Ocean Connections Pilot 1 Evaluation
National report ENGLAND

Project details

Intellectual output/deliverable

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Introduction

This report synthesises learning from the initial data collection for the UK Pilot 1. It should be noted that the pilot was curtailed as a result of the COVID-19 pandemic and resulting school closures so some of the teacher's plans could not be carried out. A summary of these intentions is included in a coda to the report, to inform planning for Pilot 2.

Pilot 1 was conducted with 60 Year 5 (aged 9-10) pupils from Leigham Primary School in SW England. The Pilot was planned to begin with a visit to the local aquarium focusing on how ocean organisms are adapted to survival in the Ocean. Teachers planned to build the pilot project on the students' own questions that arose from their experience of the aquarium site, with ongoing liaison with the education team at the aquarium to seek further expert responses to questions. The intention was for pupils to use the Ocean Connections VR tool to maintain connection with the space following the visit to the aquarium by recording their questions, findings, explorations, responses and further questions as a learning journey within the VR space. Unfortunately, this final aspect of the pilot was curtailed by the pandemic. (For more detail about the content of this pilot, refer to IO3: Toolkit, Example UKP1)

Data was collected by researchers from the project across four visits, one to the aquarium and three to the school during 'Oceans' lessons, which took place on Monday afternoons from January 21st to March 20th (when schools closed due to Covid-19). Data sources include a pre-post questionnaire, pupil focus group interview, field notes and photographs. Note that for the UK, the post questionnaire was a much smaller sample as it needed to be conducted on site for pupils to be able to engage with it and so could only be completed with the small number of 'key worker' children still attending school during lockdown. Please note that once all pilots have been completed, the teachers will be interviewed and their perspectives included in the final evaluation report.

The report is laid out according to the different strands of evaluation undertaken, the questions framed within each strand, and relevant themes identified within the data. These themes are driven by both the educative principles underpinning the project (see IO1: State of the Art Synthesis Report) and emergent themes that arose during the piloting of the projects.

STRAND 1: Evaluation of pupils' outcomes in terms of learning about, and attitude to, Ocean Literacy

1a. What do pupils learn about OL through engaging in the pilot projects?
Within the educative principles identified for the project were four core strands of ocean literacy common to the curricula of England, Denmark and Spain:
1. Humans and the Ocean are inextricably linked
2. The Ocean supports a great diversity of life and ecosystems
3. There is one big Ocean
4. The Ocean is a major influence on weather and climate

Questionnaire analysis indicated that children built on having learned about plastics, pollution, 'seas' and general learning about the ocean, to more nuanced predominantly fact-based learning around OL focused on for example: penguin habitat and capabilities; ocean-life tracking practices; the fact that we have only explored 5% of the Ocean; there is one big ocean and 5 ocean basins. When asked how much they had learned from the project 71% (5) UK students reported quite a lot and 29% reported a lot, none felt they had only learned a small amount. The questionnaire analysis also shows that on OL knowledge checking questions the UK cohort (7 pre- and post-) showed some knowledge improvements with 6 students (86%) correctly responding that there is one ocean that is large, finite and has limited resources compared with 18 (40%) of students before the pilot; and all students responded correctly that there is a declining population of ocean animals, compared with 23 pupils (51%) before the pilot. This learning is re-iterated in the children's qualitative responses detailed below.

The evidence in this pilot suggests that pupils' learning focused on two of the four Ocean Literacy aspects included in the Ocean Connections educative principles: that **humans and the oceans are inextricably linked**, and that the **Ocean supports a great diversity of life and ecosystems**. In this pilot, the planned learning had not focused on the One Ocean or on Weather and Climate, though the questionnaires showed that pupils had learned that there is one ocean with finite resources.

Following the pilot project, pupils understood some important facts about the relationship between humans and the Ocean in terms of the impact of the Ocean on humans, stating that "about 50% of our oxygen is from the ocean" (FG, MO, UKP1, p3), and that humans impact the Ocean "…microplastics [in the ocean] mostly come from clothing" (FG, MO, UKP1, p4). Pupils also connected this inter-relationship to a sense of responsibility for and empathy with the Ocean "If I was the ocean and I haven't got hands or anything to pick up the litter, so obviously the humans have to take care of the ocean as well, like treat it like you would like to be treated" (FG, MO, UKP1, p11).

