Whodunnit?

UNIT A3

This unit looks at the story of Piltdown Man. It illustrates some possible errors that scientists and others can make accidentally or even deliberately. This context is then used to challenge pupils about their approach to investigations.

Using this unit

The details provided of the story of Piltdown Man are intended to show how evidence can be accumulated and possibly falsely interpreted. A comparison is made with the pupils' own investigations and practical work.

Misjudgments might involve any of the following: invalid conclusions; unreliable data; an unfair test and even plain dishonesty. Activities are given to illustrate each of these. It may prove difficult to provide opportunities for every pupil to work through each activity so it is suggested that pupils be grouped and each group could work on one activity and report back to the whole class. Reporting back is important to ensure that the final overall conclusions and thoughts are not left out.

Useful resources

A useful website, 'Piltdown Man by Richard Harter' can be found at
http://www.tiac.net/users/cri/piltdown.html

Notes on the activities

Pupils place one hand under a cold tap and one under a hot tap. When they place them into a bowl of warm water, one will interpret it as cold and one as hot. Take care the hot tap is not so hot that it scalds.

Links with KS3 programme of study

- Use of a range of sources of information (breadth of study).
- The interplay between empirical questions, evidence and scientific explanation. The ways in which scientists work today and examples of how they worked in the past (Sc1 ideas and evidence).
- Use of results to draw conclusions and considering whether evidence is sufficient to support any conclusions or interpretations made (Sc1 investigative skills).

Moral and spiritual aims

- To promote appreciation of the importance of honesty and integrity in the scientific enterprise.
- To develop understanding of some of the factors that could lead scientists into making false claims.

Answers to questions

1. This is really not a fair test as hands started at different temperatures and 'feeling' temperature is not objective enough.
2. Use a thermometer.
3. (c).
4. A fair conclusion might be that the water in the bowl feels colder than the water from the hot tap. The water in the bowl has a temperature between that of the cold and hot tap water.
5. Encourage a range of answers. Who knows!
6. Any historical event not well recorded will be open to this, e.g. the disappearance of the dinosaurs, the changes at the ice age, the BSE crisis, the origins of AIDS, etc.
7. Lydia is correct. The others try to jump to a conclusion which is not supported.
8. For example, the fragments of bone had been dyed but no one looked very carefully. No one noticed the filed teeth or chewing gum. They jumped to a conclusion which they 'wanted' to be correct.
9. Starting mass is not the same. This is important for the fairness of the test.
10. Start with the same mass, leave for longer, plot a graph of mass lost vs time, etc.
11. The samples were only fragments. The reputations of the characters misled people and prevented them asking about reliability. There were many 'claims' in the story, e.g. the find being made in a quarry, but little real evidence.
12. Held at different heights. Mark a set height on wall or use a ruler to check. It is always the same.
13. Chemical tricks and false teeth were used in the deception.

Extension idea

Possible extensions include discussions of the contemporary debate over BSE and GM foods. Are scientists, politicians and the media giving accurate information and how does the public react to such 'scare stories'?

	Agree	Don't know	Disagree
These skulls could be very old		✓	
These skulls are probably very old	✓		
These skulls are very old		✓	
These skulls are certainly very old			✓

Whodunnit?

UNIT A3

Do you always believe everything you read in newspapers or magazines? Do you believe what you watch on TV, or what the teacher tells you or even what scientists say? Do you think a scientist could prove something is really true?

Have you ever tried to fiddle an experiment in science when you hoped to get a particular result? Perhaps your result was in fact right and the book or the teacher or the scientist was not quite correct. How would you check?

The intriguing case of the man who never was!

Case history

In 1908, a workman brought to Charles Dawson, the amateur archaeologist and fossil collector, what he thought to be the fossil remains of an early human ancestor. He claimed to have discovered them in a quarry in the Piltdown area of Sussex.

In 1912, Dawson contacted his friend Arthur Woodward, the curator of the Natural History Department of the British Museum, about the fragments. Could they be the remains of skulls from early humans never before seen, let alone identified or named?

In November of 1912, the news broke in newspapers, and in December the bones of Piltdown Man were officially declared to be an important find. The creature appeared to fill a gap in the scientists' chart of human evolution and British scientists were very excited about the find. Up until then, all the important fossil discoveries about humans had been found in other countries. Now Britain had its very own fossilised human.

Activity

Fill a washing-up bowl with warm water. Ask your friend to place their left hand under the cold tap for 1 minute. Meanwhile you place your left hand carefully under the hot tap for 1 minute. Now both of you place your left hands in the bowl of warm water.

