Ondata Research

Operation Earth Phase 2.5 Evaluation Report

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Contents

Operation Earth is led by:

UK Association for Science and Discovery Centres

Operation Earth is in partnership with:

UKRI Natural Environment Research Council

Executive Summary

Introduction

The Operation Earth programme is managed by the Association for Science and Discovery Centres (ASDC) and funded by the Natural Environment Research Council (NERC). The programme ran from September 2021 to March 2022 and is known as Phase 2.5. This follows on from two previous phases. Operation Earth involved ten centres from around the UK and reached an audience of over 67,000 through a mix of digital, remote and in-person events.

In-person	26803
Remote learning (e.g. science boxes)	514
Digital engagement	40113
Total audience	67430

Table 1. Audience engagement numbers by type

In addition, the project has reached an estimated audience of 60,000 through a dedicated episode of Glasgow Science Centre's 'Spark of Science' podcast which is broadcast by two local digital radio stations. The centres participating in Operation Earth Phase 2.5 were:

- Catalyst Science Discovery Centre and Museum.
- Dynamic Earth, Edinburgh.
- Glasgow Science Centre.
- National Space Centre, Leicester.
- Natural History Museum, London.
- Oxford University Museum of Natural History.
- Techniquest, Cardiff.
- Thinktank, Birmingham.
- W5, Belfast.
- Xplore!, Wrexham.

The programme's vision was: *To engage, inspire and involve families with school-age children across the UK with the amazing stories, science and people of NERC's world-leading environmental research.*

For Phase 2.5, the programme mission was: *To enable science centres and collaborating NERC researchers, to reach widely across the UK during COP26 and into 2022, delivering interactive activities through innovative and blended approaches, that bring the relevance of the UK's climate and environmental science and research to life.*

This evaluation report focuses on the impact of the activities on the audiences engaged with and the impact of participating in the programme on science centres. The key points in the programme were:

- The Operation Earth training academy held by ASDC in September 2021.

- Operation Earth activities ran between October 2021 and March 2022 with a mixture of online, in-person and remote learning models being used. Some science centres held activities directly linked to COP26 which was held in Glasgow in November 2021. Science centres were able to decide for themselves which activities to run and this formed part of their application to join the programme.
- A campaign was co-ordinated by ASDC to raise awareness of the Operation Earth programme with politicians and researchers of the impact of the work being undertaken by science centres, particularly around the time of COP26.

A range of activities were run by centres, with a range of examples described below.

- On gallery drop-in activities: Oxford University Museum of Natural History's *"Super Science Saturday: People and Planet is a family science fair where researchers and community organisations share their work. This particular event focused on human impact on the planet and was linked to our current exhibition Meat the Future which looks at the effects of our meat consumption on the planet/other living things."*
- Family show: Catalyst Science Discovery Centre and Museum's *"Operation Earth - Family show explores environmental science through roleplay: trying to discover why "Earthy" is poorly."*
- Outreach: Techniquest's *"Outreach workshops focused on ocean science, looking at how ocean acidification and a warming planet affect the seas and life within it. Families took on the role of oceanographers, observing differences in water using carbon dioxide and using ocean biodiversity mats to complete counts of wildlife species. Families with school aged children were able to engage with NERC research and understand the role climate scientists in the UK play in climate change."*
- Group visit/interaction: *"What is COP26? Prior to COP26 we are holding a series of workshops in person (to cater for groups who do not have advanced digital access) in the new community groups space 'The Bothy'. These workshops aimed to raise awareness of what COP26 is."*
- Synchronous digital activity: Workshop – primary aged children: Dynamic Earth ran *"Dino's Kids Club - Guide to the Climate Crisis workshop featuring Operation Earth NERC science and scientists. Engaged and inspired school-aged children with NERC science, building science capital".*
- Asynchronous digital activity: "*W5 developed and designed an activity pack which aims to encourage families to explore Environmental Science and in turn highlight some of the climate issues our world is facing. These activities are hands-on, and completely accessible to families with children aged 2-14yrs."*

Evaluation

The evaluation for Operation Earth Phase 2.5 has been flexible and pragmatic and Mixed Methods approach was used. This mixture of quantitative and qualitative methods incorporated existing tools already in use in science centres and new tools developed by Ondata Research specifically for this programme.

Key Findings

All of the centres participating in Phase 2.5 had previously participated. However, this did not mean that all staff involved in each centre had previous experience of Operation Earth project management or delivery. The training academy provided an opportunity to revisit and refresh science centre staff's knowledge about the Operation Earth topics (such as oceans and clean air) and provide an overview of ASDC's expectations for the programme, including guidance in relation to the evaluation. The key themes arising in terms of impact of the training academy were:

- An increase in knowledge and ability to link with research:
  "Knowledge - of various scientific facts, public engagement techniques, and research, especially about climate anxiety amongst young people."
  "The training academy was brilliant at improving our knowledge and confidence in delivering NERC science."
- An improved confidence around using the Operation Earth activities and *"confidence in dealing with the difficult reality of climate science and how to honestly tackle this with visitors, while supporting anyone with eco-anxiety".*
- Development in communication skills: *"Provided me with new ways of thinking about engagement and new frameworks of how to effectively carry it out."*
- An opportunity to build links with the wider network and learn from peers: *"It's been great to get a feel for how other centres deliver content, and the activities and sessions that work for them."*

In terms of the Operation Earth activities run by centres, 75% were for a family audience with the remaining activities aimed at community groups (17%) and young people under the age of sixteen (8%). Table 2 summarises the types of activities run by the centres.

