TWENTY FIRST CENTURY science

STEPPING STONES 2008

ACTIVITIES FOR TEACHING IDEAS ABOUT SCIENCE IN OCR GCSE SCIENCE A

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Materials written by teachers at a Twenty First Century Science conference in 2008

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The activity ideas in this pack were developed by teachers attending a Twenty First Century Science residential training course in Manchester 2008.

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INTRODUCTION

Twenty First Century Science is an OCR suite of GCSE science specifications:

Entry Level
GCSE Science A
GCSE Additional Science A
GCSE Additional Applied Science
GCSE Biology A
GCSE Chemistry A
GCSE Physics A

GCSE Science A is designed to develop the scientific literacy of all students. In order to be scientifically literate an individual needs to know some science, but they also need to know something about how this knowledge has been generated. It is therefore important that the GCSE Science course helps students to develop their understanding of particular scientific concepts (referred to as **Science Explanations**) and ideas about the nature of science (**Ideas about Science**), also known as How Science Works.

The GCSE Science A specification identifies six key Ideas about Science:

IaS1 Data and their limitations
IaS2 Correlation and cause
IaS3 Developing explanations
IaS4 The scientific community
IaS5 Risk
IaS6 Making decisions using science and technology

See also the student-speak versions of the ideas about science specification statements in *Assessment for learning ideas about science* which you can download from www.21stcenturyscience.org.

The materials in this booklet were produced by groups of teachers participating in a 90-minute workshop. The purpose of the workshop was to identify simple ways in which the key concepts of each IaS could be presented to students, through either non-science or science-based contexts.

These activities are designed to stimulate students' thinking about particular Ideas about Science; to generate discussion about the importance of understanding Ideas about Science; and to build students' confidence in their grasp of Ideas about Science, so they may apply this understanding to new areas of science as they meet them.

Colleagues may wish to use these activities as starting points for their own lesson ideas. New activity ideas welcome. Please email your suggestions to uyseg-c21@york.ac.uk. We will update this publication periodically.

Each activity is presented as explanatory notes for teachers, and may be accompanied by student sheets if required.

IaS1 Data and their limitations

Activity 1.1 Sprint speed

Possible learning outcomes

- When I measure the same thing several times, the results may be different. I can give reasons for this.
- I can explain why repeating measurements of something will give me a better idea of what its real value is.

Suggested approach

a Give students the following information:

"An athlete runs the 100m sprint in 11.54 seconds on Monday, and then 12.02 seconds on Wednesday."

Give pairs of students 3 minutes to predict what his time will be in the actual race on Saturday.

b Then give pairs 5 to 10 minutes to compare their prediction with another pair and:

i agree on a consensus view
ii say how confident they are about the prediction
iii explain why they feel more or less confident.

Facilitate the work of these groups of 4, and note those who make points related to the activity's outcomes.

c Ask the spokesperson for some of the groups of four to feed back, drawing out key ideas. For example, there may be opportunities to discuss ideas of data, such as importance of replication of data, how we may decide when enough data are enough, influence of other variables, and determining the best estimate of a true value.

IaS2 Correlation and cause

Activity 2.1 Pirates

Possible learning outcomes

- I can give an example from everyday life of a correlation between two things.
- I can explain that even when there is a correlation between two things, this doesn't necessarily mean that one is causing the other. Something else might be causing them both ... and I can give an example to show this.

Suggested approach

a A fun website suggested that there is a correlation between the decreasing number of pirates on the seas and the rise in average global temperatures.

Conclusion?
"We should encourage pirates in order to keep global temperatures low."

b Ask students whether they agree with this statement. Are they convinced that reducing the number of pirates *caused* global warming?

c Ask students to write short statement in pairs/small groups to distinguish between correlation and cause, using an example from everyday life.

ACTIVITY 2.2 IS IT A GOOD PLAN?

Possible learning outcomes

- I can judge how good an investigation plan is by seeing whether factors we are not testing have been controlled (good) or not controlled (bad).
- I can explain why it is important in an investigation to control all the factors apart from the one I want to change.
- To test whether a factor increases the chance of an outcome, we may compare two groups, e.g. affect of smoking on risk of lung cancer. To evaluate this sort of study, I look at the size of the groups and how well they are matched.

Suggested approach

a Introduce the following context:

"Some high-frequency sound generators have been installed in shopping centres in order to keep young people away from the premises after closing hours. It is claimed that younger people (under the age of twenty) can hear these high sounds, whereas older people cannot."

You may be able to find localish newspaper headlines related to this context.

b What sort of experiments would students set up to verify this? In pairs, students have ten minutes to design their study. They may ask teacher for assistance if they are unsure about whether particular equipment can be used; for instance, if students ask about a sound-proofed room, you could show them an image of anechoic chamber.

c Two pairs of students then compare ideas, and evaluate the two studies against criteria from some of the IaS2 specification statements. (See the student-speak versions of the ideas about science specification statements in *Assessment for learning ideas about science* you can download from www.21stcenturyscience.org.) The four students combine forces to produce an improved design for a study.

