Introduction

Key Stage 2 Thematic Units

Supporting the Areas of Learning and **STEM**

Northern Ireland
Curriculum

Contents

What is 'STEM'?

'STEM' is a government initiative aimed at promoting children and young people's engagement with **Science, Technology, Engineering** (which includes ICT) and **Mathematics**. The government has identified STEM-related industries as being critical to the future competitiveness and prosperity of the UK. Northern Ireland's ability to compete in the global market will more and more depend on having a supply of talented and skilled people entering into STEM-related careers.

STEM has become an educational priority in Ireland and the UK as well as across the rest of Europe. The 'Report of the STEM Review' (DE and DEL, September 2009) highlights the importance of developing these areas. The review has defined its vision for STEM as:

"empowering future generations through science, technology, engineering and mathematics to grow a dynamic, innovative economy."

It is therefore essential that our schools spark pupils' interest in these subjects. Schools should also aim to highlight for the pupils the links between STEM-related knowledge and skills and the Areas of Learning. It is also important to highlight the links between school-based learning and the world of work. The overall aim is to encourage increasing numbers of our pupils, and girls in particular, to go on to further and higher education in STEM-related areas.

'STEM in education begins with the early development of mathematical and scientific ideas in pre-school education which are built upon in primary and post primary education... Throughout, pupils are provided not only with knowledge of the subjects, but also develop investigative and problem-solving skills and an understanding of their application in the real world and their impact upon society.'

(NI), (2009, DE&DEL, p.19)

What is a Thematic Unit?

A Thematic Unit is a vehicle through which to deliver teaching and learning to pupils through a themed approach. When learning is 'joined up' for children, they are presented with a more meaningful context in which to develop skills and acquire knowledge. It is envisaged that each unit will form the core of a cross-curricular topic which could last from six weeks to a full term. Thematic Units are **non-statutory** and can be adapted to suit the needs and interests of individual schools and pupils.

The units in this resource have been developed to support teachers of Key Stage 2 pupils. Schools can decide which year group will use each of the units, and each unit should be presented in a manner relevant to pupils' age and ability.

Aims and Content

The aims of the resource are:
- to support the delivery of the Northern Ireland Curriculum and address the STEM agenda;
- to provide teachers with a bank of Thematic Units and activity ideas through which to deliver STEM-related learning;
- to enrich the learning experiences of the pupils by providing opportunities for practical problem solving, investigating and research in real-life and local contexts;
- to encourage the development of links with STEM-related businesses and industries; and
- to provide real world contexts for learning to promote an awareness of some familiar and non-familiar roles within STEM-related industries.

These Thematic Units focus on Science, Technology, Engineering (including ICT), and Mathematics. The units also support the statutory requirements for the Areas of Learning of the Northern Ireland Curriculum, in particular The World Around Us and Mathematics and Numeracy. Opportunities to incorporate the theme into other Areas of Learning are signposted throughout the resource and you should aim to use a connected learning approach to make the theme relevant to other classroom work.

This resource consists of five Thematic Units.
- Bridges;
- Water;
- Wind;
- Textiles; and
- Farming.

Within each unit, you are provided with a number of lesson ideas, suggested learning intentions, Assessment for Learning opportunities and new vocabulary for each activity in the theme. These are only suggestions and should be adapted to suit the teaching and learning happening in your classroom.

The **main** areas of STEM addressed by each thematic unit:

	Science	Technology	Engineering	Mathematics	ICT	Areas of Learning
Bridges		✓	✓	✓		The World Around Us Mathematics and Numeracy Personal Development and Mutual Understanding
Water	✓	✓				The World Around Us
Wind		✓	✓	✓	✓	The World Around Us Mathematics and Numeracy The Arts
Textiles	✓	✓			✓	The World Around Us The Arts
Farming	✓	✓	✓	✓		The World Around Us Personal Development and Mutual Understanding Mathematics and Numeracy

