Evaluation Report

Relationship + Engagement = Impact
Lessons learned from the evaluation of Explore Your Universe 4

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Introduction

Phase 4 of Explore Your Universe signalled a radical and brave departure from the previous phases of this STFC-funded project. While still aiming to engage families and school-age children with STFC science, this pioneering project was a move from 'content-led' to 'audience-led' and drew on participatory methodologies and partnerships with community organisations to develop programmes that aimed to engage deeply with small numbers of individuals, with a particular focus on those from communities who have not traditionally engaged with science communication and/or science centres. In taking this step, STFC as a funder has aligned itself more firmly with movement in the field of science communication/informal science towards more equitable forms of engagement, including an emphasis on working with marginalised communities.

Recent years have seen the articulation of significant critiques of traditional forms of science communication and public engagement, including as practiced by science centres. Although informal science institutions are excellent at inspiring and exciting audiences, they have struggled to be inclusive of more diverse individuals, particularly those from marginalised and minoritised backgrounds. Despite calls to democratise science and efforts of those within informal science education and science communication to support this, in reality much public engagement activity has reinforced patterns of participation/exclusion from science found in schools, wider society and in science itself (Ballo, 2021; Dawson, 2014). That is, informal science institutions have historically excluded minoritised individuals and their communities, leading to calls for fostering inclusive engagement practices (Dawson, 2019; Feinstein, 2017). Researchers have specifically called for science museums and science centres to become more equitable and to rethink how they operate. Rather than simply aiming to attract a more diverse audience, proportionally (or 'get them through the doors'), there are calls to 'reimagine museum science in the image of the underserved, and invest in new programs that are grounded in the cultures and concerns of the very people who currently avoid science museums' (Feinstein, 2017, p 536).

Philip and Azevedo (2017) echo these points, identifying four discourses about designing for equity in out-of-school time (OST) science, which includes institutions such as science centres, and their associated outcomes: '(a) building bridges to current school-based science practices; (b) providing access to science-based experiences to support long-term interest in science; (c) creating alternative science experiences that seek to change what counts as science to develop a more pluralistic science environment; and (d) reorganizing the relationship between science, equity, and justice through community-led social movements' (Philip & Azevedo, 2017; cited in Shea & Sandoval, 2020). These researchers highlight that science engagement activity and spaces are not neutral and reinforce criticisms made by others of a narrow focus on 'access'. In the fourth outcome above, they make the point that informal science learning may have a role to play in the social change, a position consistent with that advocated by Bang and colleagues (Bang et al., 2016; Bang & Vossoughi, 2016).

The issues surrounding inequitable patterns of participation in STEM, a call for informal science education and science communication to go further in broadening participation, and an articulation of what this would look like are encapsulated in a report published by CAISE (Center for the Advancement of Informal Science Education), 'Broadening Perspectives on Broadening Participation in STEM' (Bevan, Calabrese Barton, & Garibay, 2018). The authors note that although ISE and science communication can support and advance lifelong STEM engagement, participation in such experiences is unequally distributed. They argue for a more critical stance on broadening participation, in order to make it more equity-oriented, and highlight programmes that focus on building participants' capacity 'to use science as a tool for personal or community development' (Bevan et al., 201, p 5). They also critique the narrow focus of many initiatives on the STEM 'pipeline', and advocate for a 'pathways' approach, which acknowledges the many paths by which individuals can move towards STEM participation and the multiplicity of ways in which it can have value – not just for careers. Programmes which take this broader conception of STEM participation reject a deficit view and aim to connect to people 'where they are' geographically and culturally, supporting them to integrate STEM into their lives, with the goal of their being able to use it as a means for personal and community agency. They acknowledge that such a shift is not easy and requires that organisations, such as science centres, broaden their conception of

'what counts' as STEM and whose voices matter, highlighting the importance of relationships with community organisations in this process.

Although much of this work takes place in the USA, UK-based science centres and other science communication/public engagement organisations and practitioners are coming to recognise that achieving equity requires a change in what they do – or, more specifically, *how* they do it, rather than trying to change the people coming (or not) through their doors. It seems to be increasingly accepted that lack of participation in science (in school and out) is not due to a lack of interest, but rather that individuals from marginalised or nondominant communities have not been welcome or felt comfortable in science spaces (DeWitt & Archer, 2017; Godec et al, 2021). In the UK, building on years of research on science capital, researchers have likewise emphasised the importance of changing 'the field', rather than young people and have called for centering young people, their families and communities in programmes, and valuing them for who they are (Archer et al., 2021). They have called for such spaces and places to move beyond inspiring and exciting to supporting more equitable outcomes, such as critical STEM agency, or individuals and communities using STEM practices and knowledge to take action on things they care about (also see Bevan et al, 2018).

While a glance at sessions in recent ASTC, ASDC and ECSITE conferences reinforces that there has been a shift in values and priorities in informal science education and science communication towards a stronger focus on equity and collaborating with communities, the field in the UK in particular is really in the early stages of this journey. That such work was emphasised in the Inspiring Science Fund is encouraging, as is STFC's Wonder initiative, with its ethos of focusing on depth rather than breadth of engagement and reaching audiences from the 40% most deprived areas of the UK, in particular those who have traditionally not engaged with science. However, the Inspiring Science Fund projects are only starting to come on line and Wonder is likewise a relatively young programme and so there is much to be learned about working in this inclusive and participatory way. There is clearly an appetite for it in the field, but *how* to approach such work, where to start and what might be needed for it to be successful is very much an open question for many. EYU4, then, provides critical insight into this question at a transformative moment for the field, pointing the way towards how such efforts can be initiated and what might be needed to achieve impact.

This report builds upon earlier evaluations to focus particularly on the third and final phase of EYU4, the findings of which corroborate and build upon what was learned in earlier phases. It highlights the way in which relationship-building underpinned all other activity and demonstrates the value of the project in developing firm foundations on which participating science centres can build – and are building – to continue to engage new audiences with science, including STFC science, into the future. The project seems to have catalysed changes in practice and in mindset in participating science centres, engendering a deeper understanding of and commitment to community engagement. The lessons learned from the project – about relationship-building, partnership, co-development, and engagement – are substantial and hold great promise for legacy, not only for participating science centres but also for the field as a whole.

Evaluation approach

For the evaluation of the first phase of EYU4, telephone interviews were conducted with individuals from eight community partners and focus groups and follow up telephone calls were held with practitioners from the eight science centres involved in EYU4. This activity took place from November 2019 through January 2020 and was summarised in an interim report in February 2020. Data related to participants' experience and outcomes was also collected and summarised as a series of case studies (one per science centre/partnership).

Despite the challenges presented by Covid, resources enabled data collection in the final phase to be more detailed and robust, whilst also being more responsive to the situations of individual partnerships and activity. Using a template which reflected all of the areas about which data was required, the evaluator worked with each of the science centres to develop a bespoke evaluation plan, detailing how and when data would be collected. Due to the ever-shifting nature of delivery because of Covid, centres were not always successful in carrying out all of the intended data collection. Nevertheless, having a plan for each centre provided a useful reference point, supported the upskilling of science centre staff around evaluation, and ensured that the most was made of opportunities for data collection. Some data (e.g. about participant experience and outcomes) were collected directly from

participants, while other data (e.g. about metrics and session content, as well as observations of activity) were recorded in the reflection diaries. The project evaluation tools and methods used for data capture, alongside the template used for bespoke planning with individual partnership in Phase C, as well as an overview of how particular tools were used can be found in appendix C.

In addition to the data collection carried out by individual centres, interviews were conducted (via Zoom) with practitioners from all eight centres, as well as community partner organisations. More specifically, **nine** interviews were conducted with 15 practitioners from the eight participating science centres. These interviews lasted between 45 and 90 minutes and covered not only the activity that was carried out but also perspectives on partnerships, co-development, organisational and personal learning and change, and project legacy.

Staff from community partner organisations were also asked to participate in interviews. Altogether, **fourteen** interviews were conducted with community partners (note that some science centres worked with more than one partner), to gain their perspectives on the project activity and the partnerships, as well as further insight into participants and their outcomes. These interviews generally lasted from 20 to 60 minutes (occasionally longer).

Data analysis

Across both phases, a similar approach was used to analysis. Data was collated across a number of sources, to provide information about each of the metrics and outcomes of interest. These are summarised in the table below and expanded upon in appendix C.

Table 1: Data collected during Explore Your Universe Phase 4 and sources

Data	**Source**
Metrics: • Number and length of interactions • Number of participants taking part (children, adults) • Participant retention • Participant gender • Participant ages (children)	Reflection journals
IMD of participants	Postcodes when available

	Interviews with community partners
Participant connection to science	Varied by science centre including: Connection to science form (rings) Solar system rating scale (how close they are to the sun indicates connection to science) Sticky dot rating scales (related to interest in and comfort with science)
Change in connection to science	Same as above Supplemented by: Data from reflection journals Data from interviews with community partners
Participant experience of sessions (inspired and engaged, feeling of belonging/welcome)	Varied by science centre including: Sticky note feedback Alien emoji sheet Feedback forms developed by centres Sticky dot rating scale Supplemented by: Data from reflection journals Data from interviews with community partners
Memorable aspects of sessions (what participants enjoyed, would share with others)	Varied by science centre including: Passports Sticky note feedback Open response sheets/forms Supplemented by: Data from reflection journals Data from interviews with practitioners and community partners
An indication of science capital of parents/carers/wider families	Science capital anti-forms Questions from anti-forms used to make sticky dot rating scales Data from interviews with community partners
The progression of the science centre and community partnerships	Interviews with evaluator
The activities and approaches that were utilised and changes made during the programme	Interviews with evaluator Reflection journals
Who was involved in the development and delivery of the activities	Interviews with evaluator Reflection journals
Where this programme has catalysed more embedded changes within science centres	Interviews with evaluator Inclusion wheels

Reflection journals formed a key part of the programme and its evaluation – both in supporting practitioner reflection and learning and also as a record of activity and participant metrics. Across the project, 41 reflection journal entries (related to sessions – a further 5 recorded planning meetings) were collected from seven science centres in Phase A and 68 session-related entries (and three meeting-related) were collected across all eight science centres in Phase C. For the most part, each session delivered was captured in a single entry, but in some cases (e.g. Jodrell Bank with Space4Autism), sessions were recorded by more than one practitioner, as a way of having multiple perspectives on a session.

Data analysis was approached holistically and iteratively in response to the questions of interest. For each partnership (as some centres worked with more than one community partner), all of the data collected was reviewed (at least) twice: the reflection journals, any data collected directly from participants, and interviews with the science centre practitioners and community partners. The reflection journals were used to establish participant metrics as well as serving as a record of session activity. Information from the community partners and/or anti-forms were used to add further detail about participant metrics and session content (i.e. whether participants engaged in other science-related activity, IMD proxy). Next, data collected directly from participants was used to form a picture of their experience in the sessions (e.g. whether they felt inspired, welcome) and outcomes of participation (e.g. feelings of connection to science, memorable aspects of the sessions). Finally, science centre practitioner and community partner interviews were coded inductively, within categories corresponding to areas of interest (participant background, participant experience and outcomes, activity and partnership development). This analysis provided further depth and insight on the participant experience, and served to triangulate the findings emerging from the data collected from participants. The reflection diaries also often added further detail to flesh out this picture. Finally, all of this data was captured in a series of case studies, one for each science centre[1]. To the extent possible, given the different methods used to capture data across the partnerships, data is also summarised

[1] There is one set of case studies for Phase A and another for Phase C. Both sets are included as the final appendices (G & H) to this document.

descriptively across the programme, to give a broader picture of participant experience and outcomes, and is included in the 'Participants' experience and outcomes' section of this report.