IaS3 Developing explanations

Activity 3.1 The fight against MRSA

Possible learning outcomes

- I can identify examples of predictions that scientists have made, based on a scientific explanation.

- When I evaluate a scientific explanation, I look for examples of predictions that have later been confirmed. I know that these make us more confident about the explanation.

Suggested approach

a Students need basic prior knowledge of 'superbugs' (for instance after they have been introduced to MRSA in module B2 'Keeping healthy', or given a context via a short news headline or clip).

b Provide students with data of MRSA cases in a particular hospital, or national data, before and after the introduction of alcohol rub at each bed or entrance to wards.

c Ask students to put forward a possible explanation for the decline in MRSA cases, linking introduction of alcohol rubs with decline in MRSA cases.

d Show students a clear agar plate, and a plate with several days' *S. albus* bacterial growth. Emphasise that growth is not MRSA, but a different type of Staphylococcus bacterium which is safe for students to use in the laboratory. Ask students to make a prediction, drawn from their suggested explanation, of how the presence of alcohol rub would affect *S.albus* growth on the plate. Test the prediction with a simple class practical, using *S.albus* plates prepared in advance for students.

e Extension

What other explanations could be put forward for the decline in MRSA cases? Students find out what else hospitals have done to reduce MRSA infection rate.

IaS5 Risk

Activity 5.1 What makes a risk?

Possible learning outcomes

- When I discuss a risk, I take account of
  - the chance of it happening
  - how bad the effects would be if it did happen.
- I can suggest benefits of activities which have a known risk.
- I can suggest reasons for choosing whether to do something, by weighing up the risks and benefits.
- I can suggest why someone who knows the risk of a particular activity may (or may not) go ahead with it.

Suggested approach

a Following the instructions below, students work in pairs to complete the activity sheet 'What makes a risk'? This sheet is provided at the end of this booklet.

Instructions

1 Look at the list of actions.

2 For each of these actions, write down a risk associated with it.

3 Rank the risk from 1 to 10 (least risky to most risky).

4 Rank from 1 to 10 how serious the consequence is (from least serious to most serious).

5 Rank from 1 to 10 how likely you think the risk is to happen (from least likely to most likely).

b Ask two or three students to explain their highest and lowest choices. Use their answers to clarify meaning of 'consequence' and 'likelihood'.

c Ask students to look at their rankings and use them to answer: Does high consequence always mean high risk? Does low likelihood always mean low risk?

Extension

Suggest an activity that it is students would be unlikely to do, and ask them to explain why they would not do this. For instance, would you cross a busy road blindfolded?

Suggest an activity some students will carry out, which carries risks they will be aware of. Examples are drinking alcohol, eating high-fat diet, smoking. Ask students to list reasons why they might do this activity, despite the risks.

Draw out the link between willingness to accept a risk and the perception that potential benefits have sufficient value. This discussion could also be extended to distinguish between actual and perceived risk.

ACTIVITY 5.2 INTRODUCING COMPONENTS OF RISK

Possible learning outcomes

- When I discuss a risk, I take account of:
  – the chance of it happening,
  – how bad the effects would be if it did happen.
- I can tell the difference between perceived and actual risk.

Suggested approach

a Show video clips of sky-diving and young people out drinking, for example:
Sky-diving – http://www.bbc.co.uk/videonation/articles/t/tyne_skydiving.shtml
Drinking – there are several of these on sites such as YouTube, e.g. http://uk.youtube.com/watch?v=g9J67iT6jc0, although the language used often makes them inappropriate. (You will probably have difficulty accessing YouTube from a school computer, so if you decide to use one of these clips it would have to be downloaded in advance.)

b Define risk as being composed of size of consequence if risk outcome happens, and likelihood of the risk outcome happening. This could be either through class discussion or using the Risk card sort supplied.

c Compare potential risks of sky-diving and drinking.

d In small groups, students make lists of activities which they believe have short, medium and long-term risks.

e Select one example for class discussion to illustrate distinction between perceived and actual risk. Students then consider other activities they have listed:

i Do you think perceived risk of this activity is more or less than actual risk?

ii What benefit would you get from taking part in this activity? Does this benefit outweigh the risk for you?

ACTIVITY 5.3 WHAT'S THE RISK?

Possible learning outcomes

- I can suggest reasons for choosing whether to do something, by weighing up the risks and benefits.

Suggested approach

a Use a think/pair/share approach to conduct a class survey – which activities would students think of as risky? Examples might be flying on large aircraft, car ride to school, rock climbing, bungee jumping, parachuting, walking downstairs, using school toilet

b Ask students if anyone is a nervous flyer, or alternately tell students a personal story about someone who is nervous of flying.

c Ask students to compare risk from UK car journeys and international air travel, using the data below.

