

# Evaluation of the Polar Explorer Programme

For STEM Learning

December 2019



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Merchant House,  
11a Piccadilly,  
York, YO1 9WB.  
01904 632039

[www.qaresearch.co.uk](http://www.qaresearch.co.uk)  
Company registration: 3186539



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Project number:	EDUCT01-8454
Title:	Evaluation of the Polar Explorer Programme
Location:	<u>PEP_evaluation_report_v3_15012019.doc</u>
Date:	January 2020
Report status:	2 <sup>nd</sup> Draft
Approved by:	Michael Fountain
Authors:	Ben Thatcher & Kay Silversides
Comments:	To Ben Thatcher or Kay Silversides
This research has been carried out in compliance with the International standard ISO 20252, (the International Standard for Market and Social research), The Market Research Society's Code of Conduct and UK Data Protection law	

## 1. Executive Summary

This report details the external evaluation of the Polar Explorer Programme (PEP) funded by UK Research and Innovation (UKRI). Over a 3-year period, (2016-2019), the programme used the commissioning, construction, launch and operational role of the polar research vessel 'Sir David Attenborough' as a focal point and context in which to develop and deliver an enrichment programme.

The targeted element of the programme has, over a 3 year period, supported teachers in 500 UK schools for which focused support aimed to help address issues of low achievement, attainment and engagement in STEM subjects, particularly of under-represented groups. Such schools have been able to draw upon the capacity and support of local Polar Ambassadors to engage across the PEP. Teachers have had access to relevant learning resources to boost engagement with PEP and lead to positive student outcomes.

The objectives of the programme were:

- Increased engagement, achievement and STEM literacy of students
- Increase in pupils' knowledge and aspirations towards STEM education and careers
- Improve teaching and learning of science through developing staff STEM subject and career knowledge and pedagogical understanding

### 1.1 Methodology

Qa Research was commissioned to undertake a process and impact evaluation of the Polar Explorer Programme (PEP).

The purposes of the evaluation were to:

- Investigate how successful the programme is at achieving the key aims and objectives
- Assess the level of impact the PEP has had in terms of the teacher, the pupil, the school and the community
- Assess the longer-term impact of schools' engagement in the programme on teachers, pupils and schools
- Assess the efficiency of the project delivery model and provide recommendations on how to improve management, delivery and impact of the programme, especially if adopted for other similar projects or programmes.

The evaluation included the following elements:

- Analysis of existing programme data collected by STEM Learning
- Qualitative telephone interviews with 10 Polar Ambassadors, 20 teachers, 4 programme partners.

## 1.2 Key findings

	AIM	Key Finding
FOR PUPILS	1. Increase enjoyment and engagement in STEM subject lessons and extra-curricular activities	All teachers that responded to the Impact Survey across all three years of the programme (n=246) reported that the PEP had increased pupils' enjoyment of and engagement in STEM subject lessons.
	2. Increase confidence in learning science and in scientific enquiry skills	Nearly half (49%) of teachers felt that the PEP had increased confidence in learning science and in scientific enquiry skills amongst their pupils to a great extent.
	3. Increased appreciation of the importance of STEM skills	Interview evidence shows that PEP has helped teachers to reframe science within lessons with an emphasis on scientific enquiry skills and there are benefits for pupils to be fully involved in this process.
	4. Increase attainment and progression in relevant STEM subjects.	PEP was rated highly in this respect on the impact survey, with 99% of teachers agreeing it had played a role in increased achievement. A fifth (20%) said it had contributed to this outcome to a great extent.
	5. Increase awareness of the importance and relevance of science to society, and the role this plays in relation to helping people live with and adapt to climate change.	Data and interview evidence confirm that the PEP has been successful in increasing pupil awareness of a wider range of scientific careers.
	6. Increase knowledge of the work of the Polar Research Vessel	Teachers have noted in interviews that linking learning to the polar research ship has been influential in helping pupils to understand how science takes place within wider society and not just within textbooks/a classroom

	7. Increase knowledge of career opportunities available to those who study STEM subjects	62% of pupils who took part in PEP responded positively to the statement 'I know many jobs which need science, maths and engineering skills', compared with 48% before PEP.
	8. Increase STEM career aspirations	More than a quarter (28%) of teachers stated PEP had increased STEM career aspiration 'to a great extent'.
FOR TEACHERS	9. Increase confidence in the quality of science teaching in schools	All responding teachers in the impact survey (n=246) said that participating in the programme had increased their confidence in teaching STEM subjects (39% to a great extent).
	10. Enhance subject and pedagogical knowledge	Qualitative feedback from teachers suggests that the programme has been beneficial in increasing their knowledge of STEM subjects, and specifically polar and climate issues.
	11. Encourage sharing of info and resources	Some teachers interviewed explained that PEP has been rolled out across a number of, or all, years of the school with, in some cases, all school teaching and TA staff attending training on the programme and its resources.
	12. Increase access and use of high-quality resources for enrichment activities	All teachers responding to the impact survey (n=246) said that the PEP had increased their ability to access high quality learning materials, with over half (54%) saying that this was to a great extent.
	13. Increase knowledge of STEM careers and how to embed it curriculum teaching	Most teachers found it relatively straightforward to link the PEP with the curriculum.

- It is evident from survey data across all years of the programme and from qualitative interview data that the PEP has increased pupils' enjoyment of and engagement in STEM subject lessons and extra-curricular STEM activity. Teachers have also reported improved attainment in STEM subjects, however it is difficult to attribute these changes solely to the PEP.
- Teachers have also noted increased pupil confidence in relation to learning science and in scientific enquiry skills and related to this some teachers in the qualitative research identified the positive impact of adopting scientific exploration/experimentation on pupil resilience/persistence.
- Data and interview evidence confirm that the PEP has been successful in increasing pupil awareness of a wider range of scientific careers and aspiration to a lesser extent. The breaking down of gender stereotypes and the preconception that science is 'not for everyone' was also noted by teachers within the qualitative research.
- For teachers, the most significant impact appears to have been an increase in confidence derived from improved STEM subject knowledge and an increase in practical science skills enabled by access to resources and support from Polar Ambassadors. In turn, this has enabled teachers to improve the quality of science teaching and raise the profile of STEM subjects.
- It is clear that Polar Ambassadors have played a crucial role in the success of the PEP offering a variety of support around the delivery of practical science, increasing subject knowledge, inspiring and motivating, and advising on curriculum links.
- Overall satisfaction with the PEP has been high with teachers giving consistently good ratings for PEP resources as a crucial element of the programme's success.
- The evidence suggests that the PEP could have a sustained impact with most schools within the qualitative research intending to continue using the PEP materials. Impact survey data also indicates that some schools have built upon the success of the programme by supporting pupils to access the CREST Superstar award and by engaging with the STEM Ambassador programme, local Science Learning Partnerships and other CPD initiatives.
- Process evaluation of the PEP found that overall the programme had been well managed and effective in supporting schools. However, some suggestions for improvement were made around timings and improvements to the online forum.

### 1.3 Recommendations

There are several recommendations that would apply if the PEP was to be rolled out again, or to inform the development and roll-out of similar programmes by STEM Learning.

- Although most teachers were able to link the PEP with the curriculum this was not the case for all and in some cases the educationalist Polar Ambassadors were able to offer valuable guidance in this respect. STEM Learning should consider how best to support schools to make the curriculum links and offer enhanced guidance/support for those that need it.
- Feedback from schools suggests that lead in times for programmes such as this should be generous and allow time for schools to integrate activities into their planning and schedule teacher CPD sessions.
- Use of the online forum/community was variable and some teachers found it difficult to use. Consideration should be given to gathering further feedback from teachers on how this could be enhanced.
- Polar Ambassadors engaged with the PEP during the whole programme have gained valuable experience in what works in terms of communicating and liaising with schools. Consider ways in which this best practice could be shared with new ambassadors.
- The combination of high quality resources and the input of Polar Ambassadors appears to have been at the core of the PEP's success, through enhancing teacher confidence and equipping them with the subject knowledge and practical skills to enhance the quality of their teaching, with likely positive impacts on pupil engagement and attainment. . Similar programmes in the future should focus on these key elements.
- Future promotion of similar programmes should consider how best to communicate the potential benefits to schools in terms of helping them to meet development priorities in science/other STEM subjects or as part of a wider school improvement plan.
- Consider rolling out the PEP again once the research vessel begins its work in full.

