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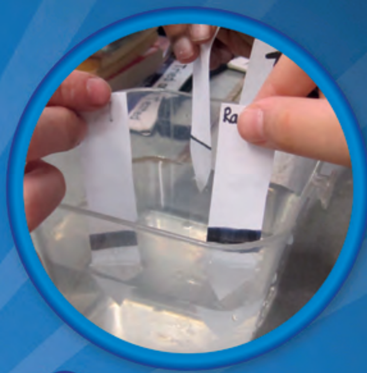

REAL SCIENCE FOR YOUNG SCIENTISTS

Cliona Murphy, Nicola Broderick and Lyndsay Kenny

REAL SCIENCE FOR YOUNG SCIENTISTS

A collection of lessons for teaching about science through inquiry in a primary classroom

RESEARCHED & WRITTEN BY

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INTRODUCTION

ABOUT REAL SCIENCE FOR YOUNG SCIENTISTS

Real Science for Young Scientists is a collection of science inquiries that were developed and piloted during the European (FP7 framework) Fibonacci Project. The Fibonacci Project was an inquiry-based science and mathematics education programme that aimed at developing an integrated strategy for scientific and mathematical literacy and awareness for primary and secondary schools across Europe. (www.Fibonacci_Project.EU)

In Dublin, the Fibonacci Project focused on developing primary school teachers' expertise in teaching *about* the nature of science using inquiry-based methodologies. Over the course of the project 25 primary school teachers from ten Dublin schools engaged with a two year continuing professional development programme in St Patrick's College, Dublin. As part of this project these teachers participated in workshops and learned about a range of newly developed science investigations and inquiries. They then introduced the new methodologies to their pupils in their classrooms.

The collection of investigations and activities that have been selected for inclusion in *Real Science for Young Scientists* have all been tried and tested in a number of Dublin schools with huge success. Feedback and suggestions from practising Irish primary teachers have been incorporated to ensure that the activities can be carried out with ease in a primary classroom and no specialised science equipment is required. We are confident that teachers and children alike will have lots of fun while engaging with the lessons in *Real Science for Young Scientists*.

INTRODUCTION TO REAL SCIENCE FOR YOUNG SCIENTISTS

Real Science for Young Scientists is a collection of lessons to support teachers in teaching a simple yet exciting and innovative programme in primary science. The content and scientific skills addressed in *Real Science for Young Scientists* are drawn directly from the Primary Science Curriculum (PSC) (DES, 1999). The programme is most suitable for children in senior primary classes (3rd – 6th Class / 8 – 12 years) but many of the inquiries can be adapted for younger classes. The main aims of the programme are to develop children's understanding about science and to provide them with frequent opportunities to apply and develop their scientific inquiry skills.

Engagement with the different lessons in each chapter will provide the children with opportunities to:

- develop their understanding *about* science and the work of scientists
- develop their scientific skills and knowledge
- work collaboratively with their peers
- reflect on, investigate and attempt to answer scientific questions that are relevant to their everyday lives
- develop their reflection and dialogical skills
- use a range of mathematical skills when gathering, interpreting, analysing and reporting the different inquiries that they will encounter

There are a number of Photo Copiable Masters (PCMs) to accompany the different inquiries in this programme. These can be found at the back of the book. No specialised science equipment is required for the different scientific inquiries in *Real Science for Young Scientists* and all the materials that are required are easily sourced. A detailed glossary is also provided to support teachers in understanding the different terminology used throughout the programme.

CONTENT IN REAL SCIENCE FOR YOUNG SCIENTISTS PROGRAMME

In addition to providing the children with opportunities to develop their science content knowledge and their scientific skills (as outlined in the PSC), *Real Science for Young Scientists* places a particular emphasis on supporting children's developing understanding *about* science. Aspects *about* science that are addressed include:

- Scientific knowledge as something that is not set in stone but that is continuously developing and changing. Scientific knowledge therefore is constantly providing us with new and exciting information about the world we live in.
- Science is a human activity involving subjectivity, creativity and imagination. For example, through the different activities and investigations the children will begin to understand that sometimes scientists have to use their creativity when designing an investigation or experiment or when they are interpreting or analysing data.
- There is no one scientific method to which all scientists rigidly adhere. Scientists have different ideas and make varying decisions and choices during scientific inquiry. Therefore, scientists do not always follow identical steps and procedures in addressing a scientific problem. However, children must develop an understanding about the true nature of scientific inquiry and know that scientists must ensure that their chosen methodologies / investigations / experiments are reliable and repeatable.
- Science and society are affected by one another. Children will be provided with opportunities to learn about how science and society are influenced and affected by one another in the context of the science that surrounds them in their everyday lives. *Real Science for Young Scientists* will help children to become aware of how school science can help them to understand the science that they are exposed to in their everyday lives via the media.
- History of Science. A number of historical events are used in *Real Science for Young Scientists* as starting points to scientific inquiry. Using historical contexts as starting points to scientific investigations support children in developing their understanding about the purpose of scientific work as 'explaining phenomena' rather than just the 'discovery' of facts. They also show the tentative and developmental nature of science and help humanise science for the children.

HOW DOES REAL SCIENCE FOR YOUNG SCIENTISTS SUPPORT CHILDREN IN LEARNING ABOUT THE REAL WORLD OF SCIENCE AND THE WORK OF SCIENTISTS?

We cannot assume that children will automatically learn *about* the real world of science and the work of scientists as a by-product of 'doing' science experiments and investigations in school. It is important therefore that teachers specifically plan for and teach about these different aspects of science. In this programme, a range of inquiries have been developed to support children in developing a more realistic understanding *about* the real world of science and the work of scientists. There are two different types of activities in *Real Science for Young Scientists* that have been developed to support children's learning: Inquiries about Science (IAS) and Inquiries in Science (IIS).

Inquiries About Science (IAS) are tasks that focus on a particular aspect *about* the nature of science and scientific inquiry rather than on a specific scientific concept. For example, an IAS might focus on developing the children's understanding about how scientists work, about how science can be subjective or about how scientific knowledge is not set in stone but is constantly changing and developing. Throughout *Real Science for Young Scientists* these aspects *about* science are initially introduced to the children using a non-science context as it makes it easier for the children to reflect on and to consider these issues later when they are carrying out their scientific investigations.

The IAS activities also afford children numerous opportunities to develop their working scientifically skills while also improving their collaborative, dialogical and reflection skills.

Inquiries In Science (IIS) on the other hand are activities that have a scientific context but also focus on different aspects *about* the nature of science and the work of scientists. The IIS in this programme are all based on content drawn from the Strands and Strand Units in the Primary Science Curriculum (see Table 1). These activities support children in developing their scientific content knowledge and scientific skills as well as affording them frequent opportunities to reflect on and discuss issues relating to the real world of science.

OUTLINE OF REAL SCIENCE FOR YOUNG SCIENTISTS

There are 6 chapters in Real Science for Young Scientists and a number of lessons within each chapter. The length of each lesson varies from 15 minutes to an hour.

Each chapter follows a similar format:

Aims: identified at the beginning of each chapter

Overview of Chapter: provides a summary of each activity.

Resources: those required for each lesson are listed

Lessons: detailed teacher guidelines are provided for each activity in every lesson. These follow a similar format throughout the programme:

Overview of activity: is provided and indicates whether the activity is IIS or IAS. It provides details of the particular focus of the activity for the teacher

Resources: those required for each lesson are listed

The Lesson and activities: detailed teacher guidelines as to how to carry out each activity or investigation with the children are provided for every lesson. A range of questions to promote investigation, reflection, discussion and assessment are included throughout

Why not try: suggestions for extension activities are provided in every chapter

WHY USE REAL SCIENCE FOR YOUNG SCIENTISTS?

Engagement with this programme will:

- Provide children with opportunities to develop a better understanding of science concepts and scientific inquiry
- Provide children with frequent opportunities to apply and develop their working scientifically skills
- Humanise science for children, making it more interesting for them to learn
- Give children a better appreciation of the role of science in contemporary society
- Make science more relevant to the children's everyday lives
- Support children in developing their science and mathematical inquiry and problem solving skills
- Support children in developing their reflection and dialogical skills
- Provide frequent opportunities for children to work collaboratively with their peers

TABLE 1: OVERVIEW OF LESSONS

	PSC: Strand	PSC: Strand Unit	Working Scientific Skills (WSS)	Integration
CHAPTER 1: UNDERSTANDING HOW SCIENTISTS WORK	Materials	Properties and characteristics materials	*Working Scientifically* Questioning; Observing; Inferring: Hypothesising; Predicting; Investigating; Recording and Communicating; Problem Solving; Collaborating	*English*: Oral; Reading; Writing. *Visual Arts:* Making drawings.
CHAPTER 2: WORKING LIKE SCIENTISTS	Energy and Forces Materials	Heat (i) Properties and characteristics of materials (ii) Materials and change	*Working Scientifically* Observing; Inferring: Hypothesising; Predicting; Investigating; Recording and Communicating; Problem Solving; Collaborating	*English*: Oral; Reading; Writing. *Mathematics*: Data; Capacity; Problem solving. *S.P.H.E*: Media Education.
CHAPTER 3: THE BARE BONES	Living Things	(i) Human life (ii) Plant and animal life	*Working Scientifically* Observing; Inferring: Hypothesising; Predicting; Investigating; Recording and Communicating; Problem Solving; Collaborating	*English*: Oral; Writing. *History*: Early people and ancient societies. *Geography*: Natural environments *Visual Arts*: Making drawings.
CHAPTER 4: CSI STOLEN TROPHY	Materials Living Things Environmental Awareness and Care	i) Properties and characteristics of materials (ii)Materials and change Human life Science and the environment	Working Scientifically Observing; Inferring: Hypothesising; Predicting; Investigating; Recording and Communicating; Problem Solving; Collaborating	*English*: Reading; Oral. *Mathematics*: Measurement; Problem Solving. *S.P.H.E*: Self Identity.

TABLE 1: OVERVIEW OF LESSONS

	PSC: Strand	PSC: Strand Unit	Working Scientific Skills (WSS)	Integration
CHAPTER 5: EXPLORING SOUNDS	Energy and Forces Materials Environmental Awareness and Care	Sound Properties and characteristics of materials Science and the environment	*Working Scientifically* Observing; Inferring: Hypothesising; Predicting; Investigating; Recording and Communicating; Problem Solving; Collaborating Designing and Making Exploring; Planning; Making; Evaluating	*English*: Reading; Oral; Writing. Mathematics: Data. *S.P.H.E:* Environmental Care *Art*: Construction
CHAPTER 6: PARACHUTES AND MORE!	Energy and Forces Materials Environmental Awareness and Care	Forces Properties and characteristics of materials Science and the environment	*Working Scientifically* Observing; Inferring: Hypothesising; Predicting; Investigating; Recording and Communicating; Problem Solving; Collaborating Designing and Making Exploring; Planning; Making; Evaluating	*History*: Stories from the lives of people in the past; Life during World War II. *Mathematics*: Data; Area. *English*: Reading; Oral.

CHAPTER 1:

UNDERSTANDING HOW SCIENTISTS WORK

Aims	The aim of this chapter is to support children in developing their understanding about science and the work of scientists. The activities in this chapter are Inquiries About Science (IAS) that are designed to help children become aware of the work of scientists and to begin to apply and develop a range of scientific inquiry skills. In particular the inquiries focus on the differences between scientific observations and inferences and on how scientists develop and test hypotheses when attempting to explain different phenomena.
Overview of Chapter	OBSERVING SELLOTAPE This Inquiry About Science (IAS) activity focuses on the development of children's observation skills. TRICKY TRACKS This IAS activity introduces the children to the differences between scientific observations and scientific inferences. ICE BALLS This IAS activity provides children with opportunities to develop their own observation and inference skills when examining the physical properties of three ice balls. The children have to develop realistic hypotheses regarding how they think the different ice balls were made. THE MAGIC BUCKET This IAS is a black box activity (see glossary) that presents the children with challenges similar to those encountered by scientists.

LESSON 1 – SCIENTIFIC OBSERVATIONS & INFERENCES

[2]*A.L.L: Approximate Lesson Length*

[3]*WSS: Working Scientifically Skills*

OBSERVING SELLOTAPE (A.L.L[2] 45MIN)

WSS[3]: *Observing*

> Teacher Note
> The aim of this activity is to help the children develop their observation skills and to help them understand that when making scientific observations, scientists do not only use their sense of sight, they use many senses.

Resources:
Roll of sellotape
Tricky Tracks (PCMs 1-3)
(Adapted from Lederman & Abd-AL Khalick, 1998)[1]

The Sellotape Activity
The roll of sellotape is passed around the class and each child must say something different about the sellotape (make an observation). The teacher will say the last thing about the sellotape. (*Hint:* say something about the smell or taste of the sellotape, children seldom think of using their senses of smell or taste when asked to make an observation). Allow each child time to hold and examine the roll of sellotape. If a child has difficulty making an observation they may pass and try again at the end.

Possible observations: The sellotape is round. The sellotape feels smooth on the outside. The sellotape can roll. The sellotape feels sticky on the inside.

When all the class and the teacher have said one thing about the sellotape a discussion is held about the importance of using different senses when making observations.

Offer the children the opportunity to make further observations, using different senses.

Question to guide discussion
Why do you think it is important for scientists to be good observers? *To gain as much information from the evidence as possible.*

Extension activity
This activity may be repeated any number of times using different objects. Examples: a teabag (wet and dry), a polo mint, a lemon.

TRICKY TRACKS

WSS: *Questioning; Observing; Inferring; Analysing.*

Teacher Note
This is an IAS that helps children learn about how scientists make *observations* and *inferences* during their inquiries. In this activity the children are required to make *observations* and *inferences* about the 'Tricky Tracks' picture. Their attention should be drawn to the fact that when a scientist makes an *observation* about a particular phenomenon they describe exactly what can be seen (observed). For example, an observation on the *Tricky Tracks* images could be *"I see black marks on a white background. There are two different sized marks. There are more of the little marks than the bigger ones".*

When scientists make an inference on the other hand they are attempting to provide an explanation about what is observed. So for example, an *inference* as to what the marks on the white background are in the *Tricky Tracks* images could be *"I see a set of bird tracks and one set of tracks is bigger than the other"* or *"It looks as if the animal from the bigger set of prints attacked the animal with the smaller footprints"*

When doing the *Tricky Tracks* activity it is important to draw the children's attention to the fact that while their *observations* are the same their *inferences* can be different from one another as long as they are based on the evidence and are not wild guesses. It is extremely important to emphasise that when scientists make *inferences* they do not make wild guesses rather they draw on their previous knowledge, experience and the available evidence. So like scientists, when they are making inferences on the tricky tracks picture they must be based on the evidence (the picture of the tracks) and on their previous knowledge/ experience (animal tracks in the sand / soil).

Through guided discussion the children should begin to realise that scientists do not always have all the evidence and often have to make inferences. Because of this scientists cannot always reach definitive conclusions.

The Tricky Tracks Activity
Display Tricky Tracks Figure 1 or administer a copy of the image to each group. Ask the children to discuss what is happening in the picture. Ask each group/ child to write a short account of what they think is happening in the picture.

Display Figure 2 and ask the children to make observations about the picture. Record their responses. *Possible responses: I see a set of bird tracks. One set of tracks is bigger than the other. The picture is of animal tracks in the sand.*

These responses are examples of inferences rather than observations. The children can't see the birds hence these statements are *inferences* rather than *observations*.

Ask the children if they can see the birds. If they can't see the birds how do they know for sure that these are bird tracks? They could be dinosaur/frog tracks. Explain to the children that these statements are *inferences* rather than observations. They are interpreting the evidence (tricky tracks) and using their experiences and knowledge of bird tracks in the sand/soil to make sense of and interpret the evidence.

An observation on the other hand is stating simply what you see. I see two sets of black marks. One set of marks is bigger than the other. All *observations* should be the same. *Inferences* on the other hand can vary. However, it is important that the children know that inferences that they (or scientists) make must be based on the evidence. Inferences ARE NOT wild guesses.

Display Figure 3 and ask the children to make observations. Again record their responses. *Possible observations: I see two sets of black marks. One set is bigger than the other. One is on the right and one is on the left and then there is a section where there are both big and small black marks together in a kind of circle.*

Next ask the children to make inferences. *Examples: A big bird and a small bird's set of tracks. Both birds are heading in the same direction, possibly for some food. The bigger bird begins to run as the footprints become more spread out.*

Reiterate that scientists' inferences may be different and that this is acceptable. However, their inferences are not wild guesses. They must be based on the evidence and their previous experiences and knowledge.

Display figure 1 again and ask the children to make observations and inferences. The children at this stage should be coming more familiar with the differences between scientific observations and inferences. Emphasise the fact that the observations they make should be the same, however, their inferences can be different

LESSON 2 – ICE BALLS (A.L.L. 45 MIN)

WSS: *Questioning; Observing; Inferring; Hypothesising; Predicting; Investigating; Analysing; Recording and Communicating; Problem Solving; Collaborating.*

S[4]: *Materials*
SU[5]: *Properties and Characteristics of Materials*

Teacher Note
This is an *IAS activity* where the children use their developing knowledge *about* scientific observations and inferences and *about* how scientists make and test hypotheses during scientific inquiry, while they are examining the physical properties of three ice balls (see glossary). The children will be drawing on their past experiences and knowledge about the properties of ice and will use different senses to help them make observations and inferences regarding how the ice balls were made.

Resources: *Per group of 4:*

3 ice balls per group
3 different coloured balloons (to make ice balls)
1 x filled with water; 1 x filled with salt and water;
1 x filled with sugar and water.
3 paper plates, Scissors, Basin, Magnifier,
Kitchen paper / towel to mop up water, PCM 4

How to make the ice balls

1. *Water ice ball:* Attach a balloon to the tap. Turn on tap to full pressure and fill the balloon with water until it is about the size of a tennis ball. Carefully remove balloon from the tap and tie a knot in it.

