

Mystery Boxes is based on an activity devised by Brian Matthews of the Engaging Education Consultancy and Goldsmiths College, who is the author of *Engaging Education* (2006). It has been developed by the Science Museum Learning team as part of the BP-funded project Talk Science.

Talk Science from the Science Museum aims to give teachers innovative tools and techniques to run contemporary science discussions in the classroom. The project draws on the Science Museum's expertise in developing contemporary science exhibitions, and managing dialogue and debate in the Science Museum's Dana Centre, a purpose-built venue for science discussion around contemporary science topics.

Supported by



# Instruction booklet

# mystery boxes activity



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# Mystery Boxes Activity

**In this activity students have to work out what's inside six Mystery Boxes without opening them.**

A mock science conference is held to discuss different groups' ideas and build a consensus about the content of each box, based on the students' evidence. Students will want to know what is in the boxes, but this is never revealed.

The boxes are an analogy for science – scientists are unable to 'open the box' to find a definitive answer as to whether or not their ideas are correct but instead form theories based on evidence from their research, which are open to further revision.

## Learning outcomes

**Skills used: discussion, developing an argument, observation, negotiation and teamwork**

- Scientists generate scientific theories based on evidence, but they do not find definitive answers.
- Scientific knowledge and ideas change over time and are open to further revision as our understanding of the world around us evolves.
- Science is a social and creative activity.

## NC links

KS3 Science QCA (2007): 1.2, 2.2 and 2.3

KS3 Science QCA APP (2009): AF1, AF3

KS4 Science QCA (2007): (How Science Works) 1a–d, 2a–d, 3a–c, 4c

QCA Personal, Learning & Thinking Skills (PLTS)

## Timing of activity

**Whole lesson, approx. 1 hour**

## Groupings

**Groups of 3–4 students max.**

(We recommend 1 Mystery Box set per class of 24 students).

## Materials provided

- A set of six Mystery Boxes (each box contains a single item)
- Resource CD containing:
  - PowerPoint presentation
  - Student observation sheet
  - Student 'how to' sheet

## Additional materials needed

- Post-it notes
- Marker pens
- Timer
- Whiteboard or flip-chart-sized paper (for use in mock conference)

Fig. 1



## Advance preparation

- Prepare A4 observation sheets with Post-it notes for individual group results (Fig. 1).
- Draw up a large grid on flip-chart-sized paper or a whiteboard for class results. There should be one square for each Mystery Box (Fig. 1).

# Step 1

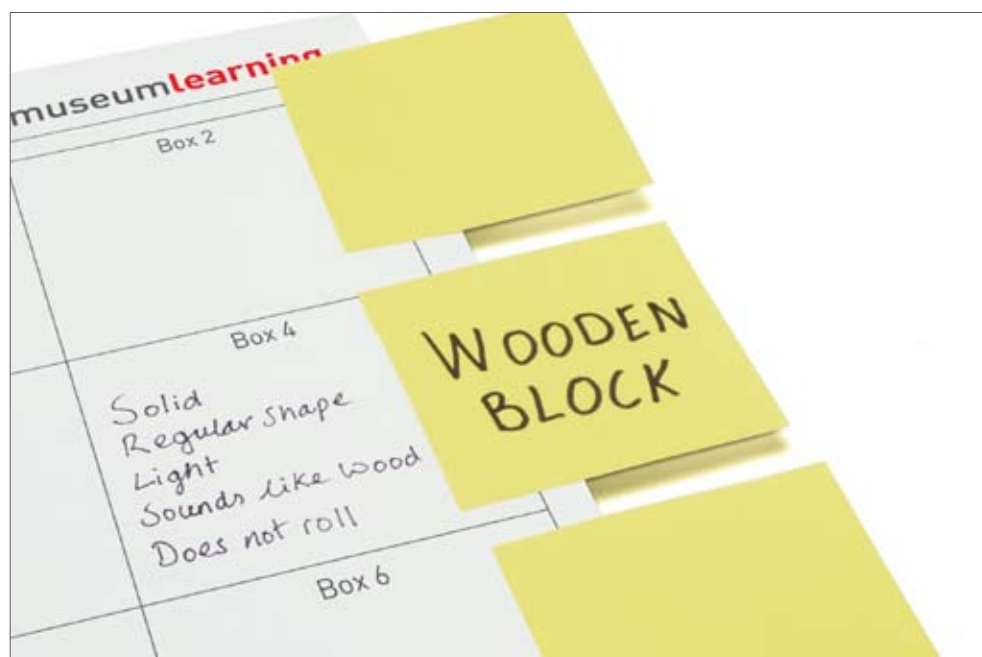
## Introduction: 25–30 minutes

PowerPoint slides 1, 2 and 3

Give each group a Mystery Box, a 'how to' sheet and an observation sheet with Post-it notes attached.

