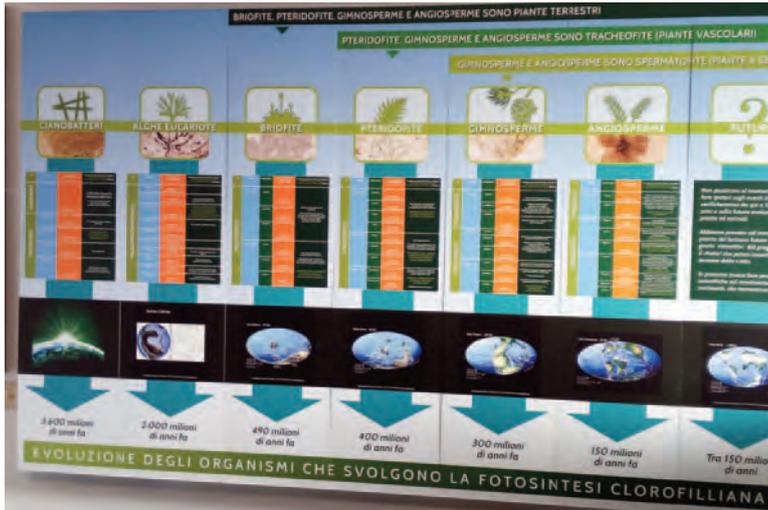
FUN AND SERIOUS: AN EXPERIENCE WITH INTERACTIVE GAMES IN TIMES OF DISTANCE LEARNING

Even though plants are everywhere around us and we all use them for the most diverse purposes, the psychological attitude known as plant blindness is surprisingly widespread. The definition of plant blindness (Wandersee and Schussler, 1999) includes the inability to perceive plants as living organisms, let alone appreciating the remarkable biodiversity found in the plant lineage as a consequence of a billion years of evolution. Spreading botanical education as a way of addressing plant blindness is a primary goal of botanic gardens, and should be a priority for all educational agencies and institutions. As part of the science communication activities of the Botanic Garden Museum of the University of Bari (Italy), we started the *E-Mo. Ve!* project, an acronym of the Italian *Evoluzione del Mondo Vegetale* (literally "Evolution of the Plant World"). Evolution was chosen as the main topic of this educational project because of its value as a strong unifying theme in natural sciences, especially relevant for developing "botanical literacy" (Uno, 2009). With the help of a small competitive grant from the Italian Ministry of Education, we set up a permanent exhibition with interpretive panels that place the phylogenesis of photosynthetic organisms in the general context of the changes that occurred during the evolution of planet Earth. Additional panels briefly trace the debate on biological evolution (from Linnaeus' immutable species to Darwin's concept of variation and selection), define the framework of evolutionary biology, and discuss the basics of molecular systematics.

"The game on flower development has been very useful to understand how gene expression works, and what a mutant is" Marco, 19 yo, 1st-year University student



↑ Jurassic landscape with Cycas plants
Design: Mario De Tullio, Pooya srl.



Since the very beginning of our project, we decided to include interactive computer games within the exhibition as a way of reinforcing key messages to visitors. However, we designed the games as stand-alone elements, so that they could also be used outside of the exhibition context. After several attempts, three games were produced. The first game was titled “**The time machine**” (in Italian, “La macchina del tempo”) because it involves travelling back in time to see plants from past ages. Each level starts with a question that introduces Cyanobacteria, Eukaryotic Algae, Bryophytes, Pteridophytes, Gymnosperms, and Angiosperms respectively. We did consider whether the addition of many algal taxa into the “Eukaryotic Algae” category would be too much, but in the end, we included these for the sake of clarity. After selecting one of the choices, the player travels to the desired geological era, going through the animation of a “time-tunnel”, where tabs with the names and symbols of the six major groups of plants considered in the game are shown on repeat. One of the main challenges encountered by many Botany students is being able to remember the names of plants they have never heard of before. By repeating the names of the six groups, the players are more likely to remember them at the end of the activity, or at least the names become more familiar. Each activity is set in a scenario showing the main features of each geological era, and where possible the most representative animals of that time. Small animations and sound effects help to attract the attention of the player.