2. *Salt and water ice ball:* Using a funnel put two teaspoons of salt into the balloon. Attach the balloon to the tap and repeat as above. Shake the balloon a little to help the salt dissolve in the water before freezing.

3. *Sugar and water ice ball:* Repeat step two, but put two teaspoons of sugar into the balloon.

4. Leave the balloons in the freezer for 48 hours.

Teacher Note
NB: The teacher or another adult should make the ice balls at least 48 hours in advance of the lesson. The children should NOT know how the ice balls were made.

Tip for making Ice Balls: It is a good idea to colour code the different ice balls by using different coloured balloons. So for example, use a green balloon to make the water ice balls, a white one for the sugar and water ice balls and a yellow balloon to make the salt and water ice balls.

Things to note
There will be no significant difference in the appearances of the three ice balls so the children should be encouraged to use different senses when making their observations and inferences (in particular their senses of taste and touch).

However, the ice ball made from pure water will look more transparent in appearance than the other two ice balls. The ball made from salt and water will begin to melt slightly quicker than the other two, as the salt lowers the freezing/ melting point of water.

Depending on the amount of sugar and salt added, the texture of these ice balls may not feel as smooth as the ice ball made from pure water.

Ice Balls Activity
Divide the children into groups. Distribute a basin with 3 ice balloons to each group. Each group is provided with PCM 4 to record their observations and inferences.

Instruct the children to cut open their first balloon (they may choose the colour) and place it on a paper plate. They then must carefully observe the ice ball (they can use a magnifier). Direct the children to explore the different designs, shapes, textures etc. of the ice ball. Encourage the children to remember what makes a good observer: *using all five senses.* Encourage the children to not only look at the ice but to feel, smell and even taste it.

Safety Note
Tell the children that they normally should NEVER taste anything in science class. However, today they have special permission to taste the ice balls.

Children record their observations on PCM 4. Each group must also record possible explanations (inferences) as to how they think the ice balls were made. They repeat this process for all three balls.

Afford the children time to make, discuss and record their observations and inferences.

Questions to guide discussion
1. Do you notice any differences between the ice balls?
2. How are they the same / different?
3. How does each ball feel? Do they have different textures?
4. Can you describe the smell / taste of the ball?
5. Can you make any inferences as to how the balls were made?
6. How could you find out?

Each group must record on their recording sheets how they could test their ideas/ hypotheses.

The groups are given the opportunity to share their observations, inferences and hypotheses with the whole class.

The children could test their ideas by making ice balls at home. However, they should take photos of their original ice balls to compare it with the ice-balls they make.

[4]S: Stand
[5]SU: Strand Unit

LESSON 3 – THE MAGIC BUCKET (A.L.L. 30 – 45 MIN)

WSS: *Questioning; Observing; Inferring; Hypothesising; Predicting; Investigating; Recording and Communicating; Problem Solving; Collaborating.*

Resources: *The Magic Bucket, a small basin, water, red and green food colouring, PCM 5, writing/colouring materials for recording.*

How to make a Magic Bucket: (See figure 1)

1. Cut a small hole through one side of the bucket about one third of the way up the side of the bucket and secure a small tube that will allow water to flow out of the bucket.
2. Cut a hole in the centre of the lid of the bucket and insert a funnel.
3. Securely tie a strong plastic bag around the end of the funnel (inside the bucket). *The bag will catch the water that is poured into the funnel.*
4. Fill the bucket with water to just below the level of the tube.
5. Put lid on the bucket.

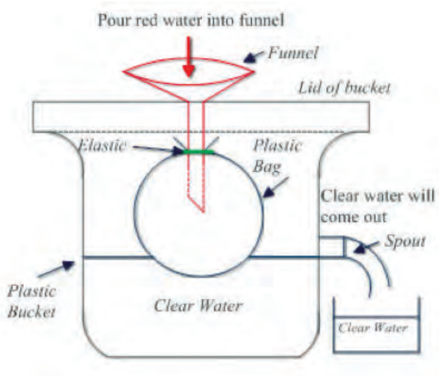


Figure 1: Diagram of Magic Bucket
Ref: Persson, H. (2009)
https://www.youtube.com/watch?v=7tJkltfO4tc

Teacher Note
This is an IAS activity, the aim of which is to present the children with challenges similar to those encountered by scientists. *The Magic Bucket* is a black box activity (See glossary). The children are presented with 'the magic bucket' and they have to try to figure out why clear liquid pours out of the spout despite the fact that different coloured liquids are poured into the funnel. The children (like scientists) don't have all the information so they have to observe the bucket and come up with explanations (hypotheses) about what they think is happening.

How the magic bucket works
(information for TEACHER ONLY)
When the water is poured into the funnel it is caught in a plastic bag which is attached to the bottom of the funnel. As the water in the bag takes up more space it displaces the water already in the bucket which is what is seen pouring out of the tube. The children are instructed to make deductions as to what is happening inside the bucket and to suggest hypotheses as to how they think the Magic Bucket works.

NB: It is important that you DO NOT tell the children what is happening inside the bucket because this activity is trying to help develop children's understanding that often scientists do not have all the information/ evidence and therefore they cannot always be 100% certain.

The Magic Bucket Activity

The *Magic Bucket* is presented to the children. The children are encouraged to make observations about the bucket. They may examine the bucket but cannot look inside.

Possible observations: *"The bucket is big. There is a tube coming out of the side of the bucket. There is a funnel at the top".*

The children are then asked to predict what they think will happen when water is poured into the funnel at the top of the *Magic Bucket*. The teacher (or a child) pours the water into the funnel, until water pours out of the tube.

Ask the children to make *observations* about what they have seen.

The children are asked to predict what they think will happen if red coloured water is poured into the funnel. The red coloured water is then poured into the funnel. As the red water is poured into the funnel clear water will pour out of the tube. The children make observations and discuss whether or not their predictions were correct.

Finally green coloured water is poured into the funnel and clear water pours from the tube again.

The children are asked to explain what they think is happening in the magic bucket. Elicit from the children: *Why do you think clear water came out of the tube when red water was poured in? What do you think is happening inside the bucket for this to occur?*

Children are provided with time to discuss their *observations* and explain why they think clear water comes out each time (make *hypotheses*).

Questions to guide discussion

1. What did you observe?
2. From your observations can you draw any inferences?
3. What do you think is happening inside the bucket?
4. Why do you think clear water comes out each time?
5. Can you explain how the Magic Bucket works? Possible suggestions: There is a sponge inside that sucked the red dye up. There are two tubes inside, one for the red water and one for the clear water. There is sand or salt which filtered the red dye.
6. How do you think you were working like a real scientist?

Distribute PCM 5 and ask the children to draw pictures of what they think is happening inside the bucket (their hypotheses). They then explain their hypotheses to each other.

If time allows you could test out some of the children's ideas as to how the Magic Bucket works.

Teacher Note
If one of the children's ideas is correct and they make the magic bucket correctly, it is important NEVER to tell the children that they are correct! The only conclusion that can be drawn is that their model of the magic bucket behaves in the same way as the original one. They can never know for definite whether their model is the same as the original one. By testing out their own theories children are really modelling how scientists work by developing hypotheses, designing investigations to test these hypotheses, making predictions, analysing results and re-testing if necessary.

[1]Lederman, N. G., & Abd-El-Khalick (1998) Avoiding de-natured science: Activities that promote understandings of the nature of science. In W. McComas (Ed.), The nature of science in science education: Rationales and strategies, 83-126, Boston: Kluwer Academic Publishers

CHAPTER 2

WORKING LIKE SCIENTISTS

Aims	The aim of this chapter is to provide children further opportunities to develop their understanding *about* science and the work of scientists. The first activity is an IAS, a black box activity, designed to help children understand and face some of the challenges encountered by scientists during scientific inquiry. The last three inquiries are Inquiries In Science IIS, where the children are provided with opportunities to apply and develop a range of working scientifically skills while planning and carrying out three fair test investigations. During the IIS activities the children will be encouraged to reflect on and discuss aspects *about* the nature of science.
Overview of Chapter	THE MYSTERY TUBE (IAS) This *IAS activity* is used to help children develop their problem solving skills and to help them begin to understand that scientists' explanations, although very reliable and highly probable are not always a hundred percent certain as they do not always have all the information about a particular phenomenon. The children examine the 'Mystery Tube' and attempt to explain how it works. They are asked to test their 'hypotheses' by making their own model tube. BOUNCIEST BALL, BEST PAPER TOWEL AND BEST BUBBLES (IIS) These *IIS activities* are all fair test investigations (see glossary). In these inquiries the children are required to discuss, plan and carry out fair test investigations in groups to answer three different scientific questions. While engaging with these investigations the children's attention should continuously be drawn to the fact that they are modelling how scientists work. They are devising and carrying out carefully planned and reliable investigations to answer questions based on everyday contexts.

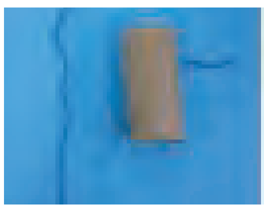
LESSON 1: THE MYSTERY TUBE (A.L.L. 45 MIN)

WSS: *Questioning; Observing; Inferring; Hypothesising: Predicting; Investigating; Analysing: Recording and Communicating; Problem Solving; Collaborating.*

Teacher Note
The Mystery Tube is a black box activity (see glossary). The children observe the four strings being pulled in the tube and have to explain how they think the tube works. They make drawings of how they think the strings are arranged inside the cardboard tube and then make their own model tube to test whether their ideas (hypotheses) are correct. If when they test their first hypothesis their tube does not behave in the same way as the original model, they can be given the opportunity to test a second hypothesis. In this way they are truly modelling how scientists work.

Resources:
Model of tube (1 per group)
Kitchen roll insert or similar, string, material to cover ends of tube, scissors, sharp pencil or screw driver to pierce holes in tube, sellotape.

Making tube (Per Group)
Cardboard tube, scissors, string, screwdriver / sharp pencil.



How to make the tube

1. Using a sharp pencil or screw driver carefully make 4 holes in the kitchen roll insert (2 opposite each other near one end and 2 opposite each other near the other end).
2. Using 2 equal lengths of string (20cm long) feed each piece of string through a hole bringing it out the opposite hole at the opposite end. Make sure to loop the strings in the centre of the tube.
3. Tie a knot near the end of each length of string. When you pull on one of the strings it should pull another one in.
4. NB: Cover the ends of the tube with paper so the children cannot see what is happening inside.

Ref: Adapted from Lederman & Abd-El-Khalick, (1998). You can also see how the mystery tube works on: https://www.youtube.com/watch?v=heOzqD88m18

The Mystery Tube Activity

Show *the Mystery Tube* to the children and demonstrate how it works. Pull one end of the string. This will cause another end to be pulled into the tube. Do this in a clockwise direction and then at random. Divide the children into groups and distribute one mystery tube to each group. Allow the children time to hold and examine their tube and to discuss their observations.

Questions to guide discussion

1. What do you observe? What can you see/feel/hear?
2. Describe what happens when you pull the different strings.
3. Why do you think this happens?
4. Could you make any suggestions as to what is inside the tube?

> Teacher Note
> Remind the children that scientists do not always have all the evidence / information they require and therefore often they have to make inferences to explain how they think things work. However, these inferences are not ‘wild guesses. They are based on the available evidence and scientists’ previous knowledge and experiences.

Ask the children to make drawings about what way they think the strings are connected inside the tube to cause it to behave in this way. These are the children’s hypotheses. Each group presents their drawings and discusses their hypotheses regarding how they think the mystery tube works.

> Teacher Note
> Explain to the children that just like they came up with hypotheses as to how the tube works. Scientists also develop hypotheses to explain certain phenomenon. Scientists then test their hypotheses to see whether or not they are correct.

The children then test their hypotheses by making their own tubes to see if their tubes behave like the original tube. While the children are making the tubes ask the children to think about how they are working like scientists. *(They are making observations and inferences, making and testing their hypotheses as to how the Mystery Tube works, using creativity and imagination in their work)*

When each group has finished and tested their model, encourage the children to share their findings with the whole class.

Teacher Note
If some of the groups do manage to make a model that behaves in the same way as the original tube it is important to highlight the fact that they (like scientists) cannot be sure that their model is the same as the original one. The most they can say is that it behaves in the same way as the original one. It is a black box activity and they can't see inside the tube. So they can never be sure how it is made. The children's attention should be drawn to the fact that this is what happens in the real world of science. Scientists make and test hypotheses in an attempt to explain phenomena, but often scientists cannot be a hundred percent sure as they don't have all the evidence or information about the phenomenon.

Encourage the children to attempt to construct the tube again at home. Remind them that scientists often don't come up with the correct answers or solutions to their investigations on the first attempt so it is important to test and retest as many times as is needed.

Teacher Note
The next three lessons in this chapter are IIS activities that require the children to carry out Fair Test Investigations *(see glossary)*. The aim of these inquiries is to provide the children with opportunities to work collaboratively to plan and to carry out fair test investigations to answer the questions being posed. Throughout each of the lessons the children's attention should continuously be drawn to the fact that they are working like scientists. For example, that like scientists, they are trying to find a solution to a question / problem, they are planning reliable investigations, they are making predictions, observations and inferences, they are measuring and recording data, they are collaborating, they are interpreting and analysing results.

LESSON 2: BOUNCIEST BALL INVESTIGATION (IIS) (A.L.L. 45 – 60 MIN)

S: *Energy and Forces*
SU: *Heat & Forces*

WSS: *Questioning; Observing; Inferring; Hypothesising: Predicting; Investigating and Measuring; Analysing; Recording and Communicating; Problem Solving; Collaborating.*

Teacher Note
In this investigation the children have to plan and carry out a fair test investigation to see whether heat affects the 'bounce' of a ball. They are given a context about someone playing tennis on a cold evening and their ball didn't bounce very well. The scenario is discussed and then the children (in groups) have to plan and carry out an investigation to see whether heat affects the bounce of a ball. Before they carry out their investigation the children should be encouraged to make predictions and give reasons for their predictions.

It is important to emphasise to the children that good scientists make predictions about their investigations. These predictions are based on their previous knowledge and observations.

Teacher Background Information
Rubber balls bounce because of the material from which they are made and because of their hollow rubberlike core that is filled with gas. The gas molecules inside the ball can expand or contract. When the ball hits the ground the force presses up against the ball and the bottom of the ball pushes in compressing the gas inside. As the ball reverts to its usual shape the gas inside acts as a spring causing the ball to bounce into the air. As they hit the ground they become deformed but because of the elastic nature will quickly return to form as they rebound from the ground. At high temperatures, the air molecules inside a rubber ball are warmer and more active, increasing internal pressure. This results in high bounces. At low temperatures, the air molecules are colder and less active, decreasing internal pressure. This results in less bounce.

**When playing tennis in warm temperatures the ball will rebound more than when playing in cold temperatures. This is why during tennis championships like Wimbledon the balls are changed after every 7 games and are taken from a fridge.*

Resources: *Some suggestions for resources that could be used for this investigation:*

Tennis balls (3 per group), measuring tapes/ metre sticks, timers, blu-tac, twine, Sheets of A1 poster paper, places for cooling balls (fridge/ freezer), places for heating balls (outside in the sun/hot press/radiator/hob). Investigation planning and recording sheets (PCM 6 & PCM 7).

TIP: If there is no freezer in the school, the tennis balls could be put in a sealed plastic bag and placed in a bucket of ice to keep them cool. Similarly some of the tennis balls could be put in sealed plastic bag and placed in a bucket of hot water to heat the tennis balls.

Setting a Context

In a whole class setting tell the children that you were recently playing tennis. It was a very cold evening and the balls you were playing with did not bounce very well. Before throwing the balls out you decided to give them another try. The next time you played tennis with the balls it was a hot sunny day and the balls bounced really well.

Pose the question to the class – *Do you think temperature can affect the bounce of a ball?*

Planning and carrying out investigation

Investigation starter question:

Does heating a ball affect how high it bounces?

Discuss with the children whether they think heating or cooling a ball affects how high it bounces. Encourage them to explain their answers.

Show the children the resources they have available to them to carry out the investigation. Then distribute an investigation planning sheet and recording sheet to each group (PCM 6 & 7). Each group must then plan and carry out a fair test investigation to see whether heating a ball affects how high it bounces. Before carrying out the investigation each group must record their predictions on the planning sheets, and should be encouraged to give a reason for their predications.

Questions to guide the planning process

- What resources will you need to do this investigation?
- How will you heat/cool the tennis balls? *(Place them in fridge / freezer, in sealed bags in bucket of ice/ hot water)*
- How will you make sure the test is fair?
- What will you keep the same? *(The type of ball, the height from which the ball is dropped)*
- What will you change? *(The temperature of the ball)*
- How many times will you drop each ball?
- Why do you think it is important to drop each ball more than once?
- How will you measure your results?
- How will you present your findings?
- What do you predict will happen? Why?

Teacher Note
One way to carry out this investigation:
Place one ball in the freezer, another on the heater and leave a third on the table, at room temperature. Leave the balls freezing / warming for 1 – 2 hours. One child holds a metre stick up against the wall. Starting with the ball at room temperature, another child drops the ball from a certain height and a third / fourth child carefully observes how high the ball bounces. They can measure this against the metre stick or stick pieces of blu-tac onto the wall around where the ball bounced and then measure it. Drop this ball twice more from the same height and measure how high it bounces each time. Repeat this for the cold and the hot ball. They could also use video to record how high the balls bounce each time they are dropped.

TIP: Try to leave the cold balls / hot balls in the cold / heat until just before you test them.

