



# TEACHING ABOUT SCIENCE

## **E** ASSESSING DATA QUALITY: MOBILE PHONES – HEALTH RISK OR SCARE ?

This is a lesson aimed at helping students to develop their understanding of how to assess the quality of scientific data.

### **Teachers' notes**

Downloaded from [www.nuffieldfoundation.org/aboutscience](http://www.nuffieldfoundation.org/aboutscience)

### **Resources for students (separate download)**

Download from [www.nuffieldfoundation.org/aboutscience](http://www.nuffieldfoundation.org/aboutscience)

OHTs E0.1 Aims, E0.2 Headlines

OHT E1.1A/B Glossary of terms (2 sheets)

Student sheets E1.1C/D Research project reports

Student sheets E1.2A/B/C Mobile phone safety debate

Student homework sheet E3.1A What scientists said

Student homework sheet E3.1B Homework questions

OHT E3.2 Stewart Report findings (2 sheets)

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# TEACHING ABOUT SCIENCE

## E ASSESSING DATA QUALITY: MOBILE PHONES – HEALTH RISK OR SCARE ?

### TEACHERS' NOTES

#### FOCUS

The possible risk from the use of mobile phones is a very topical issue and one of considerable relevance to many students.

In this activity evidence of health risks from mobile phones is presented to students who are asked to assess the strength of the evidence on the basis of its validity, reliability and repeatability.

The aim is to teach students how considering the issues of validity, reliability and repeatability can give a measure of the strength of a piece of evidence.

The evidence presented in the teaching also shows the differences between establishing a correlation between health effects and mobile phone use, and examining the causal mechanism by which mobile phone use might lead to health effects.

The lesson also emphasizes the difference between evidence providing an assessment of potential risk and evidence capable of proving the existence of an effect.

#### RATIONALE

One of the most topical interactions between science and the public over the last few decades has been over issues of risk to health from new technologies. In public debates, such as that concerning genetically modified foods, there is a conflict between the tentative nature of scientific evidence and the public need for definitive answers. Evidence of a link between an environmental factor and a particular symptom will not give clear proof but an indication of potential risk. This is exemplified by the long running debates over the link between cancer and smoking, or the dangers of nuclear power generation.

In recent years there has also been a tendency for the results of scientific research to enter the public domain rapidly and sometimes without thorough peer review and replication. The danger is that the reporting of debates between scientists may make the researchers appear biased or incompetent, rather than reflecting the central function of debate in the process of establishing trustworthy knowledge in

science. With the emphasis students often place on human errors in experiments, simplistic views of the knowledge generated from scientific research can prevail. Students often hold rather naïve views of the apparent quality of scientific data. In particular they may be unable to recognise the difference between *validity*, *reliability*, and *repeatability*.

This activity draws upon contemporary discussions about possible health risks associated with mobile phone use, to illustrate how evidence is drawn upon to assess potential risks. This case is typical of many where a claim of increased risk is made (some groups of mobile phone users may have an increased chance of developing a particular condition), as opposed to a claim of definite cause (using mobile phones results in a particular condition). It is very difficult indeed to establish increased risks. The increased risk may only involve certain populations of users (such as young people), and several potential risk factors may correlate with one another. For example, in order to establish that smokers have an increased risk of developing lung cancer, it is necessary to show that there is a higher occurrence of lung cancer amongst smokers, and that this higher occurrence is not due to other factors such as occupation or poverty. This may be difficult if smokers tend to be disproportionately represented in certain occupations and socio-economic groups.

By engaging students with a number of pieces of evidence to support opposing points of view, the activity aims to teach students the distinction between evidence of a causal mechanism – that is evidence of how emissions from mobile phones cause changes in brain tissue – and evidence of correlation – that is evidence of a statistical link between mobile phone use and changes in brain tissue. Students should also be able to make comments on the quality of the pieces of evidence by judging the validity, reliability and repeatability of the evidence. To do this students review a number of pieces of evidence and then select those that support a particular point of view. Then they present their case for this viewpoint and raise criticisms of the evidence for an opposing one.

## AS/A2 LINKS

Pilot studies have shown that this activity can be effective with students at any point in their course. However teachers may prefer to use the activity early in the course to enable the contexts and skills used to be drawn upon by students in evaluating their own investigative studies.

Teaching about the relationship of science to technology and society feature in the QCA subject criteria.

‘AS and A level specifications in BIOLOGY should encourage students to:

- be aware of advances in technology, including information technology, relevant to biology;
- recognise the value and responsible use of biology in society.’