Teaching about the principle '**The Ocean supports a great diversity of life and ecosystems**' was evident in data collected during field visits, largely focused on diversity and adaptation to the environment. For example, vocabulary and grammar had been taught using Ocean examples relating to diversity (See Photo 1), and pupils undertook an activity linking learning from the aquarium visit to exploring the diversity of animals on the local UK coastline: "[pupils] were challenged to find out about or take photographs of the diversity of animals on the UK coastline. This lesson, I arrive as they have just started looking at pictures of animals and other organisms that live nearby on Cornwall's coast." (FN, UKP1, L, p1).
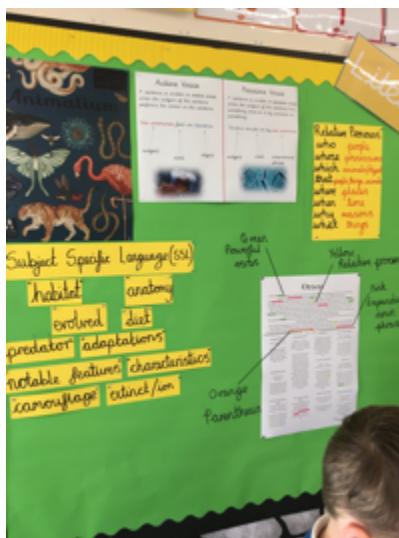
Photo 1: (Ph, UKP1, L1-4)

It is interesting to note that the teaching aimed to connect from the aquarium to the coastline, since the aquarium visit focused on key organisms in each display (Penguins, Seals, Otters, Stingrays, Seahorses etc) rather than their inter-connectedness (see Photo 2, Penguins)

Photo 2: (Ph, UKP1, LC-6)

In terms of this Ocean Literacy principle, then, the pupils' learning at KS2 was primarily focused on the topic of adaptation (linked to the KS2 National Curriculum in England), drawing on marine examples to link this to diversity as an Ocean Literacy principle: "[the teacher] has introduced a set of questions about adaptation,

trying to twist the curriculum to the marine animals as well as local examples. She then shows a brief video to explain some of the way organisms are adapted to the deep sea environment." (FN, UKP1, L2-1). However, during the field visits, the relationships between organisms within an ecosystem was not noted as a focus, and the researcher noted during field visits that "It is interesting that the marine examples are largely animal rather than plant-based." (FN, UKP1, L2 p2, researcher interpretive memo).

One theme that emerged from the data that was not derived from one of the Ocean Literacy principles that are the focus of this project was the **unknown, unexplored, large scale of the Ocean**, with pupils discussing in a focus group interview about their new knowledge that only "5% of ocean has been explored" (FG, MO, UKP1, p 4)"; "3.7km [is the] range of the depth [of the ocean]" (FG, MO, UKP1, p5) and "It's huge" (FG, MO, UKP1, p5). It is interesting to speculate whether there is a relationship between pupils' perspectives about the huge scale and unexplored nature of the ocean and pupils' perspectives about how concerned we need to be about keeping the Ocean clean, and their sense (or otherwise) of environmental responsibility. This may be something to consider exploring further in Pilot 2 and across the different settings with different curriculum contexts.

1b. What impact does engaging with the pilot projects have on pupils' attitudes to the Ocean, and to environmental responsibility?
[Data sources: Semi-structured focus group interviews with pupils; Questionnaire]

From the questionnaire data, there is no clear statistical impact – comparing pre and post - in the items asking about perceived importance. However qualitative data from both pre– and post- questionnaires shows that students find those issues quite important. In the pre-questionnaire, 73% (33 out of 45) felt issues like air/water pollution and climate change were important. This view was rooted in: empathy with animals (44%), taking care of the planet (34%); concerns for the future and survival (20%). Although one student felt that "it has not really ever affected me". UK students' perception of recycling and environmentally friendly products from the pre-questionnaire was that 71% (32 out of 45) found it very important, with only 4% (2 out of 45) finding it not very important. The most common reason given for this being important from 32% of the listed responses was that children felt a need to stop killing/damaging/extinction.

Their qualitative perceptions of pollution/recycling and climate change from the post questionnaires were insightful, even if numbers were too small to offer statistical significance. UK students reflected on how: the Ocean sustains us, it takes up most of the space on Earth, pollution threatens the sea and animals; we threaten ourselves and others if we don't look after the world; how plastic waste is a key threat; air and water quality are important; that "there is no planet B!). One child reflected that it's not really important because "it's being dealt with".

When responding to questions regarding how often they talk with their families about environmental issues, the dominant choice was 'only a few times', with 26 of 45 of UK students indicating this choice in the pre-questionnaire, and 6 indicating they talked about it every week. Then 5 out of 7 in the post-questionnaire indicated 'only a few times', with 1 indicating they talked about it every week. However, with the size of the 2nd questionnaire cohort it is difficult to draw concrete conclusions from this.

