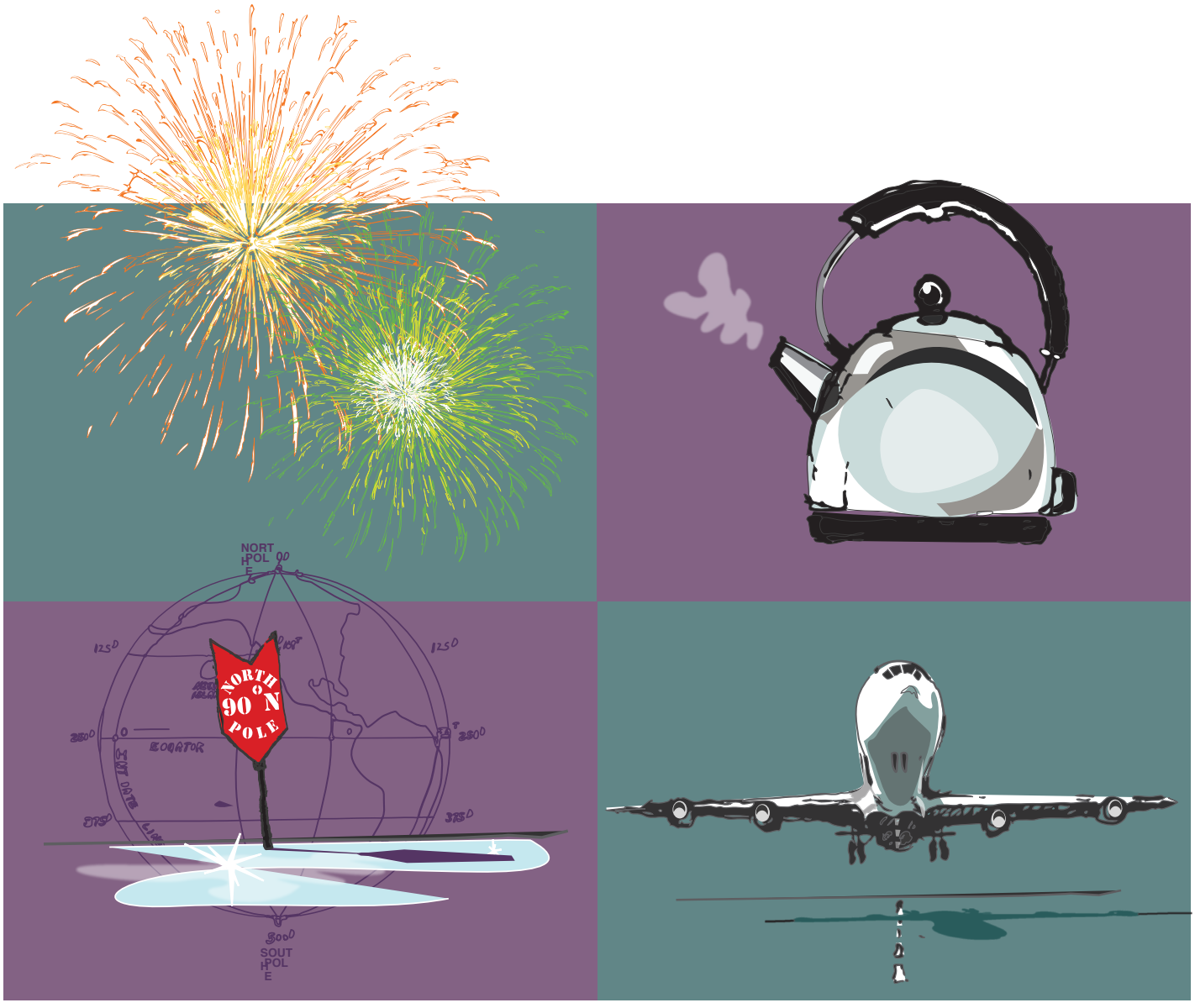
“I can explain!”

Developing children's scientific literacy

FREE SAMPLE UNIT: HOT AND COLD



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why & how?
PRIMARY SCIENCE TEACHING TRUST

FREE SAMPLE UNIT: HOT AND COLD

THIS FREE SAMPLE 'HOT AND COLD' UNIT INCLUDES:

Introduction to developing scientific literacy
Printable set of hot and cold cards
Background knowledge and information for teachers
Concepts explored in the unit, and alternative ideas children may hold
A series of activities to develop understanding
Teacher questions to help children make progress
Language prompts for children as a photocopiable sheet
Description of progression in explaining

THE ACTIVITIES COVER:

Generating simple explanations
Challenging the ideas of others
Sequencing, generating more complex explanations
Grouping and classifying
Describing, using scientific vocabulary
Justifying a new idea

The children work together as a group (ideally of three) rather than individually. They talk and listen to each other, while justifying what they think and, where appropriate, they challenge what others think. The activities are designed to be done in a given order as they tend to increase in complexity, although it is not essential to stick to the order, or to do them all.