Year 2007	**Serious injuries**	**Deaths**
UK road accidents	24 322	2714
Deaths caused by airline accidents, domestic and international	0	750

Sources:
International air travel http://aviation-safety.net/statistics/
UK road accidents: www.dft.gov.uk/pgr/statistics/datatablespublications/accidents/

d With more able groups, go on to discuss which of the following data would give a better measure of risk, for
i UK road accidents
ii Airline accident deaths for each hour of travel, deaths per journey, deaths per total distance travelled

For air travel, you might also consider deaths for each flight phase (take-off, initial climb, cruising, approach, landing).

ACTIVITY 5.4 SAFE AS HOUSES?

Possible learning outcome

- I can explain why every activity carries some risk, even though this may be very small.

Suggested approach

a Give students a few minutes to discuss the following scenario.

"You are wrapped in bubble-wrap, wearing a crash helmet, sitting in an ultra-soft chair in a padded room with walls and floor covered in thick foam."

Are you at any risk? If so, from what?"

b Develop the idea by challenging groups to come up with the lowest risk situation they can, and describe this to rest of class.

c Do the class think any situation has reached zero risk? Draw out idea that no activity is without risk.

ACTIVITY 5.5 IDEAS ABOUT RISK

Possible learning outcomes

• I can spot when someone is using the 'precautionary principle' to decide what to do in a certain situation ('When risk is uncertain, better safe than sorry!').

• I can explain what the ALARA (As low as reasonably achievable) principle means.

• I can use the ALARA principle in a particular situation.

Suggested approach

a Describe simple everyday examples of the precautionary principle and ALARA in operation.

The precautionary principle applies if, in a particular situation:
• the risk is not clearly known or understood, and
• the consequences may be serious
It is then advisable not to proceed (until you know more).

The ALARA principle applies in situations where people are exposed to ionising radiation or a hazardous chemical and
• there is good reason for doing whatever leads to being exposed (there is some benefit)
• it involves a risk (nothing is completely safe)
• the degree of exposure, and hence of risk, can be reduced by taking actions of various kinds
• the further the risk is reduced, the more expensive or restrictive (inconvenient) it becomes

It is therefore necessary to decide what level of risk is acceptable.

Both principles can be relevant to corporate decisions (e.g. affecting social policy or industrial practice). The precautionary principle (only) is also sometimes relevant to an individual's decision.

b Provide student pairs with a set of cards, *Ideas about Risk*.
Students sort the cards into two columns, one for examples where the precautionary principle is being used, the second for examples of ALARA.

c Two pairs compare their decision, and come to an agreement for their group of four.

d Ask different students to choose one of the following, and justify their decision when they feedback to the class:
• a good situation to use ALARA
• a poor situation to use ALARA
• a good situation to use precautionary principle
• a poor situation to use the precautionary principle

e Students add their own examples to blank cards.

5.2 INTRODUCING COMPONENTS OF RISK : STUDENT SHEET

Dying as a result of being hit on the head by a falling coconut. 1 in 250,000,000	Dying as a result of a shark attack. 1 in 300,000,000	Having a minor car accident.
Catching a cold.	Having your car stolen in the next twelve months.	Winning the lottery. 1 in 14,000,000
Increased risk of developing cancer after 1000km flight. less than 1 in 1,000,000	Having a serious car accident.	Dying from a heart attack or stroke. 1 in 2.5
Catching influenza.	Dying from an asteroid collision. 1 in 500,000	Increased risk of developing cancer from having a chest X-ray. less than 1 in 1,000,000
Catching avian 'flu. 1 in 100,000,000		

ACTIVITY 5.5 IDEAS ABOUT RISK: STUDENT SHEET

Precautionary Principle	**ALARA**
Not jumping off a bridge into a river when you don't know the dangers, from river bottom or currents	Setting NHS exposure standards for chest X-rays.
The Government recommending that children under eight should not use mobile phones	Setting a procedure that school technicians should follow when transferring concentrated acid into smaller containers.
Avoiding an exit at a football ground where hostile supporters from two teams are chanting at each other as they leave	Having regulations that require a dentist to leave the room while the patient has a dental X-ray.
Closing London's Millennium footbridge to pedestrians until engineers could redesign it	Rotating duties for workers in a nuclear power station, so that each person spends only a limited amount of time in areas where they might be exposed to higher levels of ionising radiation
Banning the use of laptops and mobile phones on an aircraft, while landing and taking off	Treating a skin cancer patient with the minimum effective dose of gamma radiation.

5.1 WHAT MAKES A RISK? STUDENT SHEET

Activity	Risk	How serious do you think the risk is? (1 to 10)	Consequence (1 to 10)	Likelihood (1 to 10)
Not doing science homework				
Flying to Tenerife				
Eating a reheated BigMac				
Swimming with sharks				
Sunbathing on a tropical beach with no sunscreen				
Using your mobile phone ten times a day				
Changing a light bulb				
Playing with matches				
Going out with your best friend's ex				
Sitting next to someone with a cold				