Pupils were clear that it was important to take responsibility for the environment, "you're responsible and like looking after our planets and our oceans" (FG, MO, UKP1, p 9). Participating in the project had also changed some of their perspectives on this key issue, as noted by one pupil in the focus group interview, "I see it in a different way, because before I didn't know this much about it and I didn't know how important the oceans were, but now I know so I'm going to take more care." (FG, MO, UKP1, p20)

More specifically, two key themes emerged in the pupils' attitudes: they planned to **change their behaviour in order to be more environmentally friendly:** "…in January I didn't agree, like I didn't really care about littering in the ocean and now I've found out more now, now I know we need to take care of our ocean and stop littering" (FG, MO, UKP1, p19), and "I used to just put everything in the brown bin but now I realise how much is destroying the ocean I put it in the right bins now." (FG, MO, UKP1, p20). Some of these changed attitudes

and behaviours appear to be linked to a perception of **the Ocean as a living thing,** as indicated by the following quotes: "the ocean can't [pick up litter] for itself, and like animals can't do it, so it's kind of all over to humans to do it." (FG, MO, UKP1, p11); "it's such a bigger deal because you wouldn't like to be treated that way." (FG, MO, UKP1, p20), and "[I feel] quite sorry for it because people just litter and litter in it." (FG, MO, UKP1, p20). This element of the students' learning is connected to the creative pedagogies feature '**individual, collaborative and communal action for change'.** In future pilots it would be interesting to explore the link between the Ocean as a living 'being' that pupils can empathise with, and the OL principle that 'humans and the oceans are inextricably linked. It would also be interesting to explore (potentially with the VR tool) the relationship between this perspective and the pupils' learning about the scale of the Ocean. Is it harder to empathise with the Ocean as 'alive' when it is hard to comprehend its size and scale? Or does it make no difference?

1c. To what extent is this impact (on learning/attitudes) maintained over the short and medium term?

[Data sources: Semi-structured focus group interviews with pupils]

It is difficult to respond to this question with the level of depth we had anticipated, due to the disruption to the pilots cause by COVID-19 and the resultant impact on the planned pre-test, immediate post-test, delayed post-test questionnaire design. However, the focus group interview yielded some insight into the pupils' perceptions of their learning. The UK Pilot 1 took place on an afternoon each week for 2 months, and pupils felt that this regular sequence of lessons was notable: "I think it's kind of different because we wouldn't have learned this many facts about the ocean just like in one class. And I found it was a bit more fun to learn more stuff." (FG, MO, UKP1, p12).

Strand 2: Evaluation of pupils', teachers' and aquarium educators' perspectives on the innovation (combination of digital technology and creative pedagogies for teaching OL)

2a. What are participants' (pupils, teachers & aquarium educators') perspectives on the effectiveness or otherwise of the combination of creative pedagogies and AR/VR to teach Ocean Literacy?

[Data sources: Pupil Focus Group Interviews]

There is little data on this question from UK Pilot 1. Pupils felt that the aquarium visit aided their learning, as it was a concrete experience: "I found when we got to go on the trips I found that helped us learn stuff because we actually saw it and then we also learnt some facts there as well" (FG, MO, UKP1, p21). However, they did not expand on the combination of creative approaches and the VR experience due to the limitations and early end to the pilot as a result of Covid-19.

While the questionnaires did not focus directly on this question, students open responses about good things about the project indicated that they "enjoyed trying out virtual reality", with 85% (6/7) on the post questionnaire indicating that the VR was their favourite part. Some students also commented on their enjoyment around some of the more arts-based dialogic practices stating "I made a 3D masterpiece showing plastic pollution in the sea", "I also found creating a local seascape really fun because I love to draw (crafts mentioned by 5/7: 71%).

Although it does not relate directly to question 2a regarding the effectiveness of the Ocean Connections approach, it is interesting to note that questionnaire data, showed that the trip to UK aquarium was a popular part of the project "the Living Coasts was the best trip ever. I loved the seals, they were so cute. (Living coast, mentioned explicitly by 6/7: 85%). On the post questionnaire all UK students indicated that the only not so good thing about the project was that they wanted more time.

2b. What are participants' (pupils, teachers & aquarium educators') perspectives on the affordances and barriers of the combination of creative pedagogies and AR/VR to teach Ocean Literacy?

[Data Sources: Pupil Focus Group Interviews, Teachers/Educators Individual interviews]

The key barrier evident in the data was the pupils' lack of opportunity to engage with the VR. This is partly because this was first introduced in early March, and the initial lesson had some teething problems in the pupils accessing the VR tool: "However a few obstacles were encountered. If you press the controller twice on the VR headset it logged you out of the website for example. So MOC constantly had to keep logging back in. This was extremely time consuming and frustrating. The internet speed in the classroom was not good enough for 4 VR goggles to be streaming the videos so they came out as photos!" (FN, UKP1, L3 p1). Unfortunately, the Covid-19 lockdown followed immediately after this lesson, meaning that it was not possible for pupils to engage with the VR. As they noted, "We didn't get much time on [the VR headsets] and stuff that they kept not working properly and we only got a certain amount of time, we didn't get any extra time. So I feel like we should have had more time to have had that experience." (FG, MO, UKP1, p24)

Strand 3: Evaluation of the implementation of the educative principles

3b. During the projects, where and how did the features of creative and digital pedagogies within the educative principles manifest?

