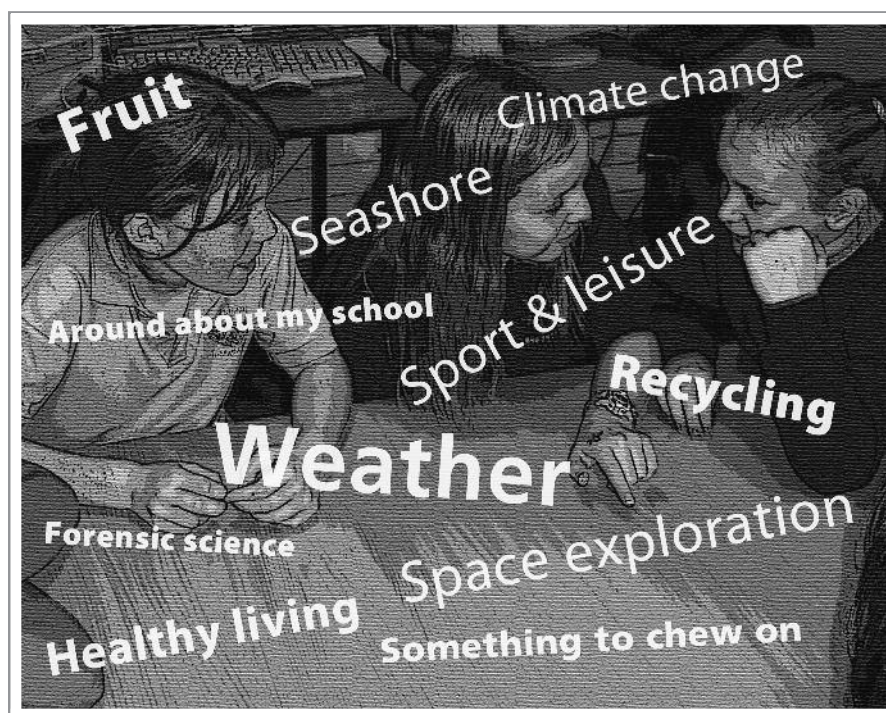


Scientific Enquiry Materials

KS2

TEACHER'S GUIDE



First published in 2007

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Contents

| | |
|---|----|
| Icons used in these materials | 4 |
| Introduction | 5 |
| Structure of the activities | 5 |
| Teacher's notes | 5 |
| Enquiry Sheets | 6 |
| Using the materials | 8 |
| Links to the Skills Framework | 8 |
| Assessment for learning | 9 |
| Peer and self-assessment | 9 |
| Encouraging the expression of ideas | 9 |
| Collaborative working | 9 |
| Open questioning | 10 |
| Personalised learning | 10 |
| Response modes | 10 |
| Embedding the use of ICT within enquiry | 10 |
| Health and safety | 11 |
| Summary of the units' contents | 12 |

Icons used in these materials



In some instances, further support material can be found on the CD accompanying this material. This icon signals the availability of that additional support material.



This icon is used to identify opportunities to support pupils' development of ICT skills within the activities and to remind teachers of pupils' safe use of the Internet.



This icon is used to identify opportunities to support pupils' development of Number skills within the activities.



Links with Curriculum Cymreig are signalled within the materials.



Some of the risks to learners' Health and Safety that might be associated with the activities in these materials are highlighted. In addition, as part of the planning process, teachers are encouraged to make their own H&S risk assessments.

Scientific Enquiry Materials

Introduction

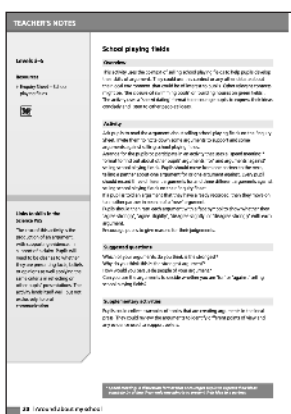
These materials support the teaching and learning of Scientific Enquiry in science at Key Stage 2. The materials are available in Welsh and in English.

The activities provide opportunities for pupils to engage in all aspects of scientific enquiry. There is a particular emphasis on the expression and sharing of ideas and the collection and evaluation of evidence. This evidence might be gathered through pupils' own investigations and observations or from secondary sources such as the Internet. In some instances, links with investigations and the published data of professional scientists are suggested as sources of evidence that make connections between the pupils' enquiries taking place in the classroom, or related investigations taking place nationally and internationally. Pupils are encouraged to hypothesise, gather evidence, think creatively, reason, explain, and reflect critically on outcomes. Techniques to encourage pupils, to monitor their own learning, to self assess and to review each other's work are also signalled within the materials.

