Darwin
experience

Milford Haven Case Study 2016-2019

• FINAL REPORT •

Contents

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Executive summary

Context:

1.1 Pupil interest and motivation for Science, Technology, Engineering and Maths (STEM) is declining and there is international focus on how to support STEM education programmes.

1.2 Teachers who are non-specialists in STEM subjects may not be well prepared to teach these subjects and the challenges of the new Welsh Curriculum.

1.3 There is national concern over pupil progress in Key Stage 3 and transition from primary school

1.4 The Darwin Centre, funded by Dragon LNG, worked with the Milford Haven cluster of schools and tracked progress of pupils from year 4 to year 6 (age 8 – 11years). They provided annual fieldtrips, workshops and supporting activities and resources. The aim of the case study was to assess whether the programme would increase pupil attainment (in science, English and Maths) at year six; increase teachers' efficacy in the teaching of STEM; and increase the number of pupils choosing to take Biology, Chemistry and Physics as single Science GCSE.

1.5 Ethical permission was gained from the University of the West of England, Bristol and data was collected in the form of questionnaires, focus group discussion, interviews and school assessment data.

Aims:

2.1 To engage, enable and enthuse young people in STEM.

2.2 To increase non specialist teachers' efficacy in the teaching of STEM.

2.3 To see a statistically significant increase in attainment (in science, English and Maths) at year six compared to data from comparison schools in Pembrokeshire.

2.4 To support transition between primary and secondary schools.

Results:

3.1 The project supported higher levels of attainment. The difference between year 4 targets and actual outcome at the end of year 6 in maths, English and science had greater gains in schools involved in the project, compared to those in the rest of Pembrokeshire.

3.2 Teachers recognised that the project positively supported the more disadvantaged and those pupils with Additional Learning Needs (ALN). Those pupils receiving free school meals (FSM) saw a greater increase in attainment in maths and science when part of the project, compared to those pupils receiving FSM in the rest of Pembrokeshire.

3.3 More pupils were actively engaged with environmental groups in year 6 - 60% more in 2018/9 as compared to 2016/17.

3.4 Pupils' subject knowledge in all areas associated with the project increased across the three years with the exception of renewable energy. Knowledge of global climate change and ocean plastic saw the greatest increase in understanding.

3.5 Pupils' enthusiasm for future STEM related employment and their enjoyment of science lessons has been maintained through the project. Maths has remained the most popular subject upon leaving primary school.

3.6 Pupils were more confident in using complex scientific language and communicating processes as a direct result of the project.

3.7 Teachers were more confident and enthusiastic in their teaching of STEM and their own subject knowledge. They intend to use and develop resources from the project in future years.

3.8 There was a significant increase in the collaboration between schools; especially with regard transition opportunities between key stage 2 and 3. This was positively welcomed and steps were taken to improve teaching and learning in key stage 3 as a direct result of the project.

Recommendations:

4.1 Continue to support all schools in the cohort for a further 2 years to ensure longer term legacy of the project; sustaining and developing subject knowledge, confidence and new pedagogies as the new curriculum is implemented.

4.2 Review, and where necessary update, the three resource booklets in line with any changes to the new curriculum as they develop. In this share further investigative / practical classroom experiments to support teachers in delivering this aspect of science related to themes of the project.

4.3 Continue tracking year 6 pupils (2018/19) into key stage 3 and 4 at Milford Haven School where long term impact can be monitored and focussed intervention developed with pupils familiar with the DC model.

4.4 Continue to track those pupils currently in year 4 and 5 into year 6 to enable long term evaluation of the project

4.5 Consider expanding the project into a similar cluster of primary/secondary schools to transfer and refine the project before possible wider dissemination.

4.6 Consider ways of encouraging more sharing of good practice amongst schools and how this can be facilitated - the current shared site on HwbCymru is not used consistently and databases were put in place towards the end of the project. These should be monitored and evaluated.

The National Context

Pupils

Young learners have often been found to be disinterested in STEM when their lessons are isolated and disjoined, missing connections to crosscutting concepts and real-world applications (Kelley and Knowles, 2016). However, the study of science and technology support the need to address current global challenges such as climate change, overpopulation, resource management, agricultural production, health, biodiversity, and declining energy and water sources (Thomas and Watters 2015). Yet research indicates that students' interest and motivation toward STEM has declined, particularly in western countries and more prosperous Asian nations (ibid.) with Murphy et al. (2004) noting that this interest in STEM wanes as they reach the end of primary school. With our global workforce requiring STEM specialists and young learners showing a disinclination towards these subjects, many nations around the world have begun to focus on supporting STEM education (English 2016; Marginson et al. 2013; NAE and NRC 2014) in order to provide a positive experience to keep the doors open for STEM based career choices.

Teachers

Many UK primary school teachers lack confidence in their science, technology, engineering and mathematics (STEM) subject knowledge which impacts on their ability to teach STEM subjects. The Department for Education (2013) reported that only 5% of primary school teachers in the UK hold a science related degree while the Welcome Trust (2013) found that in some schools there may be no teacher with a science qualification beyond GCSE (or O) level. Teachers who do not have a sound conceptual understanding of science often do not feel comfortable when teaching STEM subjects (Bleicher and Lindgren, 2005). Not only do some primary teachers feel that their subject knowledge is insufficient, they are also overwhelmed by the need to shift the focus of their teaching to more creative, practical and investigation-based science (Welcome Trust, 2013). This lack of confidence and understanding of STEM subject knowledge can result in didactic, 'cautious' teaching (Bleicher and Lindgren, 2005) which reduces pupils' performance, and enjoyment of the subject (Ofsted, 2011). While outreach can enhance learning and engagement within these subjects, provision is often ad hoc.