Supporting Thinking Skills and Personal Capabilities

The themes in this book require children to actively participate in their own learning. There is an explicit emphasis on the development of Thinking Skills and Personal Capabilities. There will be many opportunities for children to develop these skills throughout the themes in this book and they will be signposted where appropriate. The 'Talking about Thinking' texts (available in Appendix 1), can be used to help create shared learning intentions for activities, or for agreeing on success criteria with the children for an activity. These texts present the KS2 Thinking Skills and Personal Capabilities Framework in 'pupil language' as a means of making the skills explicit for pupils. An Interactive Whiteboard version of this framework is available as part of the 'Think Pack', which can be downloaded from the Key Stages 1 & 2 section of **www.nicurriculum.org.uk**
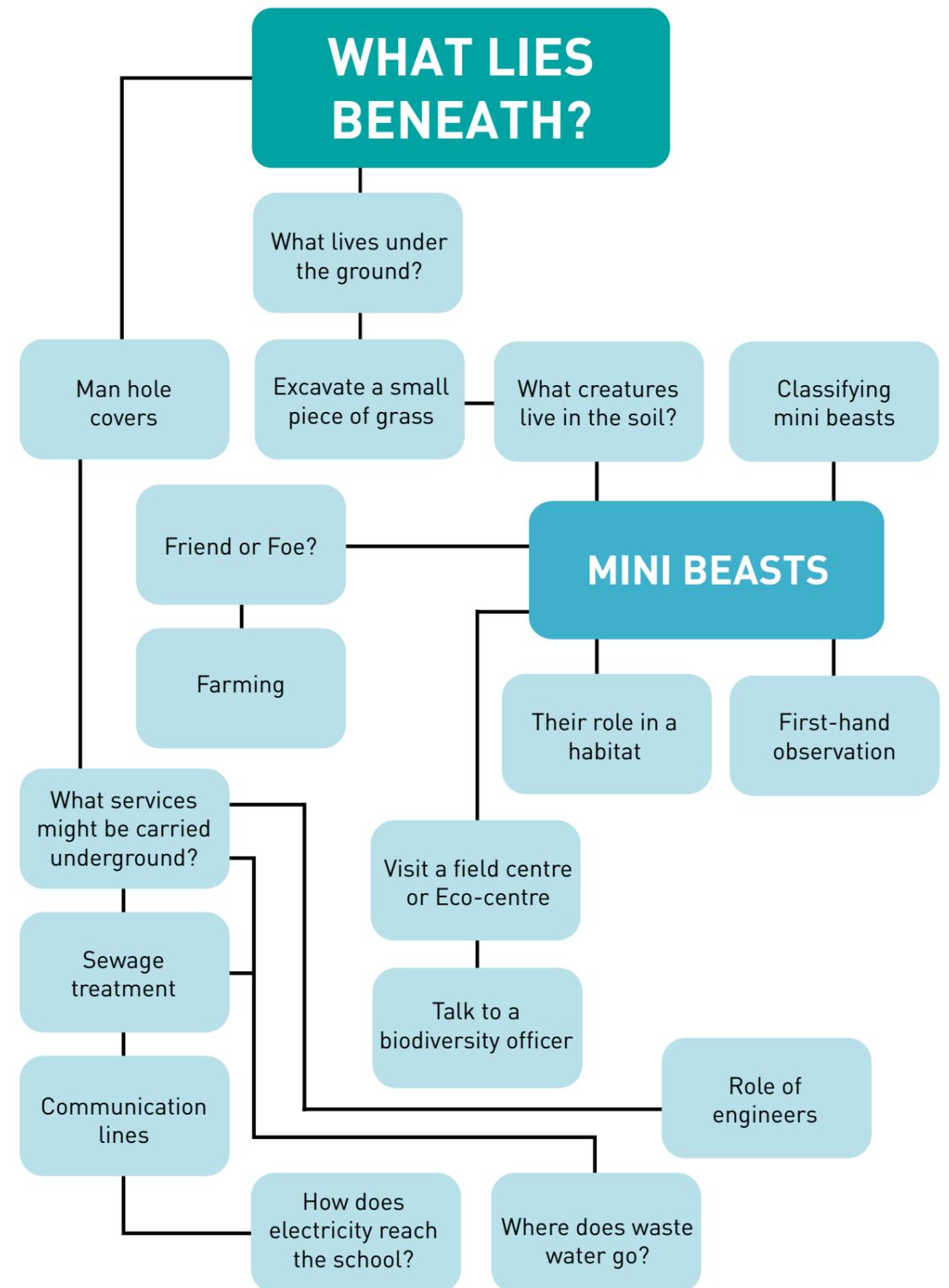
Making STEM Local and Relevant

Incorporating children's own interests and experiences into classroom learning helps children fully engage with the curriculum. Investigating STEM-related topics offers many opportunities for children to explore and investigate features of their local area - including buildings, bridges, farms, factories, hills, rivers, vehicles, animals and people, to name but a few.

These thematic units can be easily adapted to incorporate aspects of your school's local area.