Groups have 2–3 minutes with each box to:

- Work out what they think is inside the box without opening it.
- Make notes on their observation sheet justifying their decision.
- Come up with their best idea (based on their observations) as to what is in the box, which they record on the Post-it note (see Fig. 2).



**Fig. 2** Students write their best idea on the Post-it note provided.

## Prompt questions you could use with students:

- What material do you think the item is made from?
- How much space does the item take up inside the box?
- How does the item move inside the box?
- What shape do you think it is?
- Can you draw what you think it looks like?

When the 3–4 minutes is up, stop the groups and ask them to pass their box onto the next group. Repeat this until all groups have investigated all six boxes.



## Step 2

### Skills and approaches students used in this activity: 5–10 minutes

PowerPoint slide 4

Ask students to reflect on the activity:

- Give the class 2 minutes to write down as many of the skills and approaches they used to work out what was in each box.
- Write up their suggestions on the whiteboard or on flip-chart-sized paper. The list should include as many of the following as possible:

#### **Sensing\***

- Weight
- Movement
- Sound

#### **Testing**

#### **Making notes**

#### **Perseverance**

#### **Hypothesis**

#### **Prior/existing knowledge**

#### **Discussion**

#### **Imagination**

#### **Creativity**

#### **Visualisation**

#### **Curiosity**

#### **Cooperation**

#### **Negotiating**

#### **Observations**

#### **Drawing conclusions**

#### **Reasoning**

#### **Context** (e.g. items are limited by size of tin)

#### **Systematic approach**

\*Capture feedback such as weight/sound/movement as 'sensing'.



**Prompt questions to help students generate the list include:**

- How did you know it was made of this material? (Prior knowledge)
- Did anyone work in silence? (Discussion)
- Did you investigate all the boxes in the same way? (Systematic approach)
- How did you decide on your group's idea? (Negotiating, reasoning, discussion)
- Did anyone suggest an idea that you tested? (Hypothesis, testing, drawing conclusions)
- Did you try and picture in your head or draw what was inside the box? (Imagination, visualisation, creativity)

**Explain how the list represents what we recognise as the way scientists work:**

- Scientists propose ideas and test them.
- Discussion is a vital part of science.
- Science is both social and creative.





## Step 3

### Mystery Box Conference: 15 minutes

PowerPoint slide 5

Students will now go one step further in trying to work out what is in each box by staging a mock science conference. This will allow them to compare each other's best guesses (based on their observations) and to justify those guesses when asked.

- Get one person from each group to stick their Post-it notes in the relevant section of the large grid (see **Fig. 3**).
- Pick an example where the majority of groups have come to the same or a similar conclusion.

Explain that there is already cross-group agreement about the contents of the box. Without opening the box the class could feel reasonably certain that the answer is 'correct'.

- Pick a contrasting example, e.g. where different shapes or materials have been suggested.
  - Ask the groups with contrasting ideas to present their evidence.
  - Is one group's evidence more convincing than the others' evidence?
  - Pass the box in question around to be re-examined.
  - Allow groups to change their mind (or not) in light of new evidence and ideas.
- Use other examples of similar or contrasting ideas if time permits.

Explain that this is similar to how scientists peer review their work at science conferences – making your work public is part of the quality control of scientists.