Transition to Key Stage 3

Government inspectors identified that Key Stage 3 is given a lack of priority in many secondary schools (Ofsted, 2015). Pupils often repeat learning already embedded at primary school, the more able are least challenged and staffing is given lower priority (in favour of key stage 4 (GCSE) needs). Too many secondary schools do not work effectively with partner primary schools to understand pupils' prior learning and ensure that they build on this during Key Stage 3. In addition, whilst literacy skills are often a high priority in many secondary schools, numeracy is not given the same emphasis. In 2017, Estyn (the Welsh education inspectorate) reviewed science teaching at secondary schools recommendations included:

Provide stimulating and challenging learning opportunities in science involving effective practical work to meet the needs of all pupils, including the more able

Provide more subject-specific support for science teachers on improving teaching and assessment, and facilitate the sharing of good practice.

The New Curriculum for Wales

Currently, Wales is going through curriculum change in response to the Successful Futures Report (Donaldson, 2015). This concluded that learning content in Wales was outdated and needed significant review. At the time of writing, schools are replacing what the Welsh Government (Welsh Government, 2019) described as a prescriptive, narrow and outdated curriculum introduced in 1988, for a curriculum that does away with traditional subject boundaries and has four purposes. These will support learners to be:

- Ambitious, capable, lifelong learners
- Enterprising and creative
- Healthy and confident
- Ethical informed citizens of Wales and the world (Welsh Government 2019)

This new curriculum offers great opportunity with regard the teaching and learning of STEM subjects, but also provides new challenges in subject knowledge and pedagogy which teachers need support with.

The Local Context

The Darwin Centre and Dragon LNG

The focus of Dragon LNGs corporate social responsibility output is youth development and training in Pembrokeshire. The remit of the Darwin Centre is to engage and enthuse in STEM and is funded by Dragon LNG.

Since 2005, Dragon LNG funding has enabled the Darwin Centre to work with c. 45, 000 pupils (approx.. 3,000 per annum), offering schools across the county free STEM workshops and fieldtrips.

Milford Haven Case Study Schools

The Milford Haven cluster of schools, collaborated with the Darwin Centre, to develop an engaging and innovative science project for pupils from year 4 - 6.

The schools involved were:

- Coastlands Community Primary School,
- Hakin Community School and Hubberston Church in Wales VC School (which, during the project were combined and were renamed Gelliswick Church in Wales VC School)
- Johnston Community Primary School,
- Milford Haven Junior School and the Meads Infant School (which, during the project combined and were renamed Milford Haven Community Primary School)
- Neyland Community Primary School, ,
- St Francis Catholic Primary School.

Milford Haven School (the secondary school in the cluster) were a partner in the project as were Pembroke Dock Community School (who are a Pioneer School, contributing to the development of the new curriculum for Wales).

Aims

In response to calls for greater understanding of the impact of STEM education programmes the Darwin Centre set out to measure the impact of its work with the Milford Haven cluster of schools. The purpose of the Darwin Centre's intervention was to relate science to children's experiences and normalise complex theories and languages surrounding STEM for both young learners and their teachers. The aim was to,

1. To engage, enable and enthuse young people in STEM.
2. To increase non specialist teachers' efficacy in the teaching of STEM.
3. To see a statistically significant increase in attainment (in science, English and Maths) at year six compared to data from comparison schools in Pembrokeshire.
4. To support transition between primary and secondary school.

Whilst aim 3 is outside the remit of the current project, it should be noted that this goal would provide critical, long term data in STEM education which is currently under represented in the literature / research.

Delivery Model

In order to establish the impact of the work the Darwin Centre has, a case study approach was initiated in 2016 whereby cohorts of children and their teachers from the Milford Haven cluster of schools would be supported over a three year period – tracking progress from year 4 (8-9 years old) to year 6 (10 -11 years old).

Dragon LNG paid for DC to develop the resources and deliver a suite of free field trips and workshops across the three years. In addition to this, transport to fieldwork sites was paid for. Apart from schools releasing teachers to join meetings to collaborate on the development of the resources (largely in twilight sessions after school), this programme was free to schools.

Methods of data collection

Ethics permission was obtained from the University of the West of England, Bristol in line with BERA (2018) guidelines, and then from all teaching staff, parents of pupils and pupils involved in the data collection and the local authority.

A mixed method approach informed the study. This included:

- Pupil surveys pre and post activities. Each question was read aloud to ensure all participants were able to access the language. The Likert scale of 1-5 (1 being strongly agree) was used, in addition to open-ended questions to give an opportunity for greater personal reflection.
- Pupil focus groups (c.30 minutes in length) from three of the schools. Six pupils from each class, chosen by the teacher, provided qualitative feedback and evaluation using verbal and image prompts.
- Semi structured interviews with three year 6 teachers (c. 20 minutes) to evaluate experiences and confidence in teaching STEM.
- Questionnaires with all year 6 teachers
- Focus group (c. 30 minutes) with teachers from all schools and all year groups to evaluate the three year programme.
- Observations of fieldtrip and classroom workshops.
- Analysis of attainment data - year 4 – 6 progress results in maths, English and Science in the case study schools.