Overall, around one third of the total audience were reached via in-person events with the remaining two thirds via a small number of digitally-based activities. In terms of the time spent on activities, given the most common one was on-gallery drop-ins, it is unsurprising to find that 73% of the activities were under 15 minutes, with the remaining twenty seven per cent lasting 15-30 minutes (one per cent) or 30-45 minutes (twenty six per cent).

The Operation Earth programme had a strong focus on involving researchers, with 49% of events including some form of contribution from researchers, with eight of the ten centres being able to run activities in partnership.

The audience feedback (97 responses from families, representing an audience of over 450 adults and children) has been combined to discuss the impact of the programme.

In terms of the experience itself, this was overwhelmingly positive: 99% of respondents indicated they strongly agreed (87%) or agreed (12%) with the statement “We enjoyed taking part in the activity”, with 1% giving a neutral response.

There was a significant impact on people’s interest in climate and environmental science: 85% of respondents indicated they strongly agreed (55%) or agreed (30%) that after the activity they were more interested in the topics (11% were neutral and 4% disagreed). In addition to interest levels increasing, families could see a connection netween climate and environmental science and their own lives, with 92% strongly agreeing or agreeing. There was a clear indication of a sustained and ongoing impact on families, especially with regards to going on to read more about the topic (83% strongly agreed or agreed) or talk about it with family and friends (82% strongly agreed or agreed).

Participating in the Operation Earth Phase 2.5 programme has had a number of different impacts on centres and there were particular successes reported:

- Relationship-building: centres have been able to broaden their network and develop new relationships.
- Staff development: Participating in a nationally supported programme is something that supports staff development and due to ASDC’s reputation for delivering high-quality and engaging programmes, science centres feel confident in collaborating with the organisation and its partners.
- Confidence-building: the training academy and the ongoing support provided by ASDC helped to build confidence amongst science centres in delivering activities on climate and environmental science.
- Encouraged dialogue: a significant proportion of the activities (75%) were drop-in activities, encouraging some form of discussion between the science centre staff, researchers and other partners, with centres seeing the Operation Earth topics as something which encourages a longer-term engagement and dialogue with their local community.
- Science centre staff also felt that climate science enabled an engagement and discussion with the whole family.

- Access to high-quality science engagement: at a time when operational conditions within science centres was very challenging, being able to access high quality resources and support was invaluable.
- Access to grant funding for public engagement activities: centres work with a range of funders and partners in order to deliver public engagement activities and ASDC are considered to be an essential partner in providing opportunities for centres.

Recommendations

There are a small number of recommendations for ASDC to consider and these are intending to help build upon the existing high level of support and high quality programme.

- Staff in science centres have expanded upon the existing Operation Earth content, with many of the adaptations driven by the need to adapt the delivery mode of the activities from in-person to online or remote learning. Staff are keen to share their learning from the programme in terms of what worked well for them and many have expressed an interest in directly sharing workshop outlines and other resources. This could be achieved through facilitated meet-ups between participating centres. Another request is in relation to the sharing of case studies or details of the successes and challenges experienced by science centres.
- Provide opportunities for science centres to discuss the success and challenges in relation to different evaluation approaches, particularly with the move to digital data collection and the limited availability of staff members to follow-up with visitors. This could be done as an Operation Earth-focussed discussion or one for the wider ASDC network.
- Ongoing support to involve researchers in science centre activities. Some centres have established relationships but many appreciated the contacts made via the Training Academy and the time spent by ASDC in facilitating connections. Some science centres were not able to develop links but are still keen to do so in the future and would appreciate the continued support of ASDC and NERC to do this as they recognise the benefits of involving researchers in activities.

Conclusion

In terms of the programme's vision, mission and key goals Operation Earth Phase 2.5 has been very successful. The programme has been able to *"engage, inspire and involve families"* and to *"bring the relevance of the UK's climate and environmental science and research to life"*. Families have reported an increased interest in climate and environmental science, with them intending to go on to read and discuss more about the topics.

Science centres have been able to empower families to make informed decisions in relation to their own lives, with them seeing the relevance of climate and environmental science. Science centres have been supported by ASDC to run high-quality activities, delivered by confident and knowledgeable staff and in many cases in partnership with researchers and other stakeholders.

"I believe the biggest impact has been visitors wanting to make a real change, and many of them already committing to making small changes for the greater good." (Science centre staff)

Introduction

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The programme's vision was: *To engage, inspire and involve families with school-age children across the UK with the amazing stories, science and people of NERC's world-leading environmental research.*

For Phase 2.5, the programme mission was: *To enable science centres and collaborating NERC researchers, to reach widely across the UK during COP26 and into 2022, delivering interactive activities through innovative and blended approaches, that bring the relevance of the UK's climate and environmental science and research to life.*

Supporting the programme's vision and mission, there were seven key goals:

1. *To engage, inspire and involve school-aged children and their parents, carers and wider families with a sense of curiosity and positivity about the UK's environmental research and its applications for the future of our planet.*
2. *To build on the previous phases of Operation Earth and continue to support science capital for families and communities, using personalised and localised approaches that*

promote science centres and environmental science as relevant to daily life and something 'for them'.