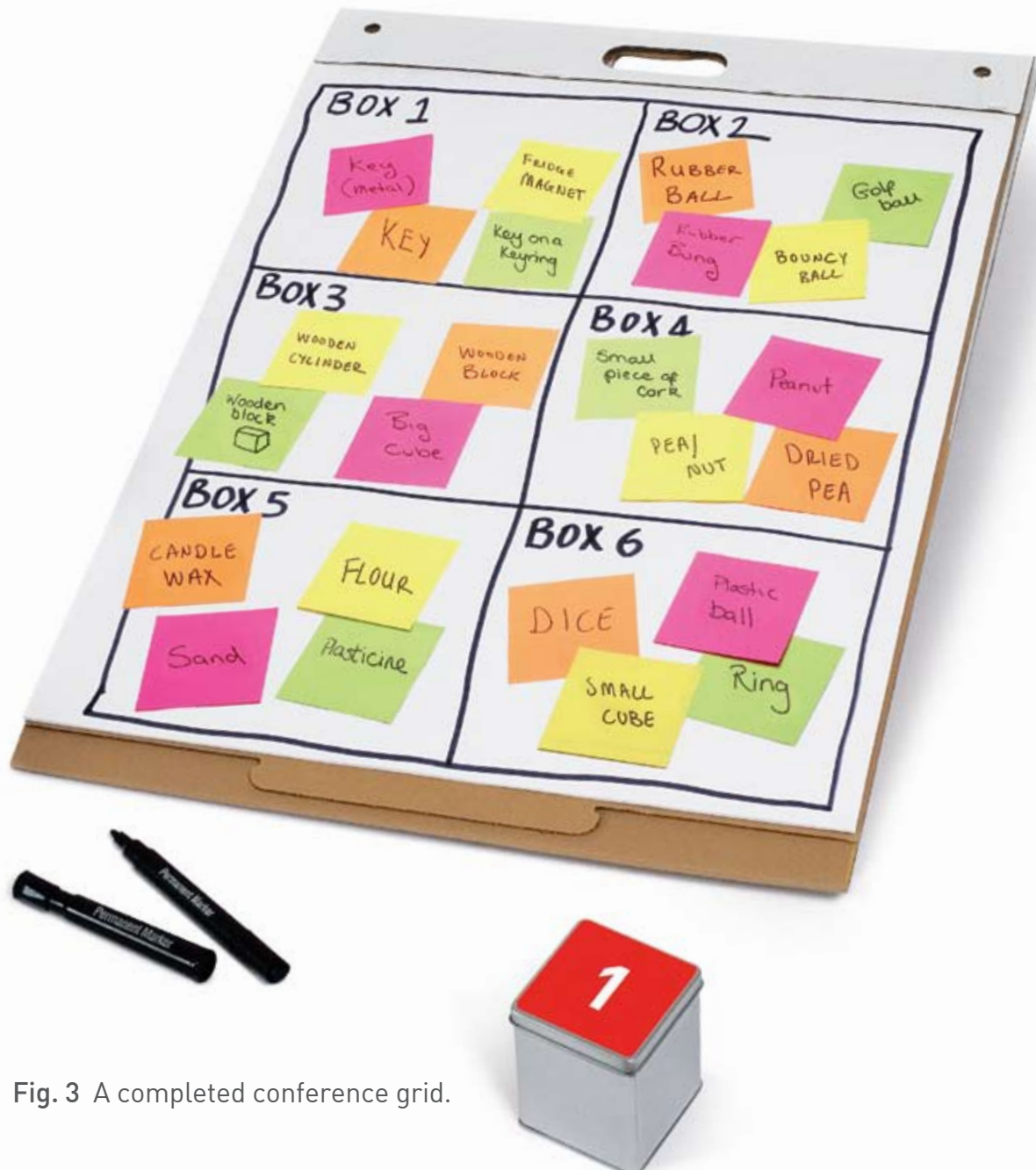


Fig. 3 A completed conference grid.

## Step 4

### What's in the boxes? 5 minutes

The answer is... you don't know, and you aren't going to tell them!

Why...?

### The boxes are an analogy for science...



*Most scientists will concede that, although they seek truth, they don't know or generate truth. They propose and test theories, knowing that future evidence may cause refinement, revision, or even rejection of today's theories...*

*However, we can reach the best possible conclusion based on the most complete and modern evidence available.*

Dr Bruce Railsback, University of Georgia



For example, it is highly unlikely that we will ever fully understand the origins of the universe, but that understanding will evolve with future research and technological advances.

Although the class will have their best ideas about what is inside the boxes, further testing and new evidence could mean the best ideas need to be revised.

However, this is not to say that we do not accept some scientific theories as if they are fact; many theories are extremely well proven to the point that no-one would dispute them, e.g. the existence of gravity or that the Earth orbits the Sun.

Scientific research is driven by the challenge of finding out 'what's inside the box'.

## PowerPoint slides 6 and 7

Use the Popper, Einstein and Railsback quotes in the PowerPoint presentation to support this step.

## Never open the boxes!

'Not knowing' may be frustrating, but it reinforces the analogy and makes Mystery Boxes truly memorable.

## Extensions

- Scientific modelling. Get students to test out their best ideas first hand. You will need a set of empty boxes, measuring scales and a range of materials to put into the empty boxes.
- Personal reflection. Have student opinions of 'science' changed through this exercise? Allow students to reflect on their perception of science before and then again after the activity.
- Social and ethical issues. Ask students to discuss in small groups how social and ethical issues could impact on scientific research. Could the funding source have any influence on the research findings? Can there be pressure from government, industry or society to find the 'desired' results?
- Revision of scientific ideas. Ask students to research examples where scientists have revised their ideas over time, e.g. the structure of the atom.
- Science in the news. Explore the level of certainty attached to information that is communicated to the public as 'scientific fact' – what degree of scepticism, if any, is appropriate when reading scientific research? Ask students to write down what elements they need to consider when deciding if a scientific study is of a high standard, e.g. sample size, who has carried out the study, funding, etc.

## Differentiation

- Support students in the main activity by having empty tins, measuring scales and a range of materials available to test.