EACH "I CAN EXPLAIN!" BOX CONTAINS FOUR UNITS:

Sound - ten sets of eight 'sound' pictures
Hot and Cold - ten sets of eight 'hot and cold' pictures
Floating and Sinking - ten copies of a pirate ship picture
Plants and Animals - Ten copies of a garden habitat picture

THE 46 PAGE TEACHER GUIDE INCLUDES:

a series of activities for each set of pictures
comprehensive science background knowledge
alternative ideas children may hold
language prompts
additional resources for further work

CLICK **HERE** TO FIND OUT MORE OR TO BUY A BOX

FURTHER RESOURCES TO SUPPORT THE DEVELOPMENT OF GOOD GROUP TALK SKILLS

are available **FREE** at www.pstt.org.uk/resources/curriculum-materials/i-can-explain

Introduction

DEVELOPING SCIENTIFIC LITERACY

For children to explain their ideas in science, they need to engage with the language of argument. By participating effectively in rational discussion with their peers, children can learn to justify their own ideas as well as make informed and confident challenges to the ideas of others.

Teaching children to think and explain their scientific ideas will provide opportunities for them to explore why they believe something to be true.

Children often accept given ideas as truths without having the chance to consider why they might be true, or whether alternative explanations may exist.This is unhelpful as it makes it very difficult for children to explain their ideas to anybody else.

Equally, they need opportunities to consider and explain why they think an idea might be wrong. The conflict between children's every day experiences and what they experience in the classroom is often inadequately explored. Without the chance to consider their 'wrong' ideas, it is difficult for children to give these ideas up. Even when they have learned the 'right' idea, they may later revert back to their original 'wrong' idea.

When they learn to explain, children begin to recognise that there may not be a single right answer to a problem or question. This helps them develop an appreciation that science is tentative and cannot always give answers. It can also show children that even though they may not share ideas, it is still possible to work collaboratively to solve a problem.

By constructing their own explanations, children have the chance to explore scientific terminology and use it with genuine understanding. Children might learn to use scientific words but not actually know what they mean, or they might find using the scientific vocabulary hinders their understanding of concepts. Learning science through argument will present children with opportunities to establish a shared language of science, where new vocabulary is used with understanding.

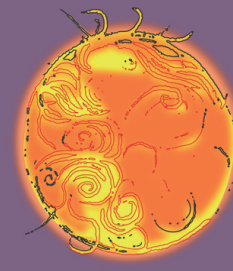
THE 'I CAN EXPLAIN!' APPROACH

These materials have been developed as part of the I can explain!' project, funded by the Primary Science Teaching Trust (formerly the Astrazeneca Science Teaching Trust).The materials are designed to help teachers develop a range of strategies which will enable children to give rational explanations, and to make cognitive gains in science through group talk activities. Children will develop the ability to work as an effective member of a group and through this, they will learn to explain and justify their ideas.

PRINTABLE HOT AND COLD PICTURE CARDS

bathwater

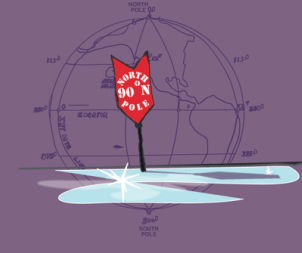
flame



sun

boiling water

moon



north pole

ice cube

lava

Hot and cold

When you get out of bed and put your feet on the floor, why does a stone floor feel colder than a carpet in the same room?

The stone floor and the carpet will be at the same temperature, which will be the temperature of the room. The person getting out of bed has a higher body temperature than that of both the floor surfaces. Because of this temperature difference, heat will transfer from the body to the floor surface. The stone floor is a good conductor of heat whereas the carpet is a poor conductor of heat. The stone floor will therefore conduct heat very quickly away from the body, which perceives this as a feeling of cold. The carpet, however, will conduct heat extremely slowly away from the body, which therefore does not perceive a feeling of cold.

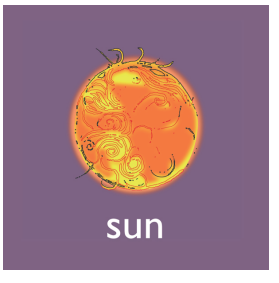
CHILDREN'S ALTERNATIVE IDEAS ABOUT HOT AND COLD

The following are some commonly held alternative ideas that children may have about hot and cold. The hot and cold activities provide opportunities for the children to explore these ideas and consider why they might be wrong.