The students could calculate the average height each ball bounced and then record their findings on a table / graph (See PCM 7).

Discussing Findings
Encourage the pupils to discuss their predictions, investigations and results with the whole class.

Questions to guide discussion

- What did you find out?
- Were your predictions correct?
- Do you think that temperature can affect how high a ball bounces?
- How were you working like scientists?

Extension Activity
This lesson could be given to the children as an activity to do at home over a number of days.

LESSON 3: BEST KITCHEN PAPER TOWEL INVESTIGATION (A.L.L. 45 – 60 MIN)

S: *Materials*
SU: *(i) Properties and Characteristics of Materials (absorbency); (ii) Materials and Change.*

WSS: *Questioning; Observing; Inferring; Hypothesising: Predicting; Investigating and Measuring; Analysing; Recording and Communicating: Problem Solving; Collaborating.*

Teacher Note
In this investigation the children examine a variety of brands of paper towels and predict which one they think will be the most absorbent i.e. which can hold the most liquid. In groups, they plan and carry out a fair test investigation to test their predictions.

Resources: Some suggestions for resources that could be used for this investigation:

Advertisements for paper towels, 3 varieties of paper towels, water, beakers, petri-dishes or saucers, jugs, basins, pipettes, syringes, timers, food colouring, elastic bands, coloured paper, writing materials, rulers, PCM 6

Setting a context
Show the children the kitchen paper towels. Show three separate advertisements for Paper Towels to the class. (These can be sourced from the web: http://www.tvads.ie/). Discuss the advertisements with the children. Next discuss with the children what they think makes a good paper towel - (absorbent, long lasting, good value for money etc).

Questions to guide discussion

- Did you like the advertisement? What did you like about it?
- What did it tell you about the product?
- Would you buy the product based on this ad?
- What information would help in making your choice about paper towels?
- Do you believe what the ad is saying about the paper towel?
- How could we find out?

Planning and carrying out the investigation

Investigation starter question:
Which kitchen paper towel soaks up the most liquid (is the most absorbent)?

In their groups the children carefully examine one piece of each of the three paper towels and predict which of the paper towels they think will soak up the most water (be the most absorbent).

Show the children the resources available to them to carry out the investigation. Distribute an investigation planning sheet (PCM 6) to each group. Each group plans and carries out a fair test investigation to see which kitchen paper towel will be best at mopping up the spill. They must record their predictions on the planning sheets, and should be encouraged to give a reason for their predications *(I think Brand A will hold the most liquid as it feels the thickest etc).*

Questions to guide the planning process

- What do you want to find out?
- What are you going to do?
- How are you going to make it a fair test?
- What paper towel do you predict will soak up / absorb the most water? Why?
- Why do you think this?
- How will you know which paper towel has soaked up the most water?

The children then discuss their findings with the whole class.

> Teacher Note
> *One way to carry out this investigation:*
> Pour 30mls of water into a beaker. Place a rolled sheet of paper towel into the beaker for 5 seconds. Remove the paper towel and hold over the beaker and allow to drip for 5 seconds. Measure how much water is left in the beaker. Repeat this for the other two paper towels. The paper towel that leaves the least amount of water in the beaker is the most absorbent.

Questions to guide discussion

1. What did you find out?
2. How did you make sure your test was fair? *Use the same size piece of paper towel, use the same amount of liquid, absorb for the same length of time etc.*
3. What did you measure? (*How much water was left in the beaker)*
4. What did this tell you?
5. Were your predictions correct?
6. What did you learn from your investigation?
7. Do you trust your results? Why?
8. Why do you think it is important for scientists to carry out fair tests? *(They obtain reliable, repeatable evidence)*

> Teacher Note
> Different groups may carry out different investigations and as a result may come up with different results. It may therefore be necessary to repeat some of the investigations to come up with more conclusive results. Children's attention could be drawn to the fact that scientists repeat investigations to make sure their results are reliable.

Extension Activity

The children could then investigate which of the three kitchen paper towels is the best value for money. The findings from this investigation could affect their opinions regarding which paper towel they should use in the future. The most absorbent towel may not be the best value for money!

LESSON 4: BEST BUBBLES INVESTIGATION (A.L.L. 45 – 60 MIN)

S: *Materials*
SU: *Properties of Materials*

WSS: *Questioning; Observing; Inferring; Hypothesising: Predicting; Investigating and Measuring; Analysing; Recording and Communicating: Problem Solving; Collaborating*

Teacher Note
In this investigation the children are set a problem solving task to find out which of three liquids makes the 'best' bubbles. The children have to discuss what they think 'best' means. So for example, does 'best' mean the liquid that makes the biggest bubbles or the most bubbles or the longest lasting bubbles? They choose one criteria for best (e.g. the liquid that makes the biggest bubble), they then make predictions, plan and carry out a fair test investigation. It is a good idea to allow the children some time for free play with the bubbles prior to conducting the investigation.

Resources: *Investigation planning sheet (PCM 6), Some suggestions for resources that could be used for this investigation: Basins, jugs, beakers, petri-dishes, small bowls, plastic wands (homemade is fine), pipe cleaners (to make wands), straws, sugar paper, timers, 3 bubble making liquids eg. Washing-up liquid, shampoo, bubble bath, shower gel.*

Setting context
Show the children three different television advertisements for 'Best Bubbles'. These can be sourced from the web: http://www.tvads.ie/. Discuss the advertisements with the children and ask them which liquid they think will make the best bubbles. Encourage them to give reasons for their answers.

Questions to guide discussion
- Which of these liquids do you think will make the best bubbles? Why?
- Do you believe these advertisements? Why / why not?
- How could we find out which liquid makes the best bubbles?
- What do we mean by best? Do we mean biggest / longest lasting / most?

In groups the children discuss what they mean by 'best' and decide on one criterion they can test for the 'best' bubbles. (For example, biggest/ most / longest lasting etc)

When they have chosen their criterion, each group then plans and carries out their investigation.

Planning and carrying out the investigation
Investigation starter question:
Which liquid makes the biggest / most / longest lasting bubbles?

Show the children the resources they have available to them to carry out the investigation. Distribute an investigation planning sheet (PCM 6) to each group. Each group then plans and carries out a fair test investigation to see which of the liquids makes the most/ best / longest lasting bubbles. Before carrying out the investigation the children record their predictions on the planning sheets, and should be encouraged to give a reason for their predications.

Questions to guide the planning process

- What are you going to do?
- What materials will you need?
- How will you make sure you have a fair test?
- How will you measure which liquid makes the best bubbles?
- Which liquid do you think will make the best bubbles? Why?

Teacher Note
To simplify things the children could all carry out an investigation to see which liquid makes the most bubbles. Here are two possible ways to carry out this investigation:

For each liquid, using the same sized wand, the children could blow into the wand and count how many bubbles are made. They could repeat this three or four times for each liquid and then take an average.

Alternatively they could put equal amounts of liquid into four beakers, place a straw in the beaker and blow gently for a set time. The children would have to devise methods of how they will measure the bubbles.

The children then discuss and compare their findings with the other groups

Questions to guide discussion

- What did you find out?
- How did you make sure your test was fair? *Use the same size wand, the same amount of liquid, blew for the same amount of time etc.*
- Were your predictions correct?
- What did you learn from your investigation?

CHAPTER 3

THE BARE BONES

Aims	The aim of this chapter is to provide children with further opportunities to develop their understanding about science and the work of scientists. The inquiries in this chapter require the children to try and make sense of a limited range of evidence by making a range of observations and inferences. They get the chance to experience the work of and challenges faced by palaeontologists during the 'bone expedition'.
Overview of Chapter	THE 'HOLE PICTURE' (IAS) In this inquiry each group is given a 'hole picture' of which only parts are visible. The children are asked to make observations and inferences about what they think the picture is. While each group is looking at the same picture, each group's picture has different holes cut out, therefore, revealing different parts of the same picture. Groups share their ideas with other groups and see if they can come up with a collective decision regarding what the picture is. EXPLORING SKELETONS (IIS) In this activity the children discuss and compare a human skeleton with the skeletons of birds, fish and mammals. They are shown images of different skeletons and asked to make observations about the skeletons and then infer to which animal they think the skeletons belong. THE GREAT BONE EXPEDITION (IAS) This inquiry enables the children to act as palaeontologists and uncover fossil bones while going on a 'research expedition'. As they uncover different bones the children are asked to think about (and make inferences) about what creature they might have unearthed. They can share their information with the other groups and look up a 'skeletal resource manual' in an attempt to figure out to which family the skeleton they have unearthed belongs.

LESSON 1 – THE HOLE PICTURE (A.L.L. 30 – 45 MIN)

WSS: *Questioning; Observing; Inferring; Hypothesising: Problem Solving; Collaborating.*

Teacher Note

The aim of the 'Hole Picture' inquiry is to help children's understanding about the nature of scientific inquiry. In particular, the 'hole' picture inquiry helps children to become aware that:

- Often scientists do not have sufficient evidence to solve the problem or to answer the question they are investigating.
- Scientists have to try to gather as much information about the particular phenomenon as possible.
- Scientists make observations and inferences, often from very limited data, and then attempt to explain the scientific phenomenon.
- Scientists' inferences are not 'wild guesses'. They are based on the evidence and their previous knowledge.
- Different inferences are acceptable as long as they are consistent with the evidence.
- Scientists collaborate with one another and share pieces of information.

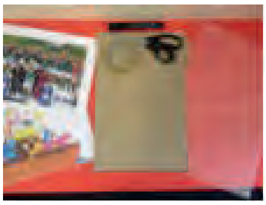
The 'Hole Picture' activity also provides children with numerous opportunities to develop oral language, critical thinking and problem-solving skills.

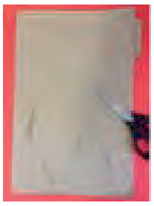
Resources:

Per group: Picture or photo on A4 sheet of paper, an A/4 cardboard folder, an acetate sheet, a whiteboard marker.

How to make the hole picture:

1. Cut about 10 small snippets (holes) out of one side of a coloured cardboard A4 folder.
2. Insert a copy of the picture/photograph into the folder, so you can see parts of the picture though the 'holes'.
3. Tape all sides of the folder together so the children cannot take the photo out of the folder.





Teacher Note

The same photo is used for every "Hole Picture", but the position of the holes cut on the folder vary from group to group. As a result each group will be looking at different parts of the same photo / picture.

Ref: Adapted from Lederman & Abd-El-Khalick, (1998).

The Hole Picture Activity

Each group is given a 'Hole Picture'. Encourage each group to look at their 'Hole Picture' and make observations about what they see. *I can see a road; I can see a wheel; The thing I can see in this area is red.* Each group records their observations. Next the children are encouraged to make inferences (suggestions) about what they think the picture might be. Like scientists they must base their inferences on the evidence they have, from their previous knowledge and experiences and they must provide a reason for their inferences. They cannot just make wild guesses. *I see a wheel and a sail so I think the picture is something to do with transport.*

Each group then places an acetate sheet over their picture, and using a whiteboard marker sketches what picture they think is inside the folder.

When each group has completed their drawing discuss the activity.

Questions to guide discussion

1. What do you think the picture is?
2. What clues (evidence) did you have to help you?
3. Were all of your group in agreement?
4. How do you think you were working like scientists? (making observations and inferences)
5. All of you have the same picture, but you didn't all come up with the same conclusion. Why do you think this was?

As each group can see different parts of the picture, they may not all come up with the same inferences (conclusions) regarding what picture is inside the folder. Discuss this fact and ask the children how they might be able to get more information about the picture (without opening up the folder!) They could look at what the other groups have drawn and examine different groups' pictures.

Teacher explains to the children that often scientists share information and this can be very beneficial in enabling scientists to make further sense of scientific phenomena / data.

Allow the children time to examine each group's picture. Children may informally question one another as to why they drew the picture they did.

After examining other groups' pictures, the groups come back to their original picture and draw a second sketch of what they think the picture is. Each group presents their picture to the class and discusses their findings.

Questions to guide discussion

1. Was the second sketch you drew the same as the first one you drew?
2. How was it the same / different?
3. Did you change your mind? Why?
4. Did looking at other groups' pictures help you? How?
5. How sure are you that your second sketch is accurate? (Very sure but not 100% sure)
6. How could you be 100% sure? (take the picture out of the folder)
7. How is this working like scientists?
8. What does this tell you about scientific knowledge? (Scientists can't always be a 100% sure. Scientists draw inferences/ conclusions based on available evidence. Is not a wild guess, is based on evidence. Often scientists don't have all the evidence / information).

Extension Activity

This activity may be repeated several times using different pictures.

LESSON 2 – EXPLORING SKELETONS (A.L.L. 45 - MIN)

S: *Living Things*
SU: *(i) Human Life;(ii) Plants and Animal Life*

WSS: *Questioning; Observing; Inferring; Hypothesising: Collaborating.*

Teacher Note
The aim of this activity is to start the children thinking about and observing different human and animal skeletons. By looking at the different skeletons the children are beginning to familiarise themselves with different animal skeletons which should help them when they engage with, the 'Great Bone Expedition' inquiry in the next lesson.

Teacher Information
There are four animal skeletons on PCM 10. They are a dog, a kangaroo, a bird and a fish

Resources:
PCMs 8-10 : Human body outline, human skeleton, dog, kangaroo, bird and fish skeletons.

The Exploring Skeletons Activity
Finding out children's ideas about the human skeleton.
Hold a discussion about the human skeleton.

Questions to guide discussion

1. What is inside our bodies?
2. Do we have bones inside our bodies?
3. Why do you think we have bones?
4. What do our bones do?
5. How many bones do you think you have?
6. Where would you find the smallest / biggest bone in your body?

Give each pair / group an outline of the human body (PCM 8) and ask them to draw as many bones as they can inside the outline of the human body. Encourage the children to think about the size, shape and number of bones in each part of the body. For example, *how many bones do you think you would find in your hand? Feel your hand. Do you think the bones in your fingers are bigger or smaller than the bones in your feet/arms/ legs/ toes etc.* Discuss the children's drawings.

Next display the image of the human skeleton on the IWB and/or administer a copy to each group (PCM 9). Ask the children to compare their drawings of the skeleton with the one on the IWB / PCM 9. Discuss the skeleton and the children's drawings.

Questions to guide discussion

1. Compare your drawing of the bones with this image?
2. Did you forget any bones? Which ones?
3. Where is the biggest /smallest bones in the body?
4. Do you know the names of any of these bones?
5. Why do you think we need bones?
6. Do some of the bones have a special job? *(E.g. the skull protects the brain, the ribs protect the heart and lungs etc)*

Divide the class into groups. Each group is presented with an image of an animal skeleton (PCM 10). Ask the children to observe the image and discuss to which animal they think their skeleton belongs.

Questions to guide discussion

1. Describe the skeleton.
2. Do you think this animal can fly / crawl / swim? Why?
3. Do you think this animal is a carnivore or a herbivore? Why?
4. What animal do you think this skeleton is from?

Ask the children to draw the animal to which they think their skeleton belongs. Allow children time to present their drawings to the rest of the class and to explain how they reached their conclusions.

Display each of the skeleton images on the board alongside the image of the human skeleton. Ask the children to make statements comparing two or more of the skeletons: For example: All of the skeletons have skulls; All of the skeletons have ribs to protect their organs; The dog and the lion have four legs; The dog, lion, kangaroo and bird have tails.

Finally ask the children to make statements contrasting the skeletons: The human is standing on two legs and the dog is standing on four legs etc.

LESSON 3 – THE GREAT BONE EXPEDITION (A.L.L. 45 – 60 MIN)

WSS: *Questioning; Observing; Inferring; Hypothesising: Predicting; Analysing; Researching: Recording and Communicating; Problem Solving; Collaborating.*

Teacher Note
The aim of this activity is to enable the children to face challenges similar to those that palaeontologists face in their work. In particular, the bone expedition inquiry will help deepen children's understanding about the following aspects *about* scientific inquiry:

- Often scientists do not have sufficient evidence to solve the problem *(the animal to which the bones belong)* that they are investigating.
- Scientists have to try to gather as much information about the particular phenomenon as possible.
- Scientists make observations and inferences often from very limited data *(a few bones)*, and then attempt to explain the scientific phenomenon *(to what animal the bones belong)*.
- Inferences are not wild guesses. Scientists base inferences on the available evidence and on their past experiences and knowledge.
- Different inferences are acceptable as long as they are consistent with the evidence.
- Scientists collaborate with one another and share pieces of information.

It is important that at different stages throughout this inquiry that the children discuss and reflect on how they are working like scientists.

Resources:
PCM 11: Script for teacher to read: The Great Bone Expedition

PCM 12: Drawings of bones cut and put in envelopes (1 set per group)

PCM 13: Skeletal resources manual (1 per group)

PCM 14: Recording sheet (1 per group)

TIP: The drawings of bones (PCM 14) will need to be photocopied, laminated and cut out in advance of this activity. Each group will need a set of bones in an envelope. It is a good idea to number the bones in each set, in case they get mixed up.

The Great Bone Expedition Activity
Tell the children that they are going to act as palaeontologists and are going to go on a "Bone Expedition" in the classroom. Divide the class into groups and give each group the name of a university/college in Ireland. The children will work as scientists for that college. Present each group with an envelope of bones (PCM 12) and a recording sheet (PCM 14).

NB: Warn children that they must not open the envelope or take anything from it until they are asked to do so.

Read the script 'The Great Bone Expedition' (PCM 11) to the class and ask them to follow the instructions. The story will pause on a number of occasions (at the end of each day of the dig) for the children to remove some bones from their envelopes. On each of these occasions the children will examine the bones and record observations and inferences on their recording sheet (PCM 14). They may write or draw their results.

