

Making science work in the new Curriculum for Wales

Figure 1 Exploring what lives on the rocky shore in year 6



Verity Jones outlines how the Darwin Experience has helped to provide scientific experiences that support the new curriculum

In 2017 I wrote an article for *Primary Science* and asked how teachers are to provide high-quality scientific experiences for young people in Wales when there is little focus on professional development or funding for science education (Jones, 2017). I noted that, since 2013, Wales has seen ongoing educational reform as, piece by piece, the new Curriculum for Wales (see *Weblinks*) has been introduced, with it becoming mandatory for primary schools in 2022. While this new curriculum hopes to build learners' skills and facilitate the application of their subject knowledge in local contexts, I argued that there was a need for examples of good practice to help others. Teachers are being asked to transform their practice and schools are encouraged to be flexible and autonomous in their approach to curriculum content and pedagogy based on local context. Titley, Davies and

Atherton (2020) note that teachers may not be prepared for this as there is a lack of confidence and subject knowledge in the work force as well as a lack of financial support for development. So, how can we move forward?

In 2017 I shared the work of the Darwin Experience, a small education charity in Pembrokeshire, Wales, with expertise in marine biology, science communication and education. With the financial support of local industry (Dragon LNG) and Pembrokeshire County Council, it had started a programme that it hoped would engage and enthuse pupils in science and help them understand complex scientific process, as well as increasing non-specialist teachers' efficacy in teaching science and supporting attainment. Five years on and I ask, what can we learn from this example as the Curriculum for Wales becomes obligatory?

Making the Curriculum for Wales work for science

Wales has seen a shift from a performance-driven education system to one focused on the learner (Evans, 2021). The aims of the Curriculum have 'four purposes'. Every child is seen as:

- an ambitious capable learner;
- an enterprising, creative contributor;
- an ethical, informed citizen;
- a healthy confident individual.

Traditional disciplinary subjects have been swapped for a curriculum organised around six Areas of Learning Experience (AoLE): Expressive Arts; Health and Wellbeing; Humanities; Languages, Literacy and Communication; Mathematics and Numeracy; and Science and Technology.

Within this new curriculum, it is the combination of science and technology as an AoLE and the core purpose of developing ethical citizenship that the Darwin Experience has focused on. It has aimed to take contemporary issues within science and give pupils opportunities to think critically, ethically and creatively. Learners have had the opportunity to develop and make informed decisions about their local contexts, and begin to establish a

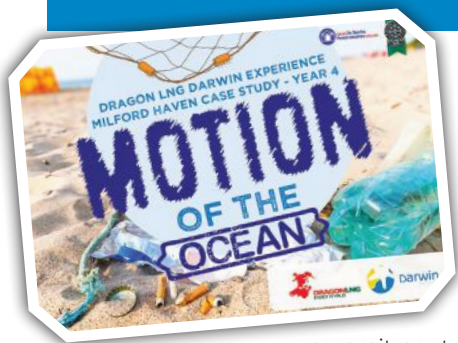


Figure 2 The 'Motion of the Ocean' workbook

commitment (whether individually or as part of a collective) to that locality through a three-year programme. So, what are the key themes that made a difference?

Working together for science development

Local partnership has been integral to the success of the programme. As a charity, the Darwin Experience is funded in part by the local authority and in part by a locally situated, global, private company reliant on science professionals. Dragon LNG is a re-gasifying terminal integral to the energy production of the UK, and major employer in the area. With Dragon LNG's financial support, the Darwin Experience has worked with a cluster of six primary schools. It paid for the development of teacher workbooks, transport to field trips and the time of Darwin Experience Officers across the three years. While a critical sponsor, Dragon LNG did not censor the content of the programme and the Darwin Experience was free to educate on all matters, including the negative impacts of fossil fuels and the need for alternatives. Apart from schools releasing teachers to join meetings in order to collaborate on the development of the resources (usually after school), this programme was free to schools. In recognition of their work, Dragon LNG was named winner of Business in the Community, Cymru's category of Responsible Business Award for Education, in 2016, and UK winner in 2017.



Figure 3 The 'Project Freshwater' workbook

Throughout the three years, regular meetings with teachers for feedback and evaluation of plans were critical. This was supported by the local authority who identified an officer to work with schools and assist with collaboration and feedback channels.

Working regularly on science themes

The programme began with pupils in year 4 (age 8–9) and followed the same three-stage process for this cohort for the remainder of their time in primary school (three academic years). Each year, the Darwin Experience provided the class teachers with a field visit, workshop and pre- and post- learning material. There was an emphasis on this being high challenge, with a focus on progression in skills and knowledge. Classes undertook preparatory work in the classroom with the teacher, using a bespoke workbook created for the project in consultation with teachers. The workbooks were drafted and shared with teachers prior to use in class and then edited based on teacher feedback.