The materials comprise eleven units, each of which offers an engaging context for pupils' study of Scientific Enquiry. All the units are designed to be innovative and to address issues of relevance and interest to pupils at KS2. Some of the contexts encourage pupils to engage with current environmental issues such as the management of waste, the local environment, chewing gum litter and climate change. Other contexts present enquiry activities within what may be, for many pupils, more familiar science topics, such as healthy living, sport and the weather.

Each Unit is made up of ten activities. Most of the activities within a unit are free-standing, allowing teachers to select an activity or activities according to the needs and interests of pupils and plans for the development of Scientific Enquiry skills.

Structure of the activities



Teacher's notes

Each activity within a unit contains 'Teacher's notes'. These can be used to inform the planning of the activity and to guide its administration with pupils. The following information is included in the Teacher's Notes.

National Curriculum levels

Each activity includes a suggestion of the range of levels of achievement for which the activity might be appropriate. Some activities are designed for pupils working across the full range of levels 2–5 inclusive, whilst other activities are specifically aimed at pupils working at a narrower band of levels, for example levels 2–3 or levels 4–5. Pupils at the lower extremes of the achievement range may well need additional teacher support in order to engage with the ideas and activities.

Overview

The overview gives a brief synopsis of the main area of focus covered by an activity and provides the teacher with an ‘at a glance’ planning guide to the content of an activity.

Resources

The resources needed for each activity are listed. The use of real materials is encouraged. In some instances, the materials listed are examples and teachers should feel able to choose other materials suited to the needs and interests of the pupils. Illustrations of objects, e.g. foods, are occasionally included as alternative stimulus material. Optional Enquiry Sheets are provided for pupils to record their own or the group’s ideas.

Links to skills in the science PoS

A brief overview of the science enquiry skills pupils may use whilst carrying out the activity is provided.

Activity

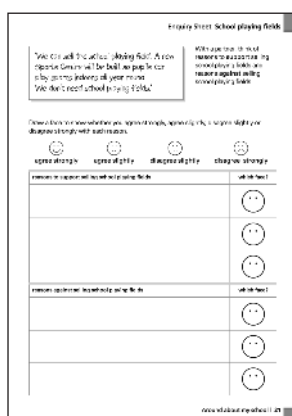
The activity is briefly described together with ways in which it might be introduced and managed.

Suggested questions

Posing open questions encourages pupils to express ideas as well as modelling the kinds of questions pupils should be asking of each other. A list of suggested questions which have been found useful in guiding pupils’ learning and in probing their understanding is included. These questions can be handed over to pupils for their own use in group discussion.

Supplementary activities

Further teaching and learning opportunities are offered as supplementary activities. These are often presented as ideas for pupils’ further investigation of a topic. They provide ideas for follow-up work that the pupils could undertake in order to develop and enhance their learning from the starting point of the main activity.



Enquiry Sheets

Optional ‘Enquiry Sheets’ linked to each activity aim to support pupils’ open-ended enquiries and encourage the development of thinking skills. Their use should be supported by interactions with the teacher. There is no expectation that pupils or groups of pupils will always record their ideas on the Enquiry Sheet. Indeed, the materials propose other ways of recording and sharing ideas such as class discussion, posters, video animations, dance or podcasts. The Enquiry Sheets might be described as graphic organisers as they can help pupils structure their thinking and learning. Some Enquiry Sheets are similar in format to the Developing Thinking tools. The following Developing

Thinking tools are featured in the Scientific Enquiry Materials.

Concept maps – Concept maps can be constructed by pupils. They can show pupils’ understanding of concepts and the links or relationships between concepts. Pupils might be asked to generate their own ideas about a ‘concept area or they might be given a range of ideas by their teacher. Individually, in pairs or in groups, learners think about and show the relationship between

their ideas using lines, arrows, writing or drawing. They can add examples to make links with the real world. Recent research suggests encouraging learners to work in pairs is particularly helpful in encouraging the discussion of ideas. Concept maps constructed before, during or after a phase of teaching might be compared to assess the progression in understanding.