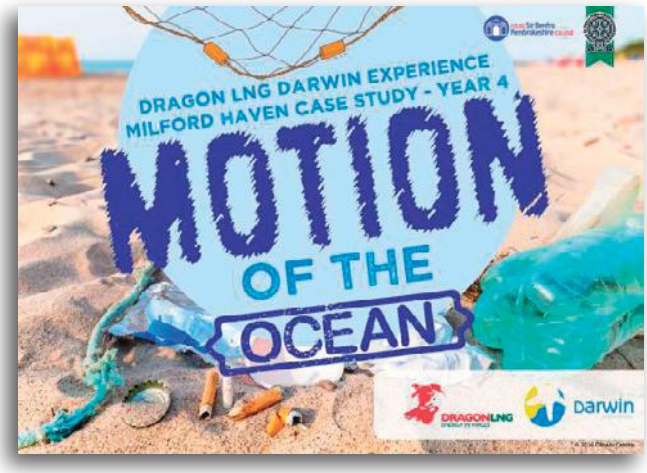
Data analysis:

A mixed method evaluative approach based on interpretivist theory was used – whereby it is suggested that the impact of the programme was constructed from the meanings the participants made of their experiences (Schwandt, 2003). All focus groups and interviews were transcribed and coded using content analysis as defined by Patton (2002, p43). To support anonymity all participants were coded.

Attainment data was results were prepared by the local authority to ensure anonymity. To assess statistical significance of results a standard T-Test was run with year 6 attainment results for schools in the project compared to those in all Pembrokeshire schools.

Activities:

All fieldwork and workshops were supported by a sequence of activities provided in bespoke workbooks for teachers to implement before and after DC fieldtrips and workshops. Cross curricular activities that supported the curriculum were embedded within this, with particular focus on literacy, numeracy and digital competency.



Year 4

Fieldtrip

Pupils were taken to a local sandy beach where they collected, sorted and weighed litter and learned about tides. Local weather data was recorded using scientific instruments.

Workshop

Returning to school, pupils researched sources of litter and considered the damage it has to marine life and what monitoring can be used.

Year 5

Fieldtrip

Pupils visited a local freshwater river at Colby Woodland Gardens to learn about the water cycle. Here they had the opportunity to explore the biotic index, identify the fauna of the river, measure the speed of the river using scientific methods and take field sketches.

Workshop

After the fieldtrip pupils explored different world rivers and the impact of pollution on these systems. Adaptations of animals living there were reviewed and reinforced through activities. Pupils undertook supported investigations relating to osmosis.

Year 6

Fieldtrip

Pupils were taken to Lydstep Beach rock pools where they were able to collect and identify marine flora and fauna with particular focus on crabs.

Workshop

After the fieldtrip pupils had the opportunity to use microscopes to observe and identify microscopic marine life; considering the importance of phytoplankton and consider crab lifecycles in more detail. Pupils undertook supported investigations relating to the acidification of the sea.

Science Squad

Twice a year, 22, year 6 pupils were selected from the schools to spend time in the science laboratories at Milford Secondary School. Here they worked with scientists to analyse the vitamin C content of various fruits and vegetables and undertake a squid dissection.

Science – a – Glow

This annual event allowed each school in the case study to send pupils to communicate their experiences and learning on the project with peers from other schools at the end of each academic year. Held at Milford Secondary School, the events had a variety of STEM related, hands on activities led by local experts to further encourage pupils' enquiry skills and reflect on the STEM skills and methods they used on DC fieldtrips and workshops. Young people were encouraged to think about the variety of employment opportunities in STEM.

Nation Digital collaboration

Nation Digital developed websites for each of the schools involved in the case study. Teachers were invited to a training session to learn how to generate content for a word press website - in order to

upload blogs, pictures etc – and use a Local Authority developed database developed for each of the fieldtrips . Here, teachers and pupils could share work and resources.

Further networks of support were provided by National Digital for teachers in the project; the Digital Competency Framework element of the curriculum was linked to the bespoke websites as an interactive document. Teachers had the ability to ask a question regarding this, to Nation Digital and / or another teacher. E.g. How do you use metadata in your project? Or how do I teach ……?

Results:

- **Pupil attainment**

In year 4 all children are set a target in maths, science and English. Results show that the difference between these targets and actual outcome at the end of year 6 had greater gains in schools involved in the project, compared to those in the rest of Pembrokeshire (see figure 1).

Figure 1.

Subject	Percentage increase from target to achieved outcome in Year 6 project schools (level 5+)	Percentage increase from target to achieved outcome in Year 6 of all Pembrokeshire schools (level 5+)
Science	12	6.9
English	8.3	6.8
Maths	13.8	7.9

Those young people receiving free school meals (FSM) showed greater gains in all subjects, with over double the amount of pupils receiving the higher level 5+ award in science and maths compared to pupils in all Pembrokeshire Schools. See figures 2, 3, and 4.

Figure 2.