Questions to guide discussion

1. What do your bones look like? Describe/Draw
2. From what animal/type of animal do you think the bone belongs? Why?
3. What about the bone makes you think that?

At the end of each 'day of the dig' each group must arrange the bones on their desk according to where they think they might be positioned. They must make suggestions (and record these) as to which creature they think the bones belong.

After four days the dig is complete and each team of researchers returns to their universities.

They then discuss what they have found on the dig.

Questions to guide discussion

1. What do you think the creature is?
2. What clues did you have to help you?
3. Were all of your group in agreement?
4. From your clues could you suggest how/ where this animal lived or what it may have eaten?

Ask the children how they could obtain more information about the species they have unearthed. *(They could look at the bones the other groups have found and how they have arranged them).*

Explain to the children that often scientists share information and this can help them to make more sense of their own evidence. Allow the children time to 'visit' the different 'universities' and to examine the selection of bones gathered from the other groups. The children may informally question one another as to why they arranged the bones as they did and what function they believe certain bones have.

Question the children on whether their opinions changed after seeing the other groups' pictures.

Finally, give each group a "Skeletal Resource Manual" (PCM 13) and ask the children to see if any of the skeletons in this manual contain bones that are similar to the ones they unearthed.

The children (in groups) must the make a final decision as to which family they think their animal belongs. They present their findings to the rest of the class.

Questions to guide discussion

1. Did information from another group influence your decision or cause you to change your initial decision?
2. Did the Skeletal Resource Manual confirm your ideas or cause you to rework your arrangement of the bones?

At the end of this lesson it is important to discuss with the children how they were working like scientists while doing this activity (observing, inferring, using evidence, sharing information, using creativity, using previous knowledge, not always getting the answer). DO NOT tell the children what animal the bones belong to. Reinforce that scientists do not always find answers but use their best interpretation.

Teacher Note
The bones are from the cat (sabor tooth tiger) skeleton on the Skeletal Resource Manual

Extension Activity

You could try doing this activity using sand trays instead of envelopes to hide the bone. It would be exciting for the children to dig for the bones in the sand.

REFERENCE: This activity has been adapted from Randak, S. & Kimmel, S. (1999) The Great Fossil Find. http://www.indiana.edu/~ensiweb/lessons/gr.fs.fd.html

CHAPTER 4

CSI: STOLEN TROPHY

Aims	In this chapter the children will learn about some of the challenges and limitations of forensic science. However, the main aim of this chapter is to provide children with more opportunities to develop their understanding *about* science and the work of scientists. By engaging with the inquiries in this chapter the children use a range of working scientifically, problem solving and critical thinking skills to solve a classroom crime. They explore various pieces of physical evidence that were found at a crime scene and learn how science can be used effectively to find solutions to problems. There are four IIS in this chapter that draw on content from the Living Things and Materials Strands of the Primary Science Curriculum. While the children engage with these inquiries they should be provided with frequent opportunities to reflect on and discuss different aspects *about* the nature of science.
Overview of Chapter	EACH ACTIVITY CAN BE TAUGHT AS A SEPARATE LESSON. FINGERPRINTS Children learn about different fingerprint patterns and practise making and lifting their own prints. They are then challenged to analyse and match prints found at the scene to that of the suspect. RANSOM NOTE In this activity children use chromatography (a process of separating mixtures of different chemicals) to separate colours from pen ink. Children test four pens and attempt to match the ink pattern with the pen used to write the ransom note. SHOEPRINT A shoeprint was discovered at the crime scene. Scientists often use shoe sizes and shoeprint patterns to determine who was present at a crime scene. Children must infer who owns the shoeprint through measuring it and analysing the pattern. MYSTERY SUBSTANCE The children analyse a mystery powder (combination of talc and baking powder) left at the crime scene. The children observe and mix different powders with water and vinegar to deduce what they think the mystery powder might be. Children then use the evidence they collected and infer who they think may have committed the crime.

Who stole the trophy?

Resources: *Each group will get Suspect Profiles and Analysis Booklet (AB) to guide their investigations (PCM 15).*

(a) The Finger Print Challenge
Pencil, paper, paper towel, sellotape, magnifying glasses.

(b) Which pen wrote the ransom note? (Chromatography)
Filter paper (coffee filter paper or blotting paper), 4 different types/brands of black markers (Black water-soluble markers (non-permanent) work best), beakers of water, scissors.

(c)Footprint challenge
Ruler, 4 old shoes (one for each of the suspects), tape measure or ruler, graph paper, soil or sand tray to make foot prints.

TIP: If there is not soil or sand to make the footprints you could paint the soles of the shoes and make foot prints on a large sheet of paper.

(d) Mystery powder lab
Water, vinegar, beakers, ruler, a selection of white powders (For example, flour, talc powder, salt, baking soda, etc).

TIP: To make the mystery powder, add the talc powder and baking soda together.

Setting the Context
A theft occurred at the school. A valuable trophy was stolen from the principal's office. There was no evidence of a break in. A ransom note was left on the desk. The Gardai were called and collected evidence for you to analyse in an effort to find the thief.

Children must:
(i) Analyse *fingerprints* found at the crime scene.

(ii) Examine *ink* from the ransom note.

(iii) Analyse *footprints* discovered.

(iv) Identify a *mystery powder.*

Children analyse the evidence collected, compare it with the suspect profiles (Analysis Booklet (AB) pg.1), decide who committed the crime and present their findings to the class.

Questions to guide discussion
Explore children's current understanding of forensic science:

1. Have you heard of forensic science before? Where?
2. Who investigates crimes?
3. How are clues gathered?
4. What kinds of things provide clues?

Present the four suspects (AB pg.2). Read each suspect profile. Allow the children 5 minutes to discuss who they think may have committed the crime, giving reasons to support their answers. For example who may have had a motive, opportunity, etc.

Question to guide discussion
1. Who do you think might have committed the crime? Why do you think this?
2. Can you be sure?
3. How could you find out?

Teacher Note
There is no clear-cut criminal identified during this series of activities, different evidence suggests different suspects. This is quite deliberate, in order for the children to see that forensic science has its limitations and does not always reach definitive conclusions. This is unlike in TV dramas, whereby the forensic team almost always solves the case. It is important to emphasise to the children that other kinds of evidence, such as eye-witness accounts, interviews of suspects etc. are still important in solving crimes.

ACTIVITY 1 - FINGERPRINT CHALLENGE (A.L.L 30 - 40 MIN)

S: *Living Things*
SU: *Human Life*

WSS: *Observing; Inferring: Hypothesising; Recording and Communicating; Collaborating*

> Teacher Note
> The aim of the first inquiry (taking fingerprints) is to enable the children to print and examine their own fingerprints carefully, observing differences between individuals and classifying their fingerprints according to three basic 'types': loops, whorls and arches. Having practised close observation of their own fingerprints, the children then try to match two sets of fingerprints found at the crime scene with those from the four suspects (Fingerprint Challenge). Discussion on the fingerprint inquiries should focus on the fact that fingerprints are unique to individuals. Fingerprints can therefore be useful evidence in crime investigations.

For this investigation divide the children into groups and distribute Analysis Booklet (AB) to each group (PCM 15).

A. Taking Fingerprints

Teacher demonstrates how to take a clear, useable fingerprint.

1. Rub the side of the pencil on a piece of paper to make the pencil pad.
   Tip: The children should press hard on the pencil when making the pencil pad.
2. Rub finger on the pencil pad.
3. Get a piece of sellotape.
4. Put the finger on the tape. The print should transfer onto tape.
5. Take the tape off gently.
6. Put the tape on a piece of paper and do not remove.

Using the pencil pad and sellotape the children then take and analyse their own fingerprints (AB P2).

They can use magnifying glasses to identify whorls/loops/arches.

B. Fingerprint Challenge

Present children with the two sets of fingerprints found at the crime scene (AB pg. 3).

Ask the children to observe and analyse the fingerprints to identify whorls, loops and arches.

Using the suspect profiles, children then attempt to match the two sets of fingerprints with two of the suspects. They must provide reasons to support their decision.

Mrs. Letter has a loop in her finger print, so has Finger Print A. Mr. Head has an arch in his fingerprint. Fingerprint B also has an arch. This could mean that either/both of them committed the crime. Children could also infer that both suspects would have fingerprints in the office as a result of working there daily. The criminal may have worn gloves.

This evidence can then be added to the evidence file (AB pg. 3). Similar to scientists, each group must keep accurate records of their observations to ensure that their results are reliable and trustworthy.

Questions to guide discussion

1. Who do you think the two sets of fingerprints belong to? Why do you think this?
2. Does this evidence tell you who has stolen the trophy? Why / why not?
3. What evidence would prove who stole the trophy? *(Video evidence or an eye witness account, but the children don't have either so they can't be sure)*

Teacher Note
The children should find that the fingerprints found at the crime scene should match two of the suspects (Mrs. Letter & Mr. Head).

Children should start to understand that scientists collect evidence to help solve problems. But scientific evidence cannot always provide all the answers. In this instance science can help identify fingerprints, but this scientific evidence cannot tell you for definite whether or not the person to which the fingerprints belong actually committed the crime.

ACTIVITY 2 - WHICH PEN WROTE THE RANSOM NOTE? (CHROMATOGRAPHY) (A.L.L 30 - 45 MIN)

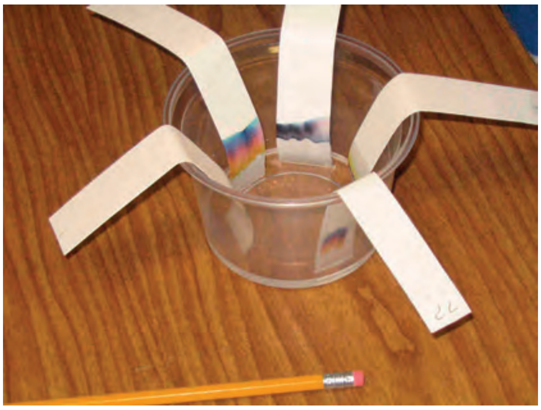
S: *Materials*
SU: *Properties and Characteristics of Materials*

WSS: *Observing; Inferring: Hypothesising; Analysing; Recording and Communicating; Problem Solving; Collaborating*

Teacher Note
The aim of this inquiry is for the children to observe how black inks are a mixture of different colours, and that these colours can be separated out through a process called chromatography. The children discover that the ink from Mrs. Letter's marker matches the ink on the ransom note. However, they must discuss whether or not this proves Mrs Letter stole the trophy.

The discussion on the chromatography inquiry should help the children to become aware that evidence found at crime scenes is often confusing and random. Good scientists can connect evidence together that may allow new and different ways of looking at a problem. However, although scientists carry out very careful tests and come up with results we can trust, these tests do not necessarily provide proof regarding who has committed the crime. This shows the limitations of scientific evidence in solving crimes.

Teacher Background Information
Chromatography is a method of separating and analysing mixtures of chemicals. Mixtures that are suitable include inks, dyes and colouring agents in food. These chemicals are soluble in solvents (e.g water) so they move with the solvent as it moves up the paper. In this case as the water seeps up through the filter paper it dissolves the colouring molecules in the ink and splits it into different coloured chemicals. Different colours are carried along quicker and further than others because some colour molecules are heavier and bigger than others.



Teacher preparation
Label four markers with the names of the four suspects. Cut out a strip of paper for each group (about 3cm wide and 12cm long). Using the marker labelled (Mrs. Letter) draw a line about 4 cm from the bottom of the strip. Label this strip 'Ransom Note'.

Show the children the four markers and the strip of paper with the ink from the ransom note. Tell the children that they must find out whether any of the suspects' markers were used to write the ransom note. The children have to analyse the ink from the different markers (using chromatography) to see if the ink matches that of the ink used to write the ransom note. The ink from Mrs. Letter's pen will match the ransom note ink.

What to do

1. Cut the filter paper into 4 strips (3cm wide and 12cm long).
2. Draw a line with each of the 4 pens about 3cm from the bottom of the strip (Be sure to label each strip).
3. Hang the 4 strips AND the 'ransom note ink' strip into a bowl of water. The water should touch the very end of the filter paper but not the ink. Water creeps up the filter paper and separates each ink mark into a dye pattern.
4. Compare the dye pattern from the four markers with the dye pattern from the marker that was used to write the ransom note. Children then record their observations and inferences (AB pg. 4).

Questions to guide discussion

1. Which dye pattern matches the ink that was used to write the ransom note?
2. To whom does this pen belong?
3. Does that mean she/he stole the trophy? Why / why not?
4. What evidence supports your claim? Add it to your evidence file (AB p4).
5. Can you connect this evidence with the fingerprints found at the crime scene?
6. Can you tell after carrying out these two tests who stole the trophy?
7. What does this tell us about scientific evidence?

ACTIVITY 3 – SHOEPRINT DISCOVERED AT SCENE OF THE CRIME (A.L.L. 30-45 MIN)

S: *Materials*
SU: *Properties and Characteristics of Materials*

WSS: *Observing; Inferring: Hypothesising; Analysing; Recording and Communicating; Problem Solving; Collaborating*

Teacher Note
The aim of this activity is for the children to carefully examine a shoeprint that was found at the crime scene and to compare the print with shoeprints from the four suspects. The children make observations about the shoe prints and then make inferences regarding to whom they think the shoeprint belongs. The print should match Mr. Tidy Up's shoe.

It is important for the children to understand that while they can match the shoeprints to the shoeprint that was found at the crime, this does not provide solid evidence that this person stole the trophy. The only thing that they can deduce from this piece of evidence is that the person was at the scene of the crime (the principal's office).

Find a place where there is sand or soil that allows you to leave recognisable footprints. Using one of the four 'suspects' shoes (Mr Tidyup) make a set of footprints on the sand / soil.

TIP: If there is no soil or sand you could paint the sole of one of the shoes and make shoe prints onto a large sheet of paper or an old sheet.

Show the children the footprints that were found at the scene of the crime. Children draw a sketch of one of the shoeprints in their booklets (AB p 5). They then measure the footprint.

Display the shoes from the four suspects. They must determine which shoe the footprints matches. The children carefully examine the soles of the shoes and compare them to their sketches and the original footprint. They can then make footprints (by putting the shoes in trays of sand or by painting the soles of the shoes and printing on paper) and compare these to the footprints that 'were found at the scene of the crime'.

Questions to guide discussion

1. Describe the footprint.
2. Which shoe made this pattern? How do you know?
3. What does this evidence tell us? (This person (Mr. Tidyup) was at the crime scene).
4. So do you think this person stole the trophy? (Not necessarily they could have been in the principal's office before the trophy was stolen).
5. Looking at all the evidence you have gathered so far, who do you think stole the trophy? Add the evidence to your file.

ACTIVITY 4 – MYSTERY POWDER LAB (A.L.L. 30 - 45 MIN)

S: *Materials*
SU: *(i) Properties and Characteristics of Materials; (ii) Materials and Change*

WSS: *Observing; Inferring: Hypothesising; Predicting; Investigating; Analysing; Interpreting; Recording and Communicating; Problem Solving; Collaborating*

Teacher Note
The aim of this IIS activity is for children to identify a 'mystery powder' that was found at the crime scene. The children are given four white powders and the mystery powder and have to conduct a number of tests to see if they can identify the 'mystery powder'. In the first test the children have to carefully examine each powder using different senses (not taste!) and then based on their observations they have to make inferences regarding what they think the mystery powder is made from. In tests two and three the children have to add water and vinegar to the powders and observe what is happening. During these tests they have to make decisions regarding fair testing.

Teacher Background Information
When vinegar is added to baking soda the mixture fizzes. Vinegar contains acetic acid and is classified as an acid. Baking soda (sodium bicarbonate) is classified as a base. When they react together they produce carbon dioxide gas.

Setting up the investigation

Place the four white powders into measuring jugs (crushed chalk, baking soda, flour, talc powder). Label the jars.

Place the mystery powder into a fifth jug (mixture of talc and baking soda (1:3). Do not tell the children that the two powders are mixed at this stage.

Each group then takes a small amount of each powder and places it into beakers / cups. They label each container so they know what the powder is. They conduct a number of tests to see if they can identify the mystery powder. They record their findings in their AB. The mystery powder (talc and baking powder) could lead the children to believe that Mrs. Baker committed the crime

Test 1: Examining the dry powders

Using a magnifying glass, the children carefully observe the different powders. Encourage the children to use different senses (NOT TASTE) when observing. Record observations (AB pg.6).

Questions to guide discussion

1. Describe the mystery powder.
2. Based on your observations (sight, smell, touch) which powder best matches the mystery powder? Why do you think this?
3. What evidence supports your findings?
4. After this test what do you think the mystery powder is? Note this in your booklet (AB pg. 6)

Teacher Note
It is important to emphasise to the children that scientists make hypotheses based on things they observe. It is also important to emphasise that good scientists make predictions about their investigations. These predictions are based on their previous knowledge and observations. They then carry out tests / investigations to see if they can gather information to support or reject their hypotheses.

Test 2: Adding water to the powders

The children add the same amount of water (30mls) to each of the substances (1 teaspoon). They then carefully observe the reactions that occur. Encourage the children to use different senses (NOT TASTE). They record their observations in their AB.

Questions to guide discussion

1. From your test can you match the reactions of the mystery powder with any other powder?
2. After this test have you a better idea of what the mystery powder is?
3. Have you changed your mind? Why/ why not?

(Possible Explanation: I first thought that the mystery powder was the washing powder. However when I added the water, the washing powder turned blue. The mystery powder did not)

Teacher Note
It is important to draw children's attention to the fact that scientific knowledge is tentative and often changes as different tests are conducted that provide new findings / information. Scientists also use new information / findings to dismiss previous ideas (e.g. the mystery powder was washing powder).