The benefits of utilising children's interest in their locality include:

- You can provide relevant experiences to develop children's skills of enquiry.
- Children can be engaged in practical problem-solving activities.
- Children can develop sensitivity to their immediate environment and gain a stronger sense of identity.
- Opportunities for engaging with people in the community can provide real situations for learning from and about others.
- The school can forge new links with the community.
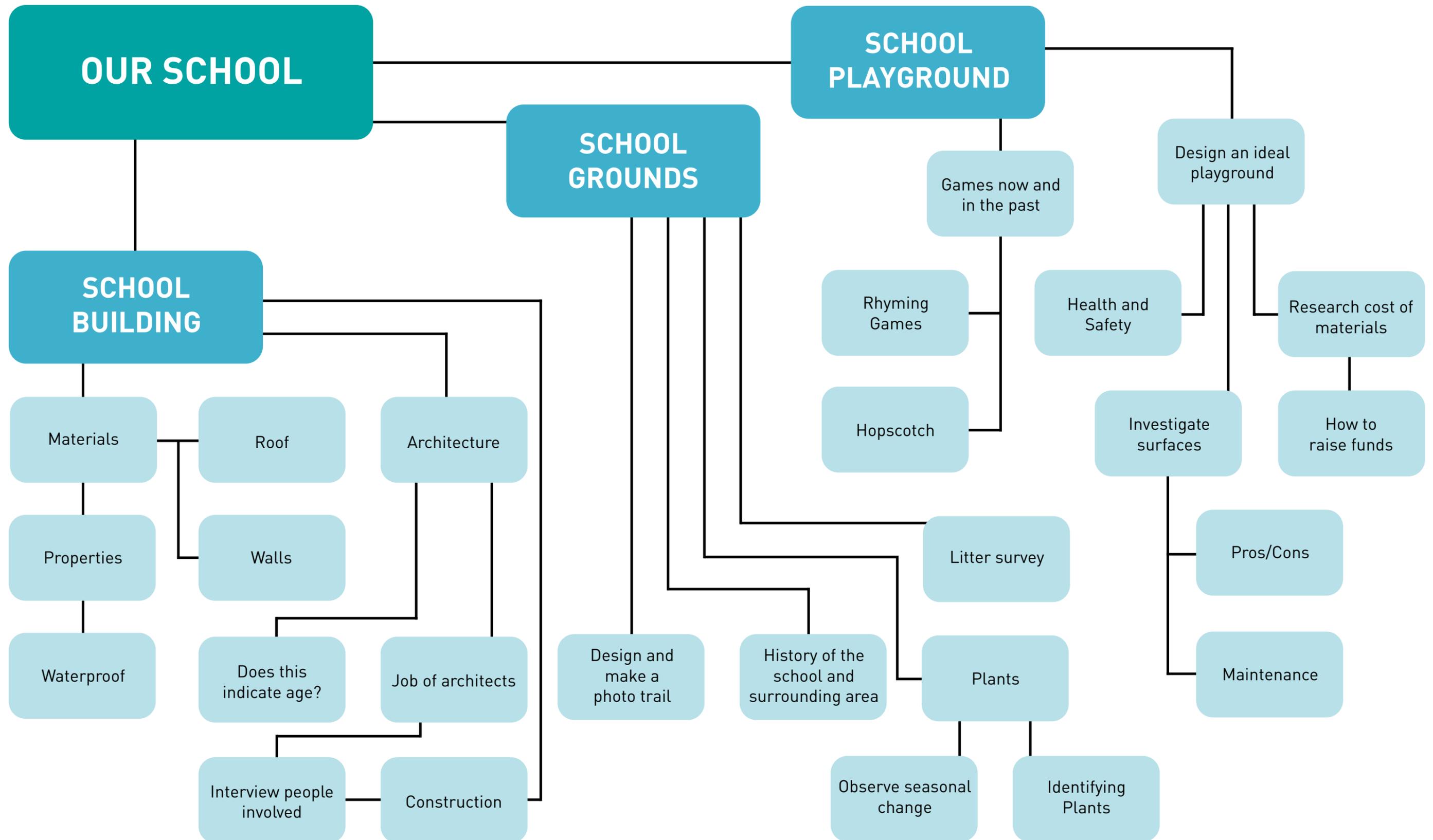- Added interest from parents and other family members in what pupils are doing at school.