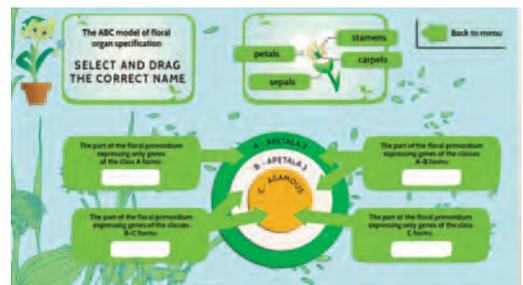
The graphic part of the games required careful consideration. Among the different possibilities, we opted for a cartoon-like layout to make the game more appealing for kids. The activities vary for each level, but they are all based on a “drag and drop” mechanism. After being instructed on the purpose of the activity, the player clicks on one detail (picture, name) and drags it to the right place on the screen. In case of error, the detail bounces back to its initial position, otherwise it sticks where the player placed it. For example, this mechanism is used in one level (Cyanobacteria) to discriminate between planktonic and benthic species, or in another one to classify three Bryophytes belonging to liverworts, hornworts, and mosses, respectively. After completing each level, a general description of each group appears on the screen. Completing all six levels opens the way to a seventh one: The Future. We tried to imagine what direction plant evolution may have taken, 250 million years from now, suggesting the possibility that some plants will develop the capability of metabolizing plastics and other man-made pollutants. The game is aimed at primary school kids, but it is also suitable for undergraduates studying Natural Sciences and Environmental Sciences as a tool to learn basic information about the diversity of the plant lineage.

← Panels describing Earth evolution are reproduced (with permission) from the Paleomap Project by Christopher Scotese (www.scotese.com) www.scotese.com) ©Mario De Tullio

“An enjoyable, yet effective way to approach complex topics”
High school student, 16 yo



↑ One level of the quiz game (Game 2) solved
Design: Mario De Tullio, Pooya srl.



↑ The ABC model of flower development as described in Game 3 Design: Mario De Tullio, Pooya srl.

“I liked The Time Machine, because I could see plants I have never heard of before”
Primary school kid, 10 yo

“The games offered a helpful visual feedback that really worked especially in on-line classes”
Giulia, 19 yo, 1st-year University student



← The time machine: the game begins
Graphic design; Mario De Tullio, Pooya srl.

The second game, **Biodiversity and plant evolution** follows the format of a quiz show. The player reads the description of a plant, and selects the corresponding picture and scientific name. The six levels correspond to the same plant groups considered in the first game. The game is designed for middle school kids, and anyone else interested in plant trivia.

We also designed a third game, **Gene expression and floral morphology**. By regulating the expression of genes involved in the determination of flower shape (ABC model), the player interacts with the development of the *Arabidopsis* flower. The four whorls of the *Brassicaceae* flower in wild type plants (sepals, petals, stamens, and carpels) are described. The player is then asked to observe some mutants with unusual flowers. In the next level, the player has a choice to switch three genes (class A, B and C) on and off, and see the sketch of the phenotype resulting from the expression of the genes chosen. This game, which requires some basic understanding about gene expression, is designed for high school students/undergraduates.

The efficacy of the three games has been tested with many visitors, mainly school children and their teachers. Most of them are positively surprised: the smile we have observed on their faces when they use the games is the best reward for our efforts.

The games proved especially useful in times of distance learning, during the recent viral pandemic that, in Italy and many other countries, prevented in person classes from taking place. Botany classes for first-year students in Natural Sciences usually include, among other activities, a visit to our Botanic Garden to provide an overview of plant diversity, and a lab activity to learn about flower morphology. Those activities were replaced with on-line classes, using games 1 and 3, respectively. Each game session involved 80-90 students. The majority of the students we interviewed very much appreciated our games as teaching tools. In particular, the “visual feedback” they received whilst using the games helped them in their learning process. Of course, the games are not a substitute for contact with living organisms, but they can still provide a complementary approach.