## 2. Introduction

The Polar Explorer Programme (PEP) aimed to engage young people in science, enable them to understand the scientific process and enhance their understanding of STEM (science, technology, engineering and maths) concepts. The programme used the commissioning, construction, launch and operational role of the polar research vessel 'Sir David Attenborough' as a focal point and context in which to develop and deliver an enrichment programme across the UK.

The targeted element of the programme has, over a 3 year period, supported teachers in 500 schools for which focused support aimed to help address issues of low achievement, attainment and engagement in STEM subjects, particularly of under-represented groups. Such schools have been able to draw upon the capacity and support of local Polar Ambassadors to engage across the PEP. Teachers have access to relevant learning resources to boost engagement with PEP and lead to positive student outcomes.

The objectives of the programme were:

- Increased engagement, achievement and STEM literacy of students
- Increase in pupils' knowledge and aspirations towards STEM education and careers
- Improve teaching and learning of science through developing staff STEM subject and career knowledge and pedagogical understanding

Funded by UK Research and Innovation (UKRI), the PEP sought to capitalise on the public interest generated by the commission of the new polar research vessel, 'Sir David Attenborough', due to be launched in 2019. The programme sought to increase awareness and understanding of the importance and relevance of STEM subjects to UK society, culture and the economy. It aimed to raise awareness of the many career opportunities for young people who attain knowledge and skills in STEM subjects.

All schools across the UK were encouraged to engage with the PEP leading to increased awareness and interest. In addition, a more targeted element of the programme supported teachers in schools for which more focused support could help address issues of low achievement, attainment and engagement in STEM subjects, particularly of under-represented groups. Such schools were able to draw upon the capacity and support of local Polar Ambassadors for a period of one year. The PEP aimed to enable better access to relevant learning resources, particularly for those teachers with no science background, and aimed to boost engagement with PEP and lead to positive student outcomes.

The programme commenced with a regional roll-out to 100 primary schools in October 2016 in the 'Northern Powerhouse' regions of the North West, Yorkshire and the Humber, Derbyshire, and the North East, aimed primarily at schools with low attainment in STEM subjects (using National KS2 pupil data record), with an additional 400 schools across the UK joining the programme in 2017 and 2018.

Interim, year-end evaluations of the programme, carried out by STEM Learning, have shown it to be high quality and impactful, with evidence to show that the programme has met or will meet its objectives outlined below:

For pupils:

1. Increase enjoyment and engagement in STEM subject lessons and extra-curricular activities
2. Increase confidence in learning science and in scientific enquiry skills
3. Increased appreciation of the importance of STEM skills
4. Increase attainment and progression in relevant STEM subjects
5. Increase awareness of the importance and relevance of science to society, and the role this plays in relation to helping people live with and adapt to climate change
6. Increase knowledge of the work of the Polar Research Vessel
7. Increase knowledge of career opportunities available to those who study STEM subjects
8. Increase STEM career aspirations

For teachers:

9. Increase confidence in the quality of science teaching in schools
10. Enhance subject and pedagogical knowledge
11. Encourage sharing of info and resources
12. Increase access and use of high-quality resources for enrichment activities
13. Increase knowledge of STEM careers and how to embed it curriculum teaching

The programme aimed to achieve this by providing teachers with:

- The dedicated support of a Polar Ambassador (recruited and trained by STEM Learning). Polar Ambassadors are all STEM Ambassadors and are a mix of educationalists and STEM Industry professionals. Polar Ambassadors provide teacher CPD, guidance and support in organising classroom and whole school activities, arranging visits to sites of interest, and signposting to other opportunities for STEM Ambassador to engage with the schools.
- A Polar Explorer activity booklet comprising of a collection of curated resources (grouped into the PEP themes of Engineering, Climate change, Animals, food chains and adaptation, Exploration, and Oceans).
- A Polar Explorer Programme school 'starter kit'. As well as the Activity booklet, the starter box contained a range of physical artefacts and items for schools to use as part of their activities and to create classroom displays.
- A dedicated Polar Explorer Programme area on the STEM Learning website. The Polar Explorer webpages provided a portfolio of support for schools – primary, secondary and FE – as well as information and resources for those interested in polar science. A range of resources, tools and guidance (catering for all age ranges) was made available for teachers, STEM Ambassadors, outreach organisations and other interested parties to freely use with their students, youth groups and wider network.
- An online community discussion group where engaged schools are encouraged to share ideas, experiences, and resources.

- A range of data collection and reporting tools for schools to monitor impact of the programme

### 3. Aims and objectives

Qa Research was commissioned to undertake a process and impact evaluation of the Polar Explorer Programme (PEP), which was delivered by STEM Learning between the 2016/17 and 2018/19 academic years.

The purposes of the evaluation were to:

- Investigate how successful the programme is at achieving the key aims and objectives
- Assess the level of impact the PEP has had in terms of the teacher, the pupil, the school and the community
- Assess the longer-term impact of schools' engagement in the programme on teachers, pupils and schools
- Assess the efficiency of the project delivery model and provide recommendations on how to improve management, delivery and impact of the programme, especially if adopted for other similar projects or programmes.

This evaluation sought to understand the success of the PEP in effecting the specific teacher and pupil outcomes outlined in section one. In addition, STEM Learning wanted to understand how effective their delivery of the PEP had been. The process evaluation wished to understand the effectiveness of the Polar Ambassador network, the physical resources that were provided to schools enrolled onto the programme, the online resources that were made available to supplement physical resources (including forums for both PAs and teachers), and STEM's central coordination of the programme. It was hoped that the evaluation would identify factors critical to the programme's success, as well as those areas that stood to be improved for the roll-out of future similar programmes.

To facilitate the evaluation, STEM Learning gave Qa Research access to programme documentation and monitoring information, the resources that were available as part of the PEP, and introduced Qa researchers to; teachers involved in all 3 years of the PEP, PAs that had supported schools during the life of the programme, and national partners involved in PEP's design and delivery.

## **4. Methodology**

### **4.1 Analysis of existing programme data**

STEM Learning collected monitoring and evaluation data throughout the life of the PEP and shared these data with Qa for inclusion in the evaluation. These data sources included; outputs from an impact survey completed by teachers at the beginning and end of their involvement in the programme as well as data collated and reported by teachers on behalf of their pupils. The outputs from analyses run on these data sources are presented throughout the report.

### **4.2 Collection of qualitative data**

As well as analysing existing data collected by STEM Learning, the evaluation included a significant element of qualitative data collection. In-depth telephone interviews were conducted with the below PEP programme participants between September and November 2019. Broadly, the aims of these interviews were to corroborate the quantitative data captured throughout the programme's life and to understand in more detail some of the impacts that monitoring and evaluation data were suggesting the PEP was having. Further, this qualitative data would allow us to understand the effectiveness of the PEP's delivery mechanisms.

#### **10 Polar Ambassadors**

Aims of these interviews were to:

- Gather feedback on their interaction with PEP teachers in schools;
- Collect information on any impacts they have observed whilst working with teachers or in schools;
- Seek feedback on physical and online resources;
- Explore reasons for varying degrees of success in the implementation of PEP in different schools;
- Request signposting to schools where the PEP has been rolled out with differing levels of success (this will be used to recruit teacher participants).

#### **20 Teachers**

Aims of these interviews were to:

- Explore teachers' perceptions of the Polar Ambassadors and their value in the PEP;
- Understand which physical resources were most beneficial and why;
- Gather feedback on the online elements of the PEP (PEP area of STEM Learning's website and online discussion group);
- Explore the impact of the PEP on the teachers' pupils;
- Actively seek suggestions for future improvements to the programme.

#### **4 National programme partners**

Aims of these interviews were to:

- Understand what aspects of the PEP worked well from a partner perspective

- Experience of working in partnership with STEM Learning/any suggestions for improvement
- Explore the benefits to the partner organisations from working with STEM Learning and vice versa.

Qa selected the PAs and teachers for interview from a list of all PAs and schools involved in the PEP throughout its 3 years. Polar Ambassadors were chosen based on their location in the UK, the number of schools they had supported, and the years in which they were active in the programme. Teachers were chosen to represent a broad range of schools on factors including; the size of the school (as defined by the number of pupils), geographic location, whether the school was urban or rural and the year in which they were involved in the programme. Once PAs and schools had been shortlisted for involvement in the evaluation, contact details were sought via STEM Learning. Where PAs and school teachers consented to take part in the evaluation, their contact details were then shared with Qa.

