Developing effective practice in KS3 practicals

Ed Walsh
Ed Walsh

- Science education consultant
- Series Editor, Collins GCSE and KS3 Science
- Regional Development Lead, Science Learning Network
- CPD provider for AQA and ASE
- ITT tutor
Good Practical Science – making it happen

The ASE project has produced two resources to support schools who are considering their own written policy:

• Supporting resources to explore different aspects of practical science, with guidance on how to create an effective policy. Each module contains presenter notes, a presentation and supporting materials.

• Case studies of how five very different departments went about creating their policies, and the impact these processes had on their teaching. Each case study includes a copy of their policy.
Structure of session

- Setting the scene – what should influence the design of activities?
- A suitable approach to running activities
- An example to explore
1. SETTING THE SCENE
Mastery of apparatus and techniques

• Sitting behind the required practical activities is a set of Apparatus and Techniques skills.
• These are crucial, assessable and don’t only apply to the required practical activities.
• If students have developed proficiency in these at KS3 they are likely to be more successful at completing the required practicals and in answering related questions at GCSE.
## Apparatus and Techniques skills

<table>
<thead>
<tr>
<th>AT</th>
<th>Apparatus and Techniques skills from Biology section of Combined Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Use of appropriate apparatus to make and record a range of measurements accurately, including length, area, mass, time, temperature, volume of liquids and gases, and pH.</td>
</tr>
<tr>
<td>2</td>
<td>Safe use of appropriate heating devices and techniques including use of a Bunsen burner and a water bath or electric heater.</td>
</tr>
<tr>
<td>3</td>
<td>Use of appropriate apparatus and techniques for the observation and measurement of biological changes and/or processes.</td>
</tr>
<tr>
<td>4</td>
<td>Safe and ethical use of living organisms (plants or animals) to measure physiological functions and responses to the environment.</td>
</tr>
<tr>
<td>5</td>
<td>Measurement of rates of reaction by a variety of methods including production of gas, uptake of water and colour change of indicator.</td>
</tr>
<tr>
<td>6</td>
<td>Application of appropriate sampling techniques to investigate the distribution and abundance of organisms in an ecosystem via direct use in the field</td>
</tr>
<tr>
<td>7</td>
<td>Use of appropriate apparatus, techniques and magnification, including microscopes, to make observations of biological specimens</td>
</tr>
</tbody>
</table>
Two students investigated the effect of caffeine on reaction time.
This is the method used.
1. Student A drinks a cup of coffee.
2. Student B holds a ruler above Student A’s hand.
3. Student B drops the ruler.
4. Student A must catch the ruler as quickly as she can.
5. The distance the ruler has fallen is recorded.

[AQA Required practical 5: investigate the effect of a factor on human reaction time.]

What might the examiner be trying to find out?
What question might follow this?
## Mark scheme

| Level 3: more than one improvement is described and includes collection of more data involving range of caffeine concentrations and / or testing without caffeine. | 5-6 |
| Level 2: more than one improvement is described | 3-4 |
| Level 1: an improvement is described. | 1-2 |
| No relevant content. | 0 |

### Indicative content
- use decaffeinated coffee as control
- blind trial or don’t tell students which coffee they are drinking.
- control start position of ruler
- left for standard time between drink and test - at least 10 minutes
- control other factors such as light in the room
- same person for different concentrations
- repeat for each caffeine concentration
- increase range of caffeine concentrations
- use caffeine solution instead of coffee to control other ingredients
- repeat investigation with more people
- control volume of coffee
Feedback from 2019 GCSE exams

There are various ways in which examiners can assess candidates’ ability to apply the skills of investigations; these often resulted in marks not being gained. For example:

• Being able to identify the variables in an investigation:
  - Confusion between dependent and independent variables
  - Knowing what a control variable is and how to manage it

• Knowing about types of error and applying this to particular contexts

• Knowing how to set up and use equipment correctly.

• Understanding the purpose of the particular steps in a method – why are we doing what we are doing.

• Understanding the science behind the required practical.
# Planning progression in WS

<table>
<thead>
<tr>
<th>Planning investigations</th>
<th>Key Stage 3</th>
<th>Key Stage 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Devise questions</td>
<td>• use scientific theories and explanations to develop hypotheses</td>
</tr>
<tr>
<td></td>
<td>• Plan variables</td>
<td>• plan experiments or devise procedures to make observations, produce or characterise a substance, test hypotheses, check data or explore phenomena</td>
</tr>
<tr>
<td></td>
<td>• Test hypotheses</td>
<td>• apply a knowledge of a range of techniques, instruments, apparatus, and materials to select those appropriate to the experiment</td>
</tr>
<tr>
<td></td>
<td>• Construct explanations</td>
<td>• use a variety of models such as representational, spatial, descriptive, computational and mathematical to solve problems, make predictions and to develop scientific explanations and understanding of familiar and unfamiliar facts</td>
</tr>
<tr>
<td></td>
<td>• Estimate risks</td>
<td>• evaluate risks ... in practical science</td>
</tr>
</tbody>
</table>
Reflecting on practical work

A. Developer's objectives
   what the pupils are intended to learn

B. Task specification
   what the pupils are intended to do

C. Classroom events
   what the pupils actually do

D. Learning outcomes
   what the pupils actually learn

Effectiveness at Level 1
Did pupils do what they were intended to do (and see the things they were meant to see)?