- Heat is a substance
- Temperature is a property of a particular material or object, e.g. metal is a colder material than plastic, or carpet is warmer than stone
- Hot and cold are different entities, rather than being opposite ends of a continuum
- Boiling is the maximum temperature a substance can reach and freezing is the minimum
- Heat only travels upwards
- Objects that readily become warm (good conductors of heat) do not readily become cold
- The bubbles in boiling water are air, oxygen, or other gas bubbles, rather than water vapour
- Materials themselves can be warm; wrapping up an ice cube in a blanket would make it melt faster
- A larger object will be hotter/colder than a smaller one

USING THE HOT AND COLD PICTURE CARDS

The resource pack contains ten sets of eight 'hot and cold' pictures, shown below.



The table below gives measurements of the typical temperature in degrees centigrade of the objects. These are given as background reference for the teacher; it is not expected that they will be shared with the children.

PICTURE	TYPICAL TEMPERATURE IN DEGREES CENTIGRADE
ice cube	0 or lower
sun	5505 at the surface
flame	1000 (up to 1400)
lava	700 - 1200
boiling water	100
north pole	-43 in winter, -34 in summer
moon	107 in the day, -153 at night
bathwater	40 - 45

Hot and cold

The activities in this lesson are designed to stimulate discussion in which children will use the language of scientific argument to construct explanations about hot and cold.

It is expected that during their discussions, the children will explore some or all of the following concepts:

- materials have heat energy and this can be measured
- temperature is a measure of how hot or cold an object is
- heating or cooling materials can cause them to change state
- heat can be transferred from one material or object to another
- some materials are good conductors of heat, e.g. metals
- some materials are poor conductors of heat; these can be good thermal insulators, e.g. air, wood
- when materials are at a lower temperature than us, materials that are good conductors feel colder than those that are poor conductors because they conduct the heat quickly away from our bodies
- when a hot object is placed near a cold object, the two objects will eventually end up at the same temperature

During their discussions, the children will identify variables that affect how high or low they think a temperature will be. For example:

- where in the object the temperature is being measured (e.g. lava that has just erupted is hotter than lava that has reached the bottom of the volcano)
- the time of day (e.g. the moon is hotter in the day than in the night)
- the time of year (e.g. the north pole is hotter in summer than in winter)
- the familiarity of the object (children will probably have touched ice and so may think that this is the coldest thing there is)
- personal preferences (e.g. people like their baths at different temperatures)
- emotional associations with temperature (e.g. children are warned about the dangers of fire so they may predict that a flame will be hotter than it is)

Some of these variables are subjective and therefore the justifications the children offer for their explanations may be opinions rather than truths. However, these explanations still have value as the important thing is that the children are giving reasons to justify them. With more experience, their justifications will become more objective.

Hot and cold

ACTIVITY 1 – GENERATING SIMPLE EXPLANATIONS

"I think ……. because ……."

Working in groups of three, the children spread out all eight cards on the table. Ask the children to think for a moment by themselves about which object shown in the pictures would be the hottest. When they have had time to think, ask them to pick up the card they have chosen and put it in just in front of them. Children may pick the same card as the others in their group – this is fine. Within their group, the children then take it in turns to pick up their card and explain why they think it would be the hottest. Only the child holding the card should talk. This can be repeated, but this time ask the children to choose the picture that they think would be the coldest.

ACTIVITY 2 – CHALLENGING THE IDEAS OF OTHERS

"Why do you think that?"

"I don't agree with you because ……"

If children have not chosen the same cards within their group, tell them they should try and understand why another person did not choose the same one. Explain that this means they will need to listen carefully to the reasons the other person is giving, as well as explaining why they do not agree. If all children have chosen the same card, ask them to consider what other people might say to them if they did not agree.

ACTIVITY 3 – SEQUENCING – GENERATING MORE COMPLEX EXPLANATIONS

"I think …… because …… but I also think …… because ….."

"That could be true, but ……"

Part 1 – reaching an agreement

This activity can be done with all eight cards, but initially is probably better done with a smaller selection of them. As a starting point, choose four cards that all groups will use. Tell the children to pick up these four cards and put the others to one side. Ask the children to work together to put their cards in order, from coldest to hottest. Tell the children that the order they choose must be one they are all happy with. Remind them that if they don't agree at first, they need to explain what they think, with reasons, and listen to the explanations of the others in their group as well. Where they disagree, they should be encouraged to give reasons.