Diamond ranking – A tool that promotes discussion or reflection about the relative importance of a range of factors or ideas. In some instances, the use of the diagonal shape assumes that there is one most important idea, several ideas of similar level of importance and finally one least important idea. In other instances, pupils may not be expected to distinguish the most important and least important ideas but they might be expected to think about and identify all those ideas that are very important, those that are quite important and those that are not at all important. These scientific enquiry materials use diamonds and other shapes such as circles to encourage pupils to reflect on the relative importance of a range of ideas.

KWHL grid – These might be used to encourage individual learners to think about and monitor their learning. Learners are invited to describe

- ▶ what they already know about a topic;
- ▶ what they want to learn about the topic;
- ▶ how they can learn more;
- ▶ what they have learned, following an activity.

Quescussion – A questioning technique that requires learners to ask only questions about stimulus materials. Learners should be encouraged to pose their own questions and to listen carefully to the questions asked by others. They should react to questions by posing new questions rather than by offering answers. Finally they should reflect on the range of questions asked and begin to classify questions according to, for instance, whether or not questions are open-ended. Asking learners to video record or audio record their questions will provide evidence of the questions posed that pupils can then review.

Audience cube – A cube that names a different type of audience on each face is introduced to pupils. Learners choose an audience on the face of the cube and then prepare a presentation or argument that targets a particular audience.

Speed meeting – This discussion format involves the whole class in very rapid paired discussions. Pupils are encouraged to take turns either presenting or listening to an argument. By placing constraints on the time allowed for the presentation of an argument, the pupils are encouraged to express their ideas concisely and to listen to each other's ideas carefully. As little as one minute might be allowed for a pupil to present an argument to another pupil. The pupils' roles are then reversed, e.g. the listener is asked to present the main points of that argument to another pupil. The speed meeting stops when pupils have expressed and listened to at least two points of view. A poll might be taken to find out which of the different views held is favoured by the majority of the class. Class discussion could be used to evaluate the evidence offered by pupils in support of their views and to provide opportunity for the expression of counter views.

Using the materials

Links to the Skills Framework

Developing Thinking across the curriculum

These materials reflect the skills identified in the 'Plan', 'Develop' and 'Reflect' sections of Developing Thinking within the Skills framework. The activities provide opportunities for pupils to plan and carry out a variety of different types of investigation which link to their own ideas and questions. They are encouraged critically to reflect on the evidence collected as well as to reflect on their approach. Throughout the activities there are suggestions that encourage pupils to agree success criteria prior to an activity. Points at which pupils might reflect upon their learning are also signalled.

Some teachers may need to allow extra time for pupils' thinking before they express ideas or carry out an activity. The open-ended questions within each activity are designed to promote the pupils' thinking skills as an integral part of their learning in science.

Developing communication

A wide range of communication skills are fostered as an integral part of learners' scientific enquiries. Pupils' expression and presentation of ideas need not be limited to the written form. These materials explicitly encourage pupils to decide upon and use a range of ways to present their ideas and findings including, for instance, writing, speech, drama and video.

Developing Number

Those activities that provide specific opportunities for developing number skills within the Skills Framework are identified. Within the materials, learners are encouraged to gather information, take and record measurements, interpret results and present their findings.

Developing ICT

Throughout the materials there are opportunities for learners to develop their ICT skills. Opportunities to develop those ICT skills of 'creating and presenting ideas' or of 'finding information' that are presented within the Skills Framework are highlighted.

Assessment for learning

The materials are based upon the principles of ‘assessment for learning’ in which pupils are actively encouraged to make their own ideas known to themselves, their teacher and other pupils. Teachers are encouraged to use these ideas in their planning for next steps in pupils’ learning.

Working in this way can prove motivating for pupils and encourages the development of their scientific literacy skills. For teachers, the time and energy invested will result in more effective and satisfying teaching and learning outcomes for themselves and their pupils.

Formative assessment can:

- ▶ offer insights into the learning needs of pupils, thereby informing the management of teaching and learning;
- ▶ help pupils achieve learning outcomes of immediate importance by focusing support where it is required;
- ▶ provide long term support for pupils in becoming more effective learners by helping them develop techniques for self-assessment and for monitoring their own learning.