Subject	Percentage increase from target to achieved outcome in project schools (level 5+, Free school meals)	Percentage increase from target to achieved outcome in all Pembrokeshire schools (level 5+, Free school meals)
Science	10.1	4.5
English	5.1	4.1
Maths	16.5	7.7

Figure 3.

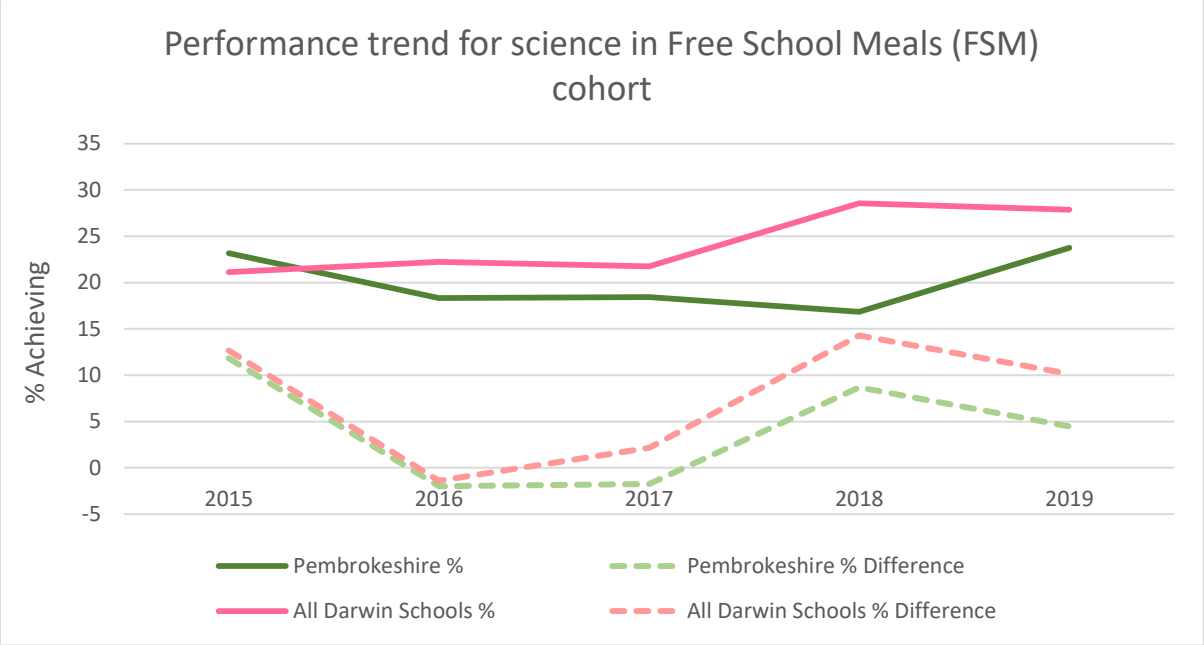
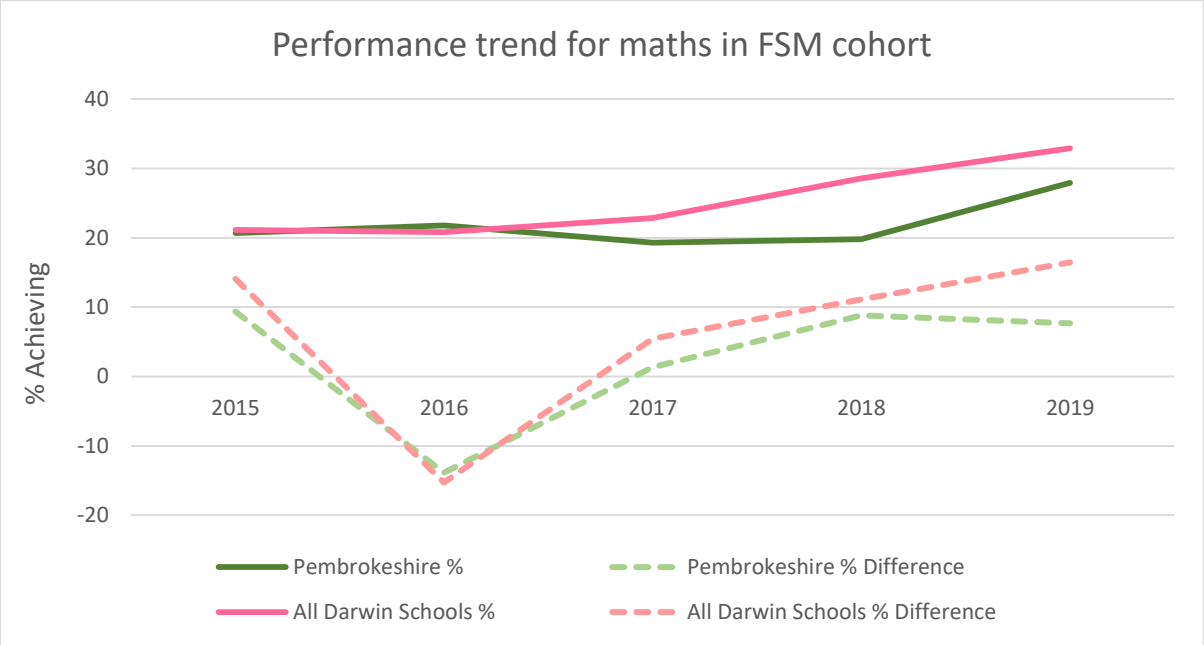


Figure 4.