Part 2 – challenging the ideas of others

When all the groups have completed Part 1, ask each group to choose an envoy who will go to another group to look at the picture order that they chose. Explain to the children that the envoy should look at the new group's picture order, and then listen to the children in that group explain why they put the pictures in that particular order. The envoy can then ask questions to challenge the decisions the group made. By using justified explanations, the envoy can try to persuade the group to change their order.

Hot and cold

ACTIVITY 4 – GROUPING AND CLASSIFYING

"I think these are a similar/different temperature because ….."

Using all eight cards, ask the children to group them into two groups of their own choice. They may initially choose to use difference in temperature as this will be familiar from the previous activities, but they should be encouraged to think of other criteria. When they have tried their own ideas, ask the children to group the cards into things that have a fixed temperature and things where the temperature may vary. Again, the idea is that the children will use the language of explaining to reach an agreement. This activity can be extended by using envoys so that their ideas and explanations are challenged further (see Part 2 of Activity 3 above).

ACTIVITY 5 – DESCRIBING, USING SCIENTIFIC VOCABULARY

All the cards are shuffled and laid out with the pictures face down. The children take it in turns to pick up a card which they don't show the others in their group. They then describe what is on the card in terms of its temperature. The children should be encouraged to use the scientific vocabulary they have learned. This can be made more difficult by e.g. making a rule that they can only say two things about the temperature of the object. An alternative way to play this game is for the children who are working it out to ask questions, to which the child holding the picture can only say yes and no.

ACTIVITY 6 – JUSTIFYING A NEW IDEA

Give individual children a piece of card 10cm x 10cm (i.e. the same size as the temperature picture cards). Ask them to think of an object that they can describe in terms of temperature. Ask them to draw the object on the card. The children can then work in groups to decide where in the sequence of cold to hot their new cards should go. Alternatively, children could place their card upside down in the sequence and the rest of the group could guess what they have might have drawn. The focus here should be on what is possible, and why, as much as the right answer.

QUESTIONS TO HELP CHILDREN MAKE PROGRESS WITH EXPLAINING

- How did your group decide?
- Did everyone in the group agree?
- What happened when people disagreed? How did you sort it out?
- How did you persuade other people to agree with your idea?
- Have your ideas changed today?
- What made you change your mind?
- What else do you think it would help you to know?

Language prompts – helping children explain

Why do you think that?

What is your reason for that?

How do you know?

What is your evidence?

Do you have any other evidence for that?

Can you think of another reason for your idea?

Can you think of any reasons why your idea might not be right?

What reasons might someone else have?

Can you explain why you do not agree with me?

Why might that not be true?

Adapted by Alison Eley from the 'Ideas, Evidence and Argument in Science (IDEAS) Project' by J. Osborne, S. Eduran and S. Simon (2004)

Progression in explaining

EXPRESSING AN IDEA OR CLAIM TO KNOWLEDGE

Children can describe what they have done and say what they think. Their description is consistent with what they have actually done.

"I have put all the noisy things together."

"I think the sun is hotter than the ice cube."

GIVING SIMPLE JUSTIFICATIONS FOR IDEAS

Children can explain what they think, giving a reason that makes sense, although it may be subjective or not be based on actual evidence.

"I think the firework is loud because it is really dangerous."

"I think the barrel will float as it is wooden."

"The fox is hungry so it will eat the bird."

JUSTIFYING EXPLANATIONS WITH EVIDENCE

Children can explain what they think, using objective evidence to support their ideas and explanations.

"I think the barrel will float as it is made of wood and wood floats."

"The lava must be hotter than boiling water as lava is melted rock and a rock doesn't melt in boiling water."

USING EVIDENCE TO JUSTIFY DISAGREEMENT

Children use objective evidence to support their explanations about why they do not agree with another child's idea.

"The fox won't eat the bird as it will be easier to catch the hedgehog because the bird can fly away."

"I don't agree that the barrel will float just because it is made of wood, as it depends what is inside the barrel."

APPLYING KNOWLEDGE TO JUSTIFY AN EXPLANATION IN A NEW CONTEXT

Children transfer ideas from one context to another. They use knowledge learned in one situation to support the explanations they generate in a different situation.

"I think the temperature on the moon in the day will be different from the night because that is what it is like for us on earth."

"Big metal ships float and they must be really heavy, so if that barrel is floating it doesn't mean it isn't heavy."

Adapted by Alison Eley from 'Talk Box' by L. Dawes and C. Sams (2004) and 'Ideas, Evidence and Argument in Science (IDEAS) Project' by J. Osborne, S. Eduran and S. Simon (2004)