As noted, data about partnership and activity development came from practitioner and community partner interviews. Two focus groups (supplemented by follow-up telephone calls) with science centre practitioners and eight community partner interviews were conducted at the end of Phase A; nine practitioner and fourteen community partner interviews were conducted towards the end of Phase C. This rich qualitative data source provided substantial insight into elements that supported partnerships, as well as the development of activity in the programme overall etc. Frequent conversations with practitioners from December 2019 onwards were also able to support interpretation of the data. (These were not recorded but notes were kept of where centres were in the process of development and delivery.) A summary of interview topics/questions covered with community partners and science centres can be found in appendix D.

Science capital

As science capital continues to be an influential construct in science centre and science engagement practice, STFC and ASDC were interested in capturing a measure of the science capital of participating families and/or young people. Science capital is, of course, challenging to measure within a project such as EYU4. In order to be comparable to national data related to science capital (e.g. from PAS and the Wellcome Monitor, or from the ASPIRES[2] and Enterprising Science projects), a lengthier, more detailed measure would have been necessary, which would not have been appropriate with the target participants for EYU4. Consequently, multiple data sources were collated, including questions on the adult anti-forms about interest in science news, connections to science and child aspirations, questions on the child anti-forms about aspirations and family science connections, and questions around comfort with science. In some cases (e.g. Science Oxford), these questions were used to create sticky dot rating scales. These responses from participants were

[2] An adult science capital index has now been created (March 2022, using ASPIRES3 data). While not released yet, it includes measures of STEM qualifications and work, as well as participation in science-related activities and other attitudinal components.

combined with information provided by the community partners about the families and their communities (i.e. the extent to which they are likely to participate in other science-related activities) to form an overall picture of the science capital of participating young people and families.

This report is structured around the themes and lessons learned from the evaluation. It begins with findings related to participants' experience and outcomes and then moves on to findings about the impact on science centres and their practice, drawing out what has been learned about partnership working, co-development, engagement strategies and evaluation.

Participants' experience and outcomes

About the participants

The main aim of the project was to engage families who did not traditionally engage with science – who generally had low levels of science capital – with STFC science. As discussed previously, it did not always prove feasible to work with families – due either to the nature of the community organisation that the science centre wished to partner with (where it was a good fit for both organisations) and/or to the reality that for families high on indices of multiple deprivation, multiple engagements over time, at regular times (e.g. every Monday afternoon), are all but impossible. However, some science centres were also able to involve families in more creative ways – for instance, using questions on the back of consent forms to find out more about the families and their connection to science. Such a practice – fitting in with what a community partner does already – is a promising avenue for future exploration.

Where the project also succeeded was in reaching individuals from areas high on indices of multiple deprivation. In this way the audiences in this project were well aligned with those targeted by the Wonder initiative. The only exception to this involved the two projects working with organisations supporting young people with autism, who tended to come from families with a wider range of socioeconomic backgrounds. However, those families face so many challenges, even those who are not from areas high on indices of multiple deprivation, that this should not be considered a shortcoming of the EYU4 programme.

Another aim of EYU4 was to reach audiences with low levels of science capital, as expressed by low levels of interest in science and/or weak feelings of connection to science. However, and likely because participation was voluntary, many participants who opted into the project did feel some connection to science and, as found by ASPIRES, Public Attitudes to Science surveys and the Wellcome Monitor, as well as other research projects, the majority of young people and adults find science interesting and have broadly positive attitudes towards it. Thus, expecting voluntary participation in science-related activities by individuals with demonstrably low levels of science capital (e.g. who do not find science interesting or feel it is entirely unconnected from their lives, in the midst of a pandemic) is somewhat unrealistic. However, combining children's responses about their interest in working in science (when asked), along with parent assessments of their children's interest in working in science, with other information provided by the community partners about engagement in science-related activities and likely science qualifications (or lack thereof), it would appear that most participating young people/families have medium or lower levels of science capital. It is also worth noting that participants engaging in briefer (particularly 1-2 session projects) seemed to have lower levels of science capital, compared with those who are able to commit to longer series of sessions and that no participants seemed to have high levels of science capital.

As an indicator of the extent of engagement with these participants, during Phase A, (2019 – February 2020) a total of 42 sessions were delivered, with 491 children and young people taking part in Explore Your Universe Phase 4 activities. There was a larger reach of ~2136 children and adults when considering wider school assemblies and the community festival Jodrell Juniors (connected with Jodrell Bank Discovery Centre) took part in. Of the 491 individuals taking part across the 8 projects, 74% had repeat engagements.

During Phase C, (2021) a total of 75 sessions were delivered, involving a total of 339 children and young people taking part in Explore Your Universe Phase 4 activities. The project saw a total of 86.3 hours of interaction (5018 minutes) with session lengths ranging from one to four hours. Of the 339 individual young people taking part across the 8 projects, ~68% had repeat engagements.

Summarised metrics tables reflecting the number of participants, number of engagements and lengths of sessions during phase C can be found in appendix A.

Participant experience

In the broadest sense, one of the main objectives of the programme was that the young people (and their families) **felt comfortable** in the activities and were **involved and engaged with STFC science.** Data collected across the project including via 'Alien emoji sheets', open feedback forms and sticky dot rating scales, highlights that this was achieved, even for the few projects which could only provide one-off engagements. Observations made by science centre practitioners and by community partners further highlight the involvement and engagement of participants in the sessions, including those who tended to be shy or reticent, as well as their comfort level with the environments and activities.

> 'They felt so determined that they just wanted to do the project ...' (Community partner, Cambridge)

Importantly, participants felt **welcome** in the sessions (see emoji sheet summary below). For instance, in the last session at Dynamic Earth, a father from the Syrian Dads Group (described by the group coordinator as 'a man of few words') said he had really enjoyed the whole programme and thanked all the Dynamic Earth staff for making him feel valued and respected. The group coordinator also confirmed that they felt welcome and comfortable in the space. Feedback from other community partners highlighted that some individuals who engaged were those who would not normally do so:

> 'We did get really good engagement, and they got engagement from members that don't usually get involved and participate, so that was really nice to hear … And those lads that don't normally engage, like Georgia said, they just want to play pool and just sit and chat and chill – they did engage in that session, you know, they were there.' (Community partner, Macclesfield)
>
> 'Some of our kids… some are shy, some don't interact but this really sparked their interest. All the kids took part.' (Community partner, Belfast)

Likewise, community partner feedback about Xplore!'s sessions with Your Space also indicated that some of the young people who engaged would not normally do so – and certainly not with people unfamiliar to them, while youth workers from The Hill described one young man who was exceedingly sceptical but came along and attended the entire day.

Although the majority of projects focused on young people, observations highlight that the activities did succeed in engaging families. This was the case whether it was families coming along for a showcase or family visit to a science centre (as in the case of Science Oxford, or Cambridge Science Centre), or whether the project was set up to engage families, as in the case of Aberdeen Science Centre, Dynamic Earth, and some of Techniquest's projects. For example, the community partner observed how whole families – including mothers and fathers – got involved in the activities at Dynamic Earth:

> 'They were just so into it… we had to sort of tear them away from it because they were, you know, and their parents were so into it as well.' (Community partner, Edinburgh)

Likewise, a community partner from Cardiff remarked that by the end parents were 'participating alongside their children', and that more men participated than usually join into their activities. Additionally, although they were not specifically asked about it in follow-up interviews, some of the community partners (e.g. NCCP, Valleys Kids, The Hill, The Land) remarked that parents of some of the young people they worked with had commented to them that their children had shared with them about the sessions they had participated in and had been eager to discuss them at home.

Four science centres (Xplore!, Techniquest, Aberdeen Science Centre, Science Oxford) used an 'Alien emoji sheet' (see appendix E), created by Science Oxford, to capture participants' experience and how they felt in the sessions, including how connected they felt to science. As with other forms of evaluation, responses to this sheet highlight the positive emotions experienced by the majority of participants in the sessions.

Table 2: Responses to 'Alien Emoji' sheet', combined across projects

How did you feel in today's activities?		
Uninspired 'It's not for me'	Neutral 'Meh, it was ok'	Inspired 'Science is for me!'
7	28	97
Did you feel…?		
Unwelcome/not included	Sort of at home	Welcome /'Right at home'
4	20	109

Colour in all the emojis that you felt about today			
Welcome	Frustrated	Science is for me	Interested
74	3	76	89
Left out	Excited	Not for me	Bored
3	88	7	9

Note: children could vote for more than one emoji above

Such feedback is corroborated by observations by practitioners and, especially, feedback from community partners reflecting that participants enjoyed the sessions. Additionally, words used by participants on open feedback forms and/or sticky notes to describe their experiences in the sessions include terms like 'happy', 'science-y', 'fun', 'safe', 'curious', 'motivated', 'excited' and 'awesome'.

Participant outcomes

Observations, as well as responses to open prompts on forms (e.g. passport, feedback sheets) and sticky notes, reflected that not only did participants **enjoy** the activities but given their levels of engagement, we can be confident that they learned about the STFC science concepts introduced in the sessions. The interactions participants had and kinds of questions they asked reinforce this. For instance, participants in the Science Oxford workshops asked, 'Why doesn't the sun brighten up in space?' and 'Why is space black and dark?' while others fed back about specific facts they had learned. A practitioner from W5 also expressed surprise in his reflection diary at the level of science vocabulary participants used, requiring him to adjust his plans to ensure the sessions supported and extended their learning.

As described previously, some science centres used methods such as sticky dot rating scales, a solar system rating scale and queries about how 'science-y' participants felt to capture

shifts in attitudes (e.g. around **connection to science, confidence, and/or enjoyment of science**) across sessions and these reflected movement in a positive direction. For example, in projects run by Techniquest more participants strongly agreed with the statements 'I love science' and 'I can do science' in the last session than in the first. The nature of the activity and data collection (anonymous, with different children sometimes attending different sessions), as well as inherent challenges with any such evaluation activity, mean that results should be interpreted with caution. Nevertheless, it is impossible to deny the positive nature of the responses and (as reflected in appendix C) evidence gathered across the project reflects that key outcomes were achieved. Additionally, combining the levels of engagement and involvement with STFC science in the sessions captured by reflection journals and interviews with evidence of connections to science reported by many of the participants via rating scales, it seems that participants' **connection to science** was reinforced and supported, and in many cases strengthened, by their experiences.

Participants also experienced gains in **skills**, as evidenced by reflection journal entries and interviews with practitioners and community partners. For instance, young people from NCCP (working with Cambridge Science Centre) developed skills related to research and writing, while those from youth groups engaging with Science Oxford as well as young people participating in sessions at Dynamic Earth, improved their presentation skills. Other community partners, particularly those working with autistic individuals, referred to the social skills that had been supported, as well as their ability to focus on tasks.