Qa's recruitment staff then liaised with prospective participants via both telephone and email to secure appointment times for interview by one of Qa's experienced qualitative researchers. National programme partners' staff members' contact details were provided to Qa and interviews were scheduled by email. All depth interviews were conducted by two qualitative researchers from Qa's Social Insight and Evaluation (SIE) team. No incentives were used in the recruitment process, as it was considered that all participant groups would be highly engaged in the evaluation process given their involvement in the PEP.

### **4.3 Qualitative analysis**

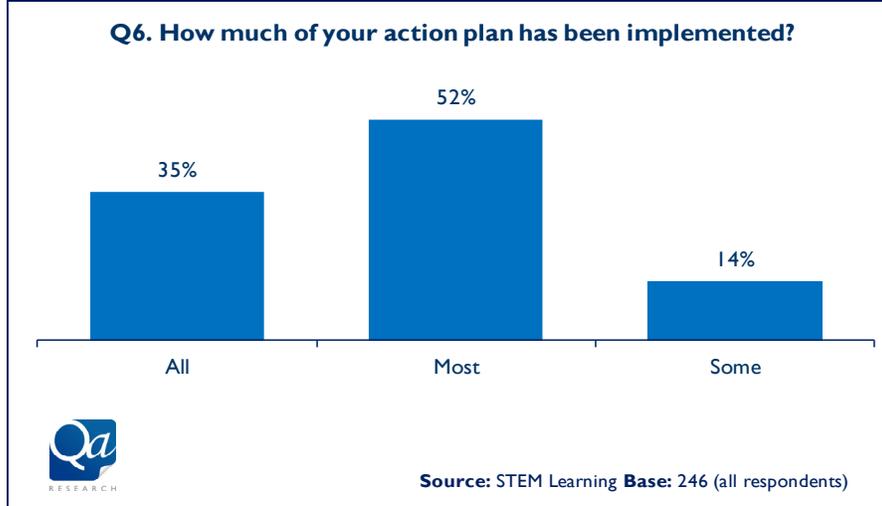
Following completion of all interviews, Qa analysed the resulting qualitative data from these three groups using a thematic framework approach. This involved listening back to recordings of telephone interviews, thematically coding the data, and transcribing any quotations that illustrated findings.

Areas of consensus were recorded, as well as which themes recurred frequently. Those points of view which were more unusual or where there was disagreement were also noted.

## 5. Implementation of the Polar Explorer Programme

As illustrated below, over half (52%) of participating schools implemented most of their action plan.

**Figure 1**



Schools adopted different ways to achieve their outcomes as shown below. The majority of schools selected and used resources within classes or planned lessons which used the PEP resources.

**Table 1**

<b>Q7. Please select the ways in which you achieved your identified outcomes?</b>	<b>Count</b>	<b>Percentage</b>
Selected and used appropriate resources for use with classes within your school	226	92%
Planned lessons which use the Polar Explorer Programme resources	225	91%
Polar Ambassador led activities with children	217	88%
Explored the Polar Explorer Programme resources page	199	81%
Held a whole school event linked to the Polar Explorer Programme	149	61%
Invited a STEM Ambassador to deliver an assembly on a Polar Explorer theme	132	54%
Engaged with the Polar Explorer online community group	73	30%
Other	56	23%
Class/school visit to a boat building yard or other Polar Explorer related activity	30	12%

**Base:246**

## 6. The impact of the Polar Explorer Programme

### 6.1 On Pupils

#### Pupil engagement in and enjoyment of the PEP and STEM subjects

The PEP has, without question, increased pupil access to hands on, practical STEM learning. Before taking part in the programme, only half of pupils surveyed (50%, n = 11,358) claimed to do 'a lot of practical activities around science'. **After participating in the PEP, this proportion increased to two thirds (66%; n = 11,001)**

+16%

Increase in pupil access to hands-on STEM learning.

Without exception, teachers that responded to the Impact Survey across all three years of the programme (n=246) reported that the PEP had increased pupils' enjoyment of and engagement in STEM subject lessons, with only one teacher rating PEP's contribution as 'very little'. Conversely, 70% said that the PEP contributed to this outcome 'to a great extent'.

Teachers were also asked to report the contribution the PEP had to increasing pupils' enjoyment in extra-curricular STEM activity; 91% agreed that it had, with 29% this time saying it contributed to a great extent.

Data collected by teachers from their pupils depict an increase in science enjoyment, as well as the increased exposure to practical STEM learning outlined above. Before being involved in the PEP, 68% of pupils (n = 11.337) said they **enjoyed learning about scientific exploration, new discoveries, and inventions, with 72% of children (n = 11,101) saying they enjoyed this after being involved in the programme.**

+4%

Increase in pupil enjoyment of science after PEP.

Teacher feedback from depth interviews also suggests that pupils have been very engaged with the PEP and many have commented on increased enthusiasm for science following involvement with the programme. In some cases, this engagement has meant better behaviour in the classroom for some schools where this has historically been a challenge.

*"Certainly, an immediate impact, they were talking about it very highly; that it was exciting, engaging, we had a talk afterwards and they really, really enjoyed the sessions. Other children round the school were looking in the classroom as well because it was really exciting." (Teacher 15)*

*"There is more of a practical approach to teaching science now. Some of our pupils have some challenging behaviour but in lessons pupils seem more engaged and behaviour is better." (Teacher 20)*

From the perspective of teachers, one of the key benefits of the programme has been an increase in the use of practical activities within science lessons, which have improved pupil engagement and motivation. Further, according to impact survey data, just under half (49%) of teachers felt that the PEP had increased confidence in learning science and in scientific enquiry skills amongst their pupils to a great extent. Data collected by teachers from their pupils using the PEP 'pupil survey' demonstrate that more children agreed that they do a lot of practical science activities at school following their involvement in the PEP when contrasted to pre-PEP science lessons (66% cf. 50% respectively). Linking learning to the polar research ship has been influential in helping pupils to understand how science takes place within wider society and not just within textbooks/a classroom, and the media attention also played a useful role.

*"Children have become more engaged had more enthusiasm for those subjects because a context was provided" (Teacher 3)*

*"Anything that's got media presence that the kids are going to see outside of school as well, that generally tends to spark a bit of interest in most of them." (Teacher 5)*

Teachers and Polar Ambassadors have spoken about how some pupils have recalled/retained information that they learnt during the programme several months/years later. This illustrates the long-term impact of the PEP on pupil engagement, and it is hoped that this recall and linking back to experiences will continue as the pupil progresses through the education system.

*"You'd like to think that your impact of the things you do is retained and becomes part of their long-term memory. Generally, we find that children do relate back to things that they've done. In terms of moving forward, into a few years' time when they perhaps have options of choosing science subjects at secondary school, I'd like to think that science teaching that's done in a very engaging way and practical way, most the children seem to enjoy it. I'd definitely say (the PEP) it had helped in that respect." (Teacher 2)*

Teachers valued the fact that the resources were linked to something 'real' and felt that this made an important contribution to pupil engagement.

*"We managed to get a couple of polar explorers to come in and talk to us about their experiences of arctic exploration (...) we had a doctor who had worked for a group of doctors who go out to the Antarctic. We had Geoff Summers who actually recreated Scott's journey across the Antarctic and he brought in the clothes that Scott would have worn; the children got the chance to try those on. He did slides; he spent an hour talking to them about his expedition. That really brought it to life for the*

*children. It inspired them. And we invited the parents as well. We had about 20 parents.” (Teacher 2)*

### **Pupil achievement in STEM subjects**

During interviews, teachers found it difficult to comment on the extent to which the programme may have influenced achievement in STEM subjects, as this can be difficult to measure/attribute to the PEP alone amongst other school interventions. However, the PEP was rated highly in this respect on the impact survey, with 99% of teachers agreeing it had played a role in increased achievement. A fifth (20%) said it had contributed to this outcome to a great extent.

An increase in enthusiasm and engagement in scientific subjects will contribute to STEM achievement. Two schools within the qualitative sample did specifically engage with the programme as part of a range of measures designed to improve the school and its teaching following underperformance identified by an Ofsted inspection. Teachers from these schools commented that the PEP played an important role in enhancing the quality of their science teaching. And some were able to observe specific positive changes such as an enriched pupil vocabulary following involvement with the PEP, as well as an increase in parental engagement. These factors were acknowledged as important in helping the schools to make progress towards developing the positive learning behaviours that helped to demonstrate that they were making improvements.