In addition to adapting the thematic units contained in this resource, the following mind maps show how STEM-related learning can be based on local issues and subjects. It may be a good idea to create one of these mind maps with your class to find out which features of the locality would be an interesting focal point for investigation.
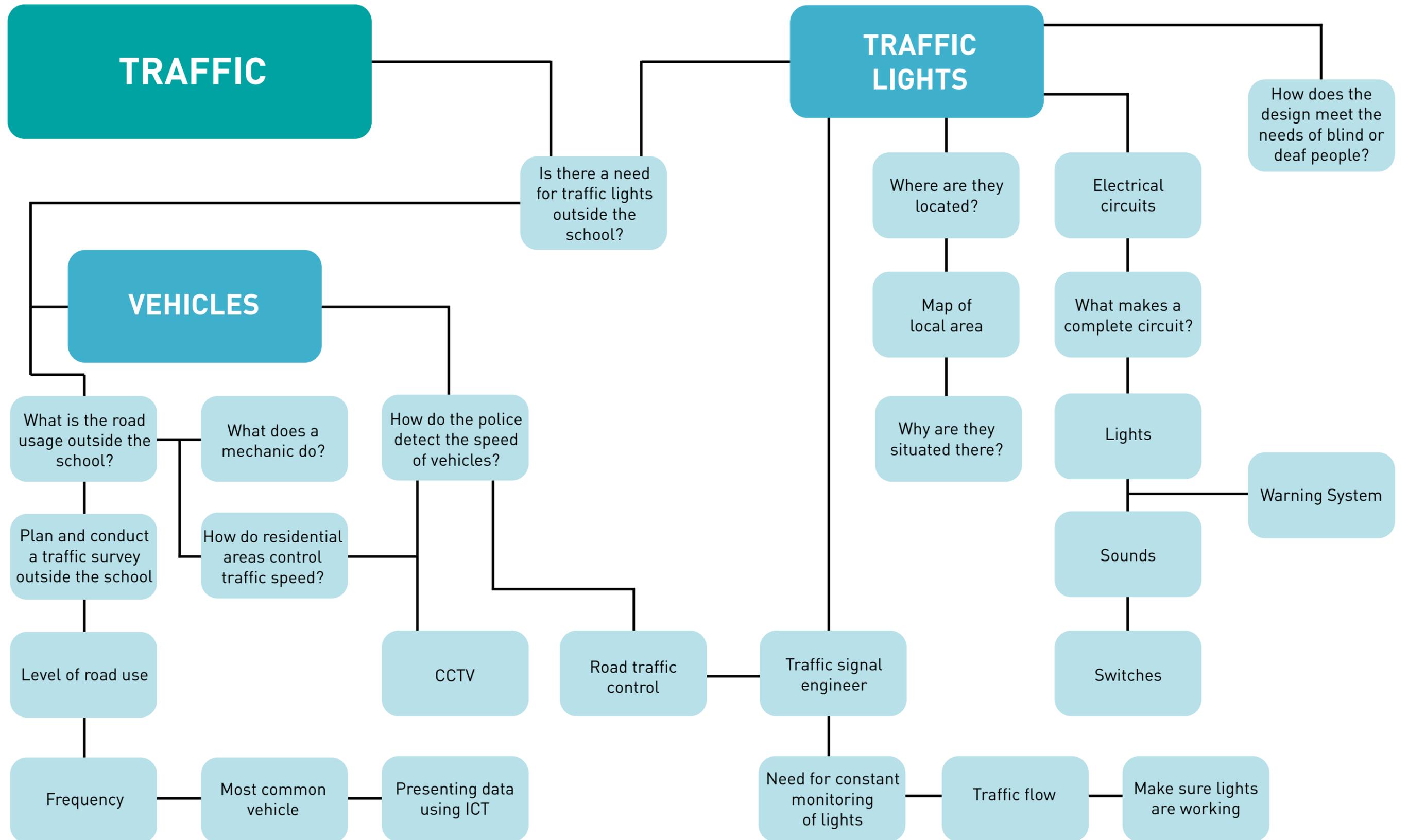
OUR SCHOOL

SCHOOL GROUNDS

SCHOOL PLAYGROUND

SCHOOL BUILDING

Design an ideal playground

Games now and in the past

Materials

Roof

Architecture

Rhyming Games

Health and Safety

Research cost of materials

Properties

Walls

Hopscotch

Investigate surfaces

How to raise funds

Litter survey

Waterproof

Does this indicate age?

Job of architects

Pros/Cons

Design and make a photo trail

History of the school and surrounding area

Plants

Maintenance

Interview people involved

Construction

Observe seasonal change

Identifying Plants

TRAFFIC

TRAFFIC LIGHTS

How does the design meet the needs of blind or deaf people?

Is there a need for traffic lights outside the school?

Where are they located?

Electrical circuits

VEHICLES

Map of local area

What makes a complete circuit?

What is the road usage outside the school?

What does a mechanic do?