While participants experienced **enjoyment and content learning** and there is evidence related to the key objectives of the Wonder initiative, STFC science was also a 'vehicle' for additional participant outcomes, often related to **broadening of horizons**. As these were unanticipated outcomes, they were not measured directly from participants but rather reflect the perspective of community partners. A number of community partners spoke about the limited experiences of those they work with and had decided to join the project in hopes that it would expose young people to new experiences that they might not have otherwise, particularly with respect to science. They felt that participation likely expanded their sense of possibilities for themselves and increased awareness of experiences that are

'out there' in the wider world beyond their immediate neighbourhood. As the community partner from Ardoyne working with W5 put it:

> Some of the kids had said "I'd really love to do this when I'm older." They said things that they probably wouldn't have thought of doing before but some of the kids were really into it and they were saying "I'd love to do this as a job when I get older," so that was a magic moment. The kids were that engrossed by it that they're actually thinking "when I grow up, I would like to do something like this," so that's great. (Community partner, Belfast)

Gains in confidence for the young people was a particularly key outcome for many of the community partners: confidence that they could engage with science and confidence that they could do the activities. Workers from one of the Banbury youth groups spoke about how working on 'their bit' for a planetarium show had really given confidence to some of their youth who tended to struggle in school and in social situations. In another example, a practitioner from Your Space noted that the being able to be successful in the activities (as well as to focus on them) had boosted the participants' confidence:

> 'Making them realise that maybe they like science when they didn't before or that even if they struggle to communicate with us, there's still an activity here that they can do that they get a result out of.' (Community partner, Oxford)

Such confidence was also manifest in young people's **pride** in what they had accomplished. This pride, linked with a sense of **agency and ownership**, seemed most evident in projects building to an 'end product' (such as activities at the festivals developed by the Jodrell Juniors in Phase A or an edition of Open Up Science in Phase C):

> 'That was something that the children chose themselves, I could see that, and that's why they took the ownership and they really loved it' (Community partner. Cambridge).

Pride was also evidenced in individual sessions where participants created something, from presentations in sessions delivered by Dynamic Earth and Science Oxford to making their own slime and rocket launchers in Wrexham with Xplore!:

> ‘I remember one little boy in particular, his mum was there, his nana was there and his auntie was there and when it was his turn to fly his rocket, his family shouted and he was proud and they watched his rocket go off.’ (Community partner, Cardiff)

Outcomes of pride and agency are also related to the Wonder outcomes of *feel* and *skills* (in that as skills were developed in creating these end products). The development of a sense of agency was also supported by responsiveness on the part of the science centre practitioners, when they clearly took on board input and suggestions from the young people.

Evaluation data also highlights the possibilities of this kind of work for **strengthening family relationships,** through the provision of opportunities for young people and parents to engage in a way they rarely had been able to. For instance, the sessions with Edinburgh Young Carers in Phase A offered children (the carers) a chance to spend time with their parents in a way that was simply not possible in their daily lives and which was highly valued by them. In another example, a community partner (Valleys Kids) who had engaged with Techniquest in Phase C described a young father who had been struggling with mental health issues but had come along to the sessions and interacted with his young son:

> ‘He had suffered with mental health and was very, very nervous, and wouldn’t engage and was quite nervous about just being involved, … and he actually turned up with his son and became involved, and did things and was talking, and he turned up every day. So I think from that – I was quite pleased to see him. It was great to see him. And he did look nervous, but he turned up and he came every day, and he had that interaction with his son and things.’ (Community Partner, Cardiff)

There were also outcomes for the community organisations themselves which, indirectly, will stand to benefit the participants. Significantly, these will likely outlast the duration of EYU4, leaving a lasting legacy. In Phase A, volunteers at the Venture became very interested in the activities and in continuing with them and the activities themselves have now been added to their repertoire of things they do with the young people. Some of the community partners from Phase C have also expressed an interest in being trained to deliver similar activities themselves, which further suggests the potential for legacy of this project.

A final example of an outcome completely unanticipated by the science centre or community partner comes from The Hill, who partnered with Science Oxford in Phase C. Although three youth groups were involved, The Hill (with a new space) were ostensibly the lead partner and had been trying for years to bring together youth groups from different areas of Banbury. On the 'family showcase' day, the leaders had carefully arranged the schedule so that youth from the different groups would overlap as little as possible, partly because of Covid but mainly due to postcode warfare between gangs in the different areas where the youth groups are based. However, they did overlap, with results that surprised the leaders:

> 'But they do tend to hang outside and they play football and they just of hang around, and at the end of the session, and at lunchtime, when they were waiting for the transport, taxis and that to arrive, they were a little bit delayed, so they all played together, and they started to play football and that out together. And that was just amazing to see because that is something we will have dreamed to have seen. We make it sound like the Bronx don't we, we're not really like that, but it is something that is just lovely and we would love, that was a stepping stone for us to – I think now we've done that once we wouldn't be, not afraid that's not the right word, but we wouldn't be afraid to actually say, and actually we're going to proactively do this, where we can bring the two groups together. Because we've seen that it works and that was really positive.' (Community Partner, Oxford)

The youth leaders plan on working with the other two groups in the future, as well as with Science Oxford. While this sort of impact was not an 'intended outcome' for EYU4, it is arguably the most powerful outcome from the programme, as it gets to the heart of what is important – critical – to these young people, their families and their lives. And it was enabled by a programme that brought people together to engage with STFC science.

Science centres and their practice

This project was ambitious. It aimed for science centres to work with new community partners to co-create programmes showcasing STFC science involving multiple engagements with young people and their families from disadvantaged backgrounds. It may not be surprising that this wider vision is not feasible within the scope intended length of the project phases (even without the challenges of a pandemic) but having it as a goal seems to have driven the science centres to develop and expand their practice. Impacts on science centres happened at a number of levels: 1) on the practitioners developing and delivering engagements and working directly with community partners; 2) across practice within a science centre more broadly, involving managers or departments and those not always directly involved in delivery of EYU4; and 3) at a more strategic level across a science centre (e.g. related to strategy and/or becoming more inclusive).

This section of the report draws on interviews with science centre practitioners and community partners, supplemented by the reflection journals, to detail the learning that emerged from the project about how to work with communities/individuals from marginalised backgrounds who have not historically engaged with science centres and STFC science. It is this learning that can be regarded as impactful for science centres and the field more widely, as well as consequential if they are able to put this learning into practice in the future.

Working in Partnership

EYU4 intended for the science centres involved to develop equitable partnerships with new community organisations. However, recruiting new community partners to participate in the project was a challenge for most of the participating science centres, particularly in the first phase when the shape of the work was still emerging. Consequently, many worked with existing partners in that first phase, but even working with familiar organisations presented challenges. In particular, due to the nature of their work, the partnering organisations struggled to find time for the intended number of engagements. For instance, Edinburgh Young Carers noted that although their work with Dynamic Earth was ‘a priority’, there were other things that came up that were simply more urgent (e.g. an emergency meeting with social services).

In the final phase of EYU4, four of the centres (Cambridge Science Centre, Dynamic Earth, Jodrell Bank Discovery Centre, W5) shifted to approach and work successfully with new community partners. Two further centres (Techniquest and Xplore!) worked with partners from the previous phase but also added new partners and one (Aberdeen Science Centre) worked with a partner they had engaged with prior to EYU4. Only Science Oxford carried on exclusively with their partner from the first phase.

A number of elements that supported partnership development emerged from the data in Phase A, and were corroborated and extended in the interviews at the end of Phase C.

- **Respecting the expertise of the community partner** was absolutely critical to the success of the relationship and, ultimately, of the activity. Every one of the community partners interviewed noted that the science centres looked to them for guidance – about logistics in the first instance and what would work for the lives and schedules of the participants, and, even more critically, what would make them feel comfortable and welcome. As often as possible for the partners, the science centres consulted them about the format and activities for any sessions, and always took on board any recommendations or suggestions. This sent a strong signal to the partners that they were respected and valued, which allowed the relationships to flourish and, ultimately, the activities to support deeper engagement for participants.
  The respect and valuing experienced by the community partners is reflected in their reporting that their relationships were truly collaborative, where each brought their own expertise:

  > 'It's such a great partnership and cooperation between us, so we are taking care of the local aspects, I mean, the science centre team are taking care of the scientific and academic aspects, so that's a nice combination. I can't really say that one group is leading the other one, we are just interacting together in a very good way and we just try to make things happen in the best way possible. I mean, we have the experience of how we can run it in the best way in the community and they know how it's best to run it to make it more interesting for local children, so that's a nice combination.'

(Community partner, Cambridge)

'A lot of the expertise – most of the expertise is coming from them. We come and bring in our little bit about what we know about science and what we know about engagement.' (Practitioner, Jodrell Bank Discovery Centre)

'[The project] was equal but I recognised that [science] is their expertise. I don't know how to make a rocket launcher so it was equal. We could say "the children have asked for this" so it was equal in that sense but it also recognised that they're the experts and they're bringing their expertise into our expertise, which worked really well.' (Community Partner, Cardiff)

- **Time** on the part of science centre practitioners was another key element supporting partnership development. All of the practitioners involved have other commitments within their role in addition to EYU4. However, **when their line managers were able to prioritise this work** (or reassign some of their other responsibilities), this gave the practitioners the time to be responsive and flexible with the community partners. EYU4 is part of a science centre's wider offer, consequently science centres can struggle to offer the time and flexibility needed to support partnership development.

  The importance of *timescale* in relationship development is also a lesson learned from EYU4. Lockdowns due to Covid offered a unique opportunity for an elongated 'getting to know you' period for partners and science centres. However, this could – and did – vary in intensity. Sometimes communications between partners would happen intermittently over a long period, perhaps with a brief e-mail or chat once a month or so to check in, followed by more frequent communications as delivery approached. This gradualness gave space for relationships to unfurl and develop in a more organic way, without the pressure of impending activity, while also not being onerous for either side. In future, it would be helpful to build in long lead-in times to activity when possible. This does not require a heavy time commitment but can support a stronger relationship which, in turn, is a more solid foundation for activity co-development when that phase begins.

  'And there's not masses of contact… I think the silver lining to Covid was the amount of time it actually gave us between starting the discussion and

actually starting the sessions … It's time more than actions I think … like all relationships it's the time of getting to know one another, not in the sense of what you do but who you are and what's going on.' (Practitioner, Cambridge Science Centre)

The value of this sort of extended time for communication for the relationship is also captured by one of the youth group leaders in Oxford: 'When they came in on that first [workshop], it was almost like we'd known them for a long time… we'd built up quite a good relationship, even over digital means… they just felt part of the team.' (Community partner, Oxford)

- **Flexibility and responsiveness on the part of the science centres**: accepting that EYU4 cannot be the top priority for their partners, however committed overall they might be, and being open to suggestions. Science centres who felt they had had the most successful experience also reported having **managed their own expectations** around what the partners would, realistically, be able to commit to and do. Put differently, partnership working was supported when the science centres were able to understand and accept their partners' challenges, their aims and their objectives.

  'Really trying to get hold of what the group wants to get out of it, what the objectives are for the group, to make sure that, as much as possible you're meeting their expectations and meeting their needs. And then being flexible so that if the first thing that you do doesn't work, or it doesn't go quite how you'd planned or expected, then you've got scope to wiggle it around.' (Practitioner, Dynamic Earth)

  'Show willing. Be understanding. Be patient. Don't be sort of bound too much by your own agenda. Make sure the outcomes are benefiting everybody.' (Practitioner, Jodrell Bank Discovery Centre)

  'If I felt something they were offering us didn't quite meet our needs I would feel comfortable to say that. I'm positive they would help us make it fit to accommodate the needs of the young people.' (Community Partner, Oxford)

- Another element that supported partnership development (as well as co-development of activity – see below) was when the **project fit with the ongoing work or mission of the community partner**. When the community partner's aims fit with what the science centre could offer, collaboration seemed just to flow and the partnership was enhanced. For example, in the case of Fersands & Fountain (Aberdeen, Phase A) and with ACE Cardiff, EYU4 fit with their interest in simply inspiring and engaging their young people with science, as a way of expanding their horizons. ACE Cardiff in particular were only able to offer limited science provision and were keen for the opportunity to have someone bring in expertise that they do not have to build young people's confidence about engaging with science. Likewise, Valleys Kids provide many youth activities but almost none focus on STEM outside of digital – so the sessions delivered by Techniquest addressed a gap in their provision that they were eager to fill, and similarly, Banbury Mosque provides English and maths support for their young people but have no science provision.