1. Each of you should say if the water in the bowl is warm or cool. The answer your friend gives will probably be different to yours. Why?

It is sometimes hard for us to be objective, i.e. not affected by our own personal opinions, when asked this kind of question.

2. How could you find out if the water was hot, warm or cool objectively so that the conclusion would not be just a matter of opinion?

3. Which of the following could you honestly conclude from the evidence of the original test alone if you wanted to be careful not to claim too much?

   The water in the bowl is:

   (a) hot water;

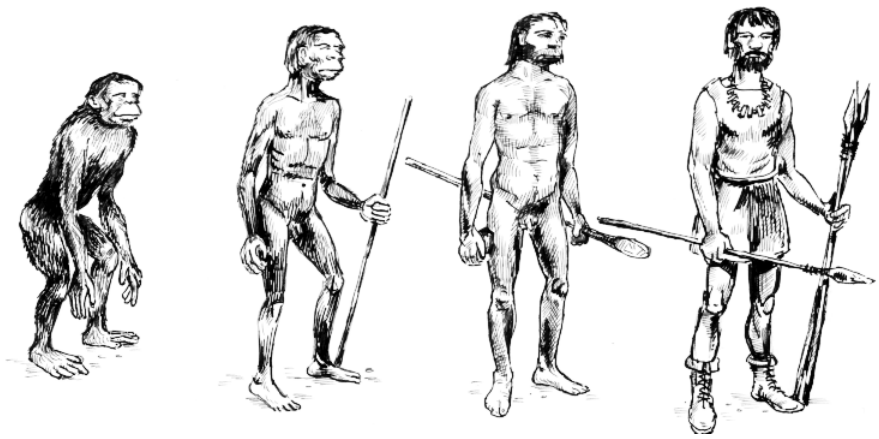
   (b) at 40°C;

   (c) hotter than water from the cold tap.

4. What other valid conclusion can you come to?

Hoax exposed

Other scientists were also interested in the Piltdown finds but they did not all believe the British scientists. Then, in 1915, fragments of a second creature were found and this helped to convince many others that their claims were true. However, between 1914 and 1950, several other fossil remains were found in various countries enabling scientists to build a more accurate picture of the life of the human species years ago, and it was this that first alerted scientists to the fact that Piltdown Man did not fit the picture!



Theoretical stages of human evolution

X-ray tests were then carried out to find out the age of the fossils. These fossils were found to be much younger than had been claimed. Finally, in 1953, it was revealed that Piltdown Man had not existed at all - the 'fossils' had been planted as a trick and many scientists had been fooled.

The evidence

The 'fossil bones' were a mixture of bones including a medieval one only 620 years old, a jawbone of an orang-utan (only 500 years old), and a chimpanzee tooth!

- They had been treated with chemical dyes (similar to shoe polish) and with corrosive chemicals to make them appear ancient.
- The teeth had been filed down to make them fit the skull and to show wear.
- A piece of chewing gum was found patching a hole!

The Suspects

John Cook. The 'Piltdown Gang' © The Natural History Museum, London

The suspects

Charles Dawson *Sir Arthur Woodward* *Martin Hinton* *Teilhard de Chardin* *Conan Doyle*

These five men were all friends:

- Dawson, the only scientist present when the bones were found;
- Woodward, who had access to lots of bone fossils;
- Martin Hinton, museum curator who even had a collection of stained fossil teeth;
- Teilhard de Chardin, a Catholic priest and good friend of Dawson and who was prone to making jokes;
- Conan Doyle, who collected fossils and wrote mysteries including the Sherlock Holmes stories.

5. Who do you think did it, and what was their motive?

Unsolved mystery

Unfortunately the culprit was never found and, to this day, no one knows for sure who did it or why (except the culprit and any accomplices).
Why did they get away with it?

Here are four possible reasons:

- An expert did the forgery so it was hard to tell;
- Dawson and Woodward said it was genuine and because they were scientists people trusted them;
- Science at the time could not prove its genuineness, but people assumed it anyway;
- The scientists wanted to find something that fitted their ideas and would make them famous. They had stopped being objective (making a careful decision based on all the evidence), which is an important aspect of their work.

The Piltdown story shows us that we can be misled, not just by hoaxers who actually falsify evidence, but also by scientists who interpret the evidence in a way that fits the ideas they have already got.
A scientist is a person who ought to use practical evidence to test theories, report observations and draw conclusions based only upon the evidence.