[Data Sources: Video data (transcriptions and parallel field notes; transcriptions and stills); Field notes; Photographs; Use of VR/AR capture; Pupil work]

In analysing the data in response to this question, we used a theory-led approach and coded the data against each of the educative principles described in the state of the art synthesis report. We also noted any emergent themes not covered by these principles. At the end of the project, we will return to the educative principles and re-focus them in light of the findings from the series of pilot projects. Our educative principles are grouped into sections that relate to different facets of the project, presented as a cube in which the facets come together as a whole.

In analysing this data, it seems that some of these facets overlap. Following the initial pilot project, one implication that can be drawn is that it would be useful for the project to generate something electronic that is more dynamic than a static cube, or a means of representing and engaging with the educative principles so that the overlaps and relations are more strongly brought out.

In this report, each section focuses on one of the faces of the cube: creative pedagogies, digital technology principles, Science Education in Society principles, and Ocean Literacy principles.

Science Education in Society

Two of these principles, **inquiry** and **student-led questioning**, tie closely with the '**empowerment and agency**' feature of creative pedagogies (see below), as pupils are empowered to develop their own (in this context, scientific) questions, and draw on and develop their own means of exploring these questions. In UK Pilot 1, pupils were encouraged to ask and record questions that occurred to them as they visited the site. Pupils asked these questions about the marine organisms they saw, but also about materials and objects forming parts of the displays: "One pupil looks at the display 'what is that, is it glass?'" (FN, UKP1, LC, p2). Pupils questions were used to design the initial pilot project lessons, "[in a previous lesson] the pupils have been thinking about some of their own questions that came out from the Living Coasts visit, related to wading birds and how they are tracked (why do they have rings on their legs?). (FN, UKP1, L1, p1). Throughout the lessons, student questioning was encouraged, and capitalised on by teachers in developing the learning: "Where's the jellyfish's face?" (to the researcher), dabbing a paper towel over the painting of a jelly fish on card. Researcher, "Does a jellyfish have a face?"(FN, UKP1, L, p2). At times, it was not clear whether the questions were always student or teacher driven, but their maintained a strong focus on questioning as a common aspect of science education and creative pedagogies: "The next question, 'why are fish, fish shaped?' – that's quite an interesting one' (Teacher RP)" (FN, UKP1 L2 p2).

Maintaining the connection between the students and the educators at the aquarium was deemed to be important, and this was achieved via ongoing questions and answers forming an ongoing **dialogue** (another overlap with the creative pedagogies): "…there was a question sheet which allowed new questions for the Living Coasts team, as a form of plenary." (FN, UKP1, L2 p1).

The educative principle of **modelling** as part of science education was strongly driven within the project from the Danish Science Curriculum (see State of the Art Danish National Report/Synthesis Report). However, it was also apparent within the UK pilot project, with students using their bodies to model animal behaviour: "It's feels like it has ribs at the back" "Sade, move your arms like that" (mimicking how a tortoise moves)." (FN, UKP1, LC, p2), and in the creation of 2-D and 3-D models of animals that are adapted to survive in the Ocean (Photo, UKP1, L3-28) and students' design of adaptations that could enable them to live in the Ocean (Ph, UKP1, L2-2).

**(Ph, UKP1, L3-28) –** Play doh modelling informing thinking about adaptation

(Ph, UKP1, L2-2) – 2-D labelled design of themselves as a marine animal

The final principle within the 'science education in society' facet of the educative principles is that of **place and community**. This situates science within a sense of place and its role within local and global communities. This feature was apparent in UK Pilot 1 where students were challenged to explore the local beaches and connect, compare and contrast the organisms they found with those they saw at Living Coasts, many of which were from elsewhere on Earth (penguins, fur seals, stingrays): "[pupils] were challenged to find out about or take photographs of the diversity of animals on the UK coastline. This lesson, I arrive as they have just started

looking at pictures of animals and other organisms that live nearby on Cornwall's coast." (FN, UKP1, L, p1). Note the relationship with the OL principle, "the Ocean supports a great diversity of life and ecosystems. Another aspect of community noted in the learning that took place in UK Pilot 1 was in relation to the pupils' sense of community, for example in their generation of groups to work together during the aquarium visit: "Forming groups: "Us three"? Gestures between people, hands holding." (FN, UKP1, LC, p2). One could argue that this is another synergy between facets of the educative principles, this time connecting to the creative pedagogies features **dialogue** and **individual, collaborative and communal action for change.**