  In another example, the leaders of the Syrian Dads' Group were keen that family members would work together as family units and that the parents would be 'enthused to help their child if they were stuck', which drove the way in which Dynamic Earth set up the activities in their sessions. Similarly, The Hill (one of the youth groups working with Science Oxford) were keen to try to collaborate with other youth groups in the area, which strongly influenced the structure of the project.

  Partnerships were also supported when the science centre could meet community partner's needs in other tangible ways. For instance, Women Connect First wanted to offer science workshops to children of the women they supported, but they did not have the necessary space available to them. Consequently, the workshops were held at Techniquest.

- **Clear communication** with the community partners was, of course, central to partnership success, and science centres needed to take the lead in this, developing their understanding of the partner. Responsiveness on the part of the science centre also further supports this: 'All I need to do is pop [practitioner] or [practitioner] a

message or an e-mail and they ping straight back. It's very easy, very friendly' (Community Partner, Wrexham). **Internal communication within the science centre** (e.g. with the delivery staff, if involved) was also key, so that everyone interacting with the partner organisation was on the same page.

- Having a **clear definition of the role of the community partner** was also useful, but this is often something that needs to emerge over the course of the project. Laying out what was expected of them and what the partners could expect was a good starting point for discussion but science centres also needed to communicate that they were flexible, and expectations were not set in stone. The very nature of the project meant that clearly articulating roles was a challenge. At times in Phase A, science centres and their community partners had differing perspectives on how clear their roles were. In contrast, this did not emerge as an issue in the final phase, which may be due to more robust communication and collaboration between the science centres and community partners.

- In Phase A, where partnerships were working well (and multiple engagements were occurring) a **'key amazing individual'** from the science centre came up in every interview. These individuals were accommodating, flexible, responsive and trusted. Nothing was 'too much to ask' of them, and, importantly, the **community partners felt these individuals knew them well and valued, respected and drew on their expertise in working with children /young people and families.** While these relationships provided a firm – and necessary – foundation on which the partnership and activity could develop further, they also present challenges to the legacy of the partnerships. In contrast, in much of Phase C, most science centres were able to involve multiple members of staff. While there often continued to be a primary contact, many community partners in this phase experienced positive relationships with more than one science centre practitioner.

- **Embedding partnerships** within staffs and within organisations is a big challenge, but one that is needed to mitigate against the possibility of the partnership dissipating when a key individual moves on. Some science centres described how they have

systems in place to share documentation from the project, and this is a key first step. Another strategy mentioned (though variable in its execution) involves staff training, particularly involving delivery staff who are directly interacting with the community partners. Training done by the community partners (such as that delivered by staff from the Venture and from Your Space to Xplore!, or from Space4Autism to Jodrell Bank Discovery Centre) could be particularly effective.

It bears emphasising that relationships are between individuals, not between organisations. That is, embedding partnerships does not require that someone from one organisation feels that they know the whole of the other. Rather, data from EYU4 suggest that what matters is that there is a sort of 'critical mass' of people from both organisations who know each other. Thus, another strategy to support embedding partnerships is having multiple members of staff (ideally from both organisations, but certainly from the science centre) involved, or giving the communities 'multiple touch points' (Practitioner, CSC) with the science centre. When science centres were able to send the same two or three members of staff to every engagement, families and community partners alike felt that they knew the science centre. Moreover, when these families went to visit the science centre (for a 'family day' or celebration event, as happened in some of the projects), they felt welcome and comfortable, likely reinforced by a feeling that they knew people who were there and what they were like. Due to these multiple points of contact, it seems that partnerships from Phase C became more embedded than those in Phase A. That these partnerships were more embedded is also suggested in the way in which they are extending beyond the duration of EYU4.

Partnerships are also more likely to become embedded when they stretch across more than one programme. For instance, Jodrell Bank worked with Space4Autism to make their centre more accessible for individuals with autism. This involved staff training, mystery shopper visits and feedback about the website, as well as extensive conversations, all before the EYU4 sessions were delivered at S4A. Such multi-faceted collaborations increase the likelihood of the partnership becoming embedded, because they are not limited to a single programme.

The success of these approaches is reflected in the glowing comments from every community partner (and science centre) interviewed. The community partners in particular were effusive in their praise, using terms such as 'perfect match', 'part of the team' and 'brilliant connection' in describing their relationships with the science centres. They also felt they could reach out to the science centres for future collaborative efforts: 'I think now I could send an e-mail or pick up the phone and ask if we wanted anything' (Claire, The Land). That these were not just words is corroborated by the legacy of the project. Many of the community partners not only expressed a wish to continue the relationship and to work further with the science centres, but also had specific ideas for ways to continue into the future. Others have been able to go a step further and have continued to deliver activities with the science centres. (More detail on these efforts are found in the Legacy section at the end of this report.)

Co-development

One aim of EYU4 was not only that science centres would develop partnerships with community partners but also that they would co-develop activities with them. One of the biggest challenges to 'true' co-development, in which the science centre and the community partner would collaborate equally to create activities for young people, concerns the focus on STFC science. The knowledge base of the community partners related to STFC science was limited at best and science was often outside of their comfort zone. However, over the course of the project, science centre practitioners arrived at a richer understanding of co-development, as a practice in which both partners contribute equally, each bringing their ***own*** expertise – which is equally valuable and valued, but distinct – to a shared endeavour.

Within this definition, some key features and approaches emerged from interviews with science centre practitioners and community partners as supportive of co-development.

- First, **a collaborative, close working relationship with the community partner** was felt to form the strongest foundation for developing activities. Such a relationship, in which the science centre practitioners knew their community partners well, meant that they were able to draw on their respective strengths (e.g. their knowledge of the families/young people, and effective ways of engaging them, as well as of what kinds of logistics might work well) and work iteratively to develop workshops and

related activity. Doing so also meant that the community partners felt that their expertise was valued. There is a clear relationship between the quality of the partnership (and its stage of development) and the extent to which activity could be co-developed.

- Another feature of successful co-development in this context is that **the science centres took the lead on content** – they proposed the activities, at least in broad terms, which were then shaped with input from the community partners. Sometimes this shaping happened prior to the first workshop/engagement with young people, other times it did not, but in all the cases there was **reflection** (either formal or informal – e.g. a brief chat over the phone) **that fed into the development of the following engagement**. The input from the community partners did not have to do with the science, but rather with their deep knowledge of the young people and their families and many community partners were able to identify elements of the activities that they had suggested, including folders for participants to keep their work in (Cambridge), or a photobooth at a Science Oxford family day. This kind of familiarity is something that a science centre practitioner could not realistically expect to develop without far more engagements (and certainly not prior to the start of the project). The willingness and enthusiasm of the science centre practitioners to draw on the expertise of the community partners doubtlessly strengthened the activity offered to the participants.

  > 'I think I definitely leant on them in terms of their expertise and knowledge of the group, and what the group's needs were. But then, some of the co-development of the content, it was based on week to week, what went well this week, what can we try and do next week.' (Practitioner, Dynamic Earth)

  And in the words of one community partner:

  > "I feel that if I gave him an idea, he would deliver. He's open to any suggestions, any ideas and times, so flexible, so we can, if we want to improve it a little more we could have another meeting and sit down and put another workshop together …" (Community Partner, Aberdeen)

- A related approach that strongly facilitated co-development was **being open and asking questions**. It may seem obvious, but asking questions not only provided science centre practitioners with information about how to shape the activities but also signalled to the community partner that their expertise was valued and their ideas were being taken on board. Many of the strongest examples of co-development started with this openness and questioning, which is something that can easily be adopted by science centres embarking on this kind of work:

  > 'That kind of openness, asking the question, stating what we have that they can use, but also listening to what they're wanting so that we can see what do we have that fits that and if not, there's a whole bunch of people who are saying we'd really like thing Y, OK maybe we need to actually think about that because that's something that is going to be useful.' (Practitioner, CSC).
  >
  > 'They were asking all the right questions. They wanted to know how to make it, what they're going to do better, and they were open to all suggestions and ideas…. That was really refreshing for us all the way through – they kept us involved and asked us, rather than saying we're coming in to do this for you, they wanted to know how can we come in and do this for you?' (Community partner, Macclesfield)

- Another feature that supported co-development was **flexibility,** both around the activity itself and around the preferred degree of involvement of the community partner. While going in with a completely open slate ('let's do something!') is unlikely to be effective, being open to possibilities is: 'It feels a little bit unprepared not to have a plan but actually it's the right thing to do. Don't have a plan, have objectives.' (Practitioner, Jodrell Bank Discovery Centre).

  However, the degree of openness that is most helpful will vary and thus flexibility around how activities are developed and delivered is critical. For some community partners, having objectives but fleshing out a plan together is effective and can further develop a relationship. Other organisations would prefer that possibilities be presented and then elaborated with their input, as in the case of Science Oxford and Banbury youth groups:

> ‘We gave them, kind of, a few, like a menu of the type of things we could do. We tried to keep it as broad as possible while also being like, “Realistically, this is what we can deliver for you.” So we told them about the planetarium, we told them about workshops, we told them about shows, all the things Science Oxford does as an organisation. And then they chose what they wanted for their kids and the overwhelming choice was the planetarium. So then we said, “OK, well, how would you want that? Do you want to come to us, do we come to you?” And we discussed – we were planning on multiple-week engagements, almost like an after-school club type thing but actually after talking to them, due to the pandemic and other reasons, they said that what would work better for us would be like a summer, like a week in the summer. So that sort of shifted during our planning. … And then we went back to them and we suggested that actually whilst we could deliver planetarium shows, why don’t we get the kids to make them? And they loved that idea, they – also we said it’d be nice for you to come and visit us or us to visit you, and we kind of collectively decided on doing both.’ (Practitioner, Science Oxford).

These conversations continued throughout development and delivery, concerning logistics (including specifics of timing and food) and activities (e.g. adding a photobooth station): ‘We tried at every step to have multiple check-in meetings, every little decision, running it by them’. (Practitioner, Science Oxford)

In contrast, other community partners would prefer lighter touch involvement, such as providing suggestions about logistics and/or smaller adjustments that might support participants’ engagement.

- As with development of partnerships, **time** is also beneficial to co-development of activity. When more time can be built into the process, activities can be created collaboratively, should the community partner have the resource to do so. As the team from JBDC found, ‘give yourself time to do a little bit really well because once you start talking to your community partner ideas will grow because that’s the whole point’. Relatedly, time allows for more conversations to take place before

> engagements start, 'to get it as right as you can on that first visit.' (Community partner, Macclesfield)

While the primary focus of co-development concerned that between the science centre and the community partner, a degree of co-development also happened between the practitioners and participants (families and young people). This emerged most strongly in the case of the partnership between Cambridge Science Centre and North Cambridge Community Partnership, where a group of young people created an edition of Cambridge Science Centre's 'Open Up Science' magazine. In this case, the theme of the magazine was 'animals', as chosen by the young people, and pairs of young people worked together to develop pages for the magazine. (Admittedly, 'animals' does not fall neatly under the umbrella of STFC science, but Cambridge Science Centre decided to let young people make the decision and then worked hard in the sessions to make links to STFC science).