3. *To showcase climate science and COP26 activities across the Operation Earth network, alongside the wider Operation Earth Key Content Areas explored through the activities of Operation Earth phases 1 and 2: Climate change, Biodiversity, Clean Air and Oceans.*
4. *To equip science centres to be able to advocate for NERC science within Operation Earth science centres and to amplify the message of climate and COP26-themed regional engagement events to national significance, by creating a mini-campaign that celebrates and advocates for NERC engagement work within science centres surrounding COP26. Strategic use of digital platforms and social media will aim to engage with policy makers, politicians, and other high-level stakeholders.*
5. *To train and upskill all participating Operation Earth phase 1 and phase 2 science centres, supporting and empowering their engagement professionals to refresh their knowledge, regroup teams and expertise, and continue with NERC-related engagement activities following prolonged periods of closure and ongoing restrictions due to Covid-19.*
6. *To increase the knowledge and skills of NERC researchers in delivering public engagement with research and to encourage use of engagement activities and longer-term partnerships between science centres and NERC researchers.*
7. *To evaluate the programme, including the impact of training for science centres and NERC researchers and the impact of the engagement activities for audiences involved, exploring the perceived relevance of NERC science and research, alongside the effectiveness of various blended approaches of delivery.*

This evaluation report focuses on the impact of the activities on the audiences engaged and the impact of participating in the programme on science centres. The key points in the programme were:

- The Operation Earth training academy held by ASDC in September 2021.
- Operation Earth activities ran between October 2021 and March 2022 with a mixture of online, in-person and remote learning models being used. Some science centres held activities directly linked to COP26 which was held in Glasgow in November 2021. Science centres were able to decide for themselves which activities to run and this formed part of their application to join the programme.
- A campaign was co-ordinated by ASDC to raise awareness of the Operation Earth programme with politicians and researchers of the impact of the work being undertaken by science centres, particularly around the time of COP26.

The following section outlines the evaluation methodology and activities undertaken to support the evaluation work of the participating science centres.

Methodology

The evaluation for Operation Earth Phase 2.5 has been flexible and pragmatic and a Mixed Methods approach was used. This mixture of quantitative and qualitative methods incorporated existing tools already in use in science centres and new tools developed by Ondata Research specifically for this programme.

The overall approach for the evaluation was agreed with ASDC and a briefing was produced for participating centres outlining the timeline and expectations. The evaluation methods were updated from previous phases, and given the challenging operational conditions for centres due to the COVID-19 pandemic, a briefing session was held for participating centres to drop in for advice and to ask questions at the beginning of the programme. Towards the end of the delivery period and ahead of the reporting deadline for centres, drop-in sessions were held for science centre staff to allow them to come along for clarification of any evaluation-related aspects. Several centres participated in these sessions and staff found the timing extremely helpful as they were working to collate the information required by ASDC and Ondata Research.

Table 3 summarises the different methods used as part of the Operation Earth Phase 2.5 programme.

Method	Purpose	Comment
Activity metrics	To gather details on all of the different activities being run across the centres in a consistent way.	Each centre completed a metrics template supplying information on the events, the target audience, involvement of researchers, etc. The full list of fields can be found in Appendix A.
Survey questions	To capture the impact of the activities on the different audience groups in relation to a range of Science Capital dimensions.	Centres were provided with a set of questions to incorporate into their existing survey tools where possible. These questions were used where appropriate and the decision on this was left up to the individual centres. The questions used can be found in Appendix B.
Staff reflection	To gather feedback from staff delivering on-gallery activities.	This tool was designed for science centre staff in order to capture their impressions of the impact of on-gallery activities on the audience groups they worked with.
Post-training reflection	To gain insight into the impact of the training academy on science centre staff and researchers.	
Post-COP26/mid-programme reflection	To understand the impact of the activities linked to COP26 on audience groups and science centre staff.	For many centres the main events forming their contribution to the Operation Earth programme were completed by December 2021, therefore this was an opportunity to gather timely feedback.
End of programme reflection	To prompt reflection on the impact of the programme as a whole on the audience groups, staff and science centres.	Some centres continued delivery up until March 2022 and the end of programme reflection included additional questions around impact.
Programme documentation	To gather context for activities and evaluation findings.	This includes training materials, campaign guidance and end of programme reports from centres.

Table 3. Summary of evaluation methods used

Any data collected from the audience groups in centres was done so directly by centres and they adhered to their own GDPR policies. Anonymised data was then securely shared with ASDC and Ondata Research. The data for the reflection tools was gathered directly by Ondata Research and was stored according to our own GDPR policy.

With regards to data analysis, descriptive statistics were used for the metrics and quantitative survey data whilst reflexive thematic analysis was used for the qualitative data[1]. Some centres gathered additional information from audience groups but this depended on the capacity available in the centre. Due to operational pressures and the changing external circumstances relating to the COVID-19 restrictions, no targets were set for evaluation data collection for the audience groups, although centres were all expected to engage with the reflection process.