Creative Pedagogies
The educative principles draw on the features of creative pedagogies developed in previous projects (CREAT-IT; CREATIONS, see State of the Art UK Report). These are **transdisciplinarity, embodied/material dialogue, risk, immersion and play, empowerment and agency, co-creation, possibilities, balance and navigation, ethics and trusteeship.** Of these, the educative principles highlight the first four of these alongside and additional feature, **emotion and affect** as important in relation to the Ocean and Ocean Literacy. These features all manifested in the projects in some way, however **embodied dialogue** was the feature that was most strongly evidence in the UK Pilot 1. **Transdisciplinarity** as a creative pedagogy was apparent in the relationships between Science and the Arts, referred to above in relation to **modelling**. Students created arts works, drawing and painting animals to create a 3-D Ocean Connections display (Ph, UKP1, L1-1; Ph UKP1, L1-10) and, in different sessions, creating play-doh models and pictures of themselves adapted to living in the Ocean (see above, Ph, UKP1, L3-28; Ph, UKP1, L2-2). However, these could be seen as interdisciplinary, in which different disciplines are linked to enhance learning within those disciplines – in other words both art and science are learned about separately with respect to the overall Ocean umbrella – rather than transdisciplinary. The data is insufficiently clear on this in UK Pilot 1. Using Morgan's (2000) definition, embraced in developing these features, in which disciplines are drawn upon as needed to flow through question-response-question, it may be the case that students drew on knowledge and inspiration from both sciences and the arts to ask and respond to their own **student-led questions** but we there is no clear evidence to suggest this is the case. In the remaining pilots, stimulating students; transdisciplinary rather than interdisciplinary thinking could be explicitly planned for to enable exploration of the value of trans- or inter-disciplinary learning within the educative principles for Ocean Connections.
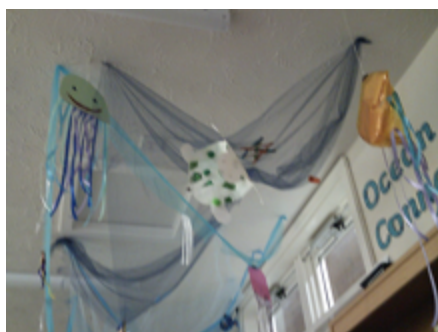
(Ph, UKP1, L1-1); (Ph, UKP1, L1-10)

The feature **ethics and trusteeship** can be linked in this project to students' ethical behaviours or positioning as regards trusteeship for the Ocean in their future actions. This is perhaps not about creativity per se: this feature is usually focused on ethical behaviour with respect to the products of teacher/learners' creativity. However, it is clear from responses above (see question 1b) that pupils were planning to take a more environmentally responsible approach to littering and recycling as a result of their learning, which is arguably a manifestation of the ethics and trusteeship feature.

In this pilot, there were many examples of pupils learning through **embodied/material dialogue**, in which they learn through engaging with an 'other' that could be another person, organism, inanimate material object/artefact via speech and tactile/sensory interaction. Of course, there is the usual impact of the classroom layout in order to facilitate dialogue (Ph, UKP1, L2-2), which is organised to enable discussion: "The class are seated in groups – near the front are tables organized into squares/rectangles – 3 across the front of the room near the whiteboard…"(FN, UKP1, L2 p1)
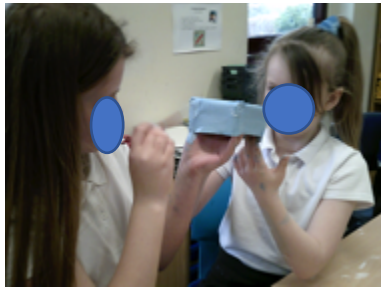
(Ph, UKP1, L2-2)

However, in addition to this, there are a range of other ways in which dialogue was seen to include embodied or material aspects beyond room layout to facilitate spoken dialogue. For example, during the aquarium visit, it was evident that, although quiet and listening to the educator 'deliver' content about animal adaptations to the ocean, pupils were engaging in embodied/physical responses to create their own understandings: "Hands mimicking otter paws, linking together in front of intent bodies" (FN, UKP1, LC, p2); "Eyes blinking and hands making a blinking motion up and down and sideways, as ML talks about the sideways blinking of penguins" (FN, UKP1, LC, p2). Focusing on embodied alongside spoken dialogue, including when detailed speech cannot be heard, shows the role of students' bodies as they engage in dialogue. In one lesson, the researcher noted the childrens' movements whilst watching a video that they later built on in discussion to develop their ideas: "The class are all focused on a video of the way that sea otters are adapted to the environment – they are mostly quiet with eyes on the screen. Some lean heads on hands, biting nails, moving and wriggling…Pupils are asked to chat with each other about what they learned from the video. I sit with a group of three pupils. One boy leans in, fiddling with a pen, talking across the table. I'm sitting at the same table but it is quite hard to hear individual voices. They seem to be building on each others' ideas, making eye contact, leaning forward, leaning" (FN, UKP1, L p2). In this extract, not only the bodies but also the technology – the material artefact that is the video itself – becomes part of the dialogue. **Technology as a material 'participant' in the dialogue** is also apparent in the VR headsets, as shown in Ph UKP1 L3-22, in which students and a teacher are seated on the floor facing each other, wearing and sharing the VR headsets and talking. The role of the digital technologies in the classroom setting connect the creative pedagogies facet of the educative principles with the digital technologies. In Pilot 2, it may be possible to explicitly build these connections by drawing on the technological principles *in tandem* with the creative pedagogies. For example, pupils as 'producers' using VR/AR, and storytellers using the VR tools was planned for Pilot 1 but unfortunately could not be completed due to the COVID-19 disruption.