*“We had a whole school project to make plastic bottle igloos...parents came into some of the lessons to see the scientific learning...some parents were engineers, artists. The collaboration and engagement were great, the language and vocabulary was brilliant – we realised we had turned a corner in developing the learning behaviours we were aiming for.” (Teacher 4)*

Another teacher noted that the PEP had helped pupils to build their resilience and helped them learn to adapt when things don't go to plan.

*“We find that sometimes children don't have much resilience/perseverance, with the science case of trial and error they got that sense that it was ok to fail and adapt....it gave them a great sense of achievement.” (Teacher 9)*

### **STEM career awareness, aspiration and stereotypes**

Impact survey data, pupil data and qualitative feedback suggest that there is an increased awareness of the range of scientific careers available as a result of the programme. With the exception of just one throughout the 3 years of the PEP, all teachers responding to the impact survey (n=246) told us that the PEP had increased this awareness, with over a third (37%) saying that this was 'to a great extent'. In their survey responses, some teachers were also confident that the programme had increased STEM career aspiration, with more than a quarter (28%) stating PEP had increased aspiration 'to a great extent'.

Pupil data, too, paint a picture of increased awareness of STEM career options thanks to the PEP. Pre-programme measures suggest that less than half of surveyed pupils (48%; n = 11,343) respond positively to the statement '**I know many jobs which need science, maths and engineering skills**'. **After involvement with the PEP, this increased to almost**

**two thirds (62%; n = 11,064).** In addition to an increased awareness of STEM careers following participation in the programme, pupils also report an increased aspiration to follow a STEM career path. At baseline, a little over a third of pupils (35%; n = 11,243) express a desire to fulfil a career in technology or engineering. After the programme, however, this has increased to over two fifths (43%, n = 10,973).

There is also evidence that the PEP has helped to dispel some myths around gender and STEM careers. According to pupil data collected both before and after participation in the programme, the belief that 'jobs in science and technology are mostly for boys' almost halved as a function of the PEP, with 14% of pupils (n = 11,294) agreeing with this statement before taking part in the PEP and only 8% (n = 10,939) agreeing with same after their time on the programme.

One teacher noted during interview that the findings from their follow up pupil survey indicated that fewer pupils perceived that STEM careers were 'for boys'. This school also had a female PA and the teacher interviewed believed this had also had a positive influence on pupil perceptions. Seeing female explorers at Technquest was also noted by this school as beneficial in terms of dispelling gender stereotypes.

Some teachers in schools in deprived areas or more rural/isolated communities engaged with the programme specifically with the aim of 'broadening horizons' and have been pleased with the result. Exposing children to individuals working in scientific professions (Polar Ambassadors and other professional schools have had contact with as part of the PEP) has allowed them to understand that there might be a profession 'out there' that would engage them and that being 'a scientist' was something that they could realistically aspire to

*"For the pupils, it has given them a sense of aspiration; they don't draw scientists now in white coats with big hair. Our scientists now don't all look like Albert Einstein (...) some of them have said to me, 'But, miss, what do I draw? Because scientists can be anybody!'" (Teacher 6)*

This sentiment was reflected in data captured from pupils as part of the PEP evaluation. At baseline, 25% of surveyed pupils (n = 11,324) believed that 'only brainy people are good for working in science and technology'. After taking part in the PEP, this proportion reduced to only 8% (n = 11,041).

In this way, the PEP has been influential in breaking down stereotypes around who can be a scientist by demonstrating that a wide range of people from different backgrounds can be scientists.

## **6.2 On Teachers and Schools**

### **Increased teacher confidence and skills to deliver STEM lessons**

All responding teachers in the impact survey (n=246) said that participating in the programme had increased their confidence in teaching STEM subjects (39% to a great extent). Furthermore, 77% stated that teacher CPD had been 'very important' or 'crucial' to the success of the PEP within their school.

Several teachers interviewed as part of the qualitative sample stated that one of the key reasons for engaging with the PEP was to increase teacher confidence in delivering practical science lessons. Not all teachers were science subject specialists and as such some lacked the confidence to deliver this.

The findings from the qualitative interviews reflect those of the impact survey. Positively, many teachers interviewed did indeed feel that a key benefit for teachers has been an increase in confidence in their own abilities that has resulted from their involvement with the PEP. This impact has been observed by teachers themselves and Polar Ambassadors.

Several teachers spoke about having the necessary subject knowledge but lacking the confidence and skill to deliver practical activities, and as such, they have valued the inspiration that the PEP has provided, particularly through the input of the Polar Ambassadors.

*“Our ambassador was phenomenal, she was in contact all the time, and would always come back to me when I had questions, and she was just so passionate about what she did.” (Teacher, 1)*

*“The hands-on aspect, that was what I wanted it to have an impact on, and it did. We had like a science day where the children went to each class to do the investigations, so the teachers have got the confidence of putting those things on, and children have had the experience of doing them.” (Teacher 8)*

*“She [Polar Ambassador] taught the staff how to use the activities, and I think that was really crucial, because sometimes when you’re looking to do that planning it’s really hard to think ‘what do I need to do here’, but to be able to practically partake in those activities and see how they link in, that had maximum benefit because the teachers were all involved and motivated.” (Teacher 18)*

This is reflected in the impact survey findings where 92% of teachers (n=246) stated that the Polar Ambassador was ‘very important’ or ‘crucial’ to the success of the PEP within their school. Furthermore, 95% of teachers rated the quality of the support provided by their Polar Ambassador as ‘good’ or ‘very good’.

In addition, there was a view amongst some teachers that their school needed a ‘refresh’ in the way science was taught as there was a tendency for it to become ‘squeezed out’ of the curriculum in the pursuit of core Maths and English skills. Findings from the impact survey support the assertion that engaging with the PEP helped to raise the profile/priority of STEM subjects within school – 97% of respondents agreed that PEP had helped with this ‘to some’ or ‘a great’ extent.

97%

agreed that PEP helped raise the profile of STEM subjects in their school.

It is clear that for some teachers/schools involvement with the PEP has led to reflection on the style and quality of science teaching prior to taking part in the programme. Some teachers commenting that as a result they have realised that the quality of science teaching in their school was lacking and the skills learnt via the PEP have enabled them to enhance the way science is taught across the school and try out new approaches.

*“Science had been squeezed out; we were trying to bring proper science teaching back in... staff have a fear of it... if you are not a science specialist.” (Teacher 9)*

*“It definitely makes you think more carefully about how you’re going to deliver the lessons (...) you can become very stale as a teacher when you’re working day in, day out, year in year out in the same year group, so this just freshens everything up and gets teachers thinking (...) this is a different way – I can do this, I can see what the impact is and judge whether I’ll do that again next year.” (Teacher 15)*

The influence of the PEP in terms of teacher motivation is also apparent in the findings from the impact survey where 98% stated that the PEP had helped to increase enthusiasm and motivation for teaching ‘to some’ or ‘a great’ extent.

The adaptation and use of different teaching styles was also noted by Polar Ambassadors.

*“Seeing me teach science in quite an open-ended way, a lot of primary science is taught like a recipe, I would leave things a lot more open...I did tweak lesson plans to allow for that, to let the investigations be more child-led, modelling a different way of teaching primary science.” (Polar Ambassador)*

It is evident that the PEP has helped teachers to reframe science within lessons with an emphasis on scientific enquiry skills and the recognition that science experimentation does not always ‘go right’ first time and that there are benefits for pupils to be fully involved in this process.

In some cases, involvement with the PEP had influenced the way in which schools used technology to widen the learning experience for pupils. For example, one school had found a Skype call with Polar Explorers had really engaged the pupils and this had led to them making more use of Skype within lessons, e.g. to talk to railway engineers. This was particularly useful as the school was located in a rural area and it was not easy to organise/arrange educational visits. Similarly, involvement with the PEP has meant that some schools are now pursuing external links within industry to enhance learning.

*“Linking topics to school trips is something that we have started doing more of since the PEP...learning can be taken outside the classroom.” (Teacher 13)*

For some schools, the decision to take part in the PEP was driven by the need to improve standards following a poor Ofsted inspection, and the qualitative evidence suggests that it played a key role. The PEP was often part of a range of initiatives to raise the quality of teaching across the school.