Test 3: Adding vinegar to the powders

Add the same amount of vinegar (30mls) to each of the substances (1 teaspoon). They then carefully observe the reactions / changes that occur. Encourage the children to use different senses (NOT TASTE). They record their observations in their AB.

Questions to guide discussion

1. From this test can you match the reactions of the mystery powder with any other powder?
2. What powder can you now eliminate? Why? *(The flour did not fizz up, the mystery powder did. Therefore it cannot be the flour).*

At this stage the children will have completed their observation table (AB, p.6). Children compare their observations and attempt to identify the mystery powder.

Teacher Note
Children will find that some observations overlap. For example, the mystery powder smells like talc but reacts like baking powder. You may need to provide the children with a hint that the mystery powder could be a mixture of two powders.

Questions to guide discussion

1. What powder can you eliminate? Why?
2. What powder do you think it is?
3. What evidence supports your claim?
4. How could you be sure of what the powder is? *(Children could mix the talc and baking powder together and test to see if looks/ smells/reacts the same as the mystery powder).*
5. Can you be 100% sure of what the powder is? *(Just like scientists, they cannot always be 100% sure of the things they observe. Like scientists they too must use the evidence available to infer what the solution may be).*

Using the evidence they have gathered, the children record who they now think the suspect is. They add this information to their Analysis Booklets (AB pg. 6).

Collating Data

Crime Time. Tell the children that each group is going to appear on the popular TV programme "Crime Time".

Each group must

1. Gather all the evidence they have collected.
2. Collate their evidence (AB pg.7). Create a mind map to present evidence (AB pg. 8).
3. Each group will then be interviewed by the teacher for the T.V programme "Crime Time".

Questions to guide discussion

1. Can you be sure of who committed the crime?
2. What evidence have you collected to support your claim?
3. Do you think you collected your findings in a scientific way?

Teacher Note
It is important to highlight to the children that in forensic science, scientists observe and analyse evidence available to reveal useful information about crime scenes. Scientists always look at more than one line of evidence.

CHAPTER 5

EXPLORING SOUND

Aims	The aim of this chapter is to provide children with more experiences to further develop their understanding about science and the work of scientists while exploring and investigating sound insulation. The IAS and IIS activities in this chapter provide the children with opportunities to apply and develop a wide range of scientific, problem solving and designing and making skills. The inquiries will also help them to learn about noise pollution and how to reduce noise.
Overview of Chapter	EXPLORING SOUND BOXES (IAS) In this inquiry the children examine "sound boxes" that have different materials inside. Children make observations and inferences in an attempt to explain what materials they think are inside the boxes. They then construct their own models to test their hypotheses. BEST EAR MUFFS FAIR TEST INVESTIGATION (IIS) In this lesson a newspaper article introduces the children to the problem of noise pollution in Dublin city. The residents surrounding Dublin Port want the children to design a pair of ear muffs to block the noise and allow them to get a good night's sleep. Children conduct a fair test investigation to establish which material is the best at reducing sound (absorbing sound). DESIGN AND MAKE EAR MUFFS (IIS). Using the results from the fair test investigation, the children then design and make a pair of ear muffs that will help block out sound. Their designs must meet certain criteria.

LESSON 1 – SOUND BOX (A.L.L 30 - 45 MIN)

WSS: *Observing; Inferring: Hypothesising; Investigating; Analysing; Recording and Communicating; Problem Solving; Collaborating;*

Teacher Note
The sound box is another 'black box' type activity. The aim of this activity is for the children to engage with challenges similar to those encountered by scientists. The children examine the 'sound box' by listening to, shaking and rolling the box and then based on their observations *(remember observing uses a range of senses)* the children then draw inferences as to what they think is inside the sound box. The children are then given a selection of materials to see if they can make a sound box that behaves in the same way as the original one.

Children's attention should be drawn to the fact that they are working like scientists in that they are making observations and inferences and then based on these they make hypotheses about from what the sound box is made. They then test their hypotheses by making a model sound box and either accept or reject their hypotheses depending on whether or not their models (sound boxes) behave in the same way as the original. Children's attention should also be drawn to the fact that scientists use models to illustrate processes they cannot directly observe.

Resources:
Per Group
PCM 16, 1 sound box.
To make the sound boxes: Put a selection of different materials into a box with a lid (crisp box, tennis ball box). For example, rice or rolled up pieces of kitchen paper and pasta or spaghetti and marrowfat peas. Cover the box with paper.

Selection of materials for the children to make models to test their hypotheses (make sound boxes). Make sure to include a wide range of materials for the children to select from.

E.G. different shaped boxes with lids, rice, different sized / shaped pasta, spaghetti, marrowfat peas, marbles, paper, plastic cubes, sugar etc.

Teacher Note
It is a good idea to make 2 / 3 sets of different sound boxes and give them to different groups. This will permit groups with the same sound boxes to discuss their observations and inferences and see if they can reach similar conclusions regarding what is inside the sound box.

The Exploring Sound Boxes Activity

Divide the children into groups. Distribute a sound box to each group. Inform the children that the boxes contain things taken from the kitchen. *(It is important to provide a context to guide children's observations and predictions).*

Ask each group to make observations about their sound box (without opening the box). *Possible Observations: I can roll it; When I shake it, I can hear something inside. It is blue. It is a cylinder etc.* Encourage the children to discuss, record, and share observations. These can be recorded on PCM 16.

Each group must then use these observations to make *inferences* regarding what they think might be inside their sound box. *Inferences* must be supported by their observations. Possible *Inference: I think there is rice inside the box because of the sound it makes when I roll it.* Allow the groups to share their observations / inferences with one another.

Based on their inferences, the children then design and make a model of the "sound box" they have observed. They must then test their models to see if it 'behaves' in the same way as the original sound box. Discuss the activity with the children

Questions to guide discussion

1. How were you behaving like scientists? *(Making observations and predictions, coming up with hypotheses and then testing these hypotheses by making models of how they think the sound box works, collaborating with other scientists)*
2. Can you be 100% sure of what is inside the box? Why / why not?
3. Did the other group(s) with the same sound box as your group make the same observations / inferences? How were they the same / different?
4. When you shared your observations / inferences with the other group did this help you in any way? How?
5. Is this the same for scientists? Could you give me an example?

Teacher Note
Sometimes scientists are not 100% sure of the things they observe, so they have to use the evidence available, observations and imagination to create working models of the things they are investigating.

LESSON 2: REDUCING SOUND (A.L.L. 45 – 60 MIN)

S: *Energy and Forces*
SU: *Sound*

S: *Environmental Awareness and Care*
SU: *Science and the Environment*

WSS: *Observing; Inferring: Hypothesising; Predicting; Investigating; Analysing; Recording and Communicating; Problem Solving; Collaborating;*

Teacher Note
This is an IIS that requires the children to carry out a Fair Test Investigation (see glossary). The aim of this inquiry is to provide the children with opportunities to work collaboratively to plan and to carry out a fair test investigations to see which material will be the best insulator of sound. Throughout the investigation children's attention should continuously be drawn to the fact that they are working like scientists. For example, like scientists, they are trying to find a solution to a problem, they are planning reliable investigations, they are making predictions, observations and inferences, they are measuring and recording data, they are collaborating, they are interpreting and analysing results.

Resources:
PCM 17: Newspaper article
PCM 6: Investigation planning sheet
Some suggested materials for the investigation: Selection of materials to test which is best at reducing sound. For Example, cotton wool, bubble wrap, newspaper, paper towels, shredded paper, etc.
Shoe boxes, measuring tape / ruler, scissors, sellotape, markers,
Sound source: alarm clock / mobile phone

Teacher Background Information
Hard materials like metals carry sound very easily. However, softer materials like wool / cotton wool absorb sound. In this investigation the children will test different soft materials to see which is the most effective at absorbing sound.

Investigation

Setting the context
Hold a class discussion on noise pollution.

Questions to guide discussion
1. What is noise pollution? Noise pollution is generally described as any unwanted sound, or sound which produces unpleasant effects and discomforts to the ears.

2. What do you think are some of the sources of noise pollution? Aeroplanes flying over; music from a disco; neighbour's dog barking; moving and honking vehicles; industrial production noise.

3. Why is stopping noise / sound important? Noise pollution can damage a person's eardrum over a long period of time. Noise at night can prevent people from sleeping.

4. How can we reduce noise pollution? Use of ear muffs, soundproof rooms for noisy machinery, horns to be banned at night, silent community zones near schools/ hospitals.

5. Where might noise pollution be a serious problem? Building site, music venue, city traffic.

Divide the children into groups. In their groups the children read the Newspaper Article (PCM 17): *Study Claims Dublin Port Noise Above World Health Organisation Guidelines.* The children must design a set of ear muffs for a resident living in the area surrounding Dublin Port, but first they must carry out an investigation to find out which material is best at blocking sound.

Planning and carrying out the investigation

Investigation Question:

Which material is best at blocking sound?

Show the children the resources that are available for the investigation. Distribute an investigation planning sheet (PCM 6) to each group.

Allow the children time to predict which material they think will be the best at blocking sound. It is important they give reasons to support their predictions. They record their predictions on their investigation planning sheet (PCM 6). *Sample Prediction: I think the cotton wool will be the best insulator of sound because it is the thickest material. It will be harder for the sound to get through.*

Teacher Note

It is important to emphasise to the children that good scientists make predictions about their investigations. These predictions are based on their previous knowledge and observations.

Each group plans and carries out a fair test investigation to see which material is best at blocking out sound. Results must be recorded.

Questions to guide discussion

1. Why it is important for scientists to carry out fair tests? *Scientists must produce reliable, repeatable evidence so that people will trust their results and can rely on their scientific claims.*
2. What will we keep the same in the investigation? *Same size material, same noise source, same method of measuring each one.*

Teacher Note

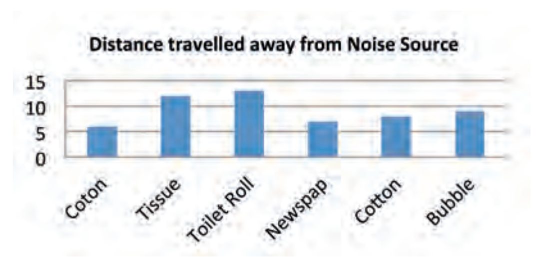
One way to carry out the investigation

1. Place an alarm clock inside a shoebox. Measure and record how far away you can walk until you cannot hear it anymore.
2. Then wrap the clock in a material and repeat the investigation. (Emphasise Fair Testing: Same area of material to be wrapped around the clock, same number of "wraps", same alarm clock, etc.). How far did you have to go this time?
3. Repeat the investigation with a variety of materials and record results in a table/ graph. See exemplars below.

Sample Table

Material	Distance travelled away from box
Cotton wool	6 meters
Tissue paper	10 meters

Sample Graph



Questions to guide discussion

1. What material did you predict would be the best at blocking sound?
2. Which material was the best?
3. What evidence supports your claim?
4. How did you carry out a fair test investigation?
5. Do you trust your results? Why?
6. How were you working like scientists?

LESSON 3 - DESIGN AND MAKE A SET OF EAR MUFFS FOR A BUILDER. (A.L.L. 45 – 60MIN)

S: *Energy and Forces*
SU: *Sound*

S: *Environmental Awareness and Care*
SU: *Science and the Environment*

WSS: *Exploring; Planning; Making; Evaluating*

Teacher Note
The aim of this activity is for the children to design and make a pair of ear muffs for a resident near Dublin Port. The children should take on board the findings from the previous investigation when coming up with their designs.

Resources: *Some suggested materials for making the ear muffs: Bubble wrap, cotton wool, pipe cleaners, cling film, plastic bags, twine, wool, lollipop sticks, sellotape, scissors, old hair bands.*

Setting the Context
The problem! The residents in the neighbourhood surrounding Dublin Port have a problem. They are not getting enough sleep because of the noise coming from the port. They are tired, annoyed and irritable as a result (as stated in newspaper article PCM 17). They want you to design and make a set of earmuffs that would help block out the sound.

Exploring
Provide the children with pictures of different types of ear muffs. Earmuffs to try on would also be of benefit during the exploration stage (if possible).

Questions to guide discussion
1. What do you see in the pictures?
2. What are they used for?
3. What materials are they made from?
4. How do you think ear muffs protect our ears?

Tell the children that they are going to design and make their own ear muffs.

Display the materials that are available and discuss the criteria that their designs should meet.

Some suggestions for criteria

- They must block sound.
- Be comfortable to wear: They should stay on without holding them.
- Durable

Planning and Making
After the whole class discussion on materials and criteria, the children work in small groups / pairs. They discuss their designs and make detailed drawings of them. Display criteria on the IWB/board to guide the children's work. They then make their ear muffs.

Evaluating
Test the ear muffs. Put on ear muffs and measure how far you have to travel away from a noise source, e.g. a radio, ticking clock so that you don't hear it anymore. Children should review what other groups have designed and see how well their ear muffs match the design proposal.

Questions to guide discussion
1. Which ear muffs are the best at blocking sound?
2. How do you know?
3. Which ear muffs are most comfortable to wear?
4. How durable do you think your earmuffs are?
5. If you could make your earmuffs again, is there anything you would change?

Presentation of Results
Children write adverts to market their earmuffs. Adverts should be presented to the class and displayed in the classroom

CHAPTER 6

PARACHUTES AND MORE!

Aims	The aim of this chapter is to provide children with more opportunities to develop their understanding about science and the work of scientists while investigating air resistance and parachutes. The three IIS in this chapter provide the children with opportunities to apply and develop a range of scientific, problem solving and designing and making skills.
Overview of Chapter	SPINNER INVESTIGATION In this inquiry the children explore paper spinners and carry out a fair test investigation to see how the surface area of a paper spinner affects the speed at which it falls. PARACHUTE INVESTIGATIONS The children carry out fair test investigations that explore how varying the size and type of material from which a parachute is made affects the speed at which it falls. DESIGN AND MAKE A CANDY BOMBER In this activity the children learn about the use of mini parachutes to deliver sweets to children in Germany during World War II. Using the results from their parachute investigations the children then design and make a parachute that will deliver a chocolate egg safely to the ground.

LESSON 1 – PAPER SPINNERS (A.L.L 45 - 60MIN)

Resources: Spinner template PCM 18; Scissors per pair; blu-tac or paper clips, stopwatches.

S: *Energy and Forces*
SU: *Forces*

WSS: *Observing; Inferring; Hypothesising; Predicting; Investigating; Recording and Communicating; Problem Solving; Collaborating.*

Mathematics: *Applying and Problem Solving; Integrating and Connecting*

Teacher Note
The aim of this activity is for the children to explore how paper spinners fall. They then plan and carry out an investigation to see if a bigger spinner falls more quickly than a smaller one.

Teacher Background Information
All things fall to the ground because of the force of gravity. Therefore, when both spinners are dropped from a height they fall to the ground. However, the bigger spinner falls more slowly because the surface area is bigger and therefore there is greater air resistance acting on the spinner, pushing it up against gravity, causing it to fall more slowly.

Activity type: Investigation

Observing Spinners
Demonstrate to the children how to make a spinner (PCM 18). Attach a paper clip or piece of blu-tac to the bottom of the spinner. The children then make spinners and are given time to fly their spinners. Encourage the children to make different observations about their spinners. Discuss the children's observations.

Questions to promote discussion

1. What did you notice about your spinner?
2. Does your spinner remind you of anything else that flies? *Sycamore seeds, helicopter*.
3. What do sycamore seeds do when they fall from the tree? *They spin through the air.*

Inquiry

How can you change the direction in which your spinner spins?

Ask the children to observe what direction their spinner spins. (Clockwise or anti-clockwise). Then ask them if they can make their spinners change direction. Encourage each pair to investigate how they can change the direction in which it spins? *(Switch the wings of the spinner around).*

TIP: It is a good idea to colour in one of the wings as it is easier to see in which direction the spinner is spinning.

Investigation

Does a smaller spinner fall to the ground quicker than a bigger one?

Ask the children if they think a smaller spinner falls more quickly or more slowly than a bigger one. Encourage them to give reasons for their answers.

The children then plan and carry out a fair test investigation to see whether a big or small spinner will fall to the ground quickest.

Investigation Question: Does a smaller spinner fall to the ground quicker than a bigger one?

1. Each pair makes a large and small paper spinner (PCM 18)
2. Using the investigation planning sheet (PCM 6) the children predict which spinner they think will fall to the ground first. The children must give reasons to support their predictions and should record these on their investigation planning sheets (PCM 6).
3. In groups the children then plan and carry out the fair test investigation.

Teacher Note

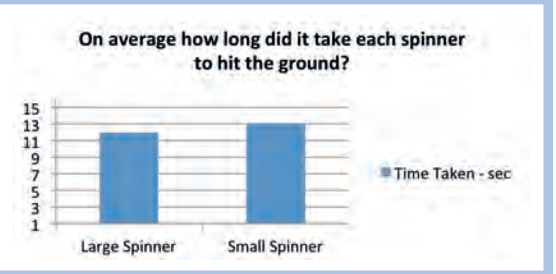
One way to carry out the investigation

The children could measure how long it takes each spinner to hit the ground (using a stopwatch). They could drop each spinner (from the same height) three times and then calculate the average. Results could be recorded on a table or graph similar to the ones below.

Sample Table

Spinner	Drop1	Drop2	Drop3	Ave. time taken
Large				
Small				

Sample graph



Questions to promote discussion

1. What did you predict? Why did you think this?
2. How did you make sure you carried out a fair test?
3. Do you trust your results? Why?
4. Did your results support your prediction? Why /Why not?
5. What did you learn from your investigation?
6. How were you working like scientists?

Extension activities

1. Explore the speed at which three different sized spinners fall. Take accurate measurements of the surface area of all three spinners.