Overall the centres had a positive experience of the evaluation processes and felt there was a good balance between qualitative and quantitative data, with the staff reflections being seen as particularly helpful. Staff were also able to develop their own knowledge and skills: *"ASDC training sessions are very comprehensive. I am an evaluation professional yet I have learned a few things about evaluation at the sessions."*

The following discussion section examines the impact of the programme on participating centres and audience groups involved in activities.

[1] Braun, V., Clarke, V. (2019) Reflecting on reflexive thematic analysis, *Qualitative Research in Sport, Exercise and Health*. 11:4, 589-597

Discussion

This section discusses the impact of the training academy on science centre staff and NERC researchers before examining the impact of the different activities on the audience groups engaged with. The section concludes with a discussion of the impact of participation in Operation Earth on the science centres.

Training Academy

All of the centres participating in Phase 2.5 had previously been involved in the programme. However, this did not mean that all staff involved in Phase 2.5 in each centre had previous experience of Operation Earth project management or delivery. The training academy provided an opportunity to revisit and refresh science centre staff's knowledge about the Operation Earth topics (such as oceans and clean air) and to provide an overview of ASDC's expectations for the programme, including guidance in relation to the evaluation. Science centre staff who attended the training academy were asked to provide feedback on the event and this informs the findings in this section (16 science centre staff and 1 researcher responded).

Invited speakers covered a range of topics, including on eco-anxiety. One of the participants explains the session on eco-anxiety further: *"[it focussed on] how to communicate such a difficult topic to the public, to help them understand and be motivated to make a difference themselves".* In addition to the talks, there was the chance to meet people from other science centres in the breakout rooms, with the discussion focussing on *"eco-anxiety and the type of activities we're doing and if there's any cross-over between our delivery - it was great to get to chat!".* As well as the discussions in the breakout rooms, there was the opportunity for peer-to-peer sharing, as representatives from different science centres shared different demonstrations based on previous Operation Earth phases, which could be used as part of the programme.

The eco-anxiety session was particularly impactful on science centre staff. It resonated with their own experiences of working with different groups and the session was able to give them some clear approaches to use and incorporate into their Operation Earth activities.

"It was great to get an insight into the psychology of eco-anxiety and I picked up some tips on how to deal with this with our groups and to make sure they are heard."

It was clear there would be ongoing reflection around this aspect and that science centre staff want to ensure a balance:

"I think there will be much discussion amongst those of us who attended to work out how we tell the facts in our shows without dismissing emotions but also giving/allowing for suggestions of positive steps we can take."

Attendees reported that this session would impact in centres beyond the Operation Earth programme:

"The highlight was the eco-anxiety workshop by Dr Caroline Hickman. We have discussed the best way to discuss climate change a lot as an organisation and she highlighted a lot of the issues and potential ways to address those issues really well."

The air pollution and ocean talks also provided new knowledge and encouraged staff to consider where the topics sits within their current activities:

"We don't have anything about oceans so far in our list of workshops/shows. It was very helpful to learn a little more and explore what activities could be put into place to approach this."

The key themes arising in terms of impact of the training academy were:

- An increase in knowledge and ability to link with research:
  "Knowledge - of various scientific facts, public engagement techniques, and research, especially about climate anxiety amongst young people."
  "The training academy was brilliant at improving our knowledge and confidence in delivering NERC science."
- An improved confidence around using the Operation Earth activities and *"confidence in dealing with the difficult reality of climate science and how to honestly tackle this with visitors, while supporting anyone with eco-anxiety".*
- Development in communication skills: *"Provided me with new ways of thinking about engagement and new frameworks of how to effectively carry it out."*
- An opportunity to build links with the wider network and learn from peers: *"It's been great to get a feel for how other centres deliver content, and the activities and sessions that work for them."*

Following the session, participants were asked to consider any action they will take as a result of their participation. There were three key themes:

- Many reported an intention to update existing activities or introduce new ones following the training academy: *"Plenty to take away - mainly to tweak and hone our own programmes on the topics covered and perhaps reconsider some things too."*
- There was the intention to "*cascade*" training with science centre colleagues, with the eco-anxiety content being the most commonly referenced as the one they intended to share. By sharing the training with colleagues this also increased the "*resilience*" of the science centres in terms of the numbers of people available to deliver the activities.
- The majority of the participants reported there would be an impact on their own personal practice: *"I will think about how I communicate tricky concepts like the climate*

crisis in the most effective way that engages our audience and inspires them to be environmental advocates."

Only one set of feedback was provided by a researcher attending the session. Their main motivation for participating was in relation to building their links with those working in science centres and museums and in order to find out more about eco-anxiety. It was a positive experience for the researcher and in terms of impact of the session as they reported the intention to *"explore the resources provided on Eco-anxiety, and develop my knowledge and skills, gaining more confidence".*

The feedback on the format of the event was very positive, summed up by the following comment:

"The format was great, the durations of the presentations were just right, and each presenter brought something different to the table, so it was very engaging. It was very well facilitated."

Some staff new to the project commented that they would have liked more in-depth information about reporting requirements and evaluation. Feedback was provided to the Operation Earth project manager following the session so that any issues could be followed up.