Effectiveness at Level 2
Did pupils learn (and can later show understanding of) what they were intended to learn?
2. PLANNING AN APPROACH
Key planning questions

Planning a practical activity

How well does it support the scheme of learning?

Which skills and processes does it develop?

How well does it prepare students for GCSE?

Does it avoid repetition at KS4?
In addition …

Students need to

• ....have key terminology at their fingertips
• .... be thinking about ‘the science behind the experiment’.
• .... be able to justify actions they take
Look at these words:

- cell
- membrane
- slide
- microscope
- eyepiece
- objective

Which of these:

- is the rectangular piece of glass on which objects are placed for viewing under a microscope?
- is a device used to magnify small objects?
- refers to the lenses on the microscope?
- is the lens closest to the object?
- is the lens closest to the eye?
- is regarded as the ‘building block’ of all living things?
- is a thin layer around the edge of a cell?
Focus on underlying concepts

Zena: I think the leaves and the acorns are made of cells, but not the trunk and branches. They’re too solid.

Will: I agree about the leaves and acorns, but I think there’s softer material inside the trunk that’s made of cells too.

Emile: I think it’s all made of cells – even the really gnarled bits on the outside.

Which part of the plant consists of cells?
Testing key skills

Kursad’s group are looking at objects through a microscope. On the side of the eyepiece lens, it says ×10 and on the side of the objective lens it says ×4. He puts his ruler under the microscope and looks at the 1 mm markings.

• How far apart will they appear?
  • 1 mm
  • 10 mm
  • 14 mm
  • 40 mm

Kursad says, ‘Actually, we should put a minus sign in front of the distance.’

• Why do you think he says that?
• Is he right? Give a reason for your answer.
Mini vocabulary warm up → Purpose of practical activity → Set up

Analyse results ← Results ← Method

Check your understanding → Spot the mistake → Apply your understanding

Learning journey

Evaluate your learning
KS3 Practicals

3. EXEMPLAR ACTIVITY
## Making waves

<table>
<thead>
<tr>
<th></th>
<th>1st estimate</th>
<th>2nd estimate</th>
<th>3rd estimate</th>
<th>4th estimate</th>
<th>Agreed value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wavelength (m)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amplitude (m)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Analyse results

1. How well did the experiment work, in terms of you being able to find values for the amplitude, wavelength, frequency and speed of the waves?

2. Were the various results for each experiment close to one another or was there a lot of variation?

3. Thinking about your answer to Question 2, how confident are you about the accuracy of the results?
Check your understanding

1. When you measured the amplitude of the wave, which points did you measure from and to?

2. Why might this have been a source of error?

3. What are the advantages of working from images of waves?

4. What are the limitations of working from images of waves?
1. Zena’s group wanted to obtain several images of the wave, so they all took turns at making the wave. Each time someone different made the wave, someone else took a photo of the wave. Why might this have been a mistake?

2. Kareem’s group did not get the horizontal reference line in their photo so they used the vertical reference line to estimate the horizontal distances. Why might this have been a mistake?
Apply your understanding

1. Emile’s group are studying water waves. They have set up an experiment, using a fish tank that is half-full of water, and are using a paddle to make waves. Looking through the side of the tank, they can see the waves travelling along the surface of the water. They want to find values for the wavelength, amplitude, frequency and speed of the water waves.
Suggest how they could modify the experiment you did in order to find these values.

2. Michelle’s group are repeating the rope wave experiment because their initial results were not very good – their estimates of the values were very different to each other.
What three pieces of advice would you give them to help them get a good set of results?
Evaluate your learning

1. This experiment involved a lot of work analysing images and estimating values. How well do you think you did this?
2. If you were able to do the experiment again, what would you do differently and why?
Thank you, and keep in touch:

- **edmundwalsh@hotmail.com**
- Freedom to Teach blog: [http://freedomtoteach.collins.co.uk/category/secondary-science/](http://freedomtoteach.collins.co.uk/category/secondary-science/)
It’s easy to leave feedback on this session via the online programme Sched. Go to the session’s page and pick your emoji!


You can also feedback on the overall conference. Please complete the online survey at:

[ase.org.uk/conf-survey](http://ase.org.uk/conf-survey)