The debate on the use of educational (serious) computer games is growing (Riopel *et al.*, 2019), and our experience confirms their usefulness in delivering effective science communication. We are now planning to update the games that have been produced, and to develop new ones on different aspects of plant science. The Italian version of the games is available at www.botanicalconnections.it



↑ Kids visiting our exhibition are instructed on the use of our games ©Giovanni Signorile

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← Live broadcast by Culture Group
©Shuiheng Jiang

In 2020, the Coronavirus COVID-19 spread across the country. Hangzhou Botanical Garden responded quickly to the arrangements of the West Lake Scenic Area Management Committee and closed the park at once. In addition, Hangzhou Botanical Garden explored new social media methods such as our WeChat official account and TikTok to convey scientific knowledge and advice about the epidemic as well as plant conservation in the garden, in an accessible and engaging format. These methods were also used by botanists to engage the general public with the garden using a live broadcasting room.

USING THE WHOLE MEDIA AND PLATFORMS

1. PREVENTING AND CONTROLLING THE EPIDEMIC USING ONLINE AND OFFLINE NETWORKS

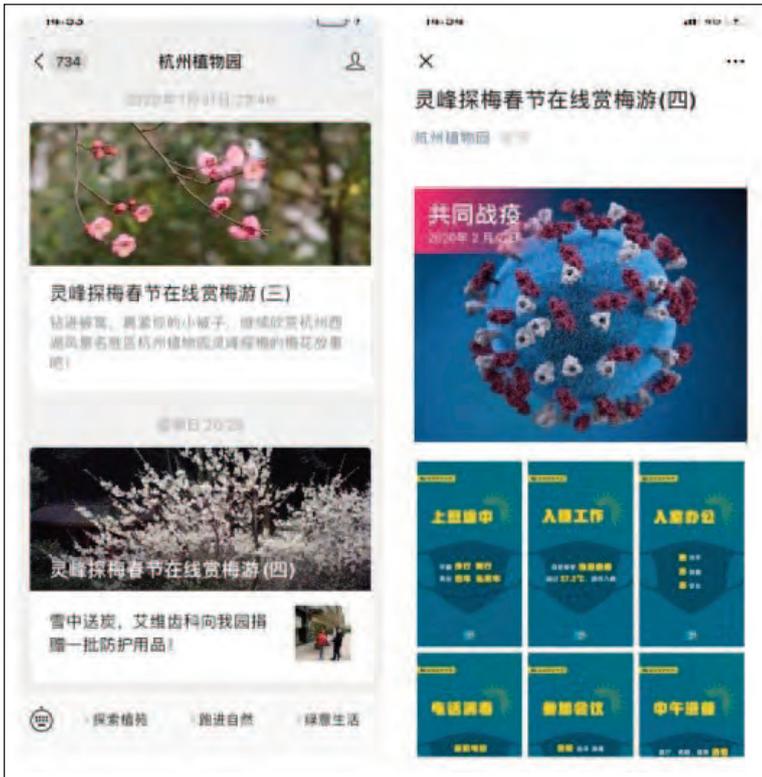
On January 23rd 2020, Zhejiang Province officially launched the first-level response to a major public health emergency and the Party Committee of Hangzhou Botanical Garden responded quickly. The Party Committee used the official website and WeChat account to provide information announcements of the West Lake Scenic Area, to the public about the operation status of the garden. At the same time, scientific articles about epidemic prevention and control, such as “What's the Difference of COVID-19?”, “Is it useful to wear a mask?”, “How to prevent it effectively?”, “The Most Comprehensive Introduction of COVID-19”, were also launched on the WeChat official account.

2. INCREASED THE NUMBER OF TWEETS TO KEEP PLANT SCIENCE POPULAR

During the outbreak, in order to make up for the fact that tourists could not come to the garden to enjoy the beautiful scenery, Hangzhou Botanical Garden increased the number of WeChat official account tweets. In addition, Hangzhou Botanical Garden published various articles about interesting and scientific plant knowledge, as well as, news and photos of flowers in the garden on the website, for instance "The Golden Nobles in the Mountain-Witch Hazel", "Only Bloom Once in the Whole Life-Agave", "Like Doves Fluttering on the Branches -National Treasure *Davidia involucrata*" and so on. Even if citizens and tourists could not visit the scene in the garden, they could still follow the footsteps of nature, increase their knowledge, and gain experience of the beautiful nature through the WeChat official account.