*"We had a new team in school...the school was a failing school. ...the PEP was the start of the school improvement, it was really pivotal; that excitement, a new way of learning, it wasn't boring it was exciting and relevant." (Teacher 4)*

*"Science was not particularly strong as a subject. We were expecting an Ofsted inspection. We got a 'good' in the inspection and the Polar Explorer was a part of that." (Teacher 6)*

This is reflected in the impact survey findings where 98% of teachers stated that the PEP met school development priorities in science or other STEM subjects 'to some' or 'to a great extent'.

### Increased access to high quality teaching resources

94%

stated that the resources were crucial to the success of PEP in their school.

All teachers responding to the impact survey (n=246) said that the PEP had increased their ability to access high quality learning materials, with over half (54%) saying that this was to a great extent. Similarly, all teachers said that PEP had improved their use of enrichment activities when delivering STEM sessions both within the curriculum and outside of it. Over a third (38%) said that PEP had driven this improvement to a great extent. Moreover, all responding teachers stated that the PEP has increased their confidence in the quality of science teaching; most likely attributable to the quality resources provided by STEM Learning as part of this programme. More than two fifths (44%) believe that the PEP had influenced this perception to a great extent.

Moreover, 94% of the 246 teachers who responded to the impact survey stated that the resources were 'very important' or 'crucial' to the success of the PEP within their school.

It was equally clear from qualitative interview data that teachers have valued the PEP resources and have found them to be of high quality - the hardcopy resource book has been very well received in particular. Others have noted that the online version is more valuable, but it appears that it is the content that has been welcomed.

*"He [PA] brought a book in, which I still have now, which I treasure, because I'm going to be using some of the lessons again this year when we do our Frozen Kingdom (...) it's jam-packed and it's really, really concise, clear and concise and so it's really easy to pick up and cherry pick and deliver those lessons. All the learning in the book is very practical." (Teacher 15)*

Most teachers found it relatively straightforward to link the PEP with the curriculum, however some found it more difficult. In the main this appeared to be due to what they perceived to be the restrictions of the science national curriculum or a lack of time to spend making the links where it was less apparent to them.

*"The science topics we were doing at the time didn't link [to PEP] as easily. Y6 national curriculum is how the heart works, evolution, electricity; I would prefer to go with a project like this (...) but the national curriculum is very prescriptive with how it is and this one-off thing didn't link to our topics, but that didn't matter to me. I fitted them in. I squeezed them in."* (Teacher 10)

Some schools had successfully adapted the resources to link with their national curriculum topics (e.g. Frozen Kingdom) and to the needs of different age groups. It is evident that some of the 'educationalist' Polar Ambassadors have been very supportive in helping teachers to link activities to the curriculum, and in advising how best to deliver practical sessions. One teacher described how they had worked with their PA to link activities to the assessment criteria from the Early Year's Foundation Stage through to Year 6, e.g. 'blubber gloves' activity for the younger children through to more recording/charting of data for Year 6.

One PA working with a school in Northern Ireland worked with the teacher to link the PEP to their 'Titanic' topic by making comparisons with the RSS Attenborough.

*"In Northern Ireland a big topic is Titanic, it was nice to be able to lead them away from that...to something more forward looking...we did comparisons between Titanic and the Attenborough."* (Polar Ambassador)

The breadth of the resources was also acknowledged by teachers, in terms of coverage of a good range of STEM topics and in the potential for their application in other curriculum areas such as geography, history (polar explorers), and design/technology.

*"I like the way that the resources were laid out, there was a clear focus on different aspects of science; there was exploration, the oceans, climate change, the engineering background to it so it covers a lot of the STEM subjects and that's a very good aspect of the project because it's not just focusing on one aspect – it's trying to bring in multiple areas."* (Teacher 2)

*"Fitted in with other areas of curriculum...polar landscape/geography."* (Teacher 12)

Others commented on the volume of resource available and felt that they could have run the PEP for longer than they did due to the amount of content.

*"We spent a good 8-10 weeks on PEP and could have gone longer – it could last a year, there is so much science in it - it's fantastic."* (Teacher 9)

Some teachers offered suggestions on how the resources could be improved, including more consistent guidance on age group suitability and links to curriculum objectives.

*"Guidance on age groups wasn't consistent, some said lower key stage 2 or key stage 1, some had objectives on and some didn't – need an objective linked to national curriculum and target age group."* (Teacher 3)

### **Increased teacher knowledge of STEM subjects and careers**

Qualitative feedback from teachers suggests that the programme has been beneficial in increasing their knowledge of STEM subjects, and specifically polar and climate issues. Impact survey data confirm this, with more than a third (37%) saying that PEP had increased this knowledge to a great extent. Knowledge increases have been reported by interviewed teachers on behalf of colleagues not specialising in STEM, and who have limited understanding of science topics. The teacher notes have been particularly useful for some in this respect.

*“The STEM PEP teaching notes are very detailed (...) I thought they were very good, actually. They gave you a lot of subject knowledge, particularly for people who didn’t have that knowledge, and the resources that went alongside were very easy and user-friendly. (Teacher 2)*

Teachers have commented on the increased knowledge of STEM careers that they have observed amongst their pupils, but this has not been as apparent for them through interview, in terms of a broad development of knowledge. However, there has been learning around the specific roles/tasks described by Polar Ambassadors. This is supported by teacher responses to the impact survey; only just over a quarter (29%) felt that the PEP had influenced their knowledge of STEM careers to a great extent.

## Sharing of knowledge/information/resources

Feedback from teachers and Polar Ambassadors suggests that use of the online forum to share knowledge/information/resources has been fairly low, mainly due to time constraints; however, a couple of teachers (and Polar Ambassadors) did state that they found the forum difficult to use.

*"I found the forum quite hard to use and I'm technology-able." (Teacher, 1)*

*"Unless you actually point them out to the schools, the schools didn't seem to be going online or using the forums. If you gave it them in their hands it was good, they would use it, but if you ask them to go and look and source... they just wouldn't do that. They just haven't got time. With the forums, and uploading content, it just got to the stage where I was like, 'guys email me the photos and I'll put them up for you'." (Polar Ambassador)*

Aside from the online community, teachers noted that there was little opportunity to share knowledge and experience with other schools on the programme, especially schools local to them or within their school partnership or cluster. However, most did not see this as a particular issue. Teachers have advised that it has been difficult to attend PEP 'celebration days' due to time commitments or owing to the travel involved. Suggestions for sharing activity included a 'showcase' web page put together by Ambassadors to illustrate their work in schools.

There has, however, been evidence that the content made available as part of the PEP has been shared within schools, with a number of teacher interviewees explaining that the PEP has been rolled out across a number of, or all, years of the school with, in some cases, all school teaching and TA staff attending training on the programme and its resources.

## Sustainability

It is evident that, for some schools, the PEP has been influential in changing the way science is taught and in raising the profile of science. Many schools were already or were intending to re-use the PEP resources. Data from the impact survey supports this with a third of teachers (n=246) stating that some of their pupils were currently, or due to, work towards the Polar Explorer CREST Superstar award. Furthermore, half (n=133) stated that they had engaged with the STEM Ambassador programme since their involvement with the PEP. Within the qualitative research some teachers noted that they were applying to be a STEM Hub, or had set up a STEM after school club, although there was an acknowledgement from some that it may not be possible to replicate the scale of involvement via the PEP due to a lack of funding.

*"The school has applied to be a STEM Hub...the PEP has engaged the school quite significantly. The link with the community/STEM ambassadors was really good, and we would not have done this without the programme." (Teacher 3)*

*"Following the PEP...we went on to work more with STEM ambassadors, it was hard to find one in our area initially but have since found someone locally." (Teacher 16)*

*"It means that teachers will continue to be more innovative about what they're doing rather than just doing what they've always done." (Teacher 5)*

*"The enthusiasm with the children and the teachers was so high...Some of them will remember for a long time some of the activities they did." (Polar Ambassador)*

However, not all teachers were certain that there would be a sustained impact. This depended to some extent on having a stable staff team and the extent to which the schools felt able to integrate the resources within their curriculum.

*"With something like this it has to be sustained year-on-year, and I honestly don't know if it's going to be. The kids who took part will remember it (...) but it's quite difficult to keep something alive." (Teacher 7)*

*"I don't know about long-lasting impact. I mean, we enjoyed it for the year. I don't know whether it's got a long-lasting impact (...) you might use some elements of it. I think it is quite different to the national curriculum science, that's why." (Teacher 10)*

## 7. Process evaluation of the Polar Explorer Programme

Overall, satisfaction with the PEP was high with 95% of teachers who responded to the impact survey (n=246) stating that the effectiveness of the PEP in supporting their school was 'good' or 'very good'. Moreover, 98% also stated that staff rated the quality of the programme as 'good' or 'very good'. However, the qualitative interviews identified the following elements to improve.