(Ph, UKP1, L3-22)

Material artefacts becoming part of an embodied dialogue was also seen supporting students learning through **playful** mimicking, trying to 'feel' what it is like to have a shell by using the giant turtle shell artefact in the Living Coasts workshop: "[Group of students moves] straight to the shell, kneeling on the floor, looking underneath. They don't read the instructions but immediately try to fit it on each others' backs, crawling around the floor. "It's feels like it has ribs at the back" "Sade, move your arms like that" (mimicking how a tortoise moves)." (FN, UKP1, LC, p2).

In school, **embodied dialogue** alongside the feature **co-creation** was also evident in pupils collaborative work on physical **models** they themselves were creating of Ocean creatures and the environments they live in (Ph, UKP1, L1-9; Ph, UKP1, L1-14). In observations in which the focus on the human was deliberately decentred (see diffractive analysis Pilot 1 report), it become apparent that the embodied relations between students and their materials can be seen as part of the embodied dialogue: "Reaching over, paintbrushes in water, boy-paintbrush-paint and girl-paintbrush-paint leaning over, bodies matching, dotting black blobs on an orange crab picture." (FN, UKP1, L1 p2)


(Ph, UKP1, L1-9; Ph, UKP1, L1-14)

The connection between Environmental responsibility with **empowerment and agency** was highlighted in response to question 1b above and pupils in this UK Pilot 1 suggested they felt able to enact agency in response to recycling and littering as a result of engaging in UK Pilot 1. It was also connected above to student-led questioning with respect to the facet of the educative principles 'science education in society'. Pupils were able to lead the direction of the learning by framing and engaging with questions stimulated by the aquarium visit and their learning on the project back in the classroom. However, the data also suggests the boundaries and limitations with respect to their empowerment and agency in terms of the locus of 'authority'. Of course, the teacher is required to coordinate, facilitate and direct the learning in the class in a responsive dialogue with the learners (see balance and navigation feature below), but one researcher observation is interesting, locating authority with the whiteboard as a source of correct knowledge: "Whiteboard youtube clip, American accented, pupils…have eyes on the screen, bodies tilted towards it. Pupils don't interrupt the whiteboard with voice or using body language or talking to each other. Fingers tapping faces, sleeve being bitten…. *It's almost like the whiteboard is the authoritative voice in the room, sharing key facts and information and using technical language.*" (FN, UKP1, L1 p2, researcher interpretive memo in italics). In creative pedagogies, disciplinary knowledge is the basis on which creative responses are built; the **balance and navigation** feature is needed to acknowledge the responsive, performative 'dance' of agency and empowerment between students, teachers and what we might term the 'authoritative-knowledge-provider' that is the whiteboard in this example.

As already highlighted, **playful** behaviour as pupils interacted and engaged in dialogue with/through materials was also a manifestation of the creative pedagogies in UK Pilot 1. Pupils became **immersed** in learning when creating art-works inspired by the Ocean, **playing** with ribbons (Ph, UKP1, L1-5) and paint, glitter and glue: "Girl rubs her hand on her belly, sings, paintbrush dipping and painting, dipping and painting. 'I made a crab. He's called Mr Crab. Spongebob is his name'. Blue paint spreading up and down, up and down on a piece of card, paintbrush in hand, blue mixes with green paintbrush is picked up and waved in the air." (FN, UKP1, L p 2).

(Ph, UKP1, L1-5; Ph, UKP1, LC-5)

Pupils' reaction to a display in which they climb across a sea wall in the aquarium (Ph, UKP, LC-5) is another example of a playful experience through which they are facilitated to learn about the ocean. There is potential for students to find this an i**mmersive** learning experience, depending on the way in which they engage with it which cannot be attributed simply from this data. As well as physically playing in the aquarium spaces/with learning materials, the data suggests a playful use of humour as part of the embodied dialogues noted in the data: "Hands mimicking otter paws, linking together in front of pupils, intent with eyes on the speaker. Fingers feeling knuckles, eyes on display showing toenails on a fur seal flipper. Laughter as ML jokes about Gemini the seal sucking her flipper, like children might suck their thumbs" (FN, UKP1, LC, p2). Again, **playfulness and humour appear in the data in tandem with embodied dialogue**: "Turtle-boy moves quickly round the floor away from their station 'the first turtle to sprint!'" (FN, UKP1, LC, p3). The use of humour is also an example of the **emotion and affect** feature, as is the pupils' delight as seeing the penguin crossing (Ph, UKP1, LC-Cam202) and sun-bathing fur seals during the aquarium visit. Pupils also engaged emotionally and playfully with technologies, including an interactive sand tool in which moving sand to create islands or deeper ocean responsively creates different land/sea creatures (Ph, UKP1, LC-4) or using a scanning tool to place their digitise and animate their drawings in a virtual tank. Based on the literature review conducted for the state of the art review, the affective dimension to humans' relationship to the Ocean was a broader response to the Ocean itself and is anticipated to connect to a developing sense of trusteeship for the Ocean as a living thing. There is no evidence in the UK Pilot 1 data of pupils' emotional/affective engagement with the Ocean in this way, or whether it is changed or facilitated differently as a result of the digital VR tool as hypothesised.
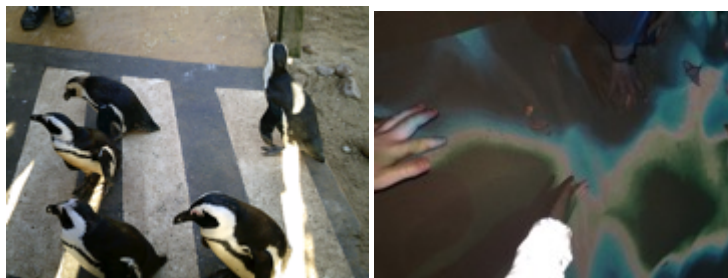
(Ph, UKP1, LC-Cam202; Ph, UKP1, LC-4)