Overall, science centre staff felt prepared to go on to confidently deliver Operation Earth activities. The following section discusses different activities and the impact on the audience groups participating.

Operation Earth Activities

Seventy five per cent of the Operation Earth activities were for a family audience with the remaining activities aimed at community groups (17%) and young people under the age of sixteen (8%). Table 4 summarises the types of activities run by the centres.

Activity Type	n	Percentage
On gallery drop-in activities	53	35%
Family show	38	25%
Outreach activity	29	19%
Group visit/interaction	16	11%
Synchronous digital activity	11	7%
Workshop – primary aged children	4	3%
Asynchronous digital activity	1	1%

Table 4. Summary of the types of activities offered by participating centres, where n is the number of activities

Overall, around one third of the total audience were reached via in-person events with the remaining two thirds via a small number of digitally-based activities. In terms of the time spent on activities, given the most common one was on-gallery drop-ins, it is unsurprising to find that 73% of the activities were under 15 minutes, with the remaining twenty seven per cent lasting 15-30 minutes (one per cent) or 30-45 minutes (twenty six per cent).

The activities were individual to the different science centres. The examples below provide an indication of the type and range of sessions but is not intended as a complete list. The activity descriptions are taken from the science centres' metrics submissions.

- On gallery drop-in activities:
    - Dynamic Earth: *"Climate Science Showcase - families engaged with researchers from 14 different research groups and environmental organisations on the topics of climate science and COP26. Dynamic Earth staff also delivered Operation Earth activities such as the ocean acidification demo and ocean plastics game."*
    - Oxford University Museum of Natural History: *"Super Science Saturday: People and Planet is a family science fair where researchers and community organisations share their work. This particular event focused on human impact on the planet and was linked to our current exhibition Meat the Future which looks at the effects of our meat consumption on the planet/other living things."*
    - Thinktank: *"GAIA - Climate Busking + Climate Pledge photo studio. To engage, inspire and involve families in Climate Science."*

- Family show:
    - Catalyst Science Discovery Centre and Museum: *“Operation Earth - Family show. Explores environmental science through roleplay: trying to discover why "Earthy" is poorly.”*
    - National Space Centre: *“What are the vital life support systems for planet Earth and how to reduce reliance on fossil fuels - alternative energy?”*
    - Xplore!: *“Show covering elements of climate change, atmosphere, and oceans sciences. Inspiring families to engage with climate science and evaluate how they can reduce their impact on the environment.”*
- Outreach:
    - Dynamic Earth: *“Earthy Boxes - Outreach activity boxes containing do-it-at-home activities and resources for children and young people exploring Earth and Environmental Sciences.”*
    - Techniquest: *“Outreach workshops focused on ocean science, looking at how ocean acidification and a warming planet affect the seas and life within it. Families took on the role of oceanographers, observing differences in water using carbon dioxide and using ocean biodiversity mats to complete counts of wildlife species. Families with school aged children were able to engage with NERC research and understand the role climate scientists in the UK play in climate change.”*
- Group visit/interaction:
    - Glasgow Science Centre: *“What is COP26? Prior to COP26 we are holding a series of workshops in person (to cater for groups who do not have advanced digital access) in the new community groups space 'The Bothy'. These workshops aimed to raise awareness of what COP26 is.”*
- Synchronous digital activity:
    - Natural History Museum: *“Online discussion event between science communicator Cristina Torrente and scientist Natalie Cooper on NERC-funded research 'The macroevolutionary consequences of trait correlations'. The event was held on Facebook and uploaded to YouTube as part of our regular Nature Live programming.”*
- Workshop – primary aged children:
    - Dynamic Earth: *“Dino's Kids Club - Guide to the Climate Crisis workshop featuring Operation Earth NERC science and scientists. Engaged and inspired school-aged children with NERC science, building science capital”.*

- Asynchronous digital activity:
    - W5: "*W5 developed and designed an activity pack which aims to encourage families to explore Environmental Science and in turn highlight some of the climate issues our world is facing. These activities are hands-on, and completely accessible to families with children aged 2-14yrs."*

A range of climate-related topics were the focus of the activities and Table 5 gives an indication of the spread of topics covered.

Operation Earth Topic	**n**	**Percentage**
Climate science	87	56%
COP26	33	21%
Biodiversity	17	11%
Oceans	8	5%
Clean Air	7	5%
Other	2	1%

Table 5. List of topics covered by Operation Earth activities, where n is the number of activities

The Operation Earth programme had a strong focus on involving researchers, with 49% of events including some form of contribution from researchers, with eight of the ten centres being able to run activities in partnership. Table 6 summarises the type of involvement of researchers in these activities.