In other partnerships (including Dynamic Earth-Syrian Dads Group, and Science Oxford-Banbury youth groups), young people developed presentations that they delivered at the end of the project. And in most partnerships where more than one engagement took place, a form of 'co-development lite' (Practitioner, Techniquest) was used, involving gathering feedback from participants about what they enjoyed and what they would like to do in subsequent sessions, and using that information to develop later activities. While this approach is certainly more consultation than co-development, it was more collaborative than simply delivering a series of pre-set workshops. At times, the logistics of a project (as determined by the community partner) also worked against even this level of co-development, such as when a partner wanted a few workshops delivered over the course of a week as part of a summer programme. However, and importantly, even consultation, when possible, can help build trust – demonstrating to participants that their voices were heard and valued: 'I also really liked having the big paper board that I could just write down on because it showed that I was listening to them… next time, I'd bring back that board and go "Here's what you wanted to look at, here's what we're doing"' (Practitioner, Techniquest). Likewise, practitioners from Xplore! followed the lead of young people at the Venture, in terms of how the sessions were structured (with time to go play and come back), the activities used (slime being offered repeatedly) and the nature of those activities

(being in a game-like style). Although perhaps not 'true' co-development, the value of such responsiveness in itself should not be underestimated, and it was recognised as a positive by community partners:

> 'So they're very receptive to providing what the children and young people wanted which was brilliant and it felt like they were there for children and young people.' (Community partner, Cardiff)
>
> 'If there was anything they suggested, the staff incorporated it into the session.' (Community partner, Aberdeen)

Whether more in-depth (as in the case of the Cambridge Science Centre partnership) or co-development 'lite', these sorts of engagements supported a key characteristic and outcome of co-development work, namely:

- **ownership and agency** for the participating young people. Co-development of activities with the young people in advance of initial sessions was unfeasible (not least due to the science involved). However, a key outcome of co-developed activities is that the participants involved feel a sense of ownership of them. While it could be considered just 'good practice' to reflect on a previous workshop to inform the next, consult participants about what they would like to do, or even to make changes during the course of a workshop, it is significant in this context because it seemed to contribute to a feeling of ownership on the part of young people, as reported by the community partners. Additionally, projects directed towards an 'end product' of some sort provide an opportunity for young people to experience agency – they are the ones deciding what the activities will be and are supported by the science centre and community partner in preparation and execution.

Overall, it is clear that all participating science centres made efforts to co-develop as much as they could in EYU4, and their understanding of what co-development meant in those contexts evolved over the course of the project. Moreover, their confidence in these approaches grew, with several practitioners expressing hopes to be able to 'take it to that next level' in future work and, indeed, some are taking initial steps to co-develop new activities with their partners, something also suggested by community partners:

‘Getting the participants to come up with ideas to form the basis of a new project. What they were offered was really, really good but now they were able to see what is offered in the Dynamic Earth and what’s possible. They might actually come up with the ideas and I think, if that does happen, that would be splendid.’ (Community partner, Edinburgh)

Engagement Strategies

The evaluation has signalled a number of strategies for working with diverse and/or underserved audiences, including families. Not all will be applicable to all audiences, nor should that be an expectation, but they can inform such efforts. It is also worth noting that some of these strategies are inextricable from what is needed to support partnership working, again highlighting the role of relationship in engaging with diverse audiences, while others are likely to be effective in engaging with almost any audiences, including those who already visit science centres.

- **‘A whole lotta stuff’**. This strategy is, quite simply, bringing in a range of activities and supplies/kit, scattering them around the room, and letting the participants choose. There is not a plan for participants to engage in a particular number of the activities (much less all of them), nor in a particular order, but rather an opportunity to see what they gravitate towards, what they seem to enjoy and how they interact with what is on offer. This can provide valuable information to guide the development of future sessions, which is particularly important in the case of STFC science. That is, because the content is unfamiliar to many children, simply eliciting what they might be interested in exploring, is unlikely to be particularly fruitful. Additionally, this strategy can be enhanced by interactions during the session itself. Engagement with activities can provide an opportunity for a ‘getting to know you’ conversation (see corresponding strategy below). Science centre practitioners can also signal that they are taking participants’ interests on board (and simultaneously highlight their voice and agency) by visibly making a note of what families and young people are interested in, as well as suggestions for future sessions. A practitioner from Techniquest also brought the list to subsequent sessions, to highlight to participants that he was following up on their suggestions.

- **Having an 'end product'**. While this strategy would be effective with a range of audiences, it also seems to be particularly effective with the groups involved in EYU4. At its strongest, it takes the form of an activity (such as those delivered by the Jodrell Juniors as part of community festivals in Phase A or the planetarium show presentations developed by the youth groups working with Science Oxford) or other physical product (e.g. the edition of Cambridge Science Centre's Open Up Science magazine developed by youth from NCCP) but can also be a celebration of a project (such as a family visit to a science centre) or even a smaller tangible output (like things decorated by youth group working with W5, which related to a new show they were helping to shape). All of these seemed to reinforce a sense of *ownership, agency and pride* in participants: 'That was something that the children chose themselves, and that's why they took the ownership and they really loved it and they kept working on those.' (Community partner, Cambridge)
- **Supporting autonomy and agency.** Building on the above two strategies, as well as being a key aspect of co-development, a number of science centre practitioners looked for opportunities to support the autonomy and agency of participants, signalling to them that the field of science is one in which they can contribute and have a degree of control. Enacting this could range from simply letting participants engage on their own terms, choosing when and with which activities to engage, to inviting participants to take over and lead activities, either longer term (as in the case of CSC's Open Up Science magazine) or in the moment: 'She said, "Ok, guys, you've seen it twice already. You know how to do it better than me." So, the little ones actually demonstrated [slime-making].' (Practitioner, Aberdeen Science Centre)
- **Logistical support** is clearly key in engaging participants from marginalised groups, but it is important to rely on discussions with community partners to determine what this should look like. In most cases this meant letting the community partner advise or lead on matters of timing and food – such as suggestions for the kinds of snacks provided by Dynamic Earth to the Syrian Dads Group in Edinburgh or the timings of coaches from Banbury to Science Oxford, which departed around 11 am, as the lives of many of the families meant earlier departures were unfeasible. The success of this timing is reflected in the large numbers attending. In a somewhat contrasting case, Edinburgh Young Carers advised Dynamic Earth not to provide

transport but to encourage families to take the bus, because it was a goal for them to equip the families with the skills and confidence to be able to take public transport. That is, while matters of transport and other logistics need to be considered, this should be led by the community partners who know the participants and their lives, rather than based on assumptions that particular approaches or timings will be preferred.

- **Flexibility and adaptation** in terms of logistics, the activity itself (the direction it may take), and in terms of expectations (not trying to cover too much in a single session and/or having back up plans) is another important strategy and one which was sometimes challenging for science centre practitioners who were more accustomed to delivering pre-set sessions or shows, making sure to cover particular objectives. This strategy also means being less prescriptive or detailed about what is planned for a session and being able to adapt on the fly, whether by offering an alternative to a child with challenging behaviour who does not want to do a particular activity (as happened in Aberdeen, among others) or just going along with the partner's usual schedule: 'we ended up having a little bit of a show, doing some demos. Then a little break for them. And then they could mooch back over once they'd had their snack and a drink, and look at stuff if they wanted to, or ask questions if they wanted to. They could just chat and finish their snacks… I think that's their typical kind of set up of things…' (Practitioner, Jodrell Bank Discovery Centre). This sort of flexibility represented a real departure for many science centre practitioners and pushed them out of their comfort zones: 'We've never done this before, we're just going to go in, get to the end and if it's a disaster, then we've learnt how not to do it.' (Practitioner, Cambridge Science Centre)
- **Creating a welcoming and comfortable environment.** Wherever the location of the engagement, ensuring that participants feel comfortable and welcome in the activity is key. This is likely easier when sessions are conducted at the community partner's space, which is already familiar to participants. As one of the Banbury youth group leaders put it, 'for the kids that are up here … school isn't always a positive environment for them. So for us, I mean I'm saying a comfortable environment… , it's relational isn't it, they've got a very good relationship with [youth leader], they trust her, they feel comfortable with her … And it's just a really safe space.' This can

be built upon by the science centre practitioners' actions, giving participants confidence that 'no question was too silly to ask', for instance.

Participants can also be made to feel welcome at a science centre (or other space), particularly by building time into sessions for casual conversation and, especially, food. At Dynamic Earth, this was taken a step further, as the Syrian families were provided with familiar snacks of baklava and dates.

- **'Getting to know you'.** Closely aligned with creating a welcoming and comfortable environment is taking advantage of opportunities for casual chats – whether around food, during breaks, or even during activities – and really *listening* to what participants have to say, to get to know them as individuals. Questions can also be used as part of check-ins at the beginning and end of sessions: 'Didn't want them to feel scrutinised… we started off by kind of asking general questions… just to understand where they were at' (Practitioner, Jodrell Bank Discovery Centre). These conversations can provide helpful insights into their experience of and interest in science, which can inform activities but, even more importantly, demonstrates caring. Such an approach helps build *trust and rapport* with participants which further supports their engagement with the science: 'They didn't just come in and get stuck in there. They'd come in and they took time to speak to them and get to know them and get to write down what their likes and dislikes were' (Community partner, Wrexham).

  It also goes without saying that multiple engagements, when possible, can facilitate this process, providing multiple opportunities for these conversations. As a practitioner from Xplore! described: 'The first day they were a bit wary of us because we were new, but when we came back the next day, they'd be calling us by our names and the second week it was like we were part of their group.' Likewise, if possible, visiting the community partner group before engagements start could also provide an excellent opportunity to get to know participants in a comfortable environment.
- **Taking into account the needs of the whole family**. When trying to engage whole families, there needs to be accommodation for siblings (particularly younger). However, this does not necessarily mean that the siblings are engaged in the same activity – childcare may take different forms. In the case of Edinburgh Young Carers,

Dynamic Earth created a sort of creche, where the siblings (who had a range of additional needs) were provided for with their own activity and looked after by other staff. This meant that the young carers could have one-to-one interactions with their parents, something they had rarely experienced in years, if at all (in the case of one family, it had never happened). In this case, this was by far the most valuable part of the project for them. This would not have been possible in an activity which involved the 'whole family', as the parents' attention would have necessarily been focused, as always, on the child with needs rather than the young carer.

- **Design for family involvement** (and acceptance of challenges). If the aim is to engage parents and carers, this engagement needs to be designed into the activity itself. That is, while celebrations and a 'final product' can be one strategy for bringing in families, to engage them on a deeper level means that the activity needs to be planned with roles for children *and* parents/carers. Simply asking that parents and carers come in to 'see what their children have done' is rarely sufficient, although this can vary. For instance, families visited W5 following their children's sessions at the Ardoyne After Schools Club, but did not stay long enough to see the show that their children had contributed to (admittedly, it was at the end of the afternoon). In contrast, families turned up in droves to Science Oxford's 'family showcase' at a community centre to see their children's presentations (though perhaps this is because they were seeing their children 'perform' rather than simply something they had contributed to.)

  It is also important to recognise that expecting close familial involvement can be unrealistic. For instance, if engaging with a youth group or after school club, adults may not be able to come an hour early to participate in an activity with their children, no matter how much they may wish to. For this kind of involvement, discussions will need to be held with the community partners and compromises made – possibly in terms of scheduling/timing, or the scope of the activity, or the depth of involvement of parents/carers. Conversations with the community partner are key to identifying which approaches are most likely to be fruitful for the broader aims of the work as well as to work through other creative ways of involving families. For example, both Science Oxford and Xplore! incorporated questions about existing interest or engagement with science into consent or sign-up forms that were sent

home prior to the activities with young people. These provided an opportunity to get to know the families and to start to make a connection with them. Such forms could also be used to encourage conversation at home about the activities.