The feature '**Possibilities'** grew out of Craft's (2002) notion of 'possibility thinking', which is apparent in the activity in which pupils are using their knowledge of adaptations in real ocean animals to think 'what if I lived in the Ocean' and redesign themselves 'as if' they needed to survive in the ocean (Ph, UKP1, L2-6). Teachers also gave students a range of possibilities through which to learn in one of the observed lessons (Ph, UKP1, L3-16). Planning for offering a range of possibilities like this also required teachers' **balance and navigation**, in order to 'step in and step out' of the students' learning and creative engagement as needed in order to foster a creative learning environment. In this data, teachers used scaffolded worksheets (Ph, UKP1, L2-6; UKP1, L3-11) and
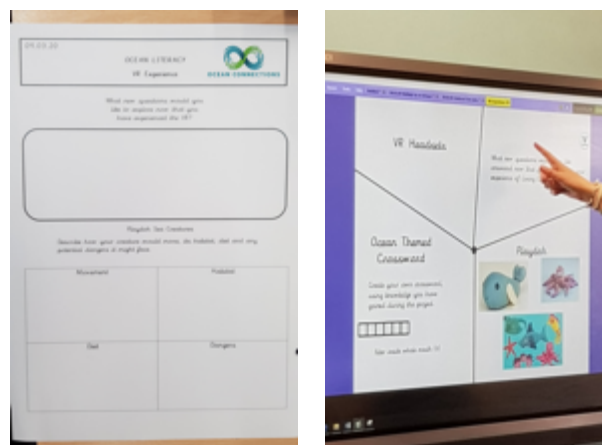
(Ph, UKP1, L2-6; Ph, UKP1, L3-11; Ph, UKP1, L3-3)

In summary, with respect to the UK Pilot 1 data, it was not clearly apparent that transdisciplinarity manifested (in constrast with a relatively strong interdisciplinary mode). Embodied dialogue was manifested most strongly, and (linked to question 1b) empowerment and agency. The relationships between the features of creative pedagogies appeared to group together: play and co-creation manifest alongside/within embodied dialogues; and empowerment and agency, trusteeship, balance and navigation and possibilities also connect. Emotion and affect may bridge these two groupings but there is limited data directly focusing on this feature.

Digital pedagogies

In UK Pilot 1, the digital pedagogies were not so foregrounded as the creative pedagogies. In part, this is a result of the Covid-19 lockdown just before the planned focus on the VR tool, and also relates to the teacher **placing learning before Technology** where they were not confident in the use of the new technologies themselves. The VR tool has the potential to enable students to **see the invisible,** but issues with the bandwidth and upload speed (see barriers, question 2 above) prevented this principle being facilitated within the project. Due to similar barriers, pupils were not able to engage with producing/creating content using digital tools and instead of **students as Producers**, students tended to be consumers of technology: "Whiteboard youtube clip, American accented, pupils in my group all have eyes on the screen, bodies tilted towards it. Pupils don't interrupt the whiteboard with voice or using body language or talking to each other. (FN, UKP1, L1 p2). Similarly, students did not have the opportunities to draw on **real data** or engage in **model-based inquiry** using digital tools, with **modelling** taking place via other means (Ph, UKP1, L3-28, see above). The teacher had intended to use the VR toolkit project space as a site for pupils to engage in **digital storytelling,** creating learning journeys of their projects, but, again due to the barriers cited above, this plan was not able to be enacted. How to draw on these digital pedagogical principles in designing and delivering pilot 2 will need some thought, as will how these principles interact with the other facets (for example in modelling, immersion and play, and material/embodied dialogue as well as connecting student questioning, empowerment and agency and students as producers with/using technology).