LESSON 2 – PARACHUTES (A.L.L 45 - 60MIN)

Resources: *Paper, jay-cloth, duster, tea-cloth, white cloth, string, blu-tac (weight), sellotape.*

S: *Energy and Forces*
SU: *Forces*

S: *Materials*
SU: *Properties and Characteristics of Materials*

WSS: *Observing; Inferring; Hypothesising; Predicting; Investigating; Recording and Communicating; Problem Solving; Collaborating.*

Mathematics: *Applying and Problem Solving; Reasoning; Implementing; Understanding and Recalling*

Teacher Note
The aim of this inquiry is for the children to work collaboratively to plan and to carry out a fair test investigation to see whether; the size of a parachute affects the speed at which it falls; and / or, whether the material from which a parachute is made affects the speed at which it falls. Throughout the investigations children's attention should continuously be drawn to the fact that they are working like scientists. For example, like scientists, they are trying to find a solution to a problem, they are planning reliable investigations, they are making predictions, observations and inferences, they are measuring and recording data, they are collaborating and they are interpreting and analysing results.

Teacher Background Information

Different factors affect the speed at which parachutes fall. For example:

Size: The bigger the parachute the slower it falls. This is because it has a greater surface area which increases the air resistance which slows down the speed at which it falls.

Shape: Parachutes that are dome shaped trap more air as they fall, making them fall more slowly.

Material: Parachutes that are made from more flexible materials fall more slowly because when they fall they become dome shaped more easily than rigid material and therefore catch more air.

Investigation

Setting the context

Display pictures of a variety of parachutes to the pupils. These can be sourced from google images.

Questions to promote discussion

1. What shape are the parachutes?
2. What materials are the parachutes made from?
3. How many ropes are attached to each parachute?
4. How do you think a parachute works? *Air fills the canopy of the parachute, slowing its descent.*
5. What does a parachute have to do to make a safe landing? *It must fill with air and fall slowly and steadily to the ground.*
6. Do you think the size of the parachute will affect how fast a parachute falls? Why? How could we find out?
7. Do you think the material from which a parachute is made will affect how fast it falls? Why? How could we find out?

Investigation Starter Questions

Investigation A: How does the size of the canopy/ parachute affect the speed of the drop?

Investigation B: Which type of material makes the canopy/ parachute that falls the slowest?

Teacher Note
Some groups could carry out investigation A, while the remaining groups could carry out investigation B.

Tip for making the parachute: The simplest parachute to make is a square piece of material with strings (of equal length) tied to the four corners. Bring the strings together at the bottom and attach blu-tac (weight). Ensure children measure the area of their chutes. For example Parachute A (50cmX 50cm) Parachute B (30cm X 30cm).

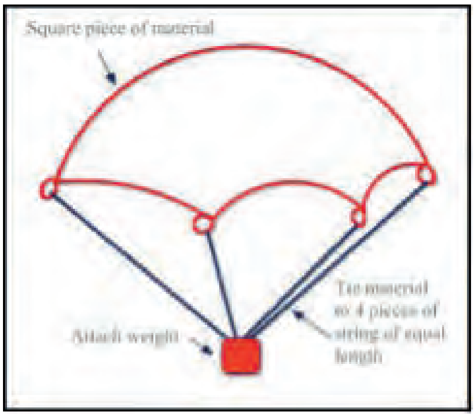


Diagram of a parachute

Planning and Carrying out the investigations

Show the children the resources that are available to them for the investigation. Distribute an investigation planning sheet (PCM 6) to each group. Each group then plans and carries out fair test investigation A (does the size affect the speed at which a parachute falls) OR investigation B (does the material from which the canopy is make affect the speed at which a parachute falls). For each of the investigations, ask the children to predict which parachute they think will fall to the ground last. Ensure they give reasons to support their predictions. They record their predictions on their investigation planner sheet (PCM 6). Each group then carries out their investigations, records and discusses their results.

Questions to promote discussion

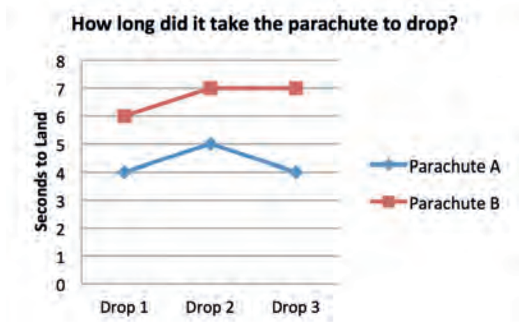
1. What materials did you use?
2. Which material worked well? Which didn't?
3. What parachute did you predict would fall the slowest? Why did you think this?
4. Which size parachute dropped the slowest?
5. Did you have any problems designing and making your parachute? If so, how did you fix them?

One way to carry out these investigations is:

1. Investigation A: Drop each of the parachutes (small, medium and large) from the same height.

   Investigation B: Drop each of the parachutes (made from three different materials) from the same height.

2. Use a stopwatch to record how long it takes the parachute to hit the ground?
3. Record results. Repeat three times. Get an average. Create graph (see example below



Sample Graph

Extension

The children could vary the following parts of a parachute to examine the effect this variation has on the speed at which the parachute falls.

1. Lengthen or shorten the length of the string.
2. Use different shapes for the parachute (e.g. round, oval, rectangular, square, etc.
3. Cut holes and/or slits in the parachute material.

LESSON 3: CANDY BOMBER (A.L.L. 45 - 60MIN)

S: *Energy and Forces*
SU: *Forces*

WSS: *Exploring; Planning; Making; Evaluating; Problem Solving; Collaborating*

> Teacher Note
> The aim of this activity is for the children to design and make a candy bomber to drop a chocolate egg safely to the ground. The children should take note of the findings from the parachute investigation when devising their designs.

Resources: *Some suggested materials: Chocolate eggs, different types of material to make the parachute (jay cloth, kitchen roll, plastic bag, nylon tights, tissue paper, newspaper, crepe paper), twine / string, blu-tac, empty cardboard boxes, empty plastic trays, empty egg cartons, sheets of cardboard, sellotape, lollipop sticks.*

Design and Make a Candy Bomber

Setting the context
Read the book "The Candy Bomber: The Story of the Berlin Airlift's Chocolate Pilot" by Michael O' Tunnell. If book isn't available read and discuss The Story of Gail Halvorsen, the Candy Bomber (PCM 19).

> Teacher Note
> In the story Candy Bomber the pilot releases small parachutes over West Berlin after the end of World War II. These parachutes contained packages of chocolate for the children of Berlin whose homes had been destroyed by the war. Eventually the candy drops were turned into an official U.S. Air Force operation as more pilots joined in.

Exploring
Tell the children that they are going to design and make a Candy Bomber that will drop a chocolate egg safely to the ground. Children should use the evidence collected from the parachute investigations to help them with their designs.

Questions to promote discussion

1. What material do you think would make the best canopy/ chute for your parachute? Why do you think this?
2. What size parachute do you think would be best? Why do you think this?
3. What materials could you use to ensure that the egg lands safely to the ground? *(Draw the children's attention to how delicate objects/eggs are packaged in shops to prevent them from breaking. Cardboard box lined with bubble wrap or cotton wool; an egg carton).*

Planning & Making
After the whole class discussion the children work in small groups to plan and make their parachutes. Each group should make a detailed drawing of their designs prior to making their candy bomber/parachutes.

> Teacher Note
> Remind the children of some of the problems they may have encountered when making the parachute in lesson two and how they overcame these.

Evaluating
Each group presents their candy bombers to the class. They test them (drop them from the same height) and evaluate their designs. Children should review what other groups have designed and see how well their candy bombers matched the design proposal (to get the egg to land safely on the ground).

Questions to promote discussion

1. How did you make your parachute?
2. Did you stick to your original design?
3. What materials did you use for the basket?
4. Did your egg land safely? How do you know?
5. Did you encounter any problems when making your parachute? How did you overcome them?
6. If you could change one part of your design, what would it be?
7. What aspect of your design do you like most?
8. What did you learn from this?
9. How do you think you were working like scientists?

Extension

1. Discuss and examine Leonardo Da Vinci's first parachute design. The design can be downloaded from the web.
2. The children could make models of Da Vinci's parachute design.
3. Read about Adrian Nicholas, a British man who tested Da Vinci's parachute design in 2000. A video of Adrian Nicholas making and flying Da Vinci's parachute can be downloaded from the web.

GLOSSARY

Black Box Activity

The magic bucket, the tube and the sound boxes are examples of Black- box activities that are used in this book.

Black box activities present children with challenges similar to those encountered by scientists in that they present children with a problem / challenge (e.g. 'the magic bucket' / 'the tube') that they have to try to figure out. Scientists are often presented with problems (e.g.'how does the magic bucket / tube work?') where they don't have all the information – so it is like a 'black box' where they can't see inside. They still have to use what they can observe to come up with hypotheses about what is happening inside (the bucket / tube).

When using black box activities, children make *observations, inferences* and develop *hypotheses* (hypotheses) to explain what they think is happening in a given situation ('how the bucket / tube works'). Based on their hypotheses the children make *predictions* and develop ways of testing them. Children can then be encouraged to make models to explain the phenomenon they have investigated.

If their initial 'hypothesis'' is not correct, they can discuss and test alternative 'hyoptheses'. This after all is what scientists do. If they do make a model that behaves in the same way as the original bucket / tube, it is important to emphasise to the children that they can never be a 100% sure that their model is exactly the same as the original bucket / tube. All they can conclude is that their model 'behaves' in the same way as the original bucket / tube. In this way they begin to understand the true nature of scientific inquiry and begin to appreciate that scientists make models in an attempt to explain things. However, they often do not have all the information, so there is an element of uncertainty in science.

Fair Test Investigation

In a fair test investigation the children are given a scientific question which poses a problem to be investigated. The children (normally in groups) have to decide on how they are going to carry out the investigation, what variable they are going to change and which variables they are going to keep the same (in order to make a fair test). During fair test investigations the children have to decide what they are going to measure to see the effect of changing one variable. They also have to: make and record predictions, measure and record results of their investigations, draw conclusions and discuss these with their peers.

When the children are planning and carrying out their investigations they, like scientists, are carrying out reliable and repeatable tests in a bid to find an answer to the question posed. However, during this process they (like scientists) are also using their creativity. They use their creativity when planning how to conduct their investigation, when deciding what equipment they will need, when they are interpreting and analysing their results and when they are drawing conclusions. It is important to emphasise this to the children while they are planning and carrying out their investigations and when they are analysing and reporting their results and conclusions.

Inference

An *inference* is an attempt at providing an explanation about what is observed. For example, an inference as to what the marks on the white background are in the Tricky Tracks images (PCMs 1 - 3) could be *"A set of bird tracks, one set of tracks is bigger than the other" or "It looks as if the animal from the bigger set of prints attacked the animal with the smaller footprints".*

Inferences can be made only by combining observations and past knowledge / experiences

Different inferences to explain things are plausible, as long as they are based on the evidence and are not merely wild guesses.

Inquiry About Science (IAS)

These are activities/ inquiries that do not focus specifically on scientific content. Instead they focus on a particular aspect *about* the nature of science and scientific inquiry (e.g. how scientists work, that science can be subjective, that science knowledge is tentative).

Inquiry In Science (IIS)

Activities that have a scientific context but also focus on different aspects *about* the nature of science and the work of scientists.

Observation

When a scientist makes an observation about a particular phenomenon they describe exactly what can be observed (seen/ felt/ heard/ smelt/tasted). For example, an observation on the Tricky Tracks images could be *"I see black marks on a white background. There are two different sized marks. There are more of the little marks than the bigger ones".* An observation is a description of something where no context or interpretation is made.

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TRICKY TRACKS

PCM 3 (FIGURE 3)

TRICKY TRACKS

Reference: Lederman N. & Abd-El Khalick F. (1998). Avoiding de-natured science: Activities that promote understanding of the nature of science. In, Mc Comas W.F. The Nature of Science in Science Education: Rationales and Strategies. pp 83-126, Kluwer Publications

PCM 4

OBSERVING ICE BALLS

OBSERVING ICE BALLS

You have three different ice balls to explore.
Cut open the balloons and carefully observe each ice ball.

Ice Ball (balloon colour)	Observations	What do you think the ice ball is made from? Why do you think this?

How could you test your ideas?

....

....

....

....

PCM 5

THE MAGIC BUCKET

THE MAGIC BUCKET ACTIVITY SHEET

Draw a diagram to show what you think is inside the Magic Bucket and how you think it works:

Describe (Infer) how you think the Magic Bucket works:

....

....

....

How could you find out if your theory is correct?

....

....

....

If you discover that your idea is not correct what could you do next?

....

....

....

PCM 6

INVESTIGATION PLANNING SHEET

INVESTIGATION PLANNING SHEET

Starter Question What do we want to find out?	
Our Investigation What are we going to do?	
Resources What equipment will we need?	
Keeping the same / Changing How will we make sure it is a fair test?	
Results How are we going to record and communicate our results?	
Our Predictions What do we think will happen?	

PCM 7

'BEST' BOUNCE

THE 'BEST' BOUNCE RECORDING SHEET

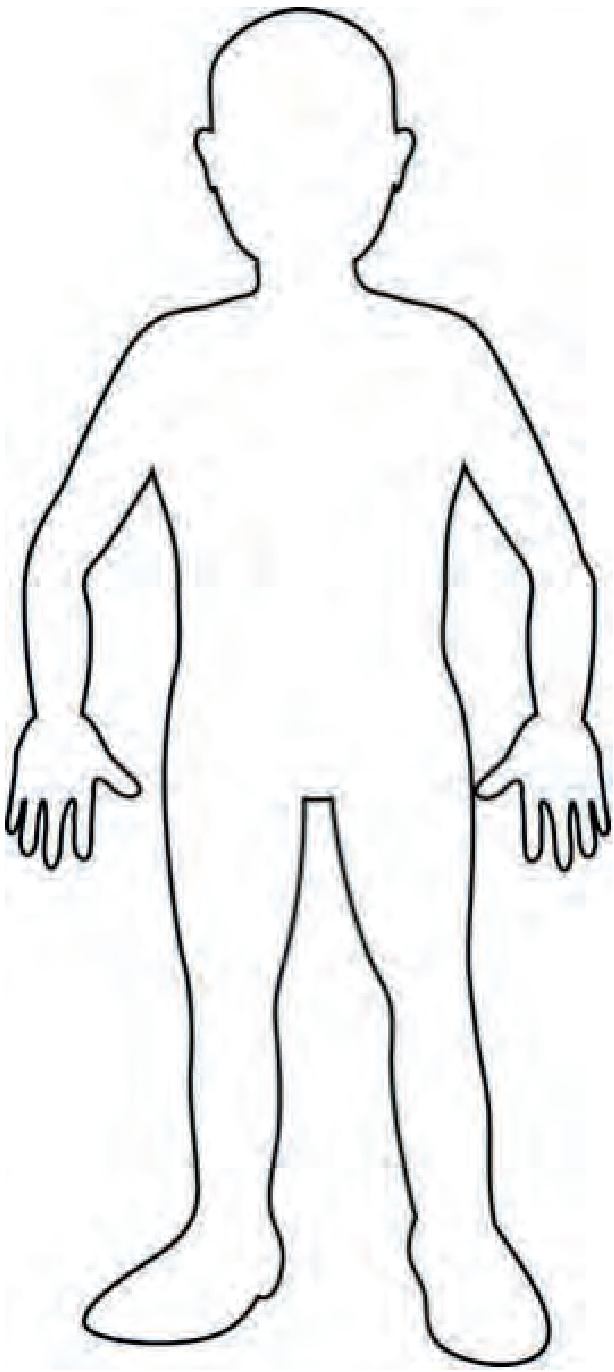
Height of bounce in cm				
Ball	**Drop 1**	**Drop 2**	**Drop 3**	**Average**
Hot				
Cold				
Room Temp				