How do the police detect the speed of vehicles?

Why are they situated there?

Lights

Plan and conduct a traffic survey outside the school

How do residential areas control traffic speed?

Warning System

Level of road use

Sounds

CCTV

Road traffic control

Traffic signal engineer

Switches

Frequency

Most common vehicle

Presenting data using ICT

Need for constant monitoring of lights

Traffic flow

Make sure lights are working

Using the Locality – Case Studies

The following case studies have been written by teachers about their experiences of using the locality and the outdoor classroom to enhance and lead teaching and learning. The case studies aim to show how learning can be brought to life for children in a way that is relevant to their lives and experience.

The first case study illustrates a project on the theme of Water. The teacher set a problem for the children in a local context. The children had to come up with a solution for encouraging salmon back into their local river.

The second case study is about a project on the theme of Wind. The teacher used a wind farm in the local area as a basis for teaching about wind power and energy.

Case Study: Water
The Glenmornan River Fish Pass

Introduction

Over 50 years ago, there was a plentiful supply of salmon on the lower part of the Glenmornan River, yet today the salmon have disappeared from this river. This case study shows how three Key Stage 2 teachers and our pupils worked together to find a way of allowing the salmon to have access to the upper part of the river for breeding and encourage their introduction back into the Glenmornan River.

This case study also aims to demonstrate how STEM can be addressed in the primary school by using the local area as a focus to bring learning to life for pupils.

Objectives

1. To give teachers and pupils an exemplar framework for developing and engaging with a real life problem.

2. To connect learning in a practical, hands-on way, as advocated in the Northern Ireland Curriculum.

3. To develop links with outside agencies, such as the Lough's Agency.

4. To provide an opportunity to raise awareness and interest in STEM subjects among the staff and children.

Schools Involved

Three primary schools were involved in the project.

- Artigarvan Primary School is a co-educational controlled primary school in Artigarvan village. The pupils involved were from Year 5.

- Loughash Primary School is a co-educational maintained school in an isolated rural area five miles from Donemana village. The pupils involved were in a composite class Years 5, 6 and 7.

- St Joseph's Primary School is a co-educational maintained school in an isolated rural area four miles from Strabane. The pupils involved were in a composite class Years 5, 6 and 7.

Strabane High School was used as the base for the entire project and one of their staff acted as the project co-ordinator and facilitator.

Case Study: Water (continued)
The Glenmornan River Fish Pass

Starting Point
The Plight of the Salmon on the Glenmornan River

As an introduction to the project, the children were presented with a problem which needed to be solved: Over fifty years ago, there was a plentiful supply of salmon on the lower part of the river, yet today the salmon have disappeared from the Glenmornan.

The children involved in the project were between nine and eleven years old, of varying ability and so differentiation was an essential element. They were asked to imagine they were detectives, finding out about the plight of the salmon on the Glenmornan River. The first task for the children was to develop possible explanations for this.

The children looked at maps of the river and local area. They were provided with some information and data about salmon catches in Northern Ireland. Based on the information, the children worked in pairs and began to draw up lists of 'who, what, why, when and where' questions that, if answered, would help them to solve the problem.

They were also asked to organise, present and interpret the data on salmon catches in Northern Ireland using a graphing package. They compared different graph formats for the best presentation of statistics.

Project Development

Through discussion the children decided that in order to begin to solve the problem, they needed to find out what type of conditions salmon need to survive and whether these conditions exist in the Glenmornan river.

The children then agreed that if these conditions did exist in the river, that they would need to find a way of allowing the salmon to have access to the upper part of the river for breeding. This would involve finding a method of overcoming a natural hazard on the river which the salmon could not negotiate (a waterfall that was over six metres high).

Based on this initial discussion and decision making, the project developed in three parts:

1. Studying the life cycle of the salmon and the habitat of the Glenmornan.
2. Researching, designing and making a model of a fish pass that would allow the salmon to travel to the source of the river.
3. Producing visual material to present their case to the general public.

Part 1
Studying the life cycle of the salmon and the habitat of the Glenmornan

We first of all had to build up the children's knowledge of a river system. We began with a study of the water cycle and visited Magilligan Field Centre. Here the children completed a river study under the direction of two field officers where they found out about the habitat and the life cycle of salmon and discussed the similarities and differences between other living things. They also learned about possible hazards for living things in the river and provided simple explanations for changes in the river that affect fish, particularly salmon.

Back in the classroom, we compared and contrasted the field work carried out at Magilligan to the river life specific to the Glenmornan river. We arranged a visit into school by personnel from the Lough's Agency (the organisation responsible for the rivers that flow into Lough Foyle). The visitors from the Lough's Agency talked to the pupils on the habitat on the Glenmornan River and a proposed fish pass for the Glenmornan waterfall.