Emergent Themes

In addition to the themes identified in relation to the educative principles developed from the state of the art, **space and light** emerged within the coding as playing a role in the **embodied dialogue** and learning. The lights being turned off/on as pupils watch clips on the whiteboard dramatically changes the atmosphere in the room: "Hair running through fingers, yawns, whiteboard draws the eyes of the class. The room has a texture of silence and the lights are off, with the whiteboard showing information about how a dolphin blow-hole has developed and is used...I hear a tap tap tap of feet on a table and one pupil is fiddling with something, causing small sounds that carry through the quiet air. Legs swing, chair-boy tips back and forward, shoes tap on the floor. Teacher hands rub together, then clicks with the mouse. Lights suddenly bright, sighs, arms raise, bodies turn. Voices raise in response to teacher question. As soon as the lights went on, the texture and feel of the atmosphere in the room changed, feeling less heavy." (FN, UKP1, L2 p3); (Ph, UKP1, L2-3). Similarly, the light and space within the aquarium, moving indoors and outdoors and from light to dark as pupils move through the space (contrast the photographs of the penguin crossing with the pupils' climbing space, for example), created changes in the pupils' experiences.

(Ph, UKP1, L2-3, pupils discussing teacher question following video once lights back on)

Another emergent theme is the necessity of the **teacher's immersion in the technology** to enable them to facilitate learning within digital spaces. This links to the **balance and navigation** feature, given the challenges in using these new technologies highlighted in response to question 2. In the UK Pilot 1, the teacher needed to try the technologies themselves to be able to assist the students (Ph, UKP1, L3-31).

(Ph, UKP1, L3-31)

Conclusions and Implications for Ocean Connections Pilot 2 and Toolkit

OL Learning

During the UK pilot 1, pupils aged 10-11 focused on learning about the adaptations aspect of the English National Curriculum through engaging with an Ocean based project. Stimulated by the aquarium visit and driven by pupils' own questioning, there is evidence that pupils developed their knowledge of the Ocean Literacy principle 'there is one big Ocean' and about the diversity and adaptations of marine life. Pupils developed, to some extent, an understanding of the relationship between humans and the Ocean, though the teaching in the project did not focus strongly on the interconnectedness within the Ocean and between the Ocean and humans. An aspect of the scale of the Ocean that related to the 'Big Ocean' OL principle that captured the pupils' interest was the relatively unexplored nature of the Ocean. It was not clear whether there is a relationship between this interest and the pupils' sense of environmental responsibility and trusteeship. Pupils' also spoke about the Ocean as something living that could be empathised with. **Pilot 2 could explore:**

- **Whether, and how, interest in the scale and unexplored nature of the Ocean and environmental responsibility connects for the pupils working in different national and curricula contexts.**
- **To what extent is pupils' learning about the OL principle 'humans and the Ocean are inextricably linked' linked in their minds to the Ocean as a living thing?**
- **Does the scale of the Ocean make a difference to the extent to which pupils empathise with the Ocean as something living?**

Digital Technology

There were some key barriers to pupils' engagement with the digital technology in the UK Pilot 1. This was in part because the national lockdown for COVID-19 disrupted the planned use of the VR tools so pupils had limited opportunity to work with them. It also related to the challenges of bandwidth and the fact that the VR space for the UK pupils was only populated with 360 video rather than some 360 photographs that, though less immersive, require less bandwidth. **Pilot 2 should include both 360 video and photographs in the VR space, and introduce the digital technology earlier in the pilot in order to facilitate space and time to troubleshoot the technology.**

The Ocean Connections Educative Principles

Findings in this pilot project demonstrated the connectivity and relationships between the different educative principles. This suggests that **Pilot 2 and the final toolkit might benefit from an alternative representation of, and opportunity to work with the principles, that more strongly facilitates teachers working with the interplay of these principles than their current representation on different faces of a cube is able to achieve. This might best happen electronically.** In this pilot, inquiry and student-led questioning (found in the Science in Society strand of the principles) manifested in tandem with the creative pedagogical approach of empowerment and agency and with dialogue. Similarly, modelling was connected to embodied dialogue, and place and community was linked to the OL principle 'the Oceans support a great diversity of life and ecosystems' as well as to the creative pedagogies 'dialogue' and 'individual, collaborative and communal action for change'. Though the UK Pilot 1 involved pupils working with both science and arts, the extent to which this engagement was transdisciplinary (the creative pedagogies feature) or interdisciplinary, was not clear within the data. **In Pilot 2, explicit planning for stimulating students' transdisciplinary thinking would be helpful, in order to enable exploration of the value of trans- or inter- disciplinary learning within the educative principles for Oceans.**

It was apparent in the UK Pilot 1 that the VR tools demonstrated the *potential* to connect the creative and digital pedagogies aspects of the educative principles, particularly in the role the tools played within the embodied/material dialogue within the classroom, but that this was disrupted by the COVID-19 lockdown. **Pilot 2 should aim to explicitly build these connections by drawing on the technological principles (e.g. students as producers with technology; digital storytelling)** *in tandem* **with the creative pedagogies.**

Key:

SI – Staff Interview
FN – Field Notes
FG – Focus Group
Ph – Photograph