Results of percentage gains/losses for individual schools can be found in figure 5. Of particular note:

- One school in the cohort achieved below target grades in science with all other schools exceeding expectation. One school reported a positive shift in over 40% from target to actual outcome. All pupils in this class reached the national expected level 4+, with over 65% of pupils leaving year 6 having achieved the higher level 5+.
- One school in the cohort achieved below target grades in English with all other schools exceeding expectation. The greatest positive shift between target and outcome achieved was over 30%.

- All schools in the cohort exceeded expectation in maths, with the greatest positive shift being over 20%.

Figure 5.

School	% difference between year 4 target and year 6 outcome in science (level 5+)	% difference between year 4 target and year 6 outcome in English (level 5+)	% difference between year 4 target and year 6 outcome in maths (level 5+)
A	**+ 7.4**	**+ 4.9**	**+ 4.9**
B	**-1.1**	**+4.4**	**+ 14.4**
C	**+16.9**	**+11.9**	**+18.6**
D	**+ 32.4**	**+20.6**	**+17.6**
E	**+20**	**-2.9**	**+22.9**
F	**+7.1**	**+14.3**	**+7.1**
G	**+41.7**	**+33.3**	**+16.7**
All Pembrokeshire Schools	**+6.9**	**+6.8**	**+7.9**

Results of individual school attainment can be found in figure 6. Of note is:

- Three schools had pupils achieve more level 4+ results in science and maths than Pembrokeshire as a whole, with 4 schools achieving this result for English.
- Four schools in the project had pupils achieve more level 5+ results than Pembrokeshire as a whole.

Figure 6.

Science

	A	B	C	D	E	F	G	All Pembrokeshire schools
% of pupils achieving level 4+	91.4	82.2	84.7	94.1	88.6	92.9	100	90.6
% of pupils achieving level 5+	39.5	16.7	39.0	70.6	45.7	64.3	66.7	40.4

English

	A	B	C	D	E	F	G	All Pembrokeshire schools
% of pupils achieving level 4+	91.4	82.2	83.1	91.2	88.6	92.9	100	89.7
% of pupils achieving level 5+	38.3	21.1	35.6	61.8	48.6	64.3	75	41.6

Maths

	A	B	C	D	E	F	G	All Pembrokeshire schools
% of pupils achieving level 4+	95.1	81.1	86.4	97.1	88.6	85.7	100	90.5
% of pupils achieving level 5+	40.7	28.9	39.0	52.9	57.1	64.3	41.7	41.2

In addition to this, many pupils in year 5 were assessed by their teacher as working at a higher level than previously when investigating the acidification of the sea:

- 3 children at level 2 produced work at level 3
- 20 children at level 3 produced work at level 4
- 6 children at level 4 produced work at level 5

Results from the T-Test for statistical significance on the individual progress levels of the pupils within the cohort schools and Pembrokeshire schools as a whole show no mean statistical significance on years, subjects or final attainment level. This finding is consistent with other small scale educational research.

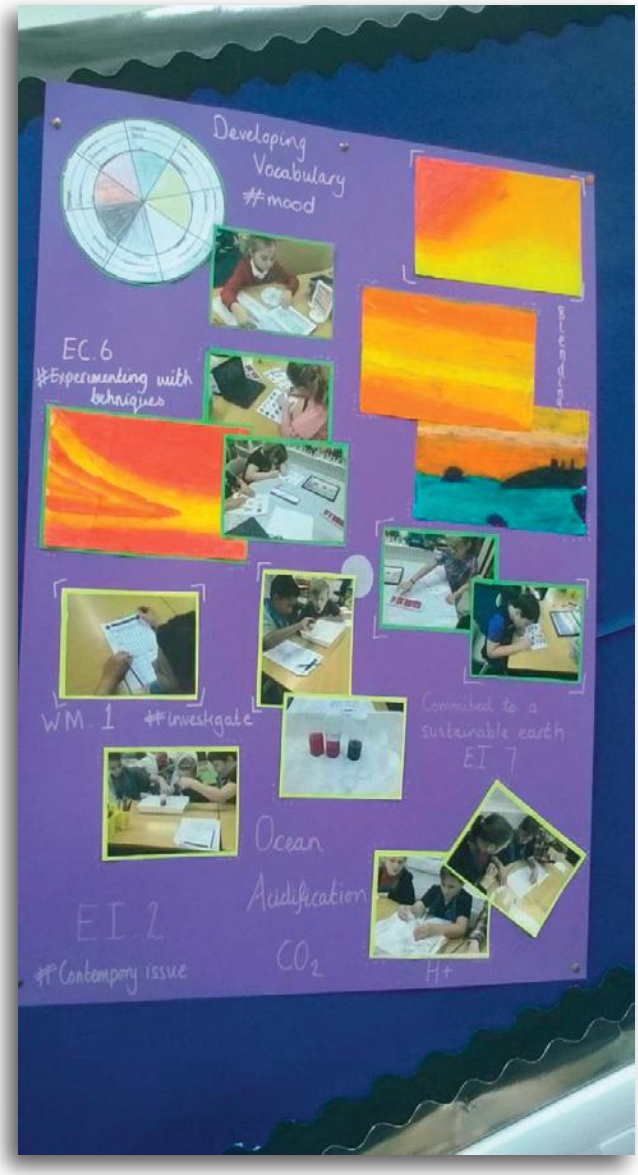
- **Teacher interviews and focus group**