RESULTS

Draw a graph to show your results of the best bounce experiment

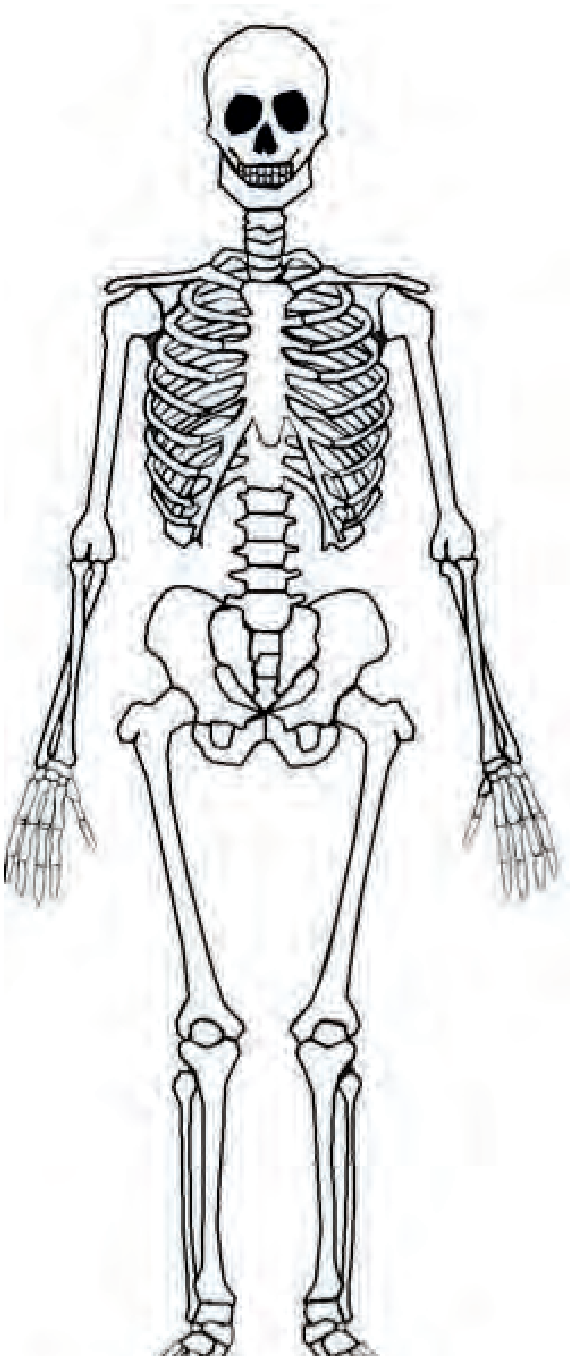
PCM 8

OUTLINE OF THE HUMAN BODY



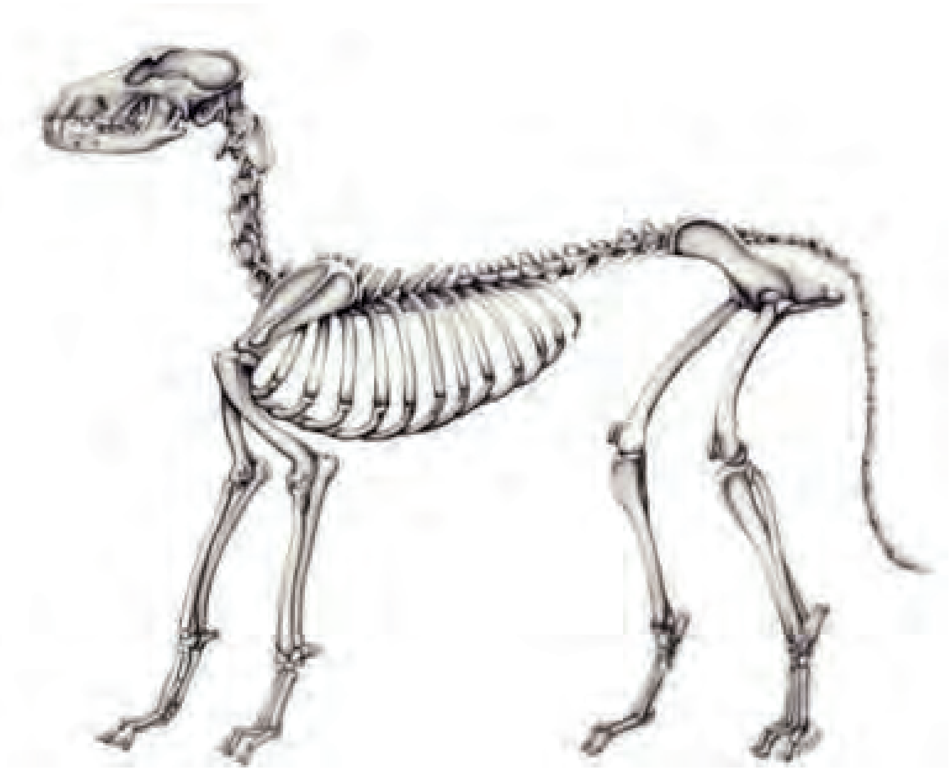
PCM 9

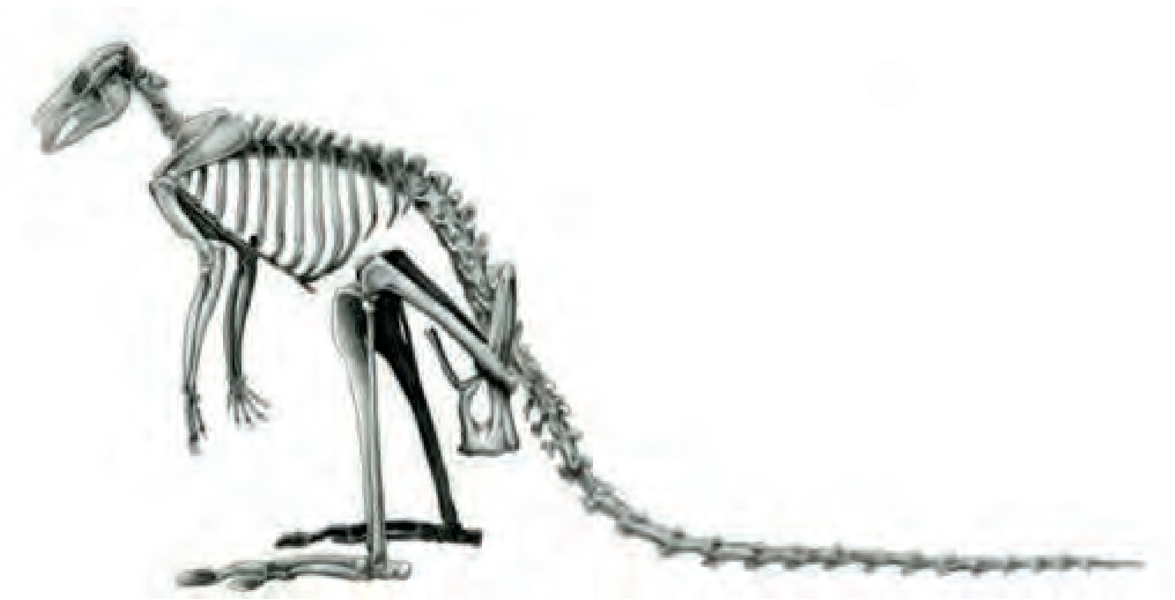
THE HUMAN SKELETON



PCM 10

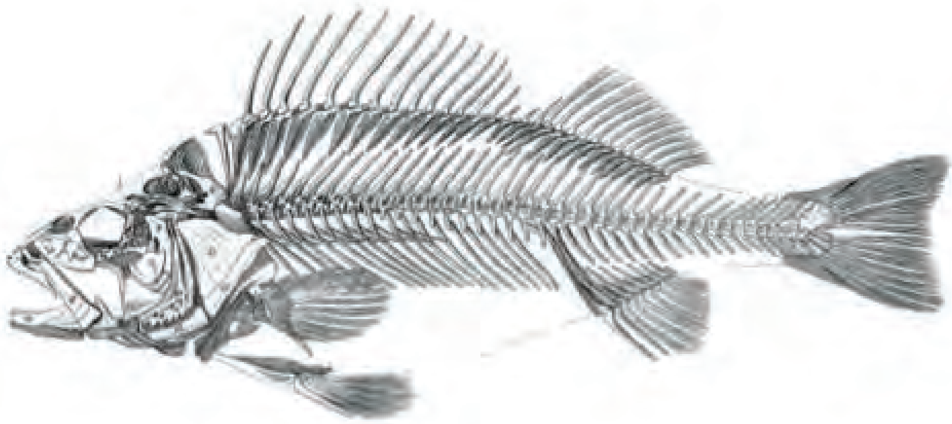
ANIMAL SKELETONS





PCM 10

ANIMAL SKELETONS



PCM 11

BONE EXPEDITION SCRIPT

In this activity, you and your group will play the roles of paleontologists working for an Irish university. One day, the head of your science department arrives at your office with some very exciting news. While construction workers were clearing a field to extend the M6 motorway they discovered a number of bones. The university will provide you and a team of scientists with funding to go to Athlone and carry out an investigation at the site.

Day 1: One clear crisp afternoon in October, you find four well preserved and complete bones. **Open envelope and remove 4 bones. (Make sure not to look at the remaining bones in the envelope).*

That night in camp, you and your colleagues begin to assemble the 4 bones you found earlier. Since the bones were all found together in an undisturbed layer, you assume that they are all from the same animal. You spend the rest of the evening trying different arrangements of the bones in hopes of identifying the animal before you get tired. *Take 3-5 minutes to assemble the bones and make notes on your recording sheet. What kind of animal do you think this is?*

Day 2: You wake up to a beautiful bright morning and you hurry back out to the dig site. The rock layers that hold your bones are very hard and only give up three more specimens. As the day ends you make your way back to camp for another try at assembling the mystery animal. **Open envelope and remove 3 bones. Take 3-5 minutes to assemble all 7 bones and make notes on your recording sheet. What kind of animal do you think this is now?*

Day 3: The next morning is cold. You can tell that winter is just around the corner and you know that this will be the last day of the digging season, and your last chance to find more bones of the mystery animal. Just as the day is about to end, one of the members of your team finds 3 final bones. **Open envelope and remove 3 bones. Take 3-5 minutes to assemble all 10 bones and make notes on your recording sheet. What kind of animal do you think this is now?*

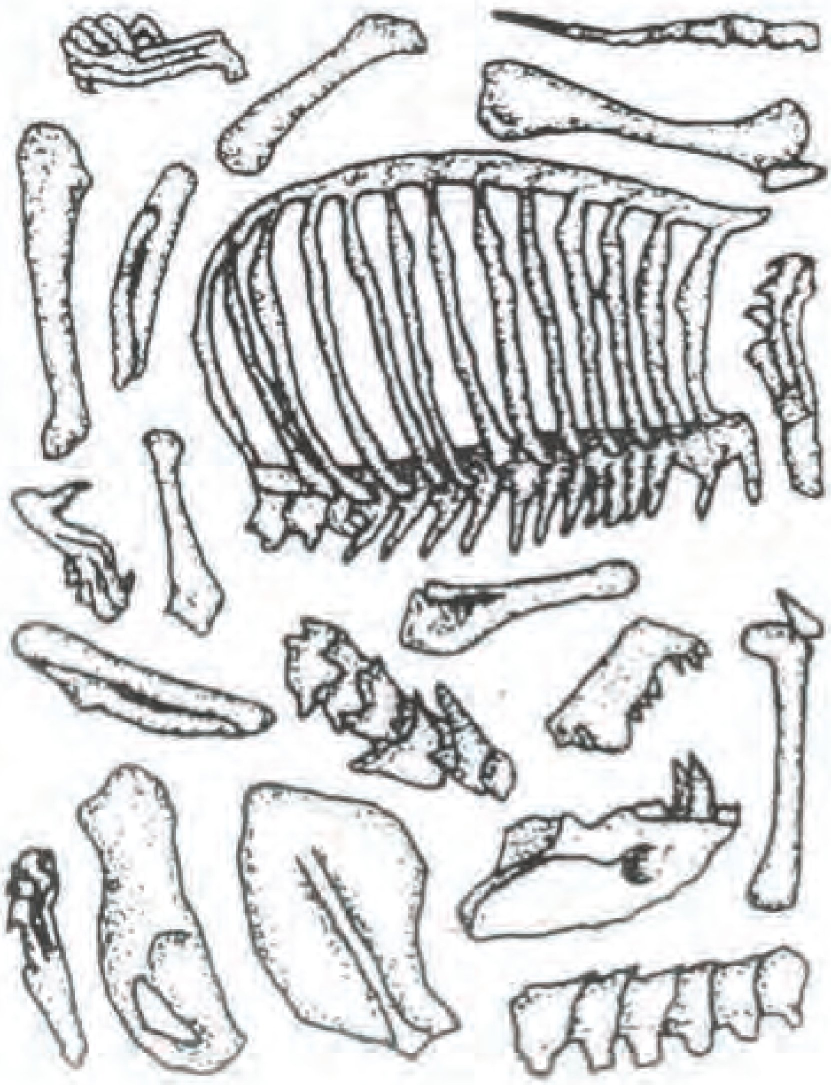
Day 4: Back in the university, you meet up with some Paleontologist friends. They tell you they have spent the summer working in a different location but with the same geological period. You show them the skeleton you found, and they tell you they have a similar one, but it looks like they have some different bones that you don't have. *For 5 minutes, compare your bones with those of a group near you, looking for clues that will help you assemble your fossils. Apply these clues to your interpretation of your skeleton. What type of animal do you think you have now?*

Day 5: In the library at the university you work for you find a Skeletal Resource Manual with drawings of the skeletons of some existing animals. You notice some interesting similarities between some of the drawings and your unknown bone. *Use the drawings to assist you in your final assembly of the bone skeleton. Fill in the recording sheet with your final interpretation of the skeleton.*

Ref: Adapted from - (Evolution & the Nature of Science Institutes) www.indiana.edu/~ensiweb

PCM 12

BONES



Ref: Taken from - (Evolution & the Nature of Science Institutes) www.indiana.edu/~ensiweb

PCM 13

SKELETAL RESOURCE MANUAL

THE BONE EXPEDITION

SKELETAL

RESOURCE

MANUAL

PCM 13

SKELETAL RESOURCE MANUAL

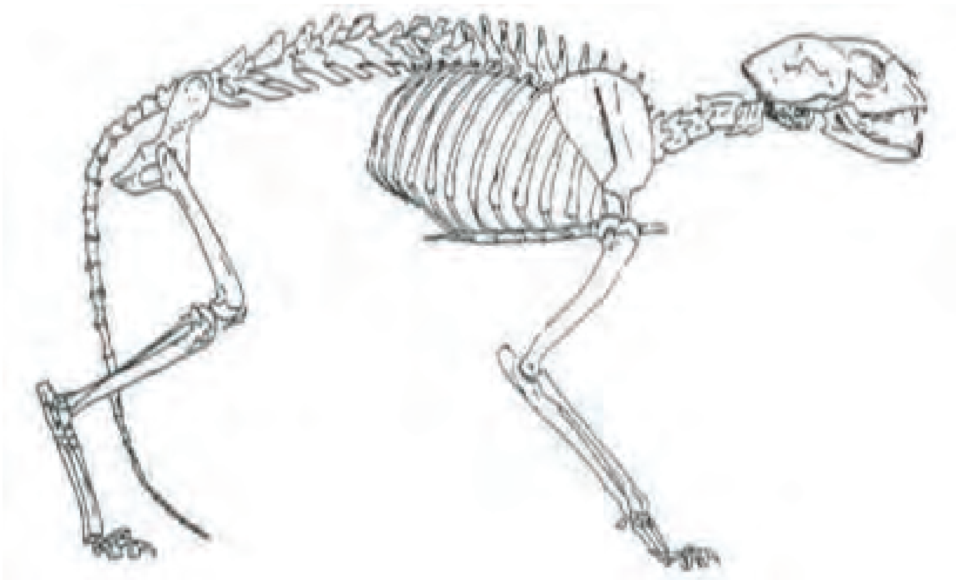
FISH (PERCH)

FROG

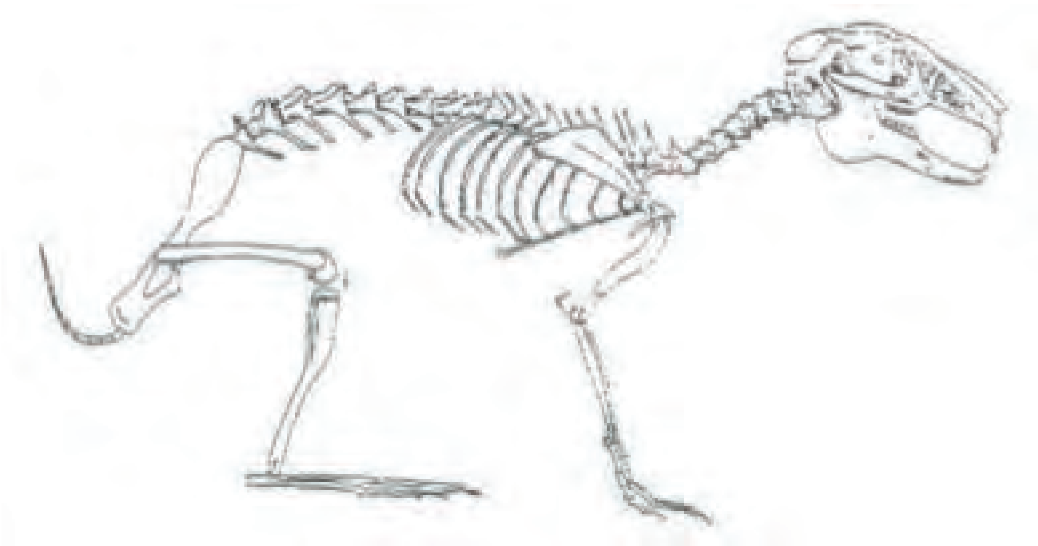
PCM 13

SKELETAL RESOURCE MANUAL

CAT



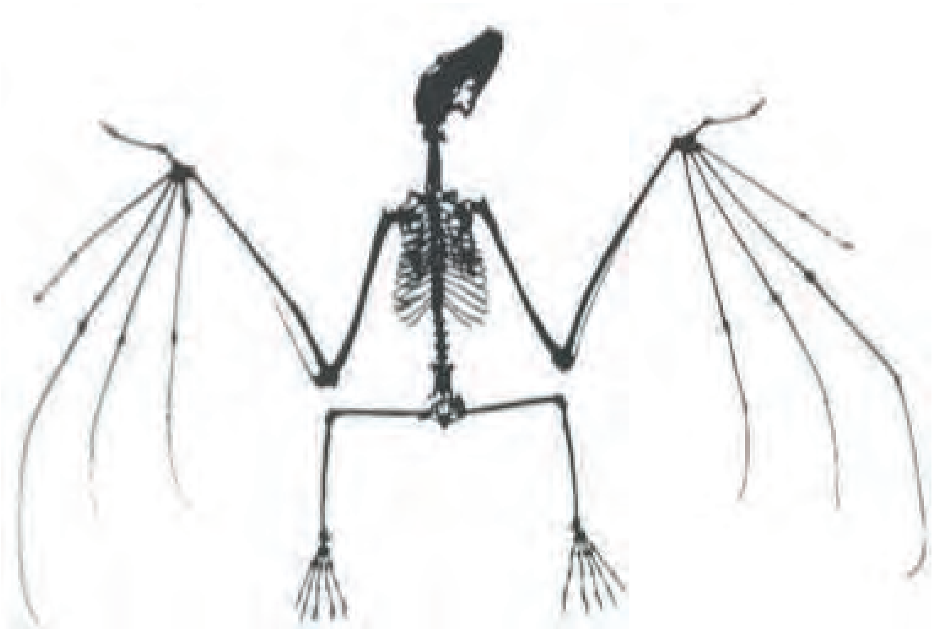
RABBIT



PCM 13

SKELETAL RESOURCE MANUAL

BAT



BIRD

Ref: Taken from - (Evolution & the Nature of Science Institutes) www.indiana.edu/~ensiweb

PCM 14

THE BONE EXPEDITION RECORDING SHEET

THE GREAT BONE EXPEDITION RECORDING SHEET

	Day 1	Day 2	Day 3		Day 4
Draw a picture of your bones				**Ideas/Bones discovered by other groups or Resource Manual**	
What type of animal do you think your bones belong to?				**What type of animal do you think your bones belong to now?**	
Why do you think your bones belong to this type of animal?				**Did you change your mind?** **Why/why not?**	

PCM 15

SUSPECT PROFILE BOOKLET

MYSTERY OF THE STOLEN TROPHY

NAME: ....