Peer and self-assessment

Many activities encourage self- and peer-assessment. Pupils are encouraged to decide their success criteria and to play an active role in making judgements about their own progress and that of their peers based on their agreed criteria. This is an essential part of the process of learning how to learn (or ‘metacognitive’ awareness) as it provides a chance to share and understand learning intentions and progress in learning. It also helps pupils to recognise good quality work – both their own and that of their peers.

Encouraging the expression of ideas

The materials emphasise social interaction between pupils and between pupils and their teachers. Individual contributions from pupils are important in helping them to become more aware of their thinking and the ways in which their ideas may change. An environment in which pupils feel comfortable enough to share their own ideas and are prepared to listen to and respect other pupils’ ideas is an essential requirement for teaching and learning. Teachers have an important role in fostering a learning community in which learners’ thinking can be freely expressed and built upon.

Collaborative working

Some of the activities signal possibilities for the ways in which pupils might be organised. In general, the expression and sharing of ideas within each activity can take place between pairs, in small groups and during whole class discussion. Achieving a balance across different groupings can help teachers to manage productive and successful collaborative learning. Interactions that have taken place in pairs and small groups can be presented to the whole class for further consideration. In the process of disseminating to the whole class, agreed outcomes can be summarised and a range of ideas can be shared, challenged and reflected upon.

Open questioning

Each activity includes suggested open-ended questions. These can be used by the teacher to probe pupils' developing understanding. They may also serve to orientate pupils' enquiries and attention and to encourage higher order thinking such as critical reflection on evidence for ideas.

The suggested questions might also be used by groups of pupils to help them probe each other's ideas and evidence. Teachers might place the questions on the interactive whiteboard or reproduce them as sets of cards for pupils' use.

Personalised learning

Many activities provide opportunities for pupils to follow their own line of enquiry. Inviting pupils to pursue enquiries that are of personal interest has been found to be highly motivating for pupils. The personalisation of learning impacts positively on pupils' engagement with the task and their development of enquiry skills.

Response modes

Many of the activities provide opportunities for pupils to express their understanding in different ways. Pupils are encouraged to discuss their ideas with each other and with their teacher. They are also invited to write, draw, use three-dimensional models, symbols, construct graphs, make video animations and podcasts and to use whole body movements to show their understanding. Each way of representing ideas facilitates the expression of some understandings and may limit the possibility of others. For instance, three-dimensional models allow pupils to show an understanding of spatial relationships that might be difficult or impossible in a two-dimensional drawing.

Initially, teachers may need to guide pupils towards the most appropriate ways of representing particular ideas. Gradually, with increasing awareness of the representational tools available to them in the classroom, pupils should be able to choose for themselves the way they communicate their understanding.

Embedding the use of ICT within enquiry

The materials suggest many ways in which ICT can be encouraged as an integral part of pupils' enquiries. For instance:

- ▶ pupils' critical use of the web is encouraged by requiring them to search for information about contemporary science and scientific claims;
- ▶ pupils' use of digital still and video cameras to record their investigations, outcome data and conclusions is encouraged;
- ▶ pupils are invited to present ideas and arguments in video clips, video-animation, podcasts and PowerPoint presentations;
- ▶ pupils' use of the interactive whiteboard to present questions, scientific enquiries, ideas and information is encouraged throughout the materials.

Health and safety

It is important for teachers to refer to their school's general health and safety policy and guidelines as well as its specific policy and guidelines for science and technology when preparing pupils for active participation in practical science activities. Pupils' participation in these activities should be preceded by the teacher carrying out a full risk assessment of potential risks to pupils and to themselves before planning any of the scientific enquiry activities.



This icon is used on the teachers' pages to highlight some of the risks to health and safety that might be associated with the activities within these materials.

The pupils themselves should also be given opportunities to develop their health and safety skills at the Planning, Developing and Reflecting stages of their scientific enquiry. When planning their scientific enquiries, they should be given opportunities to identify 'any hazards and risks to themselves and others'. When pupils follow their planned approach / method, they should 'use apparatus and equipment correctly and safely'. When reflecting on their work, pupils could 'suggest how the approach / method could have been improved' from a health and safety perspective. (KS2 PoS for Science Skills 2007).

Further information and advice on health and safety in primary science can be found in the Association for Science Education publication 'Be Safe' (3rd edition, 2001).

Throughout the materials there are opportunities for pupils to use the Internet as part of their scientific enquiries.