- **Consistent science centre staffing**. Although there are risks around dependence on one 'key amazing individual', relationships are central to this project, and not just between the community partners and science centres. For the young people and families involved, consistent staffing was critical and it allowed the young people to trust and begin to form relationships with science centre staff which, in turn, supported their engagement: 'I was the familiar face, I could build an actual rapport with people' (Practitioner, Cardiff), and in the words of one community partner, 'If we could have the same people, because that's a big thing – don't keep changing your staff' (Community partner, Macclesfield). Such consistency also enables the staff to get to know the participants, which means they can be more responsive to their interests and needs. In short, consistent staffing creates a virtuous circle. Relatedly, consistently involving more than one member of staff extends this benefit, and participants start to feel like they know the centre itself. Consequently, this can make them feel more comfortable about visiting. For instance, when young people from Your Space visited Xplore!, they looked for the staff members who had led sessions at their organisation. In the case of Dynamic Earth, consistent catering staff serving snacks (a requirement of Covid) was yet another positive point of contact with the science centre for families from the Syrian Dads Group. In other words, through consistent staffing and multiple interactions with the same practitioners, the science centre becomes a trusted 'brand', which makes individuals who might otherwise be reluctant to go or think it's 'not for them' more comfortable and willing to visit.
- **Respect for the expertise of the community partner and their knowledge of the families/young people**. While this has been reflected in some of the other strategies, it bears reinforcing. There needs to be an ongoing, open conversation with the community partner throughout the project, whilst still respecting the limited time most community partners have available. While this can be frustrating (e.g. a particular partner may only respond to texts), the science centre practitioners

need to be as accommodating as possible, and support for the time it takes needs to be provided by management.

- **Support the work of your community partner**, such as an after-school club or other provision of the community partner. At times, this meant departing from the EYU4 aim of engaging with families, as that was not who the partner was directly working with. Depending on circumstance, fitting in with something the community partner already is aiming for in their work can be an equally successful variant of this strategy. This can support engagement because the science centre is fitting in with an approach or structure that is already engaging the target audience. Moreover, supporting existing provision enables the science centre to become a resource for the community, to contribute to what organisations are already doing in, with and for their communities.
- **Community partner funding.** Related to the above two strategies, direct support for funding for community partners can help ensure that the activity that is funded is led by community partners, based on their expertise and knowledge of their clients, and likely to be highly successful in engaging target audiences. This could take a number of forms, including joint bids (particularly in which some, if not all, funding goes directly to the community partner), support for proposal writing and/or letters of support, and logistical or other support in carrying out activities once funding is obtained.

Evaluation

The evaluation of EYU4 has been a journey, with substantial learning on the part of the science centres as well as the evaluator. At the beginning of the project, ASDC provided the science centres with a number of tools to assist them in collecting data relevant to the main questions of the evaluation and aims of the project, which were used to varying degrees by the centres. Overall, the tools were relatively successful and most were used by most centres in Phase A, however their use was not always consistent and when the optional forms were not used, they were not replaced by some other method of collecting data.

Shutdowns to science centres and work on the project for most of 2020 and well into 2021 for many provided an opportunity for reflection and re-visiting the approach to evaluation.

This was driven by two interrelated concerns: first, that science centres were struggling to collect the data that was required by the project and second, that what they did manage to collect might not have been 'capturing the magic' of the project. Consequently, in Phase C, the evaluator worked with each science centre to create a bespoke evaluation plan that would ensure that data was collected to speak to each of the evaluation questions, to the extent this was possible. In some cases, due to the nature of the engagements, it was not possible to collect data in every area, but across the programme as a whole, data was collected to address each area. The template used as the basis for evaluation plans for each centre, alongside outlines of the methods used to capture data during Explore Your Universe are outlined in appendices.

By taking a flexible and hands-on approach to the evaluation, we were able to ensure that it was responsive to the evolving projects (evaluation plans were often amended multiple times) while still addressing the aims of EYU4. We were also able to build on approaches already used by the community partners, to communicate with families for instance (e.g. by sending letters home, online, etc). This approach also meant that we were able to develop and utilise instruments that were appropriate for the engagements – that were both fun and understandable (e.g. Alien emoji sheets), that were not onerous or demanding (e.g. sticky dots on a rating scale), and that fit seamlessly into the activities themselves and thus did not feel like evaluation (e.g. using rocket icons, planets and even static charged balloons to mark a response). This kind of integrated evaluation was particularly important for participants who struggle with formal school environments and associated activities, such as writing: 'We kind of consult with people in that way here when they answer questions without realising they're being consulted with… saying to young people can you write something down? "Argh, it's like being at school, I've got to do this…"' (Community partner, Oxford).

Working with the same template across science centres not only facilitated collection of data but also sharing of instruments and methods among centres. For example, the solar system rating scale (which planet a participant chose reflected the closeness or 'heat' of their relationship with science) created by Xplore!, and the Alien Emoji sheet developed by Science Oxford, were used by multiple centres. This sort of facilitation and sharing, as well

as working closely with science centres to develop – and amend – bespoke evaluation plans also contributed to upskilling of practitioners in evaluation, an area that was daunting for many at the outset.

Reflective diaries and follow-up interviews with science centres and community partners formed a substantial part of the evaluation. This enabled us to fill in some of the gaps in actual data collection, to ensure that we had needed data or sufficient proxies related to metrics (e.g. numbers, gender, ages, science capital, IMD), and that we were capturing what science centre practitioners and the community partners considered to be most significant about the project, whether in terms of partnerships, co-development, participant outcomes or practitioner learning. In other words, by taking this approach to evaluation, we are confident in our findings that EYU4 has succeeded in engaging the target audiences with STFC science, and that we have gathered insight into what made this engagement and impact possible.

At the beginning of the project, the original intent was that the evaluation would be co-developed – ideally with the participants themselves or if not, then at least with the community partners. In reality, this would have required support that was beyond the scope of the project, as well as demanding more time and resource than was feasible from the community partners. However, a key rationale for co-development of evaluation is to ensure that it is equitable – that it captures what participants (and community partners) consider to be important, or their goals for participation. Through discussions with science centre practitioners and community partners throughout the programme (and encouraging science centres to engage in these discussions with the community partners), we were able to explore what they considered to be important and to aim to capture that in the evaluation. This was primarily accomplished via interviews but also by encouraging/reminding science centres to ask community partners about the engagements and incorporate that into the reflective diaries. As one practitioner put it: ‘We would’ve missed so much impact if we hadn’t asked them [community partner] how they felt it went’ (Kat, Science Oxford).

Carrying forward the learning

All of the science centre practitioners involved stepped outside of their comfort zone on this project. Even if it might not have appeared that way from the outside (e.g. when science centres were working with partners with whom they had established relationships), the impact of this project has been substantial. Every science centre (and practitioners within it) has learnt from this project about working with community partners and strategies for engaging with new audiences, including substantial learning about working with autistic individuals. The areas of learning are detailed in previous sections, but in follow-up interviews practitioners frequently articulated the ways in which they were extending these practices and strategies beyond EYU4:

> 'Now that I've kind of worked this way, I would generally go in with more of a plan for a first session of, say, five sessions, but I wouldn't bother planning for the rest. I would just say, "Well, I'm going to go in, main aim is to get to know the group, find out where their interests lie and then we'll go from there"… Have backups and be prepared but don't worry too much about the kind of timeline or direction that it's going to take.' (Practitioner, Aberdeen Science Centre)
>
> 'We learned just to be more chill and go with the flow…' (Practitioner, Xplore!)

Other science centre practitioners remarked on their increased awareness of a starting point for approaching new partners: 'My advice would be reach out to as many local groups as possible and go, "Hey, I've got free stuff that's fun, can we be friends?" (Practitioner, Techniquest). Although light-hearted, this quote does reflect the importance of getting out into the community. From there, the longer process of getting to know potential partners and the communities they work with can begin. Moreover, some practitioners also articulated an increased awareness of the time commitment involved – that time and resource is also required to maintain relationships over time.

Some science centre practitioners also noted that they had learned about evaluation, suggesting that their practice in this area (which is often challenging for those working in science communication/ISL) is another area where EYU4's impact will extend beyond the life of the project:

> ‘I feel like it’s kind of a skill that our team have developed through these projects. We’ve got better at going “What are we trying to ask and how is the best way to ask that?”’ (Practitioner, Science Oxford)

EYU4 has impacted not only on the practice of individuals, but also on the centres in which they work. In many ways, EYU4 acted as a test bed for new practices and approaches, or a catalyst for new ways of working, which extended beyond those directly involved in EYU4: ‘it’s certainly kick-started something that the Centre wouldn’t have been able to do’ (Practitioner, CSC). In many cases, this involved other practitioners utilising practices described in previous sections (e.g. ‘whole lotta stuff’, using reflective diaries, being more flexible, focusing on relationship-building) as well as awareness of how to work with specific audiences, such as individuals with autism. Additionally, some science centres took this a step further and incorporated these changes in approach at a department or centre-wide level. For instance, Aberdeen Science Centre is attempting to move away from one-off offerings and have ‘serial engagements with all the groups we are working with’ (Practitioner, ASC) and to use the ‘whole lotta stuff’ strategy in initial sessions with new groups outside of the EYU4 project. A practitioner from Science Oxford reflected: ‘I feel like as an organisation, we’re really learning how to work with different audiences’ and in the words of a W5 practitioner ‘within the education team … it’s easier to see the direction of, like, the multiple engagement methods.’

One area in which multiple science centres reported making changes was in their **planning** and initial sessions with groups – being more flexible and responsive to participants’ interests: ‘If whatever you want is not on the list, tell me and I will create something… We’re immediately responsive to our community’s needs, visions, aims and expectations’ (Practitioner, Aberdeen Science Centre). This is also consistent with the approach articulated by Jodrell Bank: ‘Don’t have a plan, have objectives’ (Practitioner, Jodrell Bank Discovery Centre). A practitioner from Techniquest also reflected that this flexibility should extend to the process of workshop development: ‘the way we write workshops from a development point of view needs to be much more flexible, so we can better morph it… being able to modulate your kits now and stuff much more easily and quickly and on the fly is much more valuable and useful…’ and a practitioner from Xplore! highlighted this new

approach in their work: 'this kind of working is very adaptive and you're constantly changing on the spot'.

Changes in planning can extend to making more concerted efforts to get to know groups and individuals, including devoting initial sessions to this, 'We kind of see where the community groups' interests lie. And where they want to take it' (Practitioner, Aberdeen Science Centre). In a similar vein, Xplore! has started asking teachers about what they want to achieve with their students and what kinds of activities might work best for them and plans to adapt their school booking forms to enable this information from teachers to be incorporated. These efforts to be flexible and adaptive extend to how they approach work with community groups as well.

Relatedly, science centres are looking at their processes and practices to explore ways to **focus on relationship-building** with community partners and how they might structure staff time and rotas to facilitate this. Xplore! is one place where this is happening. Staff at Jodrell Bank have also gained an appreciation of the importance of involving more individuals than the engagement team alone in this work and in developing relationships with partners: 'it's so important going with what works with the community partner. You can't push your own agenda because actually it's about shared outcomes … it's not our project and that's intrinsic to the whole thing' (Practitioner, Jodrell Bank Discovery Centre). In Aberdeen, this movement towards putting a priority on relationship-building (with content coming in after) represents a complete shift to a new focus and way of working, 'it's building the personal relationships first and then the science will flow around it, rather than going in there with "I have to hit this, this and this target on the science front"' (Practitioner, Aberdeen Science Centre). This is not to say that the science is unimportant – but rather that by focusing on the relationships first, activities can be created that enable deeper engagement with the science.

