Prifysgol Abertawe
Swansea University

Project SIARC School Outreach Report

Cronfa Treftadaeth Heritage Fund
Mewn Partneriaeth â Llywodraeth Cymru In Partnership with Welsh Government
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ON THE EDGE
Cyfoeth Naturiol Cymru Natural Resources Wales
ZSL Zoological Society of London

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Summary

Project SIARC (Sharks Inspiring Action and Research with Communities) delivery partners Swansea University, Zoological Society of London (ZSL) and Natural Resources Wales (NRW) have worked together to design and deliver a successful school outreach programme, focused on introducing 3D printing for schoolchildren to learn about elasmobranchs (sharks, skates and rays). The project focused on Project SIARC's flagship species, angelshark, spurdog, common stingray and tope. Ten participating schools (both English and Welsh language) located close to the Carmarthen Bay and Estuaries Special Area of Conservation (CBAE SAC) have fully engaged in the Project SIARC School outreach programme, with 11 classes showcasing their displays at the National Botanic Gardens of Wales (NBGW), involving around 400 pupils. Some of the home educators using the education facilities at NBGW and two additional schools were involved with the outreach programme initially but were not able to complete all of the activities and create a display. The initial project targets have been met and a number of additional positive impacts were observed during the delivery phase.

Introduction

Project SIARC aims to catalyse links between fishers, researchers, communities and government to collaborate and safeguard elasmobranchs and support a green recovery in Wales. A key objective of the project is to inspire the future generation to safeguard the marine environment, by providing a range of interactive sessions with schoolchildren aged between 7 and 11. Using flagship species, Project SIARC has worked with diverse school groups in and around Carmarthenshire, to inspire, engage and interact with pupils as well as the wider community to improve knowledge of elasmobranchs.

To extend on the Meet the Scientist sessions created by ZSL and NRW, as part of Angel Shark Project: Wales, the project team at Swansea University, Faculty of Science and Engineering have designed an outreach programme with a wider range of activities to enrich the learning process. The programme starts with a meet the scientist session (delivered by ZSL/NRW) to learn about elasmobranchs and is then followed by a 3D printing workshop to develop knowledge and skills in 3D printing. Each class are tasked to create a Welsh Marine Environment display, utilising what they have learnt. The participating classes are also provided with ideation and creative display design support sessions. In addition to teaching pupils about elasmobranchs, the aim of this programme was to support primary schools to deliver engaging STEM sessions, introduce digital engineering tools such as 3D printing and provide the resources and scope for an open-ended interdisciplinary project, which supports the new curriculum for Wales. Project displays were exhibited in The Great Glasshouse at NBGW, where the participating classes were given the opportunity to share their knowledge and inspire visitors to safeguard and celebrate the Welsh marine environment.

People involved

Schools

Primary schools taking part in the programme have been able to provide an opportunity for pupils to learn about their local marine environment and, in parallel, use this project as a platform to introduce digital engineering tools such as 3D printing, into the curriculum. The programme includes a number of activities which can be used as a part of in-class teaching and/or after school clubs. These activities have also provided opportunities for pupils to develop skills such as teamwork, communication, organisation, problem solving and creative design and, most importantly, for pupils to recognise their own capabilities and have fun. Schools and education facilities in CBAE participating in the Project

SIARC Outreach Programme are shown on the map given in Figure.1 and the participation summary is given in Table. 1:

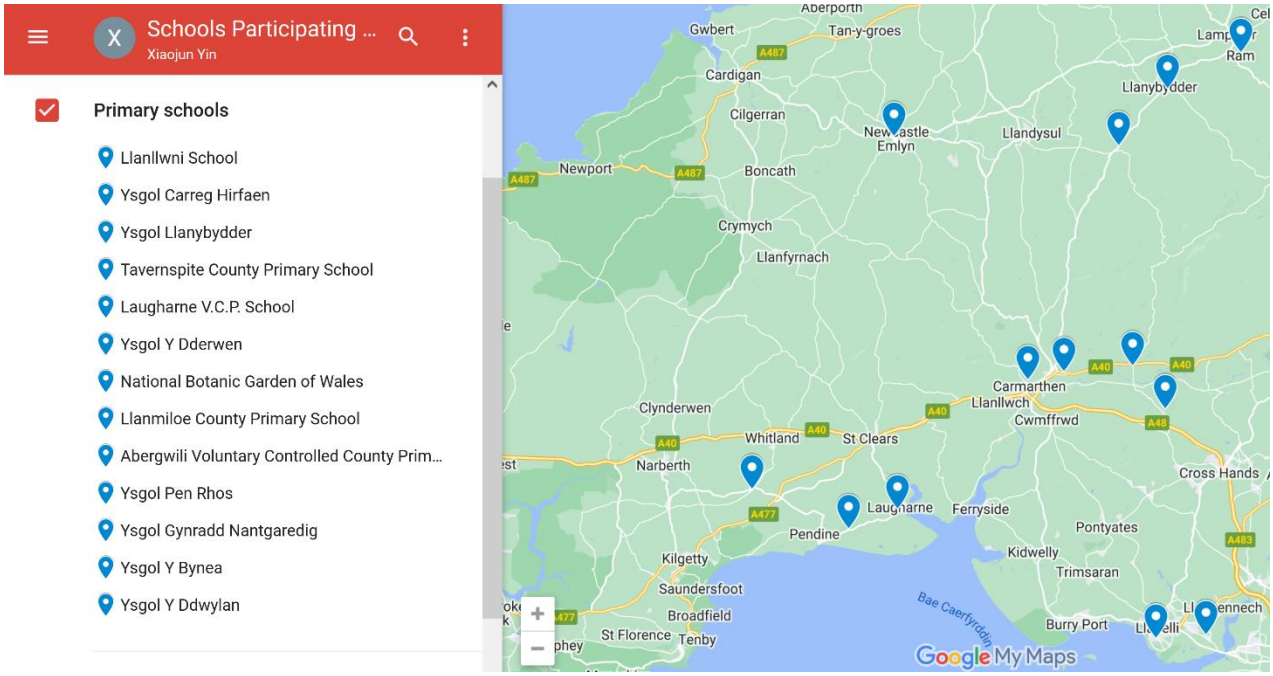


Fig. 1 CBAE School Participation Map

School	Language Medium	No. classes participated	Age of pupils	No. pupils participated	Display phase	Display date
Llanmiloe County Primary School	English	1	8 to 11	23	Phase 1	25/10/2022
Abergwili VC County Primary School	Welsh	1	7 to 11	19	Phase 1	26/10/2022
Ysgol Gynradd Nantgaredig	Welsh	1	10 to 11	30	Phase 1	26/10/2022
Tavernspite County Primary School	English	1	10 to 11	30	Phase 1	24/10/2022
Ysgol Pen Rhos	English and Welsh Classes	2	10 to 11	83	Phase 2 and 3	08/12/2022 16/02/2023
Ysgol Carreg Hifaen	Welsh	2	10 to 11	60	Phase 2	05/12/2022
Ysgol Llanybydder	Welsh	1	9 to 11	35	Phase 2	05/12/2022
Laugharne V.C.P School	English	1	8 to 11	30	Phase 2	08/12/2022
Ysgol Y Dderwen	Welsh	3	9 to 11	90	Phase 2	07/12/2022
Llanllwni School	Welsh	1	8 to 11	23	Phase 3	16/02/2003

Table. 1 Summary of schools with full participation

Swansea University Team

A small team from the Faculty of Science and Engineering at Swansea University were leading the Schools Outreach Programme for Project SIARC, in coordination with the wider Project SIARC team:

Xiaojun Yin (Ping) – Project Lead

Helen Lewis – Project Coordinator

Dimitris Pletsas – 3D printing support

Peter Dorrington – 3D printing and digital engineering tools expert

Each school was supported by the Swansea University team, who visited the school regularly to help support the teachers and pupils in the 3D printing aspect of the project as well as ideation and creative design sessions.