We collected water samples from the river which the children studied for traces of pollution using simple water treatment experiments. They recorded their results systematically and reported to the rest of the class on their investigations.

We visited the Loughs' Agency headquarters to find out how they help the conservation of the countryside and the rivers within the Foyle basin. The pupils worked in groups to sort and display information and photographs into categories of good and bad habitats and identified possible hazards for the salmon. They used maps and photographs to compile posters of the habitats and hazards within the Glenmornan river catchment area.

Part 2
Design a fish pass to bypass the Glenmornan waterfall

The children studied how different fish passes work. We visited the fish pass at the river Mourne in Sion Mills. They photographed, videoed and drew diagrams of this fish pass and other real examples to design their own fish pass which would be suitable for the Glenmornan River.

We carried out some work on scale and gradient to allow the children to make diagrams of the fish pass slope.

We looked at various models showing different gradients. Each child was given the opportunity to sketch their ideas for a fish pass and describe how it would work. After discovering that a one in four gradient was the maximum slope that would work, we had a discussion to evaluate, understand and reach a solution on the design of the fish pass.

Case Study: Water (continued)
The Glenmornan River Fish Pass

Part 3
Produce models to present project findings

In groups, the children were tasked with creating a model that showed their knowledge of parts of the project.

- Group 1 made a model of a fish pass on a waterfall;
- Group 2 made a model of the water cycle over the Foyle basin;
- Group 3 made a model of the habitats and hazards in the Glenmornan locality; and
- Group 4 made a model of the food chain focusing on the salmon fry (the most vulnerable stage in the life cycle of the salmon).

The children drew detailed labelled diagrams of their designs. They chose suitable materials for their models, based on their knowledge of material properties and using a range of technology tools safely, measured accurately, made adjustment if necessary to their designs and structures and finally evaluated their models.

The children's work and models were placed on display in the foyer of the Lough's Agency. The display could be seen by members of the general public and visiting schools. The local press were so impressed by the pupils' presentation that they devoted a full colour page to it in the newspaper.

Benefits

Throughout the project, the children experienced a range of activities which they would not have encountered in the normal classroom setting. They worked collaboratively across schools and in a different school environment. The outside classroom became a hugely important aspect of their learning and the children gained environmental knowledge as well as an appreciation of both the local and wider habitats. They have raised their awareness of sustainability and have made connections between eco systems and life cycles. The activities provided a vehicle for the children to become skilled in many other skills, including ICT. The most rurally isolated school gained particular value from mixing with and experiencing the benefits of a larger education community.

Social and interpersonal skills were developed by the children as they had to negotiate, compromise, problem solve and arrive at a consensus. The children were involved in experimental and investigative learning which demanded them becoming more self-directed, either working independently or within a group.

Having a local context for the project really did bring the learning to life for the children and gave a depth to their understanding which I don't think they would have gained, had the project been simply classroom-based.

Both the children and the staff had to take risks in carrying out the project. The teachers had to sacrifice control of a highly structured classroom setting to that of an activity-based approach. It required a bit of bravery on our part, to allow mistakes to happen and to realise that these mistakes are not disastrous provided that you learn from them. We were truly learning together, which made it feel somehow new and exciting and energised. Both the staff and the children enjoyed this approach and the enthusiasm from all involved was clear to see.

Working with another school was also an added benefit of the project. Collegiality and sharing of professional knowledge, skills and understandings enhanced already good working relationships amongst the schools and teaching staff involved.

Case Study: Wind
Bessy Bell Wind Farm

Introduction

In the catchment area of the schools involved in this project there has been a growth in the building of wind farms for electricity production. This growing number of wind turbines visible on the surrounding hills, acted as a stimulus and led to an enquiry by the Key Stage 2 pupils into renewable wind energy. The thematic nature of the topic offered opportunity to develop different aspects of the curriculum, particularly focusing on STEM subjects.

Schools Involved

Loughash P.S, Donemana and St. Joseph's P.S, Glenmornan are both small rural schools with a composite class of Years 5, 6 and 7.

Starting Point

Even though the children involved in this project had seen the wind farms on the local hills, their knowledge about the topic was patchy. It was important to clarify key words such as renewable energy, turbine and generator. A slideshow of windmills, wind turbines and wind farms led to discussions about similarities and differences in the pictures. This resulted in a range of definitions which were placed on a notice board for the duration of the project.