Likewise, Cambridge Science Centre is building on their learning from EYU4 – about working in partnership with community groups, getting to know them and valuing their expertise – to inform their approach to collaboration more broadly: 'The whole thing has become a bit of a blueprint for how we would do it', which is leading to a focus on longer-term

relationships. And Jodrell Bank has now learned to 'go local' in their efforts to partner with expert organisations (e.g. around autism).

Wider organisational change

EYU4 has clearly led to substantial impact on practice at the level of individual practitioners and wider departments, acting as a catalyst for new approaches. It acted as a proof of concept of this way of working, enabling practitioners and science centres to take risks that they were unlikely to take otherwise. But the aspiration of EYU4 went further than this, aiming to support and encourage organisations to become more inclusive, with these practices as a way in which such inclusivity was instantiated. Broader organisational support for relationship-building, and wider commitment to this way of working with community partners and disadvantaged young people and families, is key to the legacy of this project and continuing this kind of work.

While it is clear that science centre practitioners have been on a steep learning curve, with all feeling they have advanced their practice far outside of their comfort zones, the extent of wider organisational learning or movement toward inclusivity is less clear. As part of the project, multiple members of staff (not just those directly involved in EYU4) from each of the eight science centres engaged in reflective discussions about inclusivity. While details of these are found in the EYU4 methodology report, practitioner interviews provided further insight into the extent to which EYU4 may be able to impact science centres at a higher or more strategic level.

In some cases, the interviews provided evidence that senior management are beginning to take notice and support this way of working (e.g. working with community partners, multiple engagements with families/individuals who have not historically engaged with science centres). For example, Dynamic Earth have been developing ideas within specific departments to improve EDI and a working group will be initiated to hold individuals accountable. One community outreach officer was invited to meet with the board about EYU4:

> 'I have recently been invited in the very short future to a lot of meetings with the Board of Techniquest… because they are very much trying to increase their diversity

> and inclusion and I have been on the front lines of that most recently. So they're bringing me to talk to senior management and the Board about my thoughts, feelings and opinions. And there is now an EDI group as well which I am part of trying to increase its diversity.' (Practitioner, Techniquest)

In other science centres there is substantial support for these efforts within education or learning departments but shifts within the wider centres are less clear. Additionally, although the community outreach officer above was invited to meet with the board, he is still an outreach team of one, and noted that should something happen to him, there is not someone else in the centre who is part of all the relationships he has developed with community organisations.

Organisational learning from EYU4 and the support for this kind of work throughout an organisation is clearly more likely when it fits with the organisation's direction of travel – when it is moving towards increasing this kind of work generally and it is becoming more central to its mission (even if it is not there yet). For instance, when centres have received other grants (in which community engagement plays a role), a project like EYU4 can act as a testbed for this way of working and opportunities for sharing project learning are more likely to emerge organically. This was the case in for two of the centres in EYU4: first, Jodrell Bank Discovery Centre had received a National Heritage Lottery Fund grant, which involved an emphasis on working with communities. More specifically, the centre had been focusing on accessibility as a key element of its new centre (building and associated programming), with a particular emphasis on autistic individuals, as well as working with school groups. EYU4 provided an opportunity to extend and contribute to this work, which is having an impact across the centre, from its website, to its welcome, shows, outreach and café. Second, as part of an Inspiring Science Fund grant, Xplore! had also been extending its community offer, and EYU4 was able to both inform and be informed by that work, resulting in staff being far better skilled at engaging with a range of communities, as well as their centre being more welcoming and inclusive.

Another opportunity for embedding this kind of work is provided by moments when science centres are developing new organisational strategies. For instance, in 2021, Science Oxford

were developing their next five-year plan, which staff hoped would be informed by the experience of EYU4. Indeed, such impact is made more likely by the learning from EYU4:

> 'We can say, "Well, we have found that working with those audiences requires X, Y and Z." And I feel like my team were much more prepared [for a strategy meeting] and realistic but actually, if we had to put our priorities for the centre, it's probably number one – actually reach lots of different audiences and working with them and doing it properly.' (Practitioner, Science Oxford)

Legacy

Although EYU4 has concluded, the impact of the project continues, leaving a lasting legacy on which science centres can continue – and are continuing – to build. The learning from this project, as detailed in previous sections, should not be underestimated. Science centres now know far more about working in partnership with community organisations, co-development, and engaging with individuals and families traditionally excluded from science centres. This understanding is reflected in ongoing practice and is a basis on which centres can continue to build. Science centre practitioners not only know *how* to do the work, but centres know the details of what is required in terms of resource, meaning that any future investments in this kind of work will be more efficiently deployed and represent greater value for money. Additionally, that most science centres were able to involve more practitioners in Phase C means that the practices and partnerships are more likely to be embedded into the work of the centres.

Optimism around the legacy of EYU4 is warranted. Not only are practitioners able to articulate changes they have made, and continue to make, to their practice, but the relationships that have been built in this project form a very solid foundation for future efforts. Interviews were conducted with individuals from fourteen community partners (all but two of those involved in this phase) and each one expressed enthusiasm for continuing to work with their science centre partners:

> 'It just lends itself so well for us to do educational stuff down there… we'll definitely be doing more. And it's just great to be able to do more stuff around science

because, you know, that's a huge thing to sort of try and incorporate that more into people's everyday lives.' (Community partner, Edinburgh)

'Definitely, if we had the opportunity [to work with Science Oxford again] we'd definitely jump at it.' (Community partner, Oxford)

In addition to this active desire on the part of the community partners and the science centres to continue working together, new efforts have begun or were planned at the time of the interview. For example, Jodrell Bank Discovery Centre continues to work with Space4Autism, developing an autism-friendly early opening offer which was piloted in late 2021 and is being further developed, along with other aspects of their centre. S4A additionally expressed a desire that they come again to their social clubs. Plans were also being developed by Techniquest to run workshops over half term with Valleys Kids and ACE Cardiff, as well as becoming more integrated with their regular activities or curriculum 'so that we can join in and be a part of their community' (Practitioner, Techniquest). Xplore! is planning to work with an additional youth group that is run by The Venture, and staff from both The Venture and YourSpace have delivered training to Xplore!, as have staff from Space4Autism (to Jodrell Bank Discovery Centre).

There were also ideas for activity or further projects that could be co-developed. For instance, Dynamic Earth and the Syrian Dads Group would like to create an English-Arabic dictionary of science terms (relevant to STFC science and Dynamic Earth) and an Arabic guide to the science centre and/or for a new gallery about deep sea exploration. Another activity mentioned by a few community partners involved young people working alongside staff in science centres, as a way of extending their learning experience:

'I think it would be useful… if there was some kind of a way of any young people who were really, really keen and really interested, to be able to progress and continue learning in some way. Almost become like a child-mentoring type programme for those who are really keen and maybe even work alongside or just be there alongside one of the staff to just continue to learn more.' (Community partner, Aberdeen)

'If they can volunteer at Jodrell or go on work experience at Jodrell, just opens massive doors for them… we're commissioned by Department of Work and Pensions to do work experience for autistic spectrum adults but they'll always be looking for

> places… If they are into that, that's where we want to put them… having someone work experience with you is very different to having a visit.' (Community partner, Macclesfield)

Another line of work mentioned by several community partners involved science centres training their staff or volunteers to deliver science activities themselves. For example, volunteers from The Venture have incorporated activities initially delivered by Xplore! into their ongoing sessions. Likewise, YourSpace have also adopted sensory-based science activities into their work with autistic young people. Training community organisation staff to deliver science activities would be an excellent way of extending the impact of EYU4, and the work of science centres more broadly. It would further support the engagement of young people and their families with science, while also making the most of science centres' limited resources. It is also noteworthy that this suggestion came from the community partners and suggests that, having seen the activities themselves, and how young people responded, they now feel able to incorporate them into their practice. This seems less likely to be effective as an initial step – in the absence of seeing science centre staff do the delivery in the first place, but suggests an important increase in confidence, and perhaps interest in science as well, that could be built upon.

It is significant that community partners not only expressed an eagerness to continue to work with the science centres but also made concrete suggestions for activities and ways forward. This suggests that many things are in place for moving forward the partnerships, which would further extend the impact of the programme. Moreover, not only were specific ideas generated but further activity was either planned or taking place prior to the end of the project. For example, Cambridge Science Centre has continued to run an afterschool STEM club with NCCP, continuing the engagement with some children and also expanding to include some who had not participated in the EYU4 activity. They also ultimately hope to train NCCP volunteers to run the clubs, supported by kit and further support from CSC. In addition, they are beginning to develop further funding proposals together. The collaboration between Dynamic Earth and the Resettlement Programme run by City of Edinburgh Council has also led to new activity, with Dynamic Earth providing a tour for 70 Afghan adults and children.

All of this activity, learning, relationship-building and engagement must, however, be set in the context of the harsh reality of funding. The development and delivery of these sessions was funded by STFC who committed resource required to meaningfully engage with more under-served audiences and encourage their participation in STFC science. Science centre practitioners were enabled to work equitably and in partnership with their local communities. However, in the words of one science centre practitioner, 'if you can demonstrate profitability, it's much easier to make the case.' That is, depending on the business model of a science centre and where their core funding is coming from, money to support this kind of activity can be very rare indeed and re-allocating existing funding or cutting expenses can sometimes only go so far: 'You can reduce expenditure and put it into community outreach but if then you lose your income it isn't going to work'. The situation is compounded by the fact that this sort of work with marginalised groups, by definition, is unlikely to act as a generator of income – budgets are painfully tight for families from marginalised communities and the organisations that serve them. That said, some of the participating science centres are looking for funding for the staff posts that would enable them to continue with this activity and there is also the possibility of working with community partners to seek new opportunities for funding. Additionally, the relationships developed with community partners in EYU4 provide a good starting point for joint bids for activity, which may also be eligible for funding streams that the science centres alone might not qualify for.

Despite the challenges of funding, and indeed, linked to the possibility of joint bids or efforts, there seems to be a growing appetite for the idea of a science centre being a resource for its community, or communities:

> 'We need to look at having a different offering that makes the families there feel like the centre is their space… maybe offering them space to do some of their own projects in…' (Practitioner, Dynamic Earth).

Progress towards science centres becoming community resources could build on learning from EYU4 about working in partnership – this approach and commitment to equitable partnership sits at the heart of being a community resource and working in tandem with

their communities is the only way for science centres to achieve this aim. Moreover, this aspiration to be a community resource is not limited to science centres participating in this project – it is increasingly accepted as necessary for the field's survival. As identified in the Science and Discovery Centre Futures: Missions and Opportunities report (The Liminal Space, 2021), science centres must be 'able to listen, respond and adapt to the needs of the communities around them in order to become hubs for civic life'.

This vision was perhaps most powerfully articulated by the community outreach officer from Techniquest:

> 'My pie in the sky, big dream would be we can help them out by providing stuff, or people from Techniquest go there and do something, they could come here and do stuff, so we have this continuous group relationship with them that we can then reach out further into the local community with stuff… it would be turning Techniquest into another basically community hub… it would be great to turn Techniquest into something like that, where it's a continual back and forth with the community of, here's the next big thing we want to improve in it, let's bring Techniquest to see what else can be done to be part of this process and provide us with resources, with space, with ideas … not just stuff for kids but for all members of the community.' (Practitioner, Techniquest)

While this is a tremendous aim which reflects a sea change in the field, learnings from EYU4 provide robust evidence of steps that could bring centres closer to achieving it.