Zoological Society of London (ZSL) & Natural Resources Wales (NRW) Team

The ZSL/NRW team was responsible for delivering the Meet the Scientist Zoom sessions and providing educational resources for elasmobranchs and the marine environment.

Jo Barker (ZSL) – Project Manager

Jake Davies (NRW/ZSL) – Project Coordinator

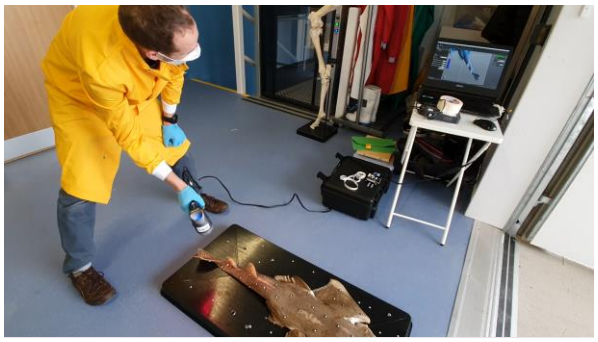
Sarah Davies (NRW/ZSL) – Project Assistant

National Botanic Gardens of Wales (NBGW)

NBGW hosted the final displays created by each school, in the impressive Great Glasshouse. As well as being a host, the Education Department at NBGW also took part in the Project SIARC Schools Outreach Programme directly. Due to the drop-in format of the NBGW education provision for home educators, the children taking part were not able to create a display of their own, however several children and their parents/carers were able to use the displays created by the participating schools as a learning activity.

Wider Project SIARC activities

The Swansea University team was able to utilise the opportunity of the dissection event organized by Project SIARC and hosted by Aberystwyth School of Veterinary Science, to laser scan two angelsharks prior to dissection. This work is in addition to the initial project plan and proved to be valuable in providing real and accurate geometry for the 3D printing aspect of the school outreach programme. Geometry obtained from the laser scanning was processed by the Swansea University team and scaled so that schools had access to this information for the 3D printing element of their display. The geometry information obtained from the laser scanning could also be potentially used by other research teams working on Project SIARC in various ways.



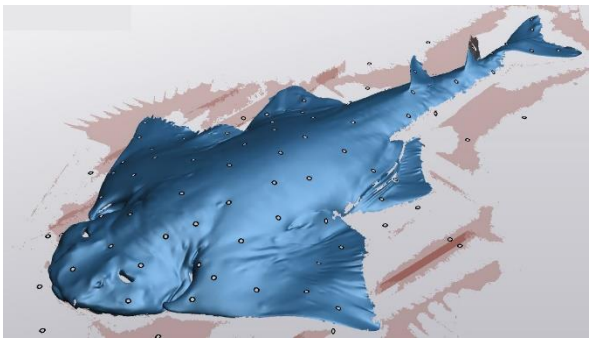


Figure. 2 Shark Scan image ***Figure. 3 Shark Scan Geometry***

Working with The Shark Trust and North Wales Wildlife Trust, the CBAE schools were also encouraged to participate in the Great Eggcase Hunt, to link with wider citizen science work delivered by Project SIARC. Information and resources were sent to the schools so they could adapt the activity to suit their own teaching and curriculum.

Outreach activities and outcome

Meet the Scientist Sessions

The Meet the Scientist Sessions have been delivered by ZSL/NRW online, via Zoom. During these sessions the team taught pupils about elasmobranchs, especially those species residing along the Welsh coastline. At the end of each session the team answered questions related to these species and our marine environment in general. Even though the zoom delivery is quite challenging, the level of interest and engagement is apparent, and the pupils typically had a lot of questions at the end of the sessions. Whilst better interaction and engagement are expected if the sessions were in person, the zoom sessions have been very effective in inspiring interest in the topic and prompted the pupils to conduct further research to learn more.