The children then were asked to draw pictures showing how they thought windmills and wind turbines worked and these thoughts were shared and discussed. This helped the children to formalize their ideas on what they wanted to investigate. At this stage, the children were encouraged to research the topic further using library facilities and the internet.

The questions and thoughts of the children became the basis for a K-W-L grid. The first two parts of the grid were filled in at this stage. The final section, 'Learned' was completed at the end of the project.

Project Development – Activities

A visit to the wind farm was the first suggestion as none of the children had been up close to the local wind turbines. After this, it was decided to research, design and build models that used wind power. The children decided to use drama and role play to investigate how people might react to renewable wind energy and the building of the wind farms.

Part 1
A visit to a wind farm

Contact was made with E.ON who is responsible for Bessy Bell wind farm in Newtownstewart, Co. Tyrone. The company arranged for a team of E.ON staff to meet the teachers and pupils from the two schools and show us around the wind turbines on the wind farm. Unfortunately, it was a very foggy day!

Safety was a key factor. Group by group, the children were shown how the wind turbines created electricity which was fed first to a power house on site and then carried by wires to the national grid. An engineer took the children inside one of the wind turbines and talked to them about the equipment and how the turbine worked.

While at the wind farm, the children gathered and recorded various bits of information. These included:

- Estimating and then measuring the height of the turbines using triangulation.
- Measuring the distances between the turbines using a measuring wheel.
- Timing the rotation of the blades and comparisons made to other blade rotations.
- Investigating the sound of the blades – where was the sound loudest, where was it least loud and what might be an explanation of the findings.

The children were able to identify local landmarks from the maps we had of the local area, and work out their grid references. They also used the points of the compass when reading the maps.

Digital photography was used to record evidence, particularly the type of landscape of the local area. Photographs were taken of the vegetation and any evidence of the effects of the wind turbines on the local environment. These were displayed back in the classroom.

There is no doubt that the visit changed the project from a theoretical exercise to something that was a real local environmental project. The children had gathered lots of information to discuss, analyse and display back in the classroom.

Case Study: Wind (continued)
Bessy Bell Wind Farm

Part 2
Research, Design and Build Models

After the visit to the wind farm, the children worked in groups of 3 - 4 pupils to make models that used wind as a source of energy.

The first type of model made was a hand-held windmill. Before making, the children looked at a range of homemade and commercial windmill models. Each group awarded marks to each model for how well it worked. They recorded their findings on a chart. Each group then discussed which materials they wished to use to make their hand held model (choice was limited to a given list). Materials were collected after each group had drawn a design plan of their model. The children were given a set time for making the model. A desk fan was used to test each model and the children were encouraged to evaluate the models and suggest ways and reasons for improvements.

A second model came from a goody bag given to the children by E.ON. This model helped the pupils to understand how the power of the wind was changed into electricity. This session was useful as an exercise for cutting accurately and making holes as care was needed in making so that the model worked well and the instructions also needed to be carefully followed by the children.

The third was the most complicated model. It was one that lit an LED bulb using wind power. These were commercially bought models which also required careful following of instructions to make them work. The models were tested, dissembled and rebuilt using oil as a lubricant the second time. The question, 'Was this a fair test?' was posed to the children and the class discussed why it was not.

The model screwed into a mineral bottle which was used as a base. The bottles were too light and were easily knocked over. It was suggested that we fill the bottles with something to add weight to help the balance. Different ingredients were placed in each bottle (e.g. salt, rice). Each bottle was filled with the same weight of ingredients. The different heights of ingredients in similar bottles led to a scientific discussion on volume and properties of materials used.

We tested the models outside in the playground on a windy day and some anemometers were used to find the windiest places in the school grounds. We discussed where the best school site for a small wind turbine would be. We made 3-D models of wind farms.

Part 3
Drama and Role Play

The wind farm project concluded when the pupils created a play about a wind farm. First, the class carried out a planning exercise to make a list of any groups and individuals whose lives would be impacted by the building of wind turbines.

I used a range of techniques to help the children understand and develop the different views held by people concerning building wind turbines. Some pupils gave

their views based on their research and their interviews of family and friends. This was developed into short interviews where the children assumed different character roles. Gradually stories from each group emerged through using improvisation rather than providing the groups with a written script.

Benefits

- The thematic approach of this project involved the children in a wide variety of activities and experiences.

- The children were able to study a sustainable energy source that was relevant to where they lived.

- The visit helped the children understand how wind farms can contribute to the conservation of the environment.

- The children had an opportunity to recognize the positive and negative environmental elements of wind farms in the community.