Thematic analysis exposed four, inter-related, key elements regarding teacher experiences over the three year programme: changes in confidence, skills, understanding and enjoyment for themselves

and the pupils in their care. The highest science qualification for all teachers involved in the project was GCSE. While many reported that they 'liked' or 'enjoyed' teaching science, all reported that their expertise and subject knowledge could be improved and that the DC team were able to support their own personal learning. Many of the teachers noted that taking part in the project allowed for the development of their own subject knowledge and confidence. As one teacher commented:

> "After the sessions with Darwin I'd go off and do my own research. They really inspired me to find out more and then I could support the children. Really push them."

It was also noted that, having had the support from the DC, many teachers felt they would be able to deliver the trips independently, or with reduced support, in the coming years. All teachers reported that they would be using the resources (pre and post activities) in future academic years, and explore the different activities



All teachers reported that the resource packs were very useful and allowed pupils to prepare for fieldtrips – resulting in more learning and understanding on the day. The suggested activities for after visits were being used as the basis for 6 – 12 week cross curricular topic work in all schools. See left for an example of a classroom display board highlighting cross curricular links based on the project. This approach was reported to be very useful and in keeping with the new demands of the national curriculum, with particular consideration to the focussed learning purposes of *Ethical Informed Citizens of Wales and the World* and *Ambitious, Capable Lifelong Learners*.

It was identified by all teachers in the cohort that science teaching in the primary sector was limited by equipment available to use. As such, the links made with the local secondary school were very much welcomed and seen as hugely beneficial as expertise and equipment could be shared.

Whilst sharing practice was considered very important by all teachers, not all schools had taken the opportunity of sharing work on the secure web pages on HwbCymru (the central site all schools in Wales use with bespoke pages created for the project). Four year 4 classes, two year 5 classes and 1 year 6 class had uploaded information on teaching experiences and examples of pupil's work over the three years.

All teachers recognised that the programme challenged learners and pushed their understandings. Mathematical activities were contextualised and embedded in the programme to make learning meaningful for pupils. The model of pre and post activities supporting fieldwork, followed by high quality, structured investigations were noted as extremely beneficial.

> "From the very beginning the children are working at a very, very high level … straight away they upped their levels from where they were working."
>
> **"**I feel that the project's influence over the past few years in school has been the single most important feature in raising the profile of STEM in school. I also feel that the added specific tasks (investigations) focus upon the raising of standards in science. If schools follow the model that the project provides it will deliver robust evidence that can be used to justify awarding higher levels in science at KS2."

A number of teachers also commented on the positive impact the project had on those children with additional learning needs (ALN); in one case reflecting on how they had seen one pupil with communication difficulties doing more work and socialising on the fieldtrip then ever seen before. In addition, it was also noted how the project enabled those more disadvantaged pupils the opportunity to do activities they had previously not done e.g. go to the beach, rock pool and pond dip. As one teacher commented:

> "Some pupils didn't know what a rock pool was before the trip and yet they only live a few miles away from the coast."

The excellent transition opportunities between key stage 2 and 3 were identified by all teachers - this was felt to be a huge benefit of the project. The secondary school hosted Science Aglow and the Science Squad allowing pupils time to become familiar with the larger school site and staff. Key stage 3 science teachers attended case study field trips to see what level the primary pupils were working at and planned to adjust their content accordingly. It was noted that the provision of a local authority officer to act as a transition lead in school allowed the primary schools throughout the case study to maintain contact with the secondary school.

- **Teacher questionnaire**

All year 5 teachers returning the questionnaires (from five schools) identified the project as one that supported STEM, extended learning and engagement and provided opportunity for collaboration.

A majority of teachers felt the project had a positive impact on their own professional development and was good preparation for the implementation of the new curriculum.

- **Pupil questionnaires**

The annual survey pupils were asked to respond to has seen fluctuations in engagement over the three years. As pupils in year 4 there were 276 responses (2016/17), in year 5 there were 410 responses (2017/18). Of the 380 pupils taking part in the project in year 6, 166 returned the DC questionnaire (2018 / 19)**.** In this final year the mean return rate was 41%, with individual schools returning questionnaires for between 4-70% of their pupils.

Findings from the questionnaire are as follows:

- There was an annual increase in numbers of pupils indicating they had been involved in an environmental project: 21% in 2016, 61% in 2017 and 89% of all pupils in 2018.
- There was an annual increase in numbers of pupils indicating they were involved in an environmental group such as an eco club: 21% in 2016, 61% in 2017 and 81% of pupils in 2018.
- 38% (63) of pupils rated science in their top three favourite subjects upon leaving primary school while 56% (93) pupils rated maths in their top three favourite subjects – with maths being the overall favourite subject in each of the three years of the project.
- 6% of the year 6 cohort reported that they did not like science which was a reduction of 3% on the previous two years.
- Across the three years there has been a consistent enjoyment of the science with pupils indicating that they 'liked' or 'really liked' the subject: 66% (218) in 2016/17, 57% (248) 9n 2017/18 and 61% (103) in 2018/19.