All of the participating schools were given questionnaires prior to the Meet the Scientist session and also after the session. Five of the schools returned the questionnaires, although not all of the participating pupils have completed them. Six questions are the same on both questionnaires, aimed to verify pupils' knowledge of the subject matter before and after the session. For all of these questions there is a percentage increase for the correct answer from the post-session questionnaire, ranging between 2% to 41%. Another common question on both questionnaires asks, 'would you like to study marine life found off the Welsh coast'. 82% of the pupils who returned the pre-session questionnaire said 'yes', or 'definitely' and 97% said 'yes' or definitely on the post-session questionnaire. The Meet the Scientist session received very positive feedback from the pupils, all of them returned positive comments to the question 'what do you think about the Meet the Scientist session?'. The most common words from the answers were good, fun, interesting or cool. Some of the more descriptive comments from pupils were:

'we got to learn about sharks and it was fun and interesting to learn about sharks!'

'really cool, full of fun and information about sharks'

'I was quite amazed! She knew a lot more about sharks than I did so it taught me a lot!'

'I thought it was really good because I didn't know all this things about sharks and it has lots of information'

It was observed that the Meet the Scientist sessions sparked an interest in sharks, Welsh marine life and inspired the pupils to do further research on these topics, especially angel-sharks. As a part of their display, majority of schools had poster boards with informative content on angelsharks. In addition, a number of schools also produced informative leaflets, QR codes linked to more information, presentations and one school even made a laminated book on angelsharks. The project team and the visitors who engaged with the displays have all been impressed by the level of detail of the information presented. This was a clear indication that the pupils had done their own research in

addition to what they had learnt from the Meet the Scientist sessions, and the displays were a great way to demonstrate the rich learning outcomes. Figure. 4 shows a display from one of the schools focusing on shark skin. Figure. 5 is a leaflet one of the schools produced.