- The project gave the children opportunity to identify, collect and record data.

- The children had fun at the wind turbines with the practical exercises of estimating, measuring, using angles and coordinates.

- In the classroom, the children had opportunity to work independently and collectively – different roles were taken within the groups e.g. leader, writer, speaker.

- Each technology session offered opportunity to research topics, discuss and draw plans, sequence work, explain and justify opinions, draw conclusions, evaluate and take risks by learning from mistakes made.

- There were various opportunities to consider the scientific properties of materials e.g. investigating using oil as a lubricant.

- Their investigation was an exercise in creativity helping the children to be imaginative and experiment with the different ideas and to use suitable language to express those ideas.

- The confidence and self esteem of the children was increased through working outside the primary school environment.

- The fears of the primary school pupils were reduced concerning moving schools by using a local secondary school for the drama and technology programmes.

- The sense of rural isolation for both children and teachers was reduced by the clustering of these two small schools.

The participants of this programme would like to thank:

- The staff of E.ON for arranging the visit to the wind farm.

- Ciara Mahon, CCEA for her input into the programme.

- The principal of Strabane High School for the use of the technology and drama suite.

Appendix 1
Talking About Thinking

The following text represents the KS2 Thinking Skills and Personal Capabilities (TSPC) Framework in pupil-friendly language. It can be used with the pupils to create shared learning intentions and success criteria and helps children verbalise how they are developing their Thinking Skills and Personal Capabilities while participating in tasks.

The framework can be used as a reminder for individual children or as a prompt for class discussion. The text can also be downloaded as a set of posters from the 'Think Pack' which is available in the Key Stages 1 & 2 section of www.nicurriculum.org.uk.

Managing Information

- I ask careful questions so I am clear about what I have to do.
- I can organise and plan what I need to do.
- I can set targets for myself and know what I have to do to get there.
- I know where to look for good sources of information.
- I can pick out which information I will need for a task.
- I can compare pieces of information to decide which is the most useful.
- I can present my information in different ways so that others will understand.
- I can use charts, tables, graphs or maps.

Thinking, Problem Solving and Decision Making

- I ask clear questions to get the information I need.
- I know good ways to help me remember things.
- I can compare and contrast things to see how they are the same and how they are different.
- I know the difference between fact and fiction.
- I can work out the reasons why something happened.
- I can work out if evidence is reliable or not and if it should be believed.
- I can weigh up the pros and cons to choose the best solution.
- If one method of solving a problem doesn't work, I can find another way to try to solve it.
- I think ahead to try and work out what will happen next.
- When I solve a problem or make a decision, I can explain my reasons clearly so that other people understand.

Being Creative

- I like finding lots of different ways to do things to make my work more interesting.
- I know that sometimes, the best tool that I have for helping me with my work is my imagination.
- I know that I can find the best way of doing something by trying out different designs, plans and ways of doing things.
- Sometimes other people can help me make a good idea even better.
- When something goes wrong or an idea doesn't work, I can make a new plan.
- I don't mind trying again to find the best way of doing something.
- I know it's okay to make mistakes because I can learn to do it better next time.

Working with Others

- When I'm working in a group, I can organise myself and others without the teacher's help.
- I take turns at having different jobs when I am working in a group.
- I help other people if they need me to.
- I listen to suggestions from others about how to make my work better.
- I can tell others what is good about their work and how they might make it better.
- I know that it is okay to have different ideas and opinions to others.
- I can work with others to reach an agreement or come to a decision.
- If people in my group don't agree, I can help them to decide what to do in a fair and calm way.
- I can listen to and respect other people's points of view, even if they're not the same as mine.

Self-Management

- I can work well by myself and also with others in a group.
- I can plan out what I need to do to make sure I get my work done on time.
- I know that it is important to learn even when it is not always about things I like.
- I know that what I am learning in one topic can help me in other work I do.
- I keep checking my work to see how well I am doing.
- When I get stuck, I know ways to help myself before I need to ask my teacher.
- I know what I am good at and where I can improve.
- I can compare how I have done things with how others have done it, to see if I can learn anything new.
- I can evaluate what I have done.
- I can set myself a target to make my work better next time.

Useful Resources

Ulster Wildlife Trust
www.ulsterwildlifetrust.org

Appetite for Action
http://schools.appetiteforaction.org.uk

Environmental Education Forum
www.eefni.org.uk (Publications: 6:1 Learning Outside the Classroom)

Northern Ireland Environment Agency
www.ni-environment.gov.uk

Think Pack – Thinking Skills and Personal Capabilities
www.nicurriculum.org.uk