↑ Flower appreciation used as the theme to launch a “Cloud Live Broadcast” on the TikTok official account of Hangzhou Botanical Garden
©Shuiheng Jiang



3. THE FRAGRANCE OF PLUM BLOSSOMS CAME FROM THE "CLOUD" AND MEDIA INTEREST CREATED AN ONLINE PLUM APPRECIATION FORUM

To meet the demand of people enjoying plum blossoms during the Spring Festival, the Botanical Garden launched a series of tweets about plum appreciation. A combination of culture, history, and beautiful pictures of plum blossoms in Hangzhou Botanical Garden were released via the WeChat official account, accompanied by video and audio broadcasts. 11 tweets were released with the plum appreciation series being viewed nearly 50,000 times. At the same time, using TikTok, the identification of the plum variety, the history of Lingfeng plum appreciation, and a video of plums on Lingfeng mountain were released to meet the demand of people enjoying the plum blossoms.

4. SEEKING OPPORTUNITIES IN THE "CLOUD", THE "CLOUD LIVE BROADCAST" ATTRACTED MILLIONS OF PEOPLE

In order to promote the resumption of work and re-opening of the garden, we used spring online flower appreciation as the theme to launch a "cloud live broadcast" on TikTok. The first issue of the flower appreciation online (March 17th) was "Plant Encyclopedia, Nianlin Li will show you the romance of spring flowers". Invited by Zhejiang Daily Zhe Video and Culture Group, our garden launched two other broadcasts and attracted millions of people. The second issue of the flower appreciation online (March 24th) was "Huajiao Ding, a talented woman who knows hundreds of Chinese herbs, will take you to recognize and enjoy wild flowers". The third issue of the flower appreciation online (April 29th) was "Big Tree will show you beautiful Iris."

5. ENJOYING TRAVELING EXHIBITIONS AT HOME, THE "ONLINE PAINTING EXHIBITION"

In March 2020, a national exhibition of museum paintings tour - "LIAN. Chinese Plants Affecting the World" - launched by Beijing Museum Painting Development Center, came to the Hangzhou Botanical Garden.

← Hangzhou Botanical Garden has launched a series of tweets about online plum appreciation @Shuiheng Jiang



↑ The stories and images of Hangzhou Botanical Garden during the epidemic were promoted, on the WeChat official account @Shuiheng Jiang



↑ Live broadcast explaining home gardening @Shuiheng Jiang



Unfortunately, the exhibition could not take place in person due to COVID-19. However, Hangzhou Botanical Garden launched painting appreciation online with the exhibition launched on the WeChat official account, official website, Weibo and TikTok. Residents and tourists could use their mobile phones and computers to enjoy the paintings online at any time.

6. THE “LITTLE MIGRATORY BIRDS” TRAVELLED TO THE BOTANICAL GARDEN DURING THE SUMMER VACATION

During the summer vacation, Hangzhou Civilization Office selected 15 activity bases in Hangzhou and launched the “little migratory birds” activity. This travelled to Hangzhou during the summer vacation with Hangzhou Botanical Garden as one of the bases. Through new media such as live broadcasting on mobile phones and promotion on WeChat, both the “little migratory birds” and teenagers who live in Hangzhou were able to visit the Garden virtually. Through the WeChat official account, they could also participate in interactive quizzes to win prizes.

In this difficult period, Hangzhou Botanical Garden has turned its dilemma into an opportunity by using new media platforms like WeChat, TikTok and more. The interactive functions of these media mean they are well placed to support engaging content about plants and allows this information to be released continuously to retain audience interest, increase the number of followers, and expand the influence of the platforms. Using this new media has not only allowed us to disseminate information to the public rapidly but has also provided a way for the audience to participate in the activities.