Moving forward

Learning from EYU4 leads to recommendations for how future programmes with a similar mission might be structured which would, in turn, support further progress of the field towards inclusive structures and practices. That is, the recommendations below would help science centres enact the learning described in earlier in this report, impacting on the development and delivery of ongoing – and new – efforts to engage marginalised communities with STFC science.

- **Extend the timeline for activity.** Developing partnerships takes time, although (as in the case of CSC-NCCP for instance) it is not always consistently intensive work over time. This will support science centres in being flexible and responsive to their community partners, and enable the relationships themselves to flourish, which will lead to stronger and more meaningful engagement. Having a more extensive timeline would also allow for a more in-depth kick-off meeting (or series of meetings) that could include a focus on evaluation. This would allow for time to discuss not only what outcomes the community partner is hoping for but how they might be captured.

- **Think creatively about family involvement.** While research shows that families are key influencers on young people's aspirations and identity, and that science capital is rooted in the family, research also highlights that as young people move into the pre-teen and teen years, the activities in which families engage shift. Moreover, families from marginalised communities (those whom EYU4 – and the Wonder initiative – aimed to engage) face serious constraints on their time. Consequently, while encouraging science centres to engage with families is admirable, the form this takes needs to be flexible. Encouragingly, some of the community partners, unprompted, reported parents of their young people telling them that their children had been discussing the EYU4 sessions at home. In future projects such discussions could be scaffolded directly – perhaps by providing questions for young people to ask their families at home, thus extending the learning from the sessions and the experience of EYU4 suggests that this could be a successful strategy.

- **Flexibility around numbers of engagements.** Although research highlights that multiple engagements are more likely to lead to impact than one-off experiences (M. Archer et al., 2021), science centres and funders need to be open to what will work best for the communities with whom they are engaging. In some cases, this may be a one-off session, but these should be conceptualised and developed as stepping stones – a good way of getting to know an organisation and its users. In this instance, a 'one-off' is not really a 'one-off' but rather a foundation for future engagements, which need to be allowed to emerge with time. In addition, looking

across EYU4, three engagements seems to be a bit of a 'sweet spot' – it may not be as impactful as six, but it does seem to be sufficient to build rapport with community organisations and individuals, and to support learning and engagement, and it seems to fit better with the capacity and schedules of some community partners and families.

- **Support science centre agency.** At the outset of EYU4, there was a concern that science centres would work with the 'usual suspects' and thus not make progress towards the development of new relationships and practices. However, even when working with familiar partners, the activity was often new – and was certainly aligned with the goals of the programme. Likewise, in order to be maximally responsive to the needs and interests of the community organisations, flexibility in how the overall aims of the project were met and in how the funding was deployed was key: 'It's been so lovely to have that autonomy and flexibility on the funding because we've really been able to provide exactly what [community partner] needed' (Practitioner, Science Oxford). Over the course of the project, ASDC moved away from being prescriptive to being supportive, demonstrating flexibility around activity, metrics, engagements and evaluation, whilst still ensuring that work fell within the overarching project aims. Additionally, trusting the science centres to choose their community partners can enable the development of partnerships with organisations that fit in with wider trajectories and aims of both (the partner and the science centre), which further increases the likelihood of ongoing engagement and impact.

- **Infrastructure support and capacity building.** In this work, **support from ASDC** is vital. It has a key role to play in making the case to continue to make the case to senior management for this way of working and embedding it in the field. In doing so in this project, cross-departmental meetings, which were driven by ASDC, were helpful, including their provision of external facilitators. Another important contribution from ASDC to this work concerns their capacity to encourage the sharing of practice among those developing and delivering the project by bringing them together in person, as well as remotely. The training academies were

invaluable and will be even stronger when they can go further in tailoring to individual levels of experience in the field, especially as the involvement of practitioners outside of management level was so central. This also helped develop a network of practitioners, committed this kind of work and learning together in a supportive environment:

'Being with everyone, talking about their difficulties and the issues that they'd had and the things that they had done that worked really well, we thought 'oh, yes, we can do that'. That was really nice, and useful…' (Practitioner, Jodrell Bank Discovery Centre)

This sharing of learning also ensures that future investments in such work are used as efficiently and effectively as possible and there is clearly a role for ASDC in coordinating and leading bids to continue this effort, which is often beyond the capacity of individual centres. Building on this, ASDC is also well-positioned to draw on the learning across the projects, and particularly the expertise of community partners, to identify potential new funding streams, such as some which may be available locally or via national strategies such as levelling up, which this kind of work might be eligible for.

ASDC's facilitation of flexible use of funding when necessary (e.g. for staff time, rather than kit) was another vital support for the project, enabling science centres to be more responsive to their community partners. Finally, and as recognised by the Science and Discovery Centre Futures report (The Liminal Space, 2021), ASDC has a critical role acting as an advocate for this practice to the field more widely, including funders. Programmes such as EYU4 – involving a number of centres – are also helpful in advocating for this kind of work, as pulling them together under one umbrella is not only useful for learning but also for demonstrating that efforts and successes of one centre are not an anomaly.

It is clear that EYU4 has provided a solid foundation – or springboard – to advance inclusive practice in science centres, working in partnership with community organisations towards the vision for the field articulated in the Liminal Space report (2021). Due to the substantial level of learning from this programme, continued investment would represent value for

money, especially if deeper impact with these audiences is desired. Science centres would be able to build on the relationships developed in this programme– as well as knowledge of how to initiate and grow relationships to reach out further, to create meaningful and sustained engagement with STFC science and lead to lasting impact for individuals from marginalised communities.

There are further examples of what this vision of inclusive and equitable informal science education/science communication can look like, both from the UK and, especially, abroad. One programme, Tech Tales, supported Native American families to use technology/robotics to construct dioramas that communicated family stories that were consequential to them, positioning them as agents and experts and valuing their cultures and funds of knowledge (Tzou et al., 2019). Another example comes from an after-school science programme in northern California, the Studio, in which Latinx community educators engage in pedagogical strategies that serve to 'reorganize historically marginalized young peoples' relationship to science and engineering' (Shea & Sandoval, 2020, p 29). Being situated and grounded in its community, the educators are able to enact caring and affirming practices which, in turn, support young people to engage deeply with science. This programme is also part of the Community Science Workshop Network (https://www.cswnetwork.org), exemplifying the way in which spaces embedded within their communities, working together, can further support equitable and agentic STEM engagement.

Such programmes are not only valuable in and of themselves, but if situated within science centres, can serve as a powerful means of catalysing and supporting institutional change. For example, the Kitty Anderson Youth Science Center, located within the Science Museum of Minnesota, not only exemplifies equitable science engagement, working with young people to challenge dominant narratives about science and 'fostering STEM skills, knowledges, and identities as tools in the service of social justice and community wholeness, connection, and healing' (McManimon, Her, & Adamji, 2019) but also is a key part of broader efforts within SMM to become a more just and equitable organisation. It is also noteworthy that these three programmes – and many others – very much work with people 'where they are at'. While Tech Tales was able to work with families, the other two

work with youth, as do many such programmes in the US, acknowledging that for many families from marginalised communities, extended engagement involving parents (or whole families) is simply unfeasible. Working with youth also simultaneously recognises and values what these young people bring, supporting them to make a difference in their own lives and those of their families and communities.

While the above examples are situated in particular programmes and organisations, they are aligned with wider movements towards equity. One promising area of development is 'community-driven science' (Lief, 2022), in which scientists and communities share power/ownership in research. More specifically, community-driven science projects emerge in response to specific community concerns (e.g. around environmental or health issues). The questions are determined by the community, who are matched with scientists who can provide the technological/research expertise to gather relevant data, which is then utilised for civic purposes (e.g. to argue for regulations on emissions). One critical element of all of these is the overarching aim of supporting young people, families and communities to leverage science towards their own ends, both personal and communal.

It is important to note here the key role of networks and the broader ecosystem in supporting this trajectory towards equity and inclusion in the field. For example, in the US, CAISE (Center for the Advancement of Informal Science Education) which is funded by the NSF and operates under the umbrella of ASTC, has been leading efforts in this arena for over a decade. In 2018 it published the 'Broadening Perspectives on Broadening Participation' toolkit, a suite of professional development tools created by CAISE's Broadening Participation Task Force. This toolkit aims to support science centres in developing goals, strategies and priorities in order to support this work. More recently ASTC has launched its Community Science Initiative, a set of interconnected projects, programs, and partnerships that are building capacity among science centres and museums to do community science. It has the goal of working across its member organisations to support them in leveraging community science approaches in order to respond to social issues and concerns and has developed a collection of resources – a framework, case studies and other toolkits – to aid its members in this endeavour (https://communityscience.astc.org). It aims to build capacity

and enable its members to act as boundary organisations, linking communities and scientists in activity towards equitable ends.

In the UK, efforts towards equity have also been embraced in the cultural sector by the Museums Association, with a particular emphasis on decolonisation as a key aspect of museums becoming more inclusive institutions (c.f. Supporting Decolonisation in Museums, Museums Association, 2021). Likewise, in the informal science sector, ASDC is exceptionally well placed to springboard from EYU4 to progress these efforts. It is clear both from EYU4 as well as multiple other programmes that organisational change is imperative to support equitable practice – that practitioners developing and delivering programmes, while critical, can only do so much without institutional support. For instance, years of efforts at the Science Museum of Minnesota to engage their communities have highlighted that organisational-level change towards equity is critical to this process and that such change must be intentional, requiring time and resource (Jones-Rizzi et al., 2021). Such transformations also require the support of wider infrastructures and ecosystems, including funders, to become embedded and sustainable. One particularly promising example of this comes from the (US) National Science Foundation's AISL (Advancing Informal STEM Learning) programme, which has invited proposals for an AISL Equity Resource Center which has the specific remit 'to advance equity within the informal STEM learning field through community building; supporting and extending infrastructures; technical assistance; and communications' (https://www.nsf.gov/pubs/2022/nsf22556/nsf22556.htm). Such an investment in equity promises to draw together and on the progress that has been made in the field and 'supercharge' diversity, equity, access and inclusion into the future. It also makes abundantly clear the value the largest US funder of STEM learning places on equity and signals to organisations across the field that equity must be a priority in their work.

In the UK, EYU4 represents a giant leap in the progression of science centres here toward being equitable, inclusive spaces/organisations where individuals and families from a range of communities and backgrounds can feel welcome and participate in science on their terms, being supported to take action on issues that matter to them. Critically, this will involve not only the physical spaces of the science centres but also support for practitioners to go out into communities and work with people there.

ASDC has supported science centres to work equitably with participants traditionally underserved and marginalised by many public engagement and science communication offers and they have risen to the challenge. The impacts of EYU4 have been wide-reaching for the science centre practitioners involved and their partnerships, as well as for the participating young people and families who have experienced greater confidence in their ability to participate in science, increased pride and agency, broadened horizons and a greater sense of belonging in science spaces. There is an ambition among science centres, which could also serve as a model or vision for the wider field, to build upon the place-based knowledge and partnerships developed in this project to become true community resources – meaningful in their regions for those who do not feel that science currently is relevant or something 'for them' and pushing towards a far more equitable STEM landscape for the future.