The development of STEM subject knowledge relating to areas the DC covered were mapped through the repetition of eight questions. See figure 8 for a table of comparative results across the three years of the project.

Of note is:

- A reduction in the percentage of pupils not knowing about global climate change from 48% in 2015 to 22% in 2019, with an increase in confidence talking about this issue (raising from 8% - 29%)
- An increase in confidence with regard knowledge about sea and air pollution – with a consistent desire to learn more about sea pollution across the three years of the project.
- Pupils reported more confidence in subject knowledge relating to the projects' themes across the three years, with the exception of renewable energy. It should be noted that due to changing financial circumstances a planned workshop on this topic was not implemented.

Figure 8.

Global climate change

	2016/17 %	2017/18 %	2018/19 %
I don't know anything about this	48	33	22
I know a little bit about it and could tell you what it means	18	27	34
I know quite a bit about it and could tell you some info / facts	8	16	29
I would like to learn more about this subject	26	22	15

The weather e.g. changes in our weather

	2016/17 %	2017/18 %	2018/19 %
I don't know anything about this	26	25	21
I know a little bit about it and could tell you what it means	36	35	41
I know quite a bit about it and could tell you some info / facts	16	22	28
I would like to learn more about this subject	22	18	11

Air Pollution

	2016/17 %	2017/18 %	2018/19 %
I don't know anything about this	41	19	8
I know a little bit about it and could tell you what it means	21	30	35
I know quite a bit about it and could tell you some info / facts	17	28	39
I would like to learn more about this subject	21	22	17

Pollution of the seas

	2016/17 %	2017/18 %	2018/19 %
I don't know anything about this	31	14	6
I know a little bit about it and could tell you what it means	27	21	22
I know quite a bit about it and could tell you some info / facts	17	38	46
I would like to learn more about this subject	26	27	26

The use of the world's natural resources e.g. mining for coal, drilling for oil, cutting down trees

	2016/17 %	2017/18 %	2018/19 %
I don't know anything about this	41	33	35
I know a little bit about it and could tell you what it means	22	32	33
I know quite a bit about it and could tell you some info / facts	11	18	18
I would like to learn more about this subject	26	18	14

Protecting the natural world e.g. WWF (Worldwide Fund for Nature)

	2016/17 %	2017/18 %	2018/19 %
I don't know anything about this	34	30	29
I know a little bit about it and could tell you what it means	25	25	36
I know quite a bit about it and could tell you some info / facts	16	24	18
I would like to learn more about this subject	25	21	18

Protecting all animals

	2016/17 %	2017/18 %	2018/19 %
I don't know anything about this	13	9	9
I know a little bit about it and could tell you what it means	26	22	22
I know quite a bit about it and could tell you some info / facts	28	32	44
I would like to learn more about this subject	32	37	25

The use of different forms of energy e.g. wind, water, sun

	2016/17 %	2017/18 %	2018/19 %
I don't know anything about this	29	31	34
I know a little bit about it and could tell you what it means	29	29	30
I know quite a bit about it and could tell you some info / facts	16	21	22
I would like to learn more about this subject	25	18	14

- **Pupil focus groups**

As noted previously, thematic analysis exposed four, inter-related, key elements regarding teacher and pupil experiences over the three year programme: changes in confidence, skills, understanding and enjoyment.

- **Changes in confidence and skills:**

All pupils in the focus groups reported an increase in confidence as a result of the project, especially with regard the skills needed to use scientific equipment and methodology. Pupils, unprompted, were able to confidently refer to methods used in fieldwork across the three year programme (measuring litter, kick sampling, pond dipping, measuring the speed of a river, using an anemometer and microscope).

All groups also referred to an increase in confidence when on the fieldtrips. For example, many pupils talked about how the fieldtrips offered an opportunity to do something or go somewhere that they had never done before. All pupils recognised this as being beneficial.

"We saw lots of things I've never seen before … lots of living stuff. It was amazing."

"If we don't get a chance to go on the trips how are we going to get our heads round these important ideas? It's important to see for yourself the place and what's really going on there."

A number of comments related to the year 6 Rocky Shore fieldtrip and how they were nervous about handling crabs. However, by the end of the session, they were comfortable with this due to the time and instruction given.

"We were terrified and wouldn't even dip a toe into the water at the start … but by the end we were both picking up crabs … I was really proud of that."

All groups referred extremely positively to the work they had done with the comprehensive school teacher (from the local secondary school) and felt they were undertaking both interesting and important work. They felt this was a hugely beneficial experience in that they were able to use well equipped science laboratories and work with highly qualified scientists. All pupils in all groups were clear in their desire to continue working with the DC into year 7 and saw how this work would support their learning and achievement.

"Now we can **do** science. It's so much more interesting and we understand more."

"It's [the project] really helped us enjoy science more, especially working with the Comp' teachers. We need to carry on working with Darwin into year 7. It would really help with our results."

"I think we should definitely carry on the project into year 7. At the Comp' there's more equipment, knowledge and experience so they could extend the level we've been doing the past three years."

Having this level of expertise to hand was acknowledged as very important and related to discussion surrounding pupil's developing understanding of complex science processes.