Figure. 4 Display showcasing knowledge of shark skin

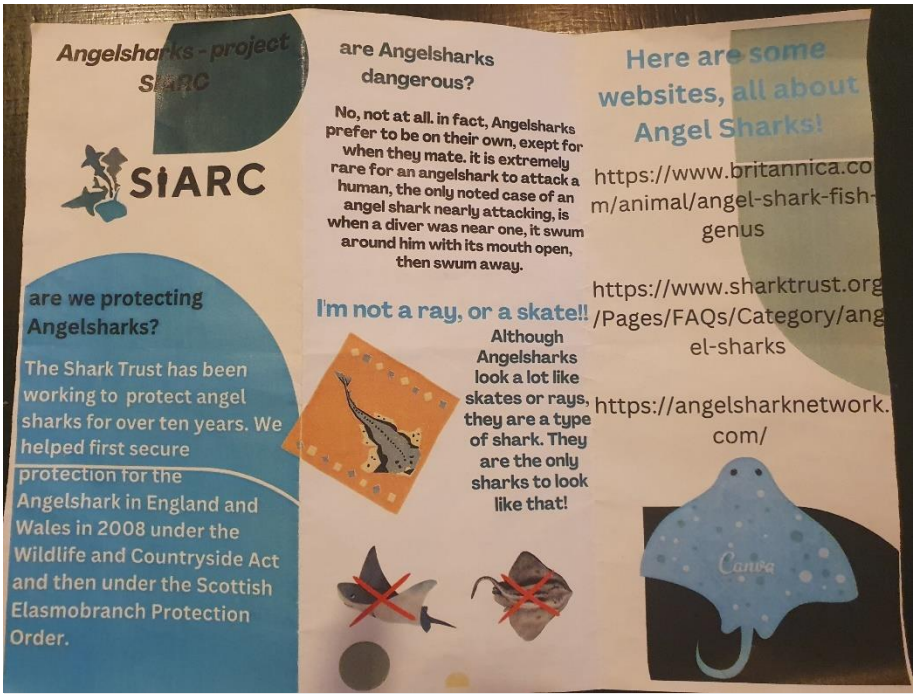


Figure. 5 Leaflet created by a participating class

3D Printing Workshops

3D printing was designed to be used as a tool to help schools to create objects for their display of the Welsh marine environment. A key feature of the display included a 3D printed angelshark, with the geometry obtained from the laser scan. To support the schools with this, the Swansea University team delivered 3D printing workshops with the classroom teachers and pupils. Equipment and printing material were provided as a part of Project SIARC activities. These sessions were aimed to help teachers and pupils develop skills in using the software Tinkercad to create 3D designs and a different software to convert the geometry into a 3D printing compatible format, then 3D print the final

product. A number of schools have developed very good 3D printing capabilities and were able to design their own objects and 3D print with confidence.

Figure. 6 School 3D printing work

Feedback from the 3D printing questionnaires from five schools indicate that only a small proportion of the pupils have not seen or heard about 3D printing previously, including several pupils who have used a 3D printer previously. Only 3% of pupils did not enjoy the 3D printing sessions, the majority have enjoyed all aspects of the sessions. When asked 'what have you learnt from the 3D printing sessions?' and 'what do you think about the 3D printing sessions', all of the comments were very positive, indicating that the classes have really enjoyed the sessions:

> *'I enjoyed it and it was very interesting it was like using lego to make very cool stuff'*
>
> *'I extremely enjoyed every bit of it, especially designing on Tinkercad!'*
>
> *'Very amazing and I want to learn more :D'*
>
> *'I learn that you can make a lot of useful stuff with 3D printing and I loved the sessions'*
>
> *'I think its fun to build stuff online and make it real! you can build anything you want, you could even build decorations for halloween or christmas! and its also cool that when were older we can add coding to tinkerpad'*

Some of the comments also indicate that there is a sense of empowerment for pupils to learn to use a tool which is perceived as hard, contributing towards an important task or taking responsibilities:

> *'that it isn't hard to create things and you can have fun while doing it'*
>
> *'you can make anything. you can design loads of useful and fun objects'*
>
> *'I learnt that its quite hard to make something! but its a cool experience'*
>
> *'It was really good I learnt a lot from the 3D sessions and I am a master at 3D printing now and I helped print the angelshark'*
>
> *'It was an amazing experience. Me and my friend were in charge of the 3D printer for a while and we both learnt a lot.'*

The Swansea University team have observed that all of the classes were able to 3D print objects after the 3D printing sessions. Some classes have developed confidence in creating their own designs in Tinkercad, converting these files into a 3D printable format and managing the printing process. One of the classes wanted to create a lighthouse as a part of their display. The pupils managed to design and 3D print the necessary structural elements, which extends the range of STEM skills being developed through this project. Some of the classes worked together and applied their teamwork and organisational skills in managing the 3D printing process. One class in particular, upon recognising that the 3D printing could take hours depending on the size of the object, had even organised a timetable and schedule for the printing activities so the class could print all the objects needed for their display in time.

Figure. 7 Pupil proudly showing their 3D printed sea creatures

3D Printing Teachers Training

As a part of the Project SIARC activities, the Swansea University team delivered teacher training sessions for 3D printing upon request from individual schools. These sessions provided opportunities for schools to strengthen their capability to deliver learning activities using 3D printing. Most of the participating schools have received teacher training for 3D printing. The teachers have all really enjoyed learning about 3D printing or further developing their existing skills. One of the teachers commented that it was the best day of school for him.

Display Creation

To showcase what the children have learnt about their local marine environment, each class was tasked with creating a 3D display. The display requirement was based on the space available in the Great Greenhouse, but was otherwise non-restrictive to encourage creativity. The Swansea University team worked with each school to support the participating classes with ideation, creative design sessions and 3D printing trouble shooting. This was a great opportunity for the children to get creative, utilising their arts and crafts skills, their ingenuity with the 3D printer and draw on their knowledge of the Welsh marine environment to establish the best way to communicate their gained knowledge through artwork. The display creation was a truly multidisciplinary activity, which showcased rich learning outcomes exceeding any expectations and the creation process has been hugely enjoyable for teachers, pupils and the Project SIARC delivery team.