‘AS and A level specifications in CHEMISTRY should encourage students to:

- appreciate the contributions of chemistry to society and the responsible use of scientific knowledge and evidence.’

‘AS and A level specifications in PHYSICS should encourage students to:

- develop essential knowledge and understanding of physics and, where appropriate, the applications of physics, and their implications for present day society.

Evaluating evidence and procedures features in ALL THREE QCA subject criteria.

‘Students should:

- assess the reliability of data and the conclusions drawn from them;
- show awareness of the limitations inherent in scientific activity including environmental issues.’

## KEY SKILLS

The activity gives students the opportunity to gain competence in the following key skill areas:

Communication Level 3

C3.1a Contribute to a group discussion about a complex subject.

Portfolio evidence of this could be in the form of a note from an assessor (the teacher) who has observed the discussion and noted how the requirements of the unit have been met, or an audio/video tape of the discussion.

## TEACHING SEQUENCE

### Starting the teaching sequence (brief)

#### Resources

OHT E0.1 Aims of the lesson

OHT E0.2 Headlines about health risks from mobile phones

#### Points to raise

The teacher introduces the main aims of the lesson (OHT E0.1) and emphasises the unusual nature of the lesson (assessing the quality of evidence, evaluating risk, no writing and lots of discussion). Students are being given the opportunity to step back and consider 'What is this thing called science?' Students will be expected to get involved in group discussion and then feed back their ideas to the whole class (link to key skills). They should think and talk!

OHT E0.2 'Headlines about health risks from mobile phones' could be used to introduce the activity.

For the remainder of the teaching sequence the students will be allocated to groups.

**Activity E1 (20 minutes)**

**Aims** At the end of this activity students should:

**1.1** understand that in many cases it is not appropriate to establish a clear causal link – rather, research focuses on identifying an increased risk;

**1.2** understand that validity, reliability and repeatability are important in assessing the quality of scientific data.

**Teacher presentation E1 (5 minutes)**

**Resources** OHTs E1.1A/B Glossary of terms

**Instructions****Commentary**

<p>Give a brief picture of the activity.</p> <p>Students should be introduced to the meanings of the key words used, using the glossary on OHTs E1.1A/B: mechanism; correlation; validity; reliability; repeatability.</p>	<p>OHTs E1.1A/B should remain displayed during activity E2 for reference.</p>
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**Student activity E1 (15 minutes)**

**Resources** Sheets E1.1A/B Glossary, E1.1C/D Research projects, E1.2A/B/C Safety debate

**Instructions****Commentary**

<p>Students are divided into groups of 3 or 4. Half the groups (Group A) should work on the case for a link between mobile phone use and health hazards; the other groups (Group B) consider the case for no link.</p>	<p>Pilot studies have shown that, using the available evidence, it is considerably easier to present a clear case against any link between mobile phone use and health problems than to give a strong case for the link. This should be considered in allocating students to each group.</p>
<p>Student groups are provided with a number of statements describing a piece of evidence and the interpretation of the scientist or group who published the evidence.</p>	<p><b>Causal mechanism v correlation.</b> Projects 1–3 exemplify the attempt to establish a causal mechanism. They each try to identify a mechanism by which microwaves could have a detrimental effect on living tissue. Projects 4–8 are examples of attempts to identify a statistical correlation between emissions and incidences of cancers.</p> <p><b>Validity.</b> Projects 1–3 and 5–6 can be criticised for lack of validity. In each case the assumption is made that any observable effect in animals is transferable to humans. This is particularly true where the animals used are very different, as in the case of the work on nematode worms. In Projects 7–8 other environmental factors cannot be excluded; an apparent link may be due to other aspects of lifestyle that are more common among mobile phone users.</p> <p><b>Reliability.</b> In Projects 7–8 the sample size is important. In such studies the key issue is at what point the correlation is strong enough to indicate a clear link. In particular, the increased incidence of tumours in mobile phone users raises the problem of a lack of statistical significance from a small sample.</p> <p><b>Repeatability.</b> Comparing the results of Projects 4–5 clearly raises the issue of repeatability. Similar studies have failed to produce the same results.</p>
<p>The students are asked to review each piece of evidence in terms of its nature (<b>causal mechanism</b> or <b>correlation</b>) and its <b>validity</b>, <b>reliability</b> and <b>repeatability</b> using a checklist.</p>	<p>The Checklist on student sheets E1.2C is intended to give a framework for evaluating the evidence. Encourage students not to become bogged down by it.</p> <p>If students are struggling to identify evidence that supports the links between health effects and phone use, encourage them to choose evidence that shows a possible risk to health (such as Projects 1, 2 and 8).</p>



**Student instructions E1 continued****Commentary continued**

The students are then asked to prepare a case either for or against a health hazard from mobile phones in two ways:

- by selecting three pieces of evidence to present in support of their case;
- preparing to question the evidence likely to be put forward by the opposing group(s).