### 7.1 Timing

Some teachers thought it would be useful if there was more lead-in time before the PEP was delivered in schools. Some schools start planning quite early and this made it difficult for them to integrate the PEP activities into a pre-prescribed curriculum and/or to schedule CPD sessions.

*"I do think that, if you're going to do something in an academic year, you need to know about it before the school year begins. You need to know well ahead of time." (Teacher 7)*

*"There were delays getting started, school starts in August in Scotland, but it wasn't until November that it was implemented, also late in getting materials from STEM." (Teacher 14)*

*"The downside was we often got into the schools after they'd planned the lessons' work. Going forward, one of the things that could be changed is you'd need to get into the schools the year prior to administering the programme so they're aware of these activities." (Polar Ambassador)*

*"The issue that we had is that we first met our ambassador in October and then we were expected to start it in the following term, but because we were new to it we didn't exactly know which way it was going to go (...) in hindsight, I would cherry pick what I think would work and then order the resources that I think we would need in good time to make it a success." (Teacher 19)*

In terms of the monitoring data also, some PAs noted that it could be difficult to encourage the schools to complete the impact data returns as they were required at the end of term when there was often a lot of conflicting deadlines.

### 7.2 Resources

Quantitative data from the Impact Survey suggests that all programme resources met with the approval of teachers. Most highly rated was the Polar Explorer Activity Booklet/Teaching Notes. 72% of teachers responding to the impact survey stated that this was 'very good', with a further 23% rating it as good.

Online resources were also highly rated, meeting with approval from 90% of teacher in the impact survey (rating these as good or very good), however, interview data suggested that these were not so popular with some, or may have been underutilised;

*"I looked there for resources, but I didn't get involved in any sort of online thing (...) that's not my thing at all." (Teacher 7)*

Others, however, stated that they preferred using the online resources over the physical assets provided. Some teachers praised the fact that the Activity Booklet (arguably the most lauded of all resources) was made available online as well as having been provided as part of the Starter Box. The online forum for teachers was acknowledged as being valuable, but teachers noted that they struggled to find the time to use this, and certainly to add content to it, despite often being encouraged by PAs;

*"Not as much as we should've done really, because we did some really good things, but I just didn't have the time to do that." (Teacher 2)*

This reflects the findings from the impact survey where only a quarter of teachers rated the online forum as 'very important' or 'crucial' to the success of the programme within their school.

Whilst the PEP Starter Box was rated as good or very good by 81% of responding teachers, only 43% rated it as very good; the lowest rating of all elements of the resources provided. Qualitative data also suggested that teachers were sometimes somewhat underwhelmed by the Starter Box, with one describing it as follows;

*"[a] very big box with not a lot in it." (Teacher 15)*

Some teachers struggled to recall the contents of the Starter Box other than the Activity Booklet/Teacher Notes, suggesting that contents were either not memorable or not particularly useful in delivering activities and investigation as part of the programme.

A small number of teachers commented that they found it difficult to access some of the equipment and consumables needed in the practical exercises, e.g. thermometers, due to lack of funds. Some of the PAs also mentioned that some schools found it difficult to get the resources together or had misunderstood the amount of resources that would be provided under the PEP

*"The expectations regarding resources is still an issue even now (...) if you're saying you want the children to design a boat we just don't have those kinds of resources, so we encouraged them to make them at home with their own materials with their parents (...) STEM Learning needs to be more realistic about what kinds of materials we can obtain because of budget constraints. When we were looking to order things in (...) we had to justify why, everything we were doing" (Teacher 19)*

As mentioned earlier, the booklet in the Polar Ambassador box was well received, however some Polar Ambassadors commented that beyond the booklet there was not a great deal in the box and schools got limited use from this, e.g. one diver, plastic boat etc.

### **7.3 Linking with STEM Ambassadors**

A few schools had engaged with other STEM Ambassadors during the PEP and following their involvement. This had been a positive experience for most although a couple noted

that it wasn't always easy to identify the 'right' Ambassador in terms of their skills/interests and it could take time to make contact with them/receive a response.

*"It would be great if you were made aware of STEM ambassadors that could cater specifically to that thing (of the Polar Explorer Programme). There's quite a long list of them, but you have to spend a lot of time phoning or emailing them to find out what they're offering and sometimes what they have to offer is nothing to do... it wouldn't be appropriate (to the programme)." (Teacher 7)*

## 7.4 Communication

Some Polar Ambassadors experienced difficulties with some schools who just wanted them to go in and deliver lessons/activities for them, rather than taking the opportunity to be empowered and upskilled. Polar Ambassadors learnt to be clearer about this in subsequent years during initial discussions with schools. One Polar Ambassador who had previously been a STEM ambassador noted that the role of PA was more involved/time consuming.

*"...since it was a big step up from the normal STEM activities; you just go to a school for an hour or two and that's it (...)with this you had reporting to do, you had to go back to the school 3 or 4 times, and be on hand at any time..."* (Polar Ambassador)

In some cases, PA's felt schools had underestimated the level of engagement/involvement required to take part in the PEP, however this issue did not appear to be widespread.

*"Most teachers didn't think the PEP was such a big project that they were going to be doing in schools...The size, the duration of the programme probably wasn't fully understood by the teachers from the onset... It was a bit of a 'ooh blimey, okay' so I don't think they realised just how much we were expecting from them"* (Polar Ambassador)

Some PAs were unsure how schools had been allocated, for example a couple discovered that other PAs had been allocated schools very near to them. A couple of PAs who had also been involved with the Tim Peake programme felt more could have been made of the media links, e.g. the PEP didn't seem as 'high profile' as the Tim Peake programme.

From the perspective of partners, working relationships with Stem Learning were very positive, however a couple made some suggestions on how this could be enhanced. Some partners would have liked a bit more information about how the project was developing and at what stage it was at so that they could have offered more support/made links where activities were complementary and offered opportunities to work together.

## 7.5 Reporting and data collection

Overall, 78% of the 246 teachers responding to the impact survey stated that the quality of the PEP reporting and data collection tools was 'good' or 'very good'. The findings from the qualitative research reflect this with most teachers finding the process manageable if a little time consuming.

A couple of the Polar Ambassadors felt that they had gone beyond the expectations of their role in the amount of time they had spent chasing schools for late returns and in providing support with this task, however this issue did not appear to be widespread. One school did note that they had found this element useful as it was rare that they got the opportunity to capture impact data on school initiatives to this level of detail and the school management team had found this very useful.

## **8. Conclusions**

### **8.1 Impact of the PEP on teachers and schools**

Qualitative feedback from teachers suggests that one of the main motivations for getting involved with the PEP was to increase teacher confidence in teaching science (particularly for non-subject specialists) and more specifically, to increase teacher confidence and ability to deliver practical science/experiments. Pre and post impact data demonstrates that schools are incorporating more practical activities within science lessons following PEP involvement.

Within the qualitative interviews, individual teachers were clear that the increased confidence they had gained via the PEP had a positive impact on the quality of their teaching and in some schools where multiple teachers had been involved, an increase in teaching quality across this school was noted. This was of particular significance for a couple of schools that had engaged with the PEP programme with a view to improving the quality of science teaching following a poor Ofsted inspection. Whilst the PEP was not the only initiative taking place to improve teaching quality, these teachers did acknowledge that the PEP had made a significant contribution by reinvigorating the way science is taught through the PEP resources and input of the Polar Ambassadors. It is also evident that teachers valued the PEP resources and found them to be of high quality and, linked to this, more than a third of teachers in the impact survey stated that the PEP had helped to increase their knowledge of STEM subjects. This is likely to further enhance the confidence of teachers.

It is clear that teachers valued the input of the Polar Ambassadors who depending on their backgrounds were able to offer assistance in different ways, i.e. educationalist PAs were able to offer support in terms of teaching styles and curriculum links, whereas PAs from industry were able to offer insight into specific science topics.

Some schools were able to build on the value of the PEP by applying elements across different areas of the curriculum. apply the PEP across different curriculum areas, e.g. geography, history, and design technology. PEP has also acted as a vehicle for different ways of using technology within schools building on the experience of using Skype to talk to STEM Ambassadors.