← Live broadcast by Zhejiang Daily Zhe video
©Shuiheng Jiang

In this difficult period, Hangzhou Botanical Garden has turned its dilemma into an opportunity by using new media platforms like WeChat, TikTok and more.



↑ Screenshots of the videos of the plum appreciation and messages from the public ©Shuiheng Jiang

11 tweets were released with the plum appreciation series being viewed nearly 50,000 times.

← The first issue of the “Cloud Live Broadcast” on flower appreciation ©Shuiheng Jiang

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EXPERIENCE OF VMU BOTANICAL GARDEN: ENGAGING VISITORS WITH TECHNOLOGIES

The COVID-19 pandemic lockdown in Lithuania was very strict and all public institutions including the Botanic Garden were ordered to close. During this time however, Vytautas Magnus University Botanical Garden in Kaunas offered several solutions to their visitors. The garden prepared educational videos and discussed them with primary school students using distance-learning platforms. Educators created virtual excursions of various topics such as plant systematics and plant genetics based on University programmes. Students were reached using live translations of laboratory experiments. Finally, a free app “Botanikos sodai” was promoted which includes an interactive map of the park and greenhouse, allowing visitors to listen to, or read information, about marked points of interest.

Vytautas Magnus University Botanical Garden (BG) in Kaunas, Lithuania, occupies an area of 62.5 ha close to the city centre. Botanical expositions and collections, a greenhouse, and a large landscaped park with an interesting pond system create a space suitable not only for plant conservation and research, but also for interactive education, cultural tourism, and community use. The BG carries out various educational and public engagement activities and implements a popular interactive programme for informal education and science communication (Mildažienė and Štuopytė, 2016). BG accepts more than 90 thousand visitors per year. However, on March 13th, 2020, following the announcement of quarantine in Lithuania due to the COVID-19 pandemic, the BG was closed to visitors. Nevertheless, the BG continued to work and looked for other ways to reach visitors, both children and adults.

↑ *Filming in progress - the educational garden*
©Indrė Sekevičienė

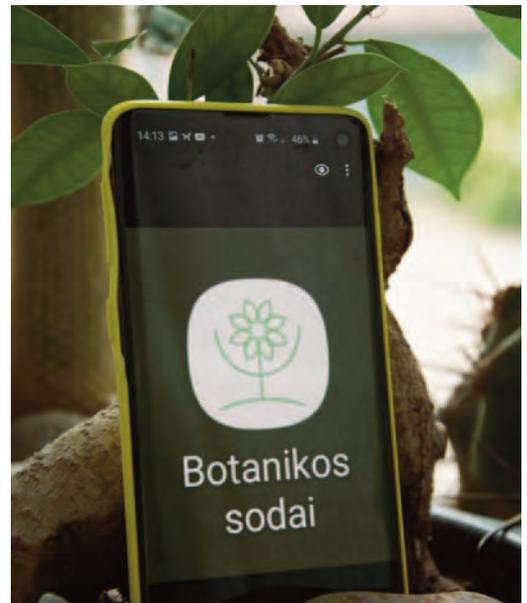
Students participated in virtual specialized tours prepared according to university programmes. The BG guide prepared and filmed fifteen specialized tours.

The BG motivates interest in the natural sciences from an early age and prepares many different educational programmes for pupils. An increasing number of schools are choosing natural science lessons led by our educators (Aleknavičiūtė and Mulevičienė, 2018). After the beginning of distance learning in Lithuania due to the quarantine, lessons and, consequently, the educational programmes of the BG for the youngest visitors were moved to the virtual space. Educational videos can provide experiences related to students' lives, taking into account different concepts and theories (Fennell, 2013). Therefore, 10-15 min educational videos were created by the staff of the BG each week during the quarantine period. Educational videos were filmed in various places in the garden including the outdoor classroom "Birds of the BG", the educational garden, the insect hotels, and the greenhouse. Students could watch the videos at a convenient time at home. In addition to the videos, tasks related to the topic of the videos and adapted to the age of the students were prepared. Finally, videos and tasks were discussed using distance-learning platforms, which allowed students and educators to hear and see each other and discuss various questions.