Pilots have also shown that many students do not recognise that they are being asked to assess evidence of RISK and proceed to try to prove or disprove that mobile phone use causes tumours. This may need to be addressed explicitly during teaching.

**Activity E2 (about 30 minutes)****Aims**

At the end of this activity students should:

**E2.1** understand that clear understanding of phenomena does not always come directly from data;

**E2.2** realise that researchers do not always agree on the interpretation of evidence;

**E2.3** understand that validity, reliability, and repeatability are important in assessing the quality of scientific data.

**Student activity E2 (25 minutes)****Instructions**

Each group of students is asked to present their case giving three pieces of evidence to support either the prosecution or defence.

The groups should then be given the opportunity to raise questions concerning the quality of:

- 1 individual pieces of evidence;
- 2 the body of evidence as a whole.

**Commentary**

Managing the discussion of the evidence is crucial in order to address the teaching aims of the task. Teachers could either:

A: run the discussion as a fairly informal session but with students raising issues via the teacher to avoid too much confrontation;

B: create more of a role play scenario with the teacher as the judge/magistrate and give both the prosecution and defence opportunity to raise questions of the evidence.

It detracts considerably from the learning aims if this part of the lesson becomes an aggressive adversarial confrontation between the two groups. Teachers should manage this part of the activity to prevent this.

Students should not treat this part of the lesson as being about banning the use of mobile phones, but rather setting guidelines about their safe use, and the development of safer technologies.

**Summing up the discussion E2****Instructions**

The final part of the discussion should:

- A: give students the opportunity to step back from the case they have argued and give a more personal reaction to the issues raised
- B: emphasise the distinction between proving an effect and indicating a potential risk.

**Commentary**

Useful questions to ask would be;  
‘Would you change the way you use your mobile phone?’

‘How do we know that smoking causes health problems?’

‘How are government policy decisions on issues of risk reached, in the absence of incontrovertible evidence?’

It may be useful to refer to examples such as smoking, the number of units of alcohol it is safe to drink, and the licensing of medicines.

## Homework activity E3 (about 30 minutes)

**Resources** Homework sheets E3.1A/B

### Aim

**3.1** Students should demonstrate that they understand how validity, reliability and repeatability are important in assessing the quality of scientific data.

### Instructions/ Task

The homework activity asks students to read a number of statements made by scientists and experts about the evidence they have responded to during the lesson. Students are then asked to respond to a number of questions about those statements.

This activity also gives the teacher the opportunity to assess the level of understanding of the teaching aims shown by the students.

### Commentary

Feedback on responses to this activity could focus on students' ability to use issues of validity, reliability and repeatability in an appropriate way.

## Ending the lesson (10 minutes)

**Resources** OHT E0.1 Learning aims, OHT E3.2 Stewart report (2 sheets)

### Points to raise

### Commentary

<p>Go through OHT E0.1 'Learning aims' for each of the three activities. Emphasise the key points.</p>	<p>Trials of this teaching sequence have shown that sufficient time should be left for a meaningful summary.</p>
<p>Say how you will be looking for students to draw on the ideas here in later lessons.</p>	<p>It is important to emphasise the links between what they have learnt and the rest of their science course(s). Here are some examples:</p> <ul style="list-style-type: none"> <li>• ideas about the quality of data, in terms of validity, reliability and repeatability, are crucial in all practical work, especially individual assessed practicals;</li> <li>• biology often deals with assessment of risk in areas such as GM organisms and smoking;</li> <li>• although AS/A-level often deals with 'established' science, cold fusion and GM organisms both give good examples where scientists disagree over the interpretation of a body of data.</li> </ul>
<p>The lesson could be closed by presenting OHT E3.2 (2 sheets). This summarises the findings of the Stewart Report from the Independent Expert Group on Mobile Phones. It presents the official advice published in June 2000.</p>	<p>OHT E3.2 gives a summary of the government report on risks from mobile phones, which emphasises the points made.</p> <ul style="list-style-type: none"> <li>• There are clear biological effects which may, or may not, be linked to health risks.</li> <li>• A precautionary approach should be taken. Discuss what this could mean.</li> </ul>