In terms of long term impact, it is clear from the qualitative feedback from teachers that the PEP resources will continue to be used within schools, however some teachers and Polar Ambassadors did acknowledge that the momentum of the PEP within schools depended to some extent on a key individual/science lead who demonstrated a clear commitment to the programme and as such this may not necessarily continue if they were to leave the school. In addition, some schools did indicate that they intend to develop their STEM curriculum on an ongoing basis with a third either pursuing, or planning to pursue the CREST Superstar award, and half engaging with the STEM Ambassador programme following their involvement with the PEP.

### **8.2 Impact of the PEP on pupils**

Pre and post impact data and qualitative feedback from teachers indicates that the most significant impact for pupils has been an increase in the enjoyment of, and engagement

with, STEM subjects within school. It is evident that the practical nature and emphasis on scientific exploration within the PEP has been at the core of this.

Within some schools this increased enjoyment and engagement within STEM subjects appears to have led to improved behavior within classes and attainment, although it is difficult to prove this is exclusively due to involvement with the PEP. Other impacts noted included increased resilience amongst pupils arising from scientific exploration, i.e. being able to recognize that science does not always go to plan and it is necessary to adapt when experiments 'fail'.

Impact data shows that PEP has been successful in raising awareness of the different types of STEM career options. The real-world context of the polar research vessel and the input of 'real' scientists/Polar Ambassadors has been influential in changing perceptions around what 'science' is and, perhaps more importantly, who can do it. The breaking down of stereotypes around science careers appears to have been of particular significance for those schools in areas of high deprivation where aspirations can be low and horizons limited; being able to meet scientists/Polar Ambassadors who are relatable has been important. In addition, the PEP has been influential in breaking down gender stereotypes via links with female PAs. These findings were corroborated by data captured from pupils, which showed that taking part in the programme had reduced both the belief that science careers were reserved for 'brainy people' and that they could only be accessed by 'boys'.

Through this evaluation, it has not been possible to identify in detail the long term impacts of involvement with the PEP on pupils, however qualitative feedback from teachers and PA's suggests that pupils remember experiments and meeting the Polar Ambassadors in class or via school assemblies several months after the event. It is hoped that this recall and linking back to experiences will continue as the pupils progress through their education.

### **8.3 Process evaluation of the PEP**

Findings from the impact survey show that satisfaction levels with the PEP are high and overall, the PEP has been very effective in enabling schools to enrich and enhance their science provision. Eight in ten schools were able to implement all or most of their action plan. High levels of satisfaction are also evident from the qualitative feedback, however a number of areas for improvement were identified. Some schools noted that it would have been useful to have had more lead-in time before the PEP was delivered to allow schools more time to integrate activities within the curriculum and schedule CPD sessions.

The evaluation findings suggest that although the resources (hard copy and online) were well received, the online forum was less well utilized and some teachers found this difficult to use/navigate. Some schools also experienced issues resourcing some of the PEP experiments as they did not have, or could not find the funding, to provide the additional equipment for these.

The importance of early and clear communication with schools was emphasized by PAs to ensure that schools understood what could be provided within the context of the PEP and in particular the role of the Polar Ambassador, i.e. to empower and upskill teachers rather than being brought in just to 'deliver' activities and workshops within the classroom.

Partners working with STEM Learning to deliver the PEP were generally very positive about their experience and their relationship with the PEP team. However, a couple noted that they would have liked more frequent communication/information about the programme so that they could have offered more support where there were opportunities to work together.

#### **8.4 Success factors**

To summarise, the findings from the impact survey and qualitative research paint a fairly consistent picture and suggest that the main success factors have been the combination of high quality resources and the Polar Ambassadors working together to increase teacher confidence and reinvigorate science teaching within schools. This has been underpinned by the teacher CPD in improving subject knowledge and skills to deliver practical scientific exploration within lessons. Linking the PEP to the building of the polar research vessel has been useful in providing a real-life context but this appears to have been a less significant factor in driving success.

## 9. Recommendations

There are a number of recommendations that would apply if the PEP was to be rolled out again, or to inform the development of similar programmes by STEM Learning.

Although most teachers were able to link the PEP with the curriculum this was not the case for all and in some cases the educationalist Polar Ambassadors were able to offer valuable guidance in this respect. STEM Learning should consider how best to support schools to make the curriculum links and offer enhanced guidance/support for those that need it.

Feedback from schools suggests that lead in times for programmes such as this should be generous and allow time for schools to integrate activities into their planning and schedule teacher CPD sessions.

Use of the online forum/community was variable and some teachers found it difficult to use. Consideration should be given to gathering further feedback from teachers on how this could be enhanced.

Polar Ambassadors engaged with the PEP during the whole programme have gained valuable experience in what works in terms of communicating and liaising with schools. Consider ways in which this best practice could be shared with new ambassadors.

The combination of high quality resources and the input of Polar Ambassadors appears to have been at the core of the PEP's success, through enhancing teacher confidence and equipping them with the subject knowledge and practical skills to enhance the quality of their teaching, with likely positive impacts on pupil engagement and attainment. . Similar programmes in the future should focus on these key elements.

Future promotion of similar programmes should consider how best to communicate the potential benefits to schools in terms of helping them to meet development priorities in science/other STEM subjects or as part of a wider school improvement plan.

Consider rolling out the PEP again once the research vessel begins its work in full.

## 10. Appendices

### 10.1 Case Studies

#### **Severn Primary (Wales)**

Severn Primary School took part in the Polar Explorer Programme during the 2017/18 academic year, and also took part in the Space Ambassador Programme, the Tim Peake Primary Project. Severn Primary School is situated in Canton, about one mile from the centre of Cardiff and serves an ethnically and culturally diverse community with over fifty different languages spoken by its pupils and teachers. A large number of families whose children attend the school come from Pakistan, Bangladesh, India and Somalia. The school has around 600 pupils, 35% of which are entitled to Free School Meals, and is rated as an 'excellent' school by Estyn, the Crown body responsible for inspecting quality and standards in education in Wales. In 2017, the school was shortlisted for the Enthuse Award (STEM Primary School of the Year).

In terms of motivations for engaging with the PEP, the school hoped to boost attainment and to enhance the pupil's life experience:

*"Our science results at the end of KS2 needed a boost, and we were hoping that something that was really engaging would help build the foundation... we did it with year 4... science relies very much on children's curiosity and their life experiences .... We are trying to make up a big gap, really, in their experiences."* (Gillian Ryder, Teacher)

Techniquet (Cardiff-based science and technology exploration centre, which provides a range of services to schools and teachers to complement formal education provision in Wales) acted as Polar Ambassador to this school, and others throughout Wales, providing schools' action plans (of which Severn Primary completed 'most', according to impact survey data), delivering ongoing support to schools via email, and running an end of programme 'Polar Takeover' event. The school focussed on the PEP for a term and added extra activities (including literacy based activities) alongside the core PEP materials, and worked alongside other organisations including Wicked Weather Watch (a charity that aims to provide clarity for children and young people about climate change and global warming) to supplement the curriculum. Overall, 240 pupils took part in PEP activities and 180 took part in three or more.

In terms of pupil impact, the school noted the greatest impacts as increased enjoyment/engagement in STEM subjects on the part of pupils and an increased awareness of the importance of science in society, with its responses to the impact survey suggesting that the PEP had impacted each of these 'to a great extent'. The school also noted an increased awareness of STEM careers, particularly amongst female pupils. Paying attention to gender stereotypes was an important consideration for the school and for Polar Ambassador Techniquet:

*"We were very careful when we were organising the Polar explorer event that we took gender into account so the keynote speakers were a mix of males and females so they could see that there was an opportunity for all people to get involved."* (Techniquet)

The school has enjoyed an improvement in its science results:

*"Our science results are creeping up. I don't know if I can directly attribute that to the PEP, but our results are creeping up...it was a very positive experience. It was well worth engaging in. (Gillian Ryder, Teacher)*

In terms of teacher impact, the school noted that the PEP had helped to improve teacher subject knowledge and confidence, the quality of science teaching and knowledge of STEM related careers. The resources, especially the booklet and teacher CPD, were identified as important factors for the success of the PEP within the school. The school paid less attention to the polar research vessel within their delivery of the programme, but placed high value on the resource booklet:

*"We really didn't use the research vessel angle very much. Think it would have been more advantageous to have supplied more than one copy of the resource booklet to schools and not put your cash into producing the actual box etc." (Teacher)*

The school has continued to use the PEP resources in the 2018/19 academic year and has plans for pupils to work towards the Polar Explorer CREST Superstar award in the future.