The BG offers a wide range of educational programmes not only for schools but also for universities. It is important to consider the needs of the Z generation, i.e. to attract the Z generation in various ways and to use innovative technologies (Jurkonis, 2017). During the quarantine, in order to maintain a continuous educational process, and to consider the needs of the Z generation, students participated in virtual specialized tours prepared according to university programmes. The BG guides prepared and filmed fifteen specialized tours on topics such as heredity, applied genetics, mutations, use of mutagens for the selection of deriving new varieties, mutagenic effects of naturally occurring alkaloids in plants, biodiversity, changes in taxonomy after genetic testing, interspecific hybrids, banana triploidy, and plant adaptation to environmental conditions. Students were able to participate in the virtual tours at a convenient time and gained detailed knowledge.



↑ Practical work demonstration directly from the educational laboratory ©Indrė Sekevičienė



↑ Mobile trilingual audio guide app ©Indrė Sekevičienė



↑ Educational programmes for the youngest visitors in the virtual space - the outdoor classroom "Birds of the BG" ©Indrė Sekevičienė

← Educational video about insect hotels ©Indrė Sekevičienė



The educational programmes of the BG for university students include not only specialized excursions but also laboratory work. Various experiments in natural sciences, such as the extraction of DNA from plant material, the investigation of microorganisms under microscopes or biofluorescence and bioluminescence investigation can be performed in the BG educational laboratory (Malakauskienė, Jurkonis and Aleknavičiūtė, 2020). Pedagogy students also come to the educational laboratory, where they learn how to teach, how to arouse students' interest in natural sciences, what theoretical knowledge is important, and how to transfer it through practical work. During the quarantine, the BG educators found a way to reach students and maintain the quality of the sessions using distance learning. Theoretical knowledge was transferred during real-time online lectures, providing the students with the possibility to ask, and find out the answers to, their questions; in addition, the students were able to speak about and discuss relevant topics. Practical work was demonstrated directly from the educational laboratory: students could observe each stage of the experiment and see the tools that are used and how long the experiment itself takes. The live experiments were conducted on various scientific topics such as geography, chemistry, botany, and zoology. The students also received the descriptions of the demonstrated experiments, which they could discuss directly with the BG staff.

Finally, for all visitors to be able to explore the garden, the BG with partners, offered a mobile trilingual audio guide app "Botanikos sodai". As well as an interactive map of the park, which can be viewed on a smartphone, the app also highlights the most interesting places in the garden, where information about the flower garden, trees, the greenhouse or historic buildings can be listened to or read. The users can choose two audio guide routes: in the garden park or in the greenhouse.

The app invites people to interact with the garden and includes a riding a bicycle game. In order to participate, people needed to download the app "Škoda atradimai" and visit the places, which are marked with special stakes according to the interactive map. These places highlight interesting personalities of Kaunas, such as the first director of the BG Prof. Constantin von Regel, and are ready for active leisure enthusiasts to explore. The main idea of the game was to invite the app users to see the places where the most famous personalities related to Kaunas were living.

Although access to the BG was not possible due to quarantine restrictions, new and innovative ways to spread information were found. By applying new methods, we were able to successfully reach visitors of all ages: pupils, university students, and adults. The quarantine did not stop our work in the BG but it challenged us to adopt information technology, learning platforms, and social network solutions. The users of the mobile app, and the participants of the virtual education activities and excursions, became virtual visitors of the BG meaning they were able to acquire knowledge about the diversity of the BG collections, whilst staying safely at home.

← Interactive entertainment and game riding a bicycle ©Indrė Sekevičienė

For all visitors to be able to explore the garden, the BG with partners offered a mobile trilingual audio guide app "Botanikos sodai".

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PIONEERS IN PUBLIC ENGAGEMENT GARDENING FROM THE HEART – DI SOUTHWELL'S STORY



Bundaberg Botanic Gardens Nursery - where Di's expertise and nurturing yields results ©Rebecca Blakemore

"Spreading goodness and cheer throughout the land" has been Diane (Di) Southwell's catch cry for 30 years. Di's positivity and desire to plant with the planet in mind has led her to a specialised nursery position at the Bundaberg Botanic Gardens in the sub tropics of Queensland, Australia.