In year 4, pupils were introduced to the theme of 'The Motion of the Ocean' (Figure 2). Classes undertook preparatory work, exploring how to interpret weather data and make simple field sketches. Each class went on a field trip to a local beach where the groups learned about tides and local weather and collected litter from the beach. The workshop in the classroom saw learners sorting the litter, researching the sources of this litter, tracking its journey, and discussing the issues surrounding ocean waste. Follow-up activities were provided and undertaken at the teachers' discretion.

As the same pupils moved into year 5 (age 9–10), they took part in 'Project Freshwater' (Figure 3). Classes were introduced to the topic through the bespoke workbook and then visited a freshwater river where they explored the biotic index, identified the fauna of the river, measured river speed using



Figure 4 Year 5 pupils exploring a river habitat

scientific methods and took more detailed field sketches (Figure 4). After the field trip, pupils explored different world rivers and the impact of pollution on these systems in a workshop led by the Darwin Experience.

As year 6 pupils age (10–11), in the third year of the programme, pupils were invited to 'Explore the Rocky Shore' (Figure 5). Learners were supported in their enquiries about rock formation and life cycles in the classroom prior to the field trip. The final field trip took pupils rock-pooling at a local beach. Learners were able to collect and identify marine flora and fauna. After the field trip, they had the opportunity to use microscopes to observe and identify marine life and consider the importance of phytoplankton and crab life cycles in more detail (Figure 5). Once again, a workbook was used to support teachers with ideas and plans for further learning.

Working to share experiences of science

To promote exchange and communication between pupils and teachers in the project, twice a year 22 pupils from across the programme were invited to the feeder secondary school. Here they worked with scientists to undertake a number of investigations. Pupils were then encouraged to share their experiences and learning back at school. This cascading of knowledge and skills was also promoted with the annual 'Science Aglow' meeting. All the schools met, shared their experiences of the project, engaged in hands-on activities and discussion around STEM, and learned more about employment opportunities within the disciplines. These activities provided important moments for pupils to share and learn from each other, supported transition to the senior school, and provided a space for teachers to evaluate the programme and learn from each other.



Working to measure success

I was invited to work with the schools and the Darwin Experience team to evaluate the impact of the programme; this was seen as crucial in order to ascertain the challenges and successes of the project. Over the three years, I analysed pupil attainment data in maths, English and science and undertook observations of fieldwork, analysed annual pupil and staff surveys and talked to pupils and teachers both in groups and one-to-one.

What was the impact?

Changes in attainment

Greater gains in maths, English and science were identified in those schools taking part in the programme, compared to other schools in the county. By year 6, targets set in year 4 had been exceeded: 12% of pupils exceeded their target in science, 8% in English, and 14% in maths (compared to an increase of 7%, 7% and 8% respectively by pupils in other schools in the county). Pupils eligible for free school meals were seen to make double the anticipated gains in attainment in maths and science when compared with those eligible for free school meals in other schools in Pembrokeshire.

Changes in confidence

All year 6 pupils in the group interviews reported an increase in confidence as a result of working on the project in years 4, 5 and 6, especially with regard to the skills needed to use scientific equipment and methodology. Pupils, unprompted, were able to confidently refer to methods used in fieldwork across the three years: quantifying litter, kick-sampling, pond-dipping, measuring the speed of a river, using an anemometer and a microscope. Participants talked about how they had initially '*felt nervous, unsure*' and

Figure 5 The 'Explore the Rocky Shore' workbook

Figure 6 Year 6 using microscopes to observe and identify marine life



even '*a bit scared*' when it came to river sampling and investigating rocky-shore habitats. However, they spoke of feeling '*more confident*', it being '*easier than I thought*', feeling that '*I could do it*', and '*now I can do science*'.

A number of pupils spoke of how the field trips offered an opportunity to do something they had never done before or go somewhere they had never been: *Without Darwin we don't get a chance to go on the trips ... how are we going to get our heads round these important ideas without them? It's important to see for yourself the place and what's really going on there.*

Teachers also recognised that through working with Education Officers from the Darwin Experience their own confidence grew in both subject knowledge and pedagogy with regard to the new demands of the Curriculum for Wales. The highest science qualification teachers in the group had was GCSE (usually completed at age 16 and a prerequisite for training as a teacher in the UK). While all teachers in the project said they '*liked*' or '*enjoyed*' teaching science, they all felt that their expertise and subject knowledge needed improvement. They reflected that it was beneficial to observe experts teach their own class. As one teacher put it:

It's great to be able to stand back and watch your class engage with an expert. I learn so much about the children, as well as pick up loads of new information and tips on how to teach these topics from the Darwin Team.

All teachers interviewed reflected on how their confidence had increased and that, having observed how the Darwin Experience team had arranged and implemented the fieldwork and workshops, they felt they would be able to deliver the trips independently, or with reduced support, in future.