### **West Winds Primary (Northern Ireland)**

West Winds Primary School took part in the PEP during the 2018/19 academic year. The school is a controlled primary school situated on the outskirts of Newtownards, Northern Ireland. The school is small with c.160 pupils. Approximately 65% of the children are entitled to free school meals and 39% of the children are identified as having special educational needs. Fifty one pupils took part in three or more PEP activities.

The school engaged with the PEP to improve the profile of science teaching as there was a feeling amongst staff that science had been 'squeezed out' due to pressure to improve and maintain results in other areas of the curriculum. The school was also keen for the pupils to see science from a real-life perspective. Gill Hume was the appointed Polar Ambassador and played a crucial role in motivating the school to try different things and embed the activities within the curriculum:

*"Gill was very inspiring and helped us with things we hadn't thought about."* (Heather Beattie, Teacher)

*"In Northern Ireland a big curriculum topic is the Titanic. It was nice to be able to lead them away from that...towards something more forward looking...we made comparisons between Titanic and the RSS Attenborough."* (Gill Hume, PA)

The school selected and used resources in class, and arranged Polar Ambassador led activities, and organised a trip to a boat building yard. The school spent 8-10 weeks on PEP activities and felt that they could have spent longer due to the amount of content available.

*"The PEP could have lasted a year, there is so much science in it - it's fantastic."* (Heather Beattie, Teacher)

For the lead teacher for the programme, the main benefits of taking part in the programme were an improved subject knowledge, increased confidence in teaching STEM subjects (in particular an enhanced ability to use a wide range of teaching and learning approaches, constituting an increase to pedagogic knowledge) and access to high quality resources. At the beginning of the programme, this teacher felt that the availability of the equipment needed to teach science was very poor. In contrast, at the end of the programme, it was felt that such equipment was very much available, suggesting that the PEP had provided valuable resources and had also encouraged the school to procure additional equipment and resources to support science teaching.

*"I would encourage it for any other school, the resources so good and so relevant, particularly with environmental change."* (Heather Beattie, Teacher)

A clear impact on pupils was noted in terms of their enjoyment and engagement in STEM learning and their appreciation of the importance of STEM skills. Also, noted were improvements in terms of pupil resilience:

*"We find that sometime children don't have resilience, perseverance, but with science, it's a case of trial and error...they got that sense that it was ok to fail and adapt....it gave them a great sense of achievement."* (Heather Beattie, Teacher)

The school plan to continue using the PEP resources. Some pupils have secured their Bronze Crest Award and there are plans to continue to higher levels.

**William Levick Primary School (England)**

William Levick Primary School took part in the Polar Explorer Programme during the 2017/18 academic year. The school is in a suburban location, has c.200 pupils, and a 'Good' Ofsted rating. The proportion of pupils who are supported through pupil premium funding is well below average. Overall, 100 pupils took part in the PEP, and 34 of those took part in three or more activities.

The school was keen to raise the profile of science within the school through the PEP and increase awareness of the range of STEM career options.

*"We've tried to [increase awareness of career options] quite a lot recently...if you ask children what they want to be when they're older they either want to be a footballer or a YouTuber. You need to widen their horizons a little bit." (Helen Peckett, Teacher)*

The Polar Ambassador assigned to the school (Ian Crowston) delivered whole school assemblies, worked with individuals' classes and was in close contact throughout. He also brought in a 3D printer to school which the pupils found fascinating. The school felt that the PA was crucial to the success of the PEP.

*"Our Polar Ambassador was the main input which moved the project forward throughout the year. He was full of practical ideas and was great with the children." (Teacher)*

The school also had a science teacher from a local secondary school teach some related lessons to Y6 children as part of their transition to secondary school. As part of this, the school did quite a lot of work themselves to assess the impact of the PEP and ran a survey to make comparisons between Year 7 students that had come from William Levick and other schools in the area. Although, the impact could not be directly attributed to the PEP, the research found that pupils from William Levick had more science lessons, completed more practical work and had a greater enjoyment of science lessons at primary school.

*"Children loved the whole project especially the assembly and practical activities. I feel it has raised the profile of STEM and the girls especially have engaged with the project, increasing their confidence and aspirations." (Teacher)*

In relation to the impact data collected for STEM Learning, teachers noted that the key impacts for pupils were around their enjoyment/engagement in STEM subjects and in their confidence to learn scientific enquiry skills. For teachers the main benefits were in terms of increased confidence to teach STEM, an increase in the quality of teaching, and an increase in the profile of STEM across the whole school.

### **Regents Park Community Primary School (England)**

Regents Park Community Primary School took part in the PEP during the 2018/19 academic year. The school is located in inner-city Birmingham and has c.600 pupils. The proportion of pupils supported by the pupil premium funding is above the national average, as is the proportion that does not speak English as their first language. The school is rated 'Good' by Ofsted.

One of the main reasons for taking part in the PEP was to give pupils a wider range of life experiences.

*"It was something that we thought, hang on, it would be really nice because it's something different, giving us an opportunity to explore different things as part of STEM, and we thought our children would be really motivated and engaged within the topics that were being offered."* (Nargis Khan, Teacher)

Over 30 teachers and teaching assistants took part in a comprehensive CPD session delivered by their Polar Ambassador. This was particularly valued by teachers in terms of giving them the skills and confidence to plan their lessons using the PEP resources.

*"She [the PA] taught the staff how to use the activities, and I think that was really crucial, because sometimes when you're looking to do that planning it's really hard to think 'what do I need to do here', but to be able to practically partake in those activities and see how they link in, that had maximum benefit because the teachers were all involved and motivated."* (Nargis Khan, Teacher)

This sentiment was reflected in the pre- and post-programme measures taken from teachers at Regents Park. The 10 responding teachers reported being better able to use a wide range of teaching and learning approaches in science at the end of the programme compared with the start (mean = 7.3 cf. 6.3 at the start of the programme, on a scale of 10). Allied to this was a feeling on the part of these 10 teachers that they had better access to high quality teaching resources as a result of taking part in the PEP (mean = 8.0 cf. 6.7).

The PEP was delivered to the whole school as the main part of a STEM focus week. Pupils took part in the PEP activities in lessons and the school also organised a trip to the science museum for year 6 and a poster competition across the whole school. The school noted that pupils had benefited to a great extent from participation in the PEP, with impacts noted across all of the outcome areas.

*"All children were fully engaged with the programme during STEM week, they took part in a range of activities and increased their enjoyment and engagement in STEM subjects."* (Teacher)

The school intend to use the PEP activities again and hope that they will be able to see evidence of more sustained impact when delivering the activities within the curriculum rather than as part of a focus week.

### **St Bridget's Primary (Scotland)**

St. Bridget's Primary School is a denominational primary school situated in the town of Kilbirnie in North Ayrshire. The primary school roll as of December 2018 was 222. The school took part in the PEP in 2018.

The teacher who instigated the engagement with the PEP shared a large Primary 5 class of 39 with another member of staff and was keen to find a way to motivate and engage pupils in science. The PEP was delivered in Primary 5 whole class lessons and also in smaller groups for experiments, throughout the year as part of a topic. The school was supported by Polar Ambassador Ricky Munday who delivered a whole school assembly about his trip to Mount Everest and brought in equipment and clothing for the pupils to try on;

*"Meeting Ricky Munday was great for the children, this is a fairly deprived area, and it was great for them to see someone with a similar background to them who had achieved these things."* (Jennifer Fleeting, Teacher)

The school also appreciated the way in which the PEP linked to climate change and the 'Boaty McBoatface' media attention helped with pupil engagement. A school trip to the Scottish Maritime Museum trip was also organised to link in with the PEP.

In terms of the impact on pupils, the lead teacher felt that raising aspirations was an important outcome for the school;

*"[The PEP] gave pupils experiences that they wouldn't have had access to."* (Jennifer Fleeting, Teacher)

The teacher interviewed as part of this evaluation said that the programme has also had a lasting impact for the school and the way in which science is taught. In particular, she said that teachers are more likely to take learning outside of the classroom by linking topics to school trips. Indeed, the 5 responding teachers in the teacher survey report that they have increased confidence undertaking extra-curricular activities, including supervising school trips, after participating in the PEP (mean = 8.0 cf. 7.0 of a possible 10 before taking part in the programme).

The school intend to continue to use the PEP resources and have set up an after school STEM club as a result of participating in the programme.