Over the past four years, Di has instigated a permaculture garden, incorporated principles of permaculture into the Gardens, and created a garden for trainees where theory is put into practice. Destiny, Di believes, led her to Grovely TAFE Horticultural College where she completed her Certificate in Horticulture, then Diploma in Horticulture and Permaculture. Di flourished under the expert tuition of Annette McFarlane who received an award in 2018 for her dedication to horticultural education. With Annette's encouragement, Di developed a resume and subsequently started her own business. Armed with a rake and secateurs, Di tended to the chamomile lawns and topiaries of Brisbane's rich, gaining recognition for her expert care of roses.

A self-described hippy gardener in an HJ station wagon, complete with hand painted flowers to hide the car's Kermit green colour, Di (nee Wicks) operated the highly successful *Wicko's Organic Gardening* business for 12 years. During an era when women gardeners were unheard of and the word 'organic' rare, Di was a woman ahead of her time. The business expanded to motels, industrial, commercial, and real estate, thriving until the day Di explains her "world stopped spinning" when her beloved mum passed away. Unable to channel her creativity, Di travelled, before returning to oversee the Port of Brisbane Gardens. She was then poached by Digit Landscapes to manage over 50 gardeners.

Life presented a much-needed change of pace when Di moved to Bundaberg and secured a position managing Bundaberg Regional Council's nursery.

Numerous school and community groups have been welcomed behind the scenes by Di's beaming smile, leaving with a better understanding of plant adaptations and horticultural techniques. Happiest with her nose in the soil, Di tends to the hundreds of seedlings that then go on to be planted in parks, roundabouts, and streets across the Council's 6,000 square km region. Each year Di passes her knowledge to the next cohort of young horticulturalists through the Gardens trainee program. Ever practical, Di created a garden that trainees can call their own where experimentation is encouraged.

But perhaps Di's most notable project has been the permaculture garden. Much to the delight of the neighbouring retirement village, a once bare patch of land has been transformed into an example of how a no dig, organic, closed system garden works. From the popcorn tree to the giant Russian cucumber and Mexican sour gherkin, this low maintenance edible landscape has fulfilled Di's lifelong dream.

With her generous nature, Di inspires people with a positive outlook. "Never give up. We all face obstacles, but we can help spread goodness and cheer. The idea that you can plant something that will outlive you but will live on for other people's enjoyment gives me great happiness."



Di at the Permaculture Garden – educating the community on a sustainable gardening approach ©Rebecca Blakemore

FRIENDS OF BOTANIC GARDENS – ADAPTING TO THE ‘NEW NORMAL’

Two years ago, a former convener of the Edinburgh Friends of the Royal Botanic Garden Edinburgh began to explore the possibility of setting up a Forum for Friends of Botanic Gardens throughout the UK. Initially, focussed on Scotland’s groups – it has now expanded into England, Wales, and Northern Ireland. The purpose of the Forum is to enable groups to share ideas and fundraising experiences which will enhance the support for their respective Botanic Gardens. With the arrival of COVID-19, the further development of the Forum has moved forward rapidly with Zoom meetings, publication of a newsletter, a directory of Friends’ Groups, and work commencing on a website. Like so many charitable organisations, Friends’ groups are facing challenging times, with their fundraising

initiatives being severely curtailed. However, Friends’ Groups are resourceful, flexible and very committed. With access to commercial printers impossible, newsletters have been delivered digitally, though some groups have printed newsletters on their home printers for those Friends who are not connected to the internet. Events are being transferred on to digital platforms in the short term; a few private garden visits are going ahead – following government guidelines for social distancing; and even plant sales (a major contributor to Friends income) have or are going ahead on a limited basis – often from the front gardens of Friend’s homes. And already some groups are thinking forward to next year when, hopefully they can return to, more or less, the ‘old normal’.