EVIDENCE FILE

COLLECT EVIDENCE IN AN ATTEMPT TO IDENTIFY THE SUSPECT

SUSPECT PROFILES

The Gardai have collected the following information about each of the suspects.
Use these along with the evidence collected to identify the criminal.

Suspect 1: Mr. Cupcake	Age: 35 Address: 14 Bunsville, Clondalkin, Co. Dublin Occupation: Baker Height: 1 meter 70 cm Location on night of crime: At home baking a cake	**Suspect 2: Mr. Head**	Age: 54 Address: Dunboyne, Co. Meath Occupation: Principal Height: 1 meter 30 cm Location on night of crime: Cinema
Suspect 3: Mrs. Letter	Age: 29 Address: 24 Woodford, Lucan, Co. Dublin. Occupation: Secretary Height: 1 meter 90 cm Location on night of crime: Book Club	**Suspect 3: Mr. Tidyup**	Age: 64 Address: Main Street, Navan, Co. Meath Occupation: Caretaker Height: 1 meter 45 cm Location on night of crime: G.A.A. club

Predict who you think committed the crime?

....

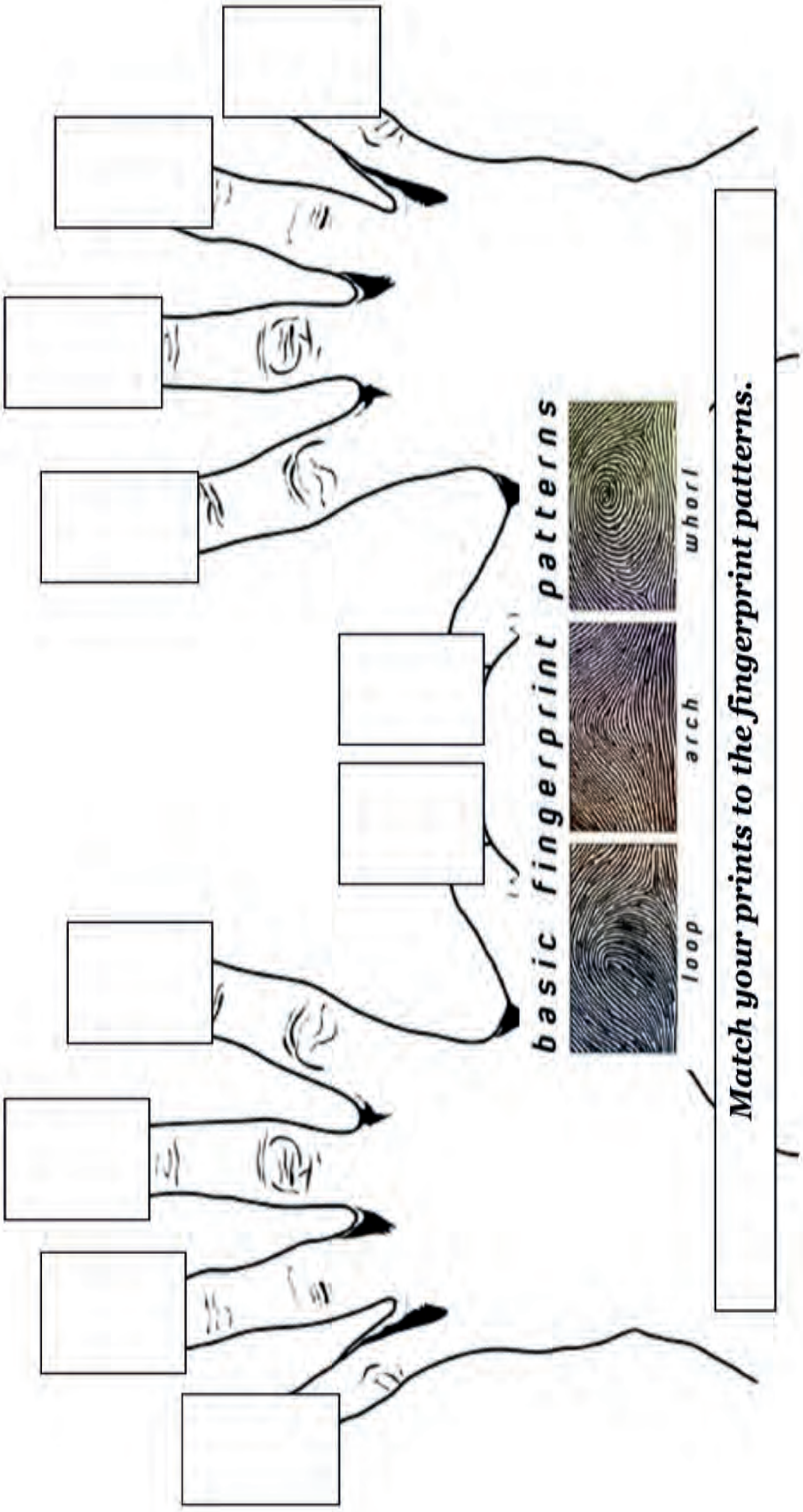
Give a reason to support your evidence?

....

PCM 15

SUSPECT PROFILE BOOKLET

FINGERPRINT ANALYSIS

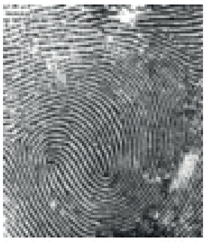
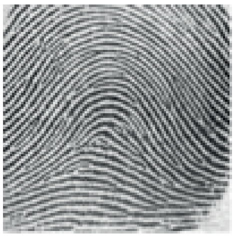


PCM 15

SUSPECT PROFILE BOOKLET

FINGERPRINT FOUND AT THE CRIME SCENE

Highlight common features between the prints found at the scene and each of the suspect's prints.

Prints found at scene		
	Finger Print A	*Finger Print B*

Mr. Cupcake		**Mrs. Letter**	
Mr. Head		**Mr. Tidyup**	

Who do you think the prints belong to?

What evidence have you to support your claim?

Does this evidence tell you who may have stolen the trophy? Why / why not?

PCM 15

SUSPECT PROFILE BOOKLET

WHICH PEN WROTE THE RANSOM NOTE?

Follow your teacher's directions to test 3 pens. Observe the colours formed.
Record your results in the box below. Compare your strips to that of the mystery pen

Pen	Sample A	Sample B	Sample C	Ransom note ink
Colours observed in ink sample				

Who do you think might have owned the mystery pen?

....

....

Use your evidence to support your answer:

....

....

....

....

PCM 15

SUSPECT PROFILE BOOKLET

FOOTPRINT DISCOVERED AT THE SCENE OF THE CRIME

The Gardai have collected the following information about each of the suspects.
Use these along with the evidence collected to identify the criminal.

Drawing of footprint	Analyse the print?
	Footprint found at the crime scene Look carefully at the pattern on the bottom of each shoe. What kind of print would it make? Now look at the footprint found outside? Draw a sketch of the pattern in the box. Measure the footprint:________________cm. Who might wear a shoe like this? Discuss, giving reasons to support your answer.

Who might the footprint belong to?

....

....

Use your evidence to support your answer:

....

....

....

....

....

PCM 15

SUSPECT PROFILE BOOKLET

MYSTERY POWDER LAB

The Gardai have collected the following information about each of the suspects.
Use these along with the evidence collected to identify the criminal.

Powder	**Observe using a magnifying glass.** *Colour, texture, smell, touch.*	**Add water and record the reaction.** *Any colour changes? Did it fizz? Did the powder dissolve (change to liquid form)?*	**Add vinegar and record the reaction.** *Any colour changes? Did it fizz? Did the powder dissolve?*
A **Flour**			
B **Baking P**			
C **Washing P**			
D **Talc**			
Mystery Powder			

Examine any patterns in the above chart.

Can you identify the mystery powder?

....

What evidence have you gathered to support your findings?

....

....

....

....

PCM 15

SUSPECT PROFILE BOOKLET

COLLATE YOUR DATA

Collate your evidence in the boxes below and identify the suspect.

Suspect 1: Mr. Cupcake		**Suspect 2: Mr. Head**	
Suspect 3: Mrs. Letter		**Suspect 3: Mr. Tidyup**	

Who do you think committed the crime?

....

What evidence have you gathered to support your findings?

....

....

....

....

PCM 15

SUSPECT PROFILE BOOKLET

MIND MAP

Create a mind map of your results.

Fingerprints:

Footprints:

Name of person who committed the crime:

Motive:

Mystery Powder:

Ransom Note:

PCM 16

OBSERVING THE MYSTERY SOUND BOX

MYSTERY SOUND BOXES

This activity is about making careful observations and coming up with theories about what is inside each box.

You have three different sound boxes to explore. Record your observations and infer what may be inside each box.

Sound Box	Observations	What do you think might be inside the box? *Support your ideas with your observations.*
A		
B		
C		

How could you test your ideas?

....

....

....

....

....

PCM 17

NEWSPAPER ARTICLE

STUDY CLAIMS DUBLIN PORT NOISE ABOVE WORLD HEALTH ORGANISATION GUIDELINES.

Adapted from article in www.irishtimes.com/news/environment 3rd January 2014

DAILY NEWS

Study claims Dublin Port Noise above World Health Organisation Guidelines

A study has found that residents of Pigeon House Road in Dublin Port are exposed to noise above night-time guidelines set by the World Health Organisation (WHO).

The study reports that the WHO guideline night-noise limit of 40 decibels is "consistently exceeded in the area, with the noise being irregular in nature and thus providing for potentially greater shocks to residents' sleep patterns". The WHO have acknowledged that noise exposure is a significant and growing "environmental issue" responsible for sleep disturbance, annoyance and even heart disease.

"Restriction of operational activity during night-time hours or some other measure(s) should be a priority not only in this area but more generally wherever port-handling activity is operating near to residential neighbourhoods."

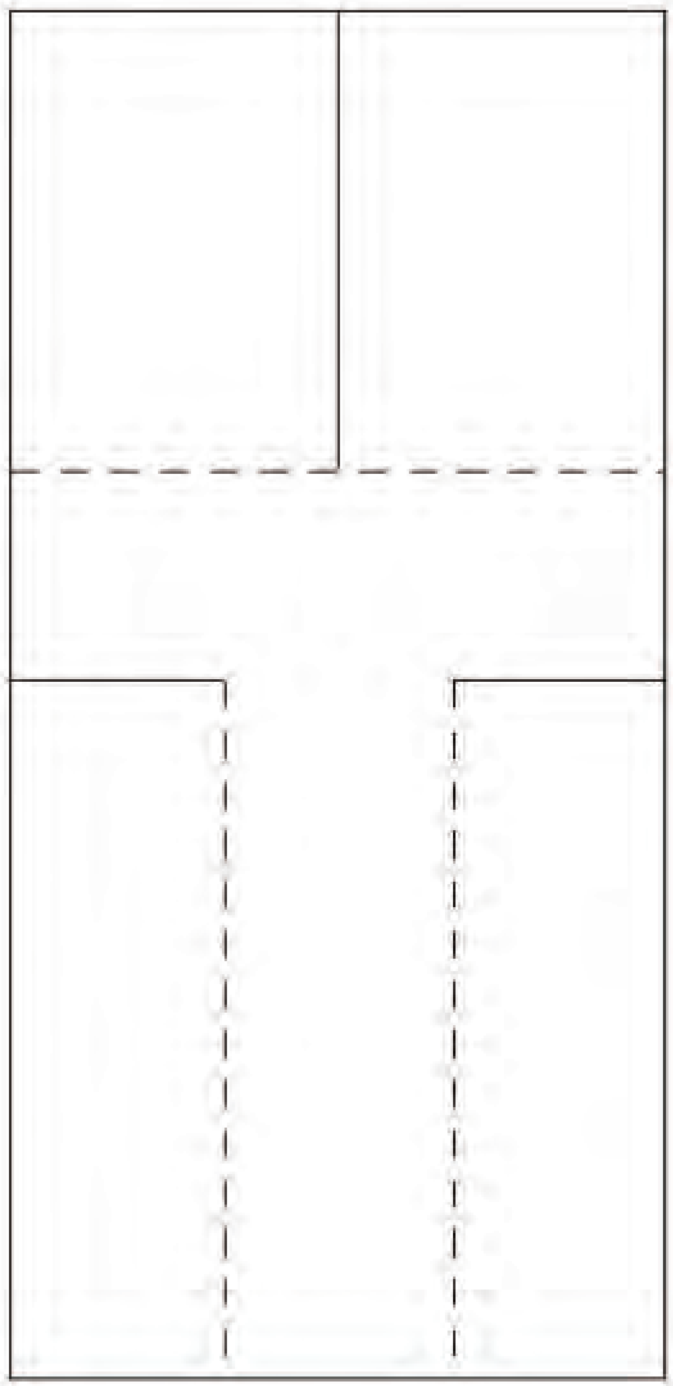
The study, for which local residents were also interviewed, "outlines the failure of planning authorities [in this case Dublin City Council] to implement their duty of care to citizens, and highlights the very real issue of noise pollution in this area in particular".

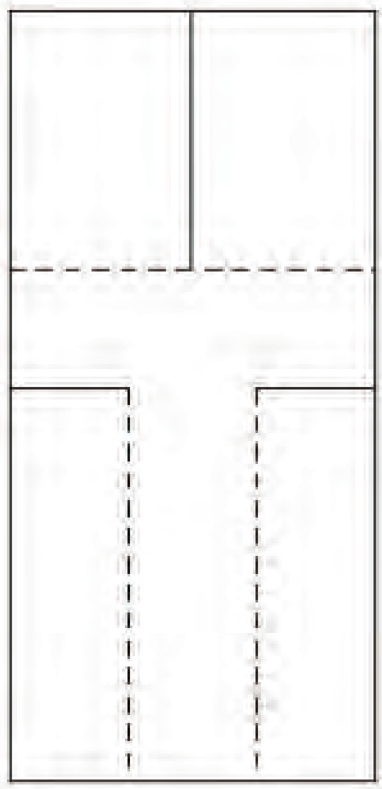
One unnamed local resident complained of "constant tiredness that I didn't have before; an underlying tiredness. It takes me longer [in the morning] to kind of kick into action . . . It affects how you behave; it affects your mood very definitely . . . I'm more irritable."

PCM 18

PAPER SPINNER TEMPLATE

DIRECTIONS: CUT ON CONTINUOUS BLACK LINE. FOLD ON BROKEN LINE.





PCM 19

STORY

THE STORY OF THE BERLIN AIRLIFT'S CHOCOLATE PILOT

THE STORY OF GAIL HALVORSEN, THE CANDY BOMBER

Adapted from www.capmembers.com

Uncle Wiggly Wings was a pilot. His real name was Colonel Gail Halvorsen. He liked to fly airplanes. He was also called the Candy Bomber.

After World War II, Germany was divided among the countries that won the war against Germany. The Soviet Union (now known as Russia) took control of the eastern half of Germany and the western half was divided among the Allied Forces of the USA, Great Britain, and France.

Beginning June 1948, Russia built blockades and would not let food and supplies reach the city of Berlin, Germany. More than two million people were hungry. The United States sent pilots to help fly food and supplies into Berlin. One day while he was in Berlin, Col Halvorsen saw a group of young children at the end of the runway. The children were hungry, but they did not complain nor beg for anything. Uncle Wiggly Wings reached in his pocket and found he had two sticks of gum. "How do you share two sticks of gum with all these children?" he asked himself. Col Halvorsen gave the two sticks of gum to the group of children. And, amazingly, the children tore the gum into enough pieces for every child to have a small taste or smell. Seeing how thrilled the children were over the gum, Uncle Wiggly Wings promised to bring them candy the next time he came. He said he would drop it to them from his plane.

There were many airplanes that passed over their city carrying supplies every day. "How will we know your plane?" asked a young girl. "I will wiggle my wings," replied Uncle Wiggly Wings. The next day as Col Halvorsen flew over Berlin he wiggled the wings of his plane to let the children know that he was going to drop candy to them. Then, he dropped many small parachutes made from handkerchiefs, each bearing sweet treats. Soon letters addressed to "Uncle Wiggly Wings" began to arrive with children requesting candy drops in other areas of the city. "Operation Little Vittles" had begun.

To help Uncle Wiggly Wings with "Operation Little Vittles," candy was shared by fellow airmen and sent by schoolchildren from across America. In May of 1949, the highway blockade ended, and the airlift delivering supplies ended in September

SEVENTH FRAMEWORK PROGRAMME

into

The Fibonacci Project
DISSEMINATING INQUIRY-BASED SCIENCE AND MATHEMATICS EDUCATION IN EUROPE

Coláiste Phádraig
St Patrick's College
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