Longevity

All teachers reported that they would be using the workbooks designed for the programme in future academic

years, and would explore the different activities further. Teachers from four of the six schools talked about how they had extended the amount of time they had initially set aside for the programme from a week to six weeks. They referred to the programme offering '*more than expected*' and '*linking with so many other subjects*.' These teachers all identified how the content of the programme was an approach that fitted with the new Curriculum for Wales. For example:

The cross-curriculum approach is just what we're looking to develop with the new curriculum. It's difficult to sometimes see how the subjects fit with the purposes, but these projects really pull out the ethical citizenship development.

There are explicit links [in the programme] to the new frameworks and the new purposes of the curriculum. Sometimes you just don't know where to start and this programme helps with that. It's really useful.

The new curriculum is challenging, but Darwin made some really explicit links to subjects and the purpose of children becoming more ethical in thinking and doing – this is going to be really useful. Next year I'll be spending a whole term on the project as I can see how we could do so much more.

Developing long-term relationships with external partners was valued and seen as a benefit of the programme. Through the annual engagement with the class, pupils were able to develop a relationship with the Darwin Experience team. Teachers and pupils saw them as figures of authority with knowledge that could be trusted. The annual survey indicated that science remained in the top three most popular subjects for the pupils, with maths coming out on top. Year on year, enjoyment of

science increased. Through these pupil surveys it was found that enthusiasm for science-related employment was maintained throughout the project and pupils could identify a wider number of science-related jobs in year 6. In addition to this, the pupil survey also revealed that 60% more young people were actively engaged in environmental groups and activities than at the start of the project, working towards improving their locality and mitigating some of the impacts of climate change. While it would be naïve to suggest that such agency was solely the response to the programme, many pupils in the focus groups referred to the Darwin Experience team as having inspired them to do more.

Changes in understanding

In one-to-one interviews, all teachers reflected on how pupils' use of subject-specific, scientific language after the sessions with the Darwin Experience team 'exceeded expectations', 'was really impressive', 'blew me away', and was 'beyond what I thought the children could do'. In group interviews, pupils confidently explained some of the processes that they had explored during the programme and reflected that it was an expectation to use subject-specific language:

[They] know so much stuff and we just use and understand the vocabulary. It's just what we do with them.

Many children used phrases such as 'quite used to', 'normally' and 'just what we do' when referring to how they talk about complex processes such as ocean acidification and the rock cycle, indicating that the objective of normalising complex concepts around science has to some extent been successful.

Changes in enjoyment

All pupils in the group interviews reported that they enjoyed lessons in school more as a result of the project. There were enthusiastic nods when asked and examples of responses include:

The work we've done in year 5 and 6 with Darwin has really changed my mind about science, how it links with other subjects,

how it's important to learn about how we look after the planet. I really love it now.

The enthusiasm for the sessions was linked with building confidence and understanding – recurring themes identified throughout the analysis. In addition to this though, pupils spoke about how knowing about the field trips and when they were planned was something to look forward to – this made school more enjoyable:

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

Going forward

This project still continues, with the Darwin Experience supporting schools to deliver the three-year programme of activities. What useful insights does our experience offer others who do not live in this area?

- Working with local industry can be beneficial to your school and potential support with finance and skills may help raise their profile and charitable status – it can be positive for both sides.
- External visitors who support the delivery of science can develop pupil and teacher skills and knowledge. As teachers, we need to use visits and visitors as opportunities to watch and learn for ourselves, as unofficial and ongoing professional development.
- Having a regular, shared programme of learning that involves either a local visit, and/or expert visitor to class, can develop enthusiasm for wider learning and school as well as improve attainment for some vulnerable groups.

The success of this programme seems to be dependent on relationships with others: with other schools, with statutory bodies (in this case the local authority) and with other institutions

(in this case the Darwin Experience). It is also dependent on a shared vision of value by teachers and pupils: teachers and pupils both valued their increased confidence, enjoyment and enhanced skills. Identifying these has been important to the ongoing success of the project.

The first phase of this programme is now over. Phase two of this research plans to follow the progress of this cohort through key stage 3 and into key stage 4, looking at GCSE choices and attainment of the 12–16 year-olds. This extension of the enquiry will provide much-needed insight into the longer-term impacts of such programmes and will allow for what Banerjee (2017) recommends: financially supporting those activities that have been identified and are known to provide positive outcomes, thus providing more strategic and cost-effective education. With the Welsh Government demanding a more autonomous approach to curriculum design, such activities and values may be unique to each area. However, identifying whether there are patterns of success that can be shared among and beyond locations is essential to the successful implementation of the new curriculum. Phase two of the research promises interesting future discussion, as the cohort of learners move into senior school and the support offered by the Darwin Experience, local industry and local authority continues.

Verity Jones is an Associate Professor at the University of the West of England, Bristol.
Email: verity6.jones@uwe.ac.uk

Weblinks

The full report is available at: <https://en-gb.padlet.com/darwin15/6irkmy0gstl5x1gb>

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