Description of researcher involvement	**n**	**Percentage**
Interactions at exhibition stands	31	53%
Developed and delivered workshop activities	21	36%
Delivered talk	4	7%
Featured in videos	3	5%

Table 6. Researcher involvement with Operation Earth activities, where n is the number of activities

The activities involved a different number of researchers depending on the type of activity. For example, for some running a large in-person event there were tens of researchers involved, whereas centres who developed workshop content in partnership perhaps only involved one or two. In terms of the experiences of the researchers themselves, following their participation in an event reflections were submitted from a small group of researchers (n=7). There was a clear development in confidence and skills in relation to communicating with younger audiences. The opportunity to discuss scientific topics was a particularly enjoyable aspect for those taking part: *"Always great to get children asking questions and excited about science and their future career possibilities"* and another researcher commented that the questions they were asked *"showed some serious engagement in the issues from parents as well as children".*

Eight of the ten participating centres were able to gather responses to the core set of survey questions from the audience groups being engaged. As discussed in the methodology section, targets for gathering survey returns were not set. This was due to the operational pressures on science centres and limited staff availability. However, centres showed a strong commitment to evaluation and looked to gather a range of information on their activities. The audience feedback (97 responses from families, representing an audience of over 450 adults and children) has been combined to discuss the impact of the programme.

In terms of the experience itself, this was overwhelmingly positive: 99% of respondents indicated they strongly agreed (87%) or agreed (12%) with the statement “We enjoyed taking part in the activity”, with 1% giving a neutral response.

There was a significant impact on people’s interest in climate and environmental science: 85% of respondents indicated they strongly agreed (55%) or agreed (30%) that after the activity they were more interested in the topics (11% were neutral and 4% disagreed). In addition to interest levels increasing, families could see a connection to their own lives:

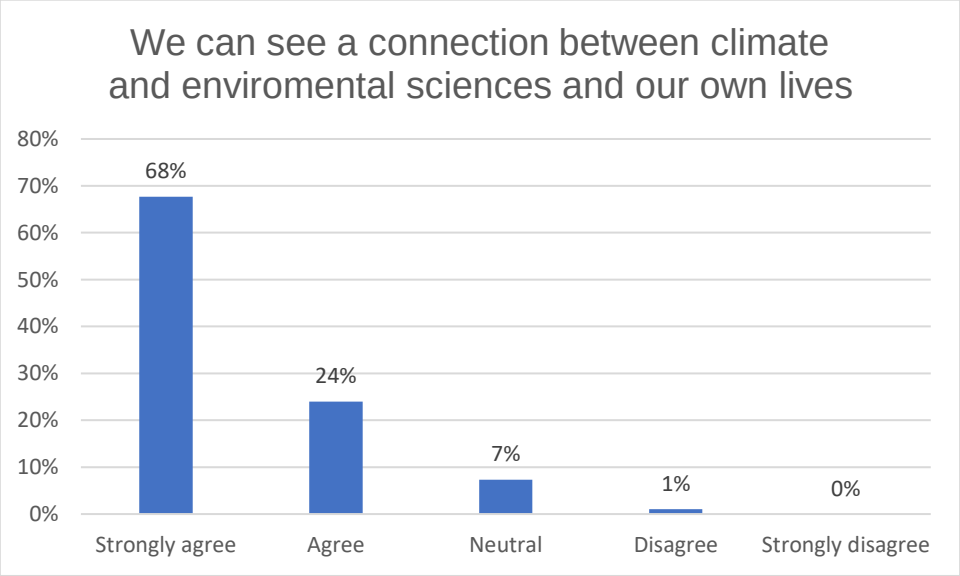

Figure 1. Respondents indicate their level of agreement with the statement "We can see a connection between climate and environmental sciences and our own lives".

There was a clear indication of a sustained and ongoing impact on families, especially with regards to going on to read more about the topic (83% strongly agreed or agreed) or talk about it with family and friends (82% strongly agreed or agreed). Table 7 summarises the level of agreement with the relevant statements.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
We are more likely to read or watch items about climate and environmental sciences	46%	37%	12%	5%	0%
We are more likely to talk to each other or to friends about climate and environmental sciences	55%	27%	14%	4%	0%

Table 7. Responses from families in relation to their own behaviour following the Operation Earth events

These questions were designed to link to the eight dimensions of Science Capital from the Science Capital Teaching Approach[2]. People have different levels of Science Capital and this can be thought of in terms of what you know (scientific literacy), how you think (science-related attitudes), what you do (out of school interactions with science) and who you know (science at home and in your community). Those with high Science Capital are more likely to have an interest in science or to go into a science-related career[3]. It is clear that the Operation Earth activities are helping to build Science Capital in families, as they have reported being more likely to read about the topics (dimension four) and talk to each other about the topics (dimension eight). They have also further developed their understanding of how science connects to their own lives, linking to another aspect of Science Capital, "personalising and localising"[2].

In terms of building science capital dimensions, one example of this can be drawn from the Climate Science Showcase at Dynamic Earth. The centre brought together families, researchers and other stakeholders to take part in climate-related activities. This encouraged intergenerational discussions between family members and between themselves and researchers, with families reporting they were more likely to talk about environmental and climate science with each other following the event with parents identifying the positivity of having role models: *"I thought it was fantastic to have so many scientists in the same place talking so passionately about what they do. It's so important for my kids to see this."*

Further insight on the impact on the different audience groups has come from science centre staff reflections. There were particular comments in relation to their knowledge and attitudes

[2] Godec, S., King, H., & Archer, L (2017). *The Science Capital Teaching Approach: engaging students with science, promoting social justice*. London: University College London.
[3] Archer, L., Dawson, E., DeWitt, J., Seakins, A., & Wong, B. (2015a). "Science capital": A conceptual, methodological, and empirical argument for extending bourdieusian notions of capital beyond the arts. *Journal of Research in Science Teaching*, 52(7), 922-948

towards environmental and climate science. Some identified improved knowledge of the topics and many centres highlighted that they felt visitors were now more "*empowered*" to take informed decisions and take personal action such as changing their diet and increasing the amount they recycle.