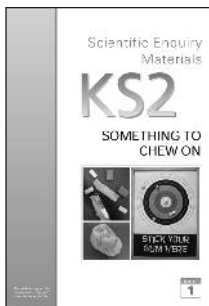


This icon reminds teachers to ensure pupils' safe use of the Internet.

The encouragement of safe and appropriate use of the Internet should be a priority for teachers and pupils. There are several websites that provide detailed and accessible information relating to pupils' safe use of the Internet. It is recommended that teachers look carefully at these sites and follow their advice for increasing pupils' awareness of how they might make safe use of the Internet. The website addresses can also be shared with pupils and their parents. Some useful websites for health and safety advice include:

- ▶ wisekids.org.uk
- ▶ www.kidsmart.org.uk
- ▶ childnet-int.org.uk
- ▶ makenterprise.com

Summary of the units' contents



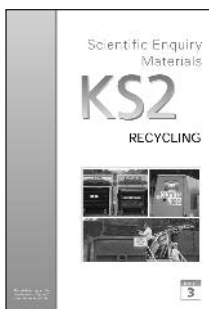
UNIT 1 – Something to chew on

The activities in this unit encourage pupils to investigate some of the properties of gum as well as to examine some of the environmental issues surrounding the use and disposal of gum. Pupils are invited to use a variety of approaches including survey, variable handling, observation and measurement to gather evidence for their enquiries. Finally, they are encouraged to use some of their own evidence and evidence available on the Internet to construct arguments 'for' and 'against' the use of gum.



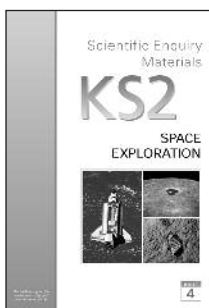
UNIT 2 – Weather

This theme encourages pupils to think about both familiar and unfamiliar weather conditions and to consider some of the impacts of different weather conditions on people and the environment. Pupils are invited to consider different methods of forecasting the weather and the ways scientists collect and present weather information. They are given opportunities to design and make a rain gauge to measure the amount of rainfall and to make and use a model to explain cloud formation. Finally, pupils explore folklore sayings associated with the weather and think about ways in which some of the ideas associated with the sayings might be investigated.



UNIT 3 – Recycling

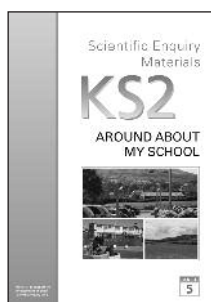
This theme aims to raise pupils' awareness of some of the issues surrounding the re-using, reducing and recycling of waste. Using their own investigations of the production of waste in school and at home, pupils' own actions are linked to sustainability issues. Pupils are encouraged to consider more generally ways in which the actions of individuals might help to conserve some of the Earth's resources. They are invited to critically examine evidence available from their own enquiries and their information searches. Suggestions for arguments in which pupils use the information collected as evidence to support or challenge claims are included within the unit.



UNIT 4 – Space exploration

This theme requires pupils to make their own observations and to consider past and future space exploration. They are asked to observe and record details of the night sky, including changes in the Moon's appearance and the surface of the Moon over a period of one month. The methods and equipment used by space scientists and how the accessibility of collected information has improved due to technological developments are explored. Pupils' ideas and knowledge about the solar system are probed and they are

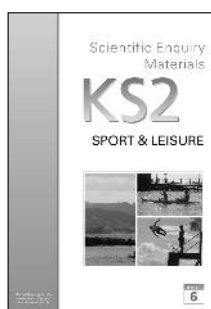
encouraged to evaluate evidence of the Apollo Moon landings. They are encouraged to identify and explore what they would like to find out about Mars, reflect on the merits of humans colonising other planets, and construct arguments 'for' and 'against' astronauts travelling to Mars.



UNIT 5 – Around about my school

Pupils are encouraged to develop their scientific enquiry skills in the context of their local environment. The suggested activities are intended to provide interesting starting points for pupils' investigations. There may be other, more relevant issues of particular interest to pupils in different localities. The theme encourages examination of the environment around the school and identification of the features that distinguish the local environment from other environments across Wales. Consideration of the contribution

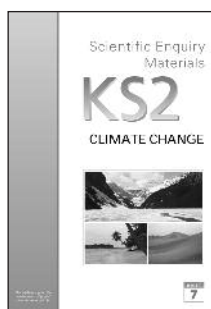
individuals can make to shaping the local environment is a common theme. Pupils are encouraged to collect evidence and develop their skills of argumentation in the context of contemporary science issues such as the selling of school playing fields, positioning of wind farms and the earlier onset of Spring.