- **Changes in understanding:**

The level of subjective specific, scientific language all groups used was remarkably high. Groups confidently explained the problems related to global climate change and considered, in detail, the processes related to the acidification of the ocean. This language and the methods used across the project had become normalised and pupils regarded this high level of engagement an expectation.

"Normally when we go on a fieldtrip we measure wind speed, draw maps and use a compass – it's just what we do now."

"Marten [DC officer] will ask 'does anyone know what a hydrogen ion is?' and if anyone does they will put their hand up. But if they don't then he'll tell us. We're quite used to it because we've been on trips with him for three years. Darwin know so much stuff and we just use and understand the vocabulary. It's just what we do with them."

- **Changes in enjoyment:**

All pupils reported that they enjoyed science lessons more as a result of the project. Knowing about the fieldtrips and when they were planned was something to look forward to and made schools more enjoyable.

"The work we've done in year 5 and 6 with Darwin has really changed my mind about science. I really love it now.

"The project gives us something to look forward to each year. It makes school fun."

"We go on trips with school, but there never as good as the ones we do with the Darwin project."

Impacts:

With regard results, impacts on the case study are identified below:

Pupils:

1. Greater confidence to engage with and use higher level STEM knowledge.
2. Maintained and grew enthusiasm for STEM subjects at the end of year 6 with desire to continue learning in this way into year 7 and beyond.
3. More than expected improvements in attainment in English, Maths and Science, with greater improvements within the FSM group.
4. Positive experiences of outdoor learning and engagement with global learning and sustainable development which pupils found engaging and empowering**.**

Staff/ individual schools:

1. The project supported higher levels of attainment. The difference between year 4 targets and actual outcome at the end of year 6 in maths, English and science had greater gains in schools involved in the project, compared to those in the rest of Pembrokeshire.
2. Teachers recognised that the project positively supported the more disadvantaged and those pupils with Additional Learning Needs (ALN). Those pupils receiving free school meals (FSM) saw a greater increase in attainment in maths and science when part of the project, compared to those pupils receiving FSM in the rest of Pembrokeshire.
3. More pupils were actively engaged with environmental groups by year 6 - 60% more in 2018/9 as compared to 2016/17.
4. Pupils' subject knowledge in all areas associated with the project increased across the three years with the exception of renewable energy. Knowledge of global climate change and ocean plastic saw the greatest increase in understanding**.**
5. Pupils' enthusiasm for future STEM related employment and their enjoyment of science lessons has been maintained through the project, with maths being the most popular subject upon leaving primary school.
6. Pupils were more confident in using complex scientific language and communicating processes as a direct result of the project.
7. Teachers were more confident and enthusiastic in their teaching of STEM and their own subject knowledge. They intend to use and develop resources from the project in future years.

8. There was a significant increase in the collaboration between schools; especially with regard transition opportunities between key stage 2 and 3. This was positively welcomed and steps were taken to improve teaching and learning in key stage 3 as a direct result of the project.

Limitations of the project:

- **Inconsistent return of surveys**

Class numbers are fluid and it is accepted that over a three year study period there will be changes to the numbers of pupils. While this is reflected in the number of questionnaires returned, some schools fluctuated significantly in their response, for example one school returned 36 questionnaires in 2016/17 and then zero the following year while another returned 50, then 154. While pupil questionnaire data has not been gathered from the same pupils consistently across the study period, these results do indicate impact of the DC's work.

- **Inconsistent analyses of questionnaires due to complexity of methods used**

Analyses of the pupil questionnaire data by officers at Pembrokeshire County Council was undertaken. They reported that the methods employed with the survey were too complex for the project and so only 'before' survey data from 2016/17 was used in the report.

- **Financial changes**

During the project financial support was reduced for the project. This led to new restraints and the need for a reduction in the support the DC had initially offered schools in the form of a workshop on renewable energy.

Recommendations:

1. Continue to support all schools in the cohort for a further 2 years to ensure longer term legacy of the project; sustaining and developing subject knowledge, confidence and new pedagogies as the new curriculum is implemented.
2. Review, and where necessary update, the three resource booklets in line with any changes to the new curriculum as they develop. In this share further investigative / practical classroom experiments to support teachers in delivering this aspect of science related to themes of the project.
3. Continue tracking year 6 pupils (2018/19) into key stage 3 and 4 at Milford Haven School where long term impact can be monitored and focussed intervention developed with pupils familiar with the DC model.
4. Continue to track those pupils currently in year 4 and 5 into year 6 to enable long term evaluation of the project.
5. Review pupil questionnaires and seek advice on appropriate methodology before further data collection.
6. Consider expanding the project into a similar cluster of primary/secondary schools to transfer and refine the project before possible wider dissemination.
7. Consider ways of encouraging more sharing of good practice amongst schools and how this can be facilitated - the current shared site on HwbCymru is not used consistently and databases were put in place towards the end of the project. Their use should be monitored and evaluated.

Acknowledgments

The Darwin Centre would like to thank: all schools, the children and staff, who took part in this project; the financial support and ongoing commitment made by Dragon LNG and Pembrokeshire County Council to this work; Keep Wales Tidy for use of their litter picking equipment; the National Trust at Colby Woodland Gardens for allowing us to use their site and facilities free of charge; and Lydstep Beach Holiday Village for access to their beach and onsite facilities.

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