A number of different activities were directly linked to the COP26 conference. This section summarises some of the activities undertaken and the impact identified by science centre staff through their reflection diaries.

ASDC supported science centres in inviting their local MPs to visit during the delivery of Operation Earth activities. Staff reported that they felt very supported in order to approach their local MP but many found they were not able to attend due to their very limited availability. Some centres intended to invest more time in relationship-building and felt that they would have had a better level of engagement if they had been able to provide more notice of their events.

There were some audience groups who indicated they would like to continue engaging with science centres following the initial Operation Earth activity and this was particularly the case for Glasgow Science Centre, especially with the focus of Glasgow being the host city for COP26. Their *What is COP26* workshop allowed them to engage with a range of community groups in different settings and facilitated discussions on climate change in the context of the groups' own interests. For example, for one disability alliance group the discussion focussed on human rights legislation and climate justice, particularly the impact on disabled people. Whilst for another, the discussions around climate change and biodiversity prompted them to engage further with COP26 itself, one staff member observed: *"They were really keen to come to further workshops at the conference and said they wanted to move other engagements in order to attend our workshops."*

Another example from Glasgow Science Centre was the use of a "pop-up shop" to engage groups in the community who had never been to the centre before and to increase the visibility of COP26:

"During the October half term holidays we ran a pop up shop at a popular shopping centre in Glasgow to raise awareness of what COP26 is and increase interest in the topics of climate change. We used videos produced as part of Operation Earth to explain COP26 in lay terms as well as some in house Powering the Future exhibits. The shop attracted just short of 2.5k people and increased awareness of both COP26 and the science centre among people who may never have come to the science centre (a third said they had never visited)."

Dynamic Earth were able to use a mixture of arts and science to engage their audience with the topics and encourage discussion as part of a Climate Showcase. There was a choir performance ("live performances from Soundhouse choir and Scottish musician Karine Polwart with a song specially written to mark COP26 and the planetary emergency") alongside Gaia, Luke Jerram's artwork (see Figure 2).

Figure 2. Climate Showcase at Dynamic Earth. Image credit: Dynamic Earth

Staff saw how this raised interest in COP26 and would consider this mixed arts and science approach again in the future: *"Visitors were interested in what was happening at COP26 and what they could do to themselves to take climate action."* The audience were also able to engage with researchers (*"particularly those studying climate science and the effects of a changing climate on our planet and ecosystems"*) with Dynamic Earth intending to continue to work with these researchers on other future projects. Staff were able to make observations of the showcase to gain an understanding of the levels of engagement with the activities and the partners: *"They [visitors] completed multiple activities, asked questions and showed wider evidence of engagement e.g. talking to other friends/family members, pulled them over to other stalls, pointed at exhibits and models, smiled, laughed, played etc."*

At Techniquest in South Wales, several days of workshops were held focussing on COP26 and the environment. These encouraged *"people to talk about ideas for societal and political changes that can help the environment"* with the local MP also visiting. The discussion topics linked closely to people's lives: *"Littering and pollution were main topics which came up in conversation. Children were focused on what to do with waste and hadn't before considered how to avoid producing waste in the first place."*

Overall, science centres key successes related to helping visitors to improve their knowledge and identify personal action they could take:

"I believe the biggest impact has been visitors wanting to make a real change, and many of them already committing to making small changes for the greater good."

Impact on Science Centres

Participating in the Operation Earth Phase 2.5 programme has had a number of different impacts on centres and there were particular successes reported.

- Relationship-building: centres have been able to broaden their network and develop new relationships.

  "It's been great to meet new researchers and organisations/enterprises that we might collaborate with again in the future. We have also gained more knowledge about the topics surrounding COP26 and how to engage families with them. Learning more from talking to visitors about the topics has also been really interesting and worthwhile."

- Staff development: Participating in a nationally supported programme is something that supports staff development and due to ASDC's reputation for delivering high-quality and engaging programmes, science centres feel confident in collaborating with the organisation and its partners.

  "ASDC projects are an incredibly important development opportunity for our team members in delivery of national programmes, understanding topical sciences and embedding national programmes and kit as part of our tried and tested centre delivery models."

- Confidence-building: the training academy and the ongoing support provided by ASDC helped to build confidence amongst science centres in delivering activities on climate and environmental science.

  "I think it built confidence in our staff as we sometimes had quiet sessions and we built our skills in delivering the sessions to these smaller groups. I also feel that our knowledge on environmental issues and climate science has improved - we've learnt new keywords and often been able to provide "added" context to the issues discussed in our show and workshop."

- Encouraged dialogue: a significant proportion of the activities (75%) were drop-in activities, encouraging some form of discussion between the science centre staff, researchers and other partners, with centres seeing the Operation Earth topics as something which encourages a longer-term engagement and dialogue with their local community.