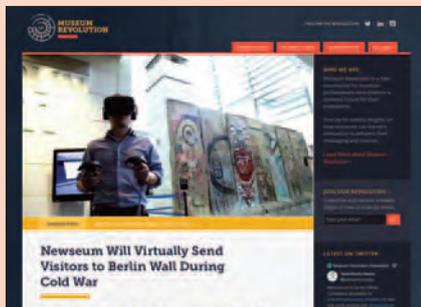
↑ *Adrian Walsh’s Garden, Belfast (To be visited in September by Friends of the Belfast Botanic Garden)*
©Adrian Walsh. Chair. Belfast Botanic Garden.

RESOURCES

Museum revolution – TeamWorks Media

Museum Revolution is an online publication run by TeamWorks Media, a marketing agency with deep museum experience. The team writes about how cultural institutions can harness the power of digital technology to scale experiences and strengthen messaging.

<https://museumrevolution.com/>



Digital strategies for museums - Cogapp

This guide is based on Cogapp's experience of working on strategic digital projects. Starting with the question 'What is Strategy?' and running through to the practicalities of how to run a systematic and successful digital strategy programme, this comprehensive guide is a complete, non-technical, introduction to an increasingly important subject.

<https://www.cogapp.com/digital-strategy>



E-learning strategies – FAO

This guide aims to support professionals involved in the design and development of e-learning projects and products. The guide reviews the basic concepts of e-learning and introduces the various activities and roles involved in an e-learning project. The guide covers methodologies and tips for creating interactive content and for facilitating online learning, as well as some of the technologies used to create and deliver e-learning.

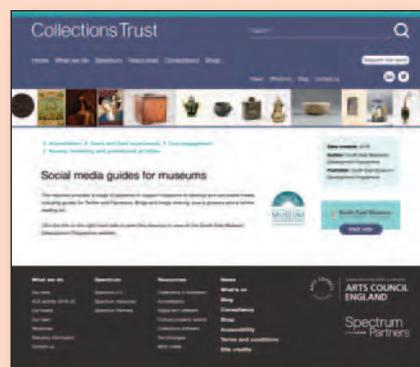


<http://www.fao.org/3/i2516e/i2516e00.htm>

Social media guides for museums – The Collections Trust

This resource provides a range of guidance to support museums to develop and use social media, including guides for Twitter and Facebook, Blogs and image sharing, plus a glossary and a further reading list.

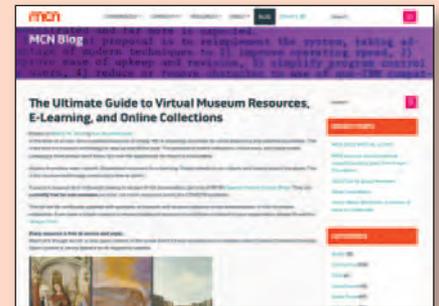
<https://collectionstrust.org.uk/resource/social-media-guides-for-museums/>



MCN blog - MCN

The ultimate guide to virtual museum resources, e-learning, and online collections.

<https://mcn.edu/a-guide-to-virtual-museum-resources/>



The Inclusive educators toolbox - Athabasca University & Aspen View Public Schools

A digital collection of ideas for inclusive education. The Inclusive Educators' Toolbox is a cooperative project between the Centre for Distance Education at Athabasca University, Aspen View Public Schools, and a global community of inclusive education researchers and practitioners.

<http://inclusivetoolbox.org/ollination-power-book/>





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Plantsnap Initiative



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PlantSnap is the most technologically advanced, comprehensive, and accurate plant identification app ever created.

It gives you a whole new way to explore the natural world in your everyday life. PlantSnap is a simple way for everyone to play a role in protecting and saving the environment simply by snapping photos of plants. This allows us to map and track every plant on the planet and share this data with scientists. PlantSnap's open source plant database features 600,000+ plants and 150 million+ plant images. The app recognizes nearly all species encountered in botanical gardens and is available in 37 languages. To date, there have been more than 25 million downloads.

BGCI has partnered with **PlantSnap** so that our member gardens can offer the app to their visitors. There are a range of benefits for gardens taking part in the initiative.

To learn more visit: <https://www.bgci.org/plantsnap/>