The displays included:

- Seascapes
- Poster boards
- Leaflets
- Presentations
- QR codes for further information
- A book with a fictional story based on angel sharks
- Poems
- Games on paper for other children to complete
- Computer games based on angel sharks
- Animations and films
- A game to fish plastic from the sea
- An adapted Welsh song ‘Yma o Hyd’ based on the angel shark
- A puppet show
- A shop selling 3D printed objects of sea creatures
- Handmade embraided items

Figure. 8 A book and handmade bags for the display

Figure. 9 QR codes to find further information

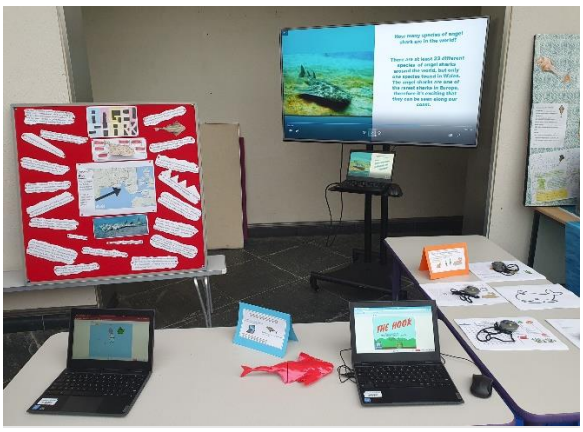


Figure. 10 Display board, presentation and games

Figure. 11 Puppet show for display

Figure. 12 Display with animated film

Figure. 13 Welsh seascape display in a glass box

Figure. 14 A school singing their adapted version of Yma o Hyd (Still Here) for angelsharks

Figure. 15 Fishing game to clear plastic

Figure. 16 Lighthouse for display

NBGW Display Day

The displays were presented to visitors of the Great Glasshouse at NBGW. Each participating class had a designated display day, during which they were responsible for running the displays and answering questions from passers-by. This was great opportunity for the pupils to engage with the wider community and share their knowledge of their local marine environment, especially what they have learnt about elasmobranchs. All of the classes were fantastic at engaging with the general public, their enthusiasm and passion for their marine environment were very inspiring.

Quote from a member of the general public

> *"What a wonderful project which amalgamates engineering skills, scientific knowledge, care for the environment and creativity! I can see that the children have got a lot out of this and their knowledge and how they have communicated it is incredible!"*

Quote from a school teacher

> *"The children have really thrived today! After feeling nervous about the thought of speaking to strangers, they have all managed to speak to multiple visitors and told me how much they enjoyed doing so. It's been a really lovely day watching those who don't always have the confidence to speak up, or who don't usually push themselves forward, telling others about their work on the angel sharks and our marine environment. I love the trip for that reason."*

Additional Impacts

The Project SIARC School Outreach Programme has met all of the initial targets set and was overwhelmingly well received by teachers, pupils and visitors who engaged with the displays. The project team have learnt with and from all the relevant parties taking part along the way. There were a number of unexpected outcomes and impacts, which are very positive.

For education

The new Curriculum for Wales has brought about several changes to primary education, and schools were required to implement the new curriculum from September 2022. This new curriculum shifts away from a relatively prescribed content-based national curriculum to a purpose-based broad framework, within which schools are to design their own curriculum. It is intended to be

interdisciplinary in nature and designed to promote a rich and varied learning experience. Verbal and informal feedback from a number of teachers taking part in the Project SIARC Outreach Programme have indicated that the activities and open-ended nature of the display project have supported the teachers in the transition to the new curriculum. One of the teachers commented:

> *' This is what the new curriculum should be about'*

The 3D printing teacher training sessions were an additional activity. The sessions have provided teachers with more confidence and helped schools to improve their digital technology capabilities.