UNIT 6 – Sport and leisure

This theme uses the context of sport and leisure activity to develop scientific enquiry skills. Additionally, some of the activities provide open-ended opportunities for pupils to record their ideas about forces. Pupils investigate the safety aspects of clothing worn by different types of sports people and the different factors that are important for a healthy lifestyle and good sporting performance. They are encouraged to plan and carry out investigations in which the management of variables is explicit. Finally, there

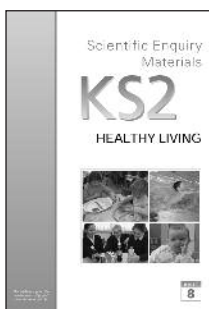
are argumentation activities that involve pupils examining the evidence for claims made in advertisements associated with sport and leisure.



UNIT 7 – Climate change

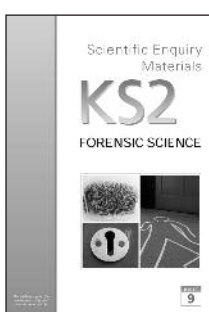
This theme aims to raise pupils' awareness of climate change. Pupils are invited to consider some of the impacts climate change might have on Wales and its people as well as some of the global effects of climate change. Argumentation activities induct pupils into the use of evidence to support or challenge their own beliefs or ideas reported in the media. There are opportunities for pupils to consider how the Earth has changed since the last Ice Age to the present and specifically how Wales might be affected by future

changes in the climate. Pupils are encouraged to reflect on how individual actions might help to influence changes in the climate.



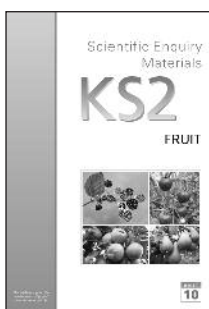
UNIT 8 – Healthy living

Initially, pupils are invited to take on the role of a researcher. They are asked to plan and carry out their own research about a topic that is of relevance or interest to them. Giving pupils ownership of their research helps to provide a meaningful context in which they can plan their approach, the collection, organisation and evaluation of data and the presentation and communication of their results. Some pupils may consider ethical issues such as confidentiality as part of their research. Additionally, the materials provide opportunities for pupils to examine some of the topical issues that are likely to impact on their lives such as pupils' safe use of the Internet, diet and obesity, watching television and travel.



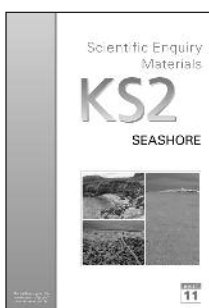
UNIT 9 – Forensic science

This theme aims to give an insight into some of the methods used by forensic scientists. Key features of the unit are the collection and evaluation of evidence. A variety of interesting contexts offer opportunities for pupils to assemble and examine evidence from information or objects available in the classroom. Enquiries are suggested in which pupils are encouraged to make direct links between evidence and their ideas. As pupils present their findings, they are required to make the links between their ideas and the evidence explicit.



UNIT 10 – Fruit

This theme builds upon pupils' early experiences of observing and sorting fruit. The theme includes listing and sorting activities and simple investigations. Pupils are encouraged to think critically about what makes a good investigable question in science and to apply their criteria to the formulation of questions. Using observation and discussion, pupils' own understanding of the term 'fruit' is explored and compared with scientists' explanations. Finally, there are some opportunities for pupils to present arguments and evidence in support of, or to refute, claims made in the media.



UNIT 11 – Seashore

This theme invites exploration of what for many pupils in Wales is the familiar environment of the sea shore. Initially, pupils engage in sorting activities that require detailed observation of shells commonly found in Wales. They are encouraged to critically evaluate plans for investigations suggested in the materials and are also given opportunities to develop their own plans. Using the Internet and other secondary sources they are encouraged to research and compare stretches of the coast line of Wales. Pupils are encouraged to use higher order thinking skills to interpret data of cetacean sightings off the coast of Wales. Finally, reflecting on a tsunami pupils consider their own learning and how it might link to their role as citizens of the world.

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