6. Can you think of examples of some things scientists cannot be sure about because they were not there at the time?

The Piltdown scientists were not trying to be objective. They wanted to find a human fossil because:

- It would prove their theory;
- Other countries had their own fossil ancestor, and Britain had none;
- It would make them famous.

So what about school science investigations?

How good a scientist are you? Are you trying to be objective? Do you ever claim too much for the data you collect?

Your science investigations at school can have errors and therefore claim too much for four different reasons:

- You may have come to invalid conclusions from your data;
- Your data may have been unreliable;
- Your test may have been an unfair one;
- Dishonesty may have been involved.

Choose one of the following three activities to look at.

1 Invalid conclusions

Sometimes you may:

- claim that you have proved something when you haven't;
- claim more than your data can support;
- collect the wrong data for the point you are trying to make.

Five people looked at a plant inside a clear plastic bag. There are water droplets on the inside of the bag.

- John says, 'It is hot in the bag'.
- Denzel says, 'It has been watered too much'.
- Lydia says, 'A colourless liquid has condensed on the inside of the bag'.
- Andrew says, 'The water came from the plant'.
- Ash says, 'The water came from the soil'.

Four of the five answers are probably correct but the evidence actually supports only one answer.

7. Who do you think is correct? Why? Explain why the others are claiming too much.
8. In what ways was the conclusion made by the Piltdown scientists invalid?

2 Unreliable data

Sometimes you only make a few measurements, or just do one test and then claim that because this data suggests something, then it has been proved. However you can be inaccurate in measuring and sometimes results are a 'fluke'. You cannot rely on the results of a single test to give a true picture. You need to repeat the test in order to obtain several readings. Then you can use averages and graphs to get a truer picture.

If you repeat the test and get the same readings again, you can be more confident that the conclusions are reliable.

This is what some pupils did to find out which is the best place to dry a piece of cloth. They took two identical hankies and dipped them in the same bowl of warm water and squeezed them hard. Then they weighed them separately. They hung one by the window facing north and the other by the window facing east and left them to dry and weighed them again every hour.

	0 hours	1 hour	2 hours	3 hours
North Hanky	10.5g	10.3g	10.1g	9.8g
East Hanky	10.4g	10.2g	10.0g	9.8g

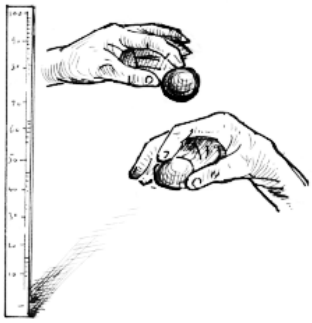
One group concluded that the north window is the better place for drying a wet hanky. Is this a valid conclusion?

9. What do you notice about the mass used at the start, and why is this important?
10. What could be done to make the conclusion more reliable?
11. In what ways was the conclusion of the Piltdown scientists not very reliable?

3 Unfair test

Sometimes you may forget that there are many things that affect what you are testing, and say that the changes are due to the wrong factor. It is necessary to isolate the one factor you are testing, by controlling all the others, so as to be able to claim you know what caused any change.

The picture shows a simple experiment to compare the height of bounce of two balls made of different materials. Each ball was held by a pupil and dropped, at the same time, onto a hard floor. A partner observed the bounce of each ball against a metre rule.



12. Why is this not a fair test? What should be done to make it fair?
13. Can you think of other ways of making the skulls seem old that the Piltdown scientists could have used?

Think again about the Piltdown skulls and copy and complete these boxes:

	Agree	Don't know	Disagree
These skulls could be very old			
These skulls are probably very old			
These skulls are very old			
These skulls are certainly very old			

Scientists still sometimes get it wrong

Poor decisions are still made today. For example, in the 1970s, American scientists failed to notice an increasing hole in the ozone layer. They had set their NASA satellites to ignore odd results and so missed a major problem. The British Antarctic Survey ship using simpler equipment proved that a real environmental problem existed and needed further investigating.

So how honest a scientist are you?

Robert wanted to do A Level Chemistry and so he needed a good GCSE grade. He was coming to the end of his GCSE science investigation. His last task was to weigh his dish of crystals. However disaster struck! In his haste, he didn't use the tongs. The crucible was hot - he dropped it. The dish fell to the floor and smashed into pieces, crystals spilling all over the floor. With five minutes to go to the end of the exam, he threw the pieces in the bin, and quickly looking at his notes, made up a number for the weight, wrote it down and handed in his paper.

What is your reaction to Robert's story?
Does it matter that he made up his results?
When might it be important for a scientist to admit to a mistake and not mislead others?