For Pupils

From surveys and observations, all of the pupils really engaged with the project in one aspect or another and it appears that the majority of pupils enjoyed all of the activities.

Quote from a pupil

> *'I really enjoyed the project because we got to 3D print the sea animals and we got to learn that there's a rare species of shark in our sea'*

Some of the activities really attracted pupils who were not as engaged with normal teaching activities. It was also observed in one of the classes, a couple of pupils who were often sent out of the classroom for disruptive behaviour have particularly taken to 3D printing, they ended up taking responsibility for the 3D printing and really thrived at this task. In other classes, it was observed that pupils who were not socially confident had gained confidence through developing skills in 3D printing, or being creative, such as making an animated story, based on angelsharks, or through talking to the general public about their newly acquired knowledge on sharks. A pupil in one of the classes had additional learning needs (ALNs) and requires additional support in order to participate in learning activities. The individual was fascinated by stingrays and worked very hard to make a stingray for the display using a recycled paper plate.

Even though the project team had expected the activities to be fun and engaging for pupils, the different layers of rich learning experience provided by the activities and the learning outcomes still came as a surprise. We have all learnt a lot from the children and their energy, passion, creativity and ingenuity have been an inspiration for us all.

Engagement with the community

The Outreach Programme had intended to utilise the displays created by schools to engage with the general public, to raise awareness and increase knowledge of the elasmobranch species found in Welsh waters, especially angelsharks. The project team did not put any specific targets on the engagement with the communities and the general public at the start of the project, as the resources were focused on inspiring future generations and working with schools. However, it was anticipated that there would be some level of engagement through the displays. The school displays were exhibited in the Great Greenhouse at NBGW, with the presence of the participating classes for seven separate days. Some of the displays were available to be viewed by visitors for a further 10 days at the end of Phase 1 and 2, without the presence of school children. It is estimated that a minimum of 500-600 members of the general public engaged with the displays. In addition, it was apparent that the pupils taking part in the project had talked about angel sharks with their own families and the project team living in the area have been approached by parents on numerous occasions, some of whom they have not previously met, saying how much they have heard about angelsharks through their children.

Future work

Throughout the delivery of the outreach programme, the Swansea University team worked closely with teachers and teaching assistants from the participating schools. Any informal feedback was noted and, where possible, the team have already adapted the outreach activities to suit the individual needs of the school. Both formal and informal feedback was generally very positive, with some of the comments from teachers given below:

> *'Learning about the angel sharks - appearance and habits to feed into the 3D printing was useful. It also took the 'fear' out of the word 'shark' for my pupils'*
>
> *'It was a great opportunity for the children, they learnt a lot. As a teacher, I was pleased that the scientist could answer the difficult questions the children were asking!'*
>
> *'The children thoroughly enjoyed the entire project. I was extremely impressed with their knowledge about angel sharks.'*
>
> *'Thank you for the session. It complemented the rest of the project brilliantly.'*
>
> *'Thank you so much for allowing our school be a part of such an exciting project. The learners learnt so much about real-life, current issues and thoroughly enjoyed.*

Some of the schools expressed that they would be interested in getting more Welsh language resources and a variety of resources in general. Some of the schools expressed an interest to adapt VR experience into the programme and would like the meet the scientist sessions to include more topics, such as dissection. This feedback has been taken into consideration in the application for the Project SIARC Phase 2 school outreach package of work. If funding and resources are available, the project team would also like to be able to evaluate and quantify some of the additional outcomes observed during Project SIARC Phase 1, especially in the area of Equality, Diversity and Inclusion (EDI). It would be interesting to study if the outreach activities have an impact in engaging pupils with ALNs and/or otherwise disengaged, and what the team could do to improve in this area. The findings could pave the way for future outreach projects.

All of the project team have really enjoyed working on this outreach programme. Seeing the children's passion for their marine environment, watching them thrive in the activities, pushing themselves and developing skills beyond our imaginations has been very inspiring for us all. We would all like to continue to develop the programme and reach out to more schools and different communities.