  "It's been nice to discuss these issues with members of the public and hear their own stories about what they do in their own lives. As this subject begins to enter the public discourse more frequently outside of the work that science centres do, I think it's really important to hear them out on these issues and listen to their concerns or ideas about it, as opposed to just "teaching" them about these concepts."

  Science centre staff also felt that climate science enabled an engagement and discussion with the whole family.

"Children were leading parents over to have a look at the microscope or eco mat and then parents became interested in the experiment and discussions over climate change."

- Access to high-quality science engagement: at a time when operational conditions within science centres was very challenging, being able to access high quality resources and support was invaluable.

  "The materials supplied are of a high quality and have life and will have impact beyond just this partnership. The Operation Earth show is being tweaked to deliver to community family groups as part of regular programming beyond March 2022."

  "Running this activity highlights the importance of continuing to feature environmental and climate science in our family programming."

- Access to grant funding for public engagement activities: centres work with a range of funders and partners in order to deliver public engagement activities and ASDC are considered to be an essential partner in providing opportunities for centres.

  "[Grants] enable us to buy the kit and consumables or contribute to the staff salaries to make that a viable programme for us."

As part of their reflections, science centre staff identified a number of challenges:

- As was expected, one of the most significant challenges were the COVID-19 restrictions and the changing guidance. Centres were spread across all four nations of the UK, which had different levels of restrictions in place at any one time. This limited face to face engagement and resulted in a mix of activities being offered. In general, science centres reported lower numbers of engagement than they would have expected in a pre-pandemic year, with a few exceptions.
- In terms of climate change, science centres reported lots of discussions and challenges in relation to what personal action could be taken versus wider political change, *"People often felt demotivated to make personal changes while large scale action was still slow."*
- Delivering engaging activities for a range of audiences groups, particularly for a wide age range, was reported as a challenge for several of the centres, however they had good approaches and strategies in place to approach working with families. *"Shaping the activities to be flexible enough for everyone in the family to get involved is difficult - the more hands-on the better. Having a range of resources available to the facilitator is hugely important so that you can tailor your delivery to the right level."*

There are a small number of recommendations for ASDC to consider and these are intending to help build upon the existing high level of support and high quality programme.

- Staff in science centres have expanded upon the existing Operation Earth content, with many of the adaptations driven by the need to adapt the delivery mode of the activities from in-person to online or remote learning. Staff are keen to share their learning from the programme in terms of what worked well for them and many have expressed an interest in directly sharing workshop outlines and other resources. This could be achieved through facilitated meet-ups between participating centres. Another request is in relation to the sharing of case studies or details of the successes and challenges experienced by science centres.
- Provide opportunities for science centres to discuss the success and challenges in relation to different evaluation approaches, particularly with the move to digital data collection and the limited availability of staff members to follow-up with visitors. This could be done as an Operation Earth-focussed discussion or one for the wider ASDC network.
- Ongoing support to involve researchers in science centre activities. Some centres have established relationships but many appreciated the contacts made via the Training Academy and the time spent by ASDC in facilitating connections. Some science centres were not able to develop links but are still keen to do so in the future and would appreciate the continued support of ASDC and NERC to do this as they recognise the benefits of involving researchers in activities.

Conclusion

In terms of the programme's vision, mission and key goals Operation Earth Phase 2.5 has been very successful. The programme has been able to *"engage, inspire and involve families"* and to *"bring the relevance of the UK's climate and environmental science and research to life"*. Families have reported an increased interest in climate and environmental science, with them intending to go on to read and discuss more about the topics.

Science centres have been able to empower families to make informed decisions in relation to their own lives, with them seeing the relevance of climate and environmental science. Science centres have been supported by ASDC to run high-quality activities, delivered by confident and knowledgeable staff and in many cases in partnership with researchers and other stakeholders.

"I believe the biggest impact has been visitors wanting to make a real change, and many of them already committing to making small changes for the greater good." (Science centre staff)

Appendices

Appendix A – Information collected on activities

1. Name of centre.
2. Date of activity.
3. Project name.
4. Activity type.
5. Short description of event/activity.
6. How does the activity/event fit within the project?
7. Please provide further comment on how the activity links to the aims of the project.
8. Number of people reached.
9. Audience type.
10. Length of activity.
11. Involvement of researchers?
12. If yes, how?
13. Any other audience insights available? E.g. proportion of audience from 20% most deprived areas or proportion of first time visitors.

Appendix B – Survey questions supplied to centres

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
We enjoyed taking part in the activity.					
Following the event/activity/visit:	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
We are more interested in climate and environmental sciences.					
We can see a connection between climate and environmental sciences and our own lives.					
We are more likely to read or watch items about climate and environmental sciences.					
We are more likely to talk each other or to friends about climate and environmental sciences.					

- How do you think climate and environmental science plays a part in your everyday life?
- Following today's activities on climate and environmental sciences, is there anything you will do differently in your own life?
- What was your favourite part of the activity and why?
- What motivated you to join today's activity?
- Any other comments?

About the authors

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Laura has extensive experience with a range of education projects across formal and informal education. In addition to evaluation she is experienced with project and resource development, delivery and training for a variety of organisations such as schools, science centres, museums, education charities, universities and professional bodies. She is undertaking PhD research relating to professional development of teachers after having completed an MRes in Educational Research with the University of Stirling.

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