Improving secondary science

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
1. Preconceptions

- Build on the ideas that pupils bring to lessons
  - Starting a lesson with a challenge activity
  - Consulting research on misconceptions
  - Using a quick knowledge test
What preconceptions do my students have?

What does research indicate?

What messages are there from examiners’ reports?

What can I learn about my own students?
Key Idea: All living things are composed of one or more cells.

<table>
<thead>
<tr>
<th>Misconception ID Number</th>
<th>Student Misconception</th>
<th>Grades 6-8</th>
<th>Grades 9-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEM001</td>
<td>All cells are the same size and shape, i.e., there is a generic cell (AAAS Project 2061, n.d.).</td>
<td>43%</td>
<td>37%</td>
</tr>
<tr>
<td>CEM005</td>
<td>There are no single-celled organisms (AAAS Project 2061, n.d.).</td>
<td>39%</td>
<td>30%</td>
</tr>
<tr>
<td>CEM003</td>
<td>Some living parts of organisms are not made of cells (AAAS Project 2061, n.d.).</td>
<td>36%</td>
<td>29%</td>
</tr>
<tr>
<td>CEM004</td>
<td>Plants are not made of cells (AAAS Project 2061, n.d.).</td>
<td>7%</td>
<td>5%</td>
</tr>
</tbody>
</table>

Frequency of selecting a misconception was calculated by dividing the total number of times a misconception was chosen by the number of times it could have been chosen, averaged over the number of students answering the questions within this particular idea.
### No friction

1. Which boxes have no friction?

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>They all have friction</td>
</tr>
<tr>
<td>B</td>
<td>Box 1 has no friction</td>
</tr>
<tr>
<td>C</td>
<td>Boxes 1 and 2 have no friction</td>
</tr>
<tr>
<td>D</td>
<td>Boxes 3 and 4 have no friction</td>
</tr>
<tr>
<td>E</td>
<td>Box 4 has no friction</td>
</tr>
</tbody>
</table>

2. Why do you think this?

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>There is no force pushing sideways</td>
</tr>
<tr>
<td>B</td>
<td>The surfaces are a little bit rough</td>
</tr>
<tr>
<td>C</td>
<td>There is movement</td>
</tr>
<tr>
<td>D</td>
<td>There is no movement</td>
</tr>
<tr>
<td>E</td>
<td>There is no force to slow the movement</td>
</tr>
</tbody>
</table>
2. Self-regulation

Model scientific thinking

Feedback from tests

Help pupils direct their own learning

Feedback from immediate questions
Using an attribution grid

<table>
<thead>
<tr>
<th>Mark allocation</th>
<th>Knowledge and comprehension</th>
<th>Application and analysis</th>
<th>Synthesis and evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selected response</td>
<td>4</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Short answer</td>
<td>4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Extended response</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>12</strong></td>
<td><strong>12</strong></td>
<td><strong>6</strong></td>
</tr>
</tbody>
</table>
3. Modelling

Use models to support understanding

- Use a range of models and in a variety of ways
- Use questions to interrogate the deployment of models
- Encourage students to critique models
In a chemical reaction, the particles are rearranged.
Use of models

**Scientific models**
- Lock and key model of enzymes
- Wave model of light
- Particulate model of matter
- Food web to explain feeding relationships

**Teaching models**
- Using rope loop to represent flow of current in a circuit
- Balloons in bell jar to show lung action
- Use of slinky to show transverse and longitudinal waves
4. Memory

Support students to retain and retrieve knowledge

- Plan lessons to reduce cognitive load for lower attaining students
- Use materials that unpack key ideas and present in bite-sized chunks
- Use questions to revisit key ideas
Managing cognitive load

From: ‘Improving secondary science’, Education Endowment Foundation
Interleaving

Graduated-interval recall is a type of spaced repetition published by Paul Pimsleur in 1967 and used in the Pimsleur language learning system. The intervals published in Pimsleur's paper were: 5 seconds, 25 seconds, 2 minutes, 10 minutes, 1 hour, 5 hours, 1 day, 5 days, 25 days, 4 months, and 2 years.

There are three generic points here about learning:
• The need to revisit, to embed
• The need to revisit more than once
• The need for the periods to increase, to encourage longer term recall.
5. Practical work

- Use practical work purposefully and as part of a learning sequence
- Select from a variety of approaches
- Place practicals at an appropriate point in the learning sequence to reinforce key ideas
- Use range of question types to support understanding
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.
What are the steps in this procedure?

Why are those steps necessary?

What would happen if we used more solvent/a higher temperature/a different metal?

What are the dependant, independent and control variables?

What is a good way of displaying the results?

What else could this procedure be used to investigate?

What does this show?

What else could this procedure be used to investigate?
6. Language of Science

- Support the development of a range of written outcomes

- Develop scientific vocabulary and support students to read and write about science

- Identify key words and embed their use in lessons

- Provide opportunities for students to read text and extract meaning
Accurate use of key terminology
- Physical items, processes and connectives
- Activation
- Reinforcement

Effective sentence construction
- Focus on function
- Emphasis on review

Being able to structure extended writing
- Using a suitable text type, e.g. steps in a procedure, evidence linked to a judgment for an evaluation

Understanding the role of command words
- Knowing what it means
- Responding effectively

Being able to structure extended writing

Effective sentence construction

Accurate use of key terminology
7. Feedback

Use structured feedback to move on students’ thinking

Use assessment activities to elicit prior understanding

Provide diagnostic feedback to support students’ understanding

Adjust lesson plans to respond to student performance
Generic level descriptors

5. Evaluate: Use the information supplied, as well as knowledge and understanding, to consider evidence for and against. Make a judgement about the value of something, with respect to a particular purpose.

The response is based on analysis – so identification of relevant features is necessary and the use of relevant criteria. Response might need to look critically, from a number of angles.

6 (or 4) marks with three (or two) level descriptors.

<table>
<thead>
<tr>
<th>Level 3:</th>
<th>A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.</th>
<th>5-6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 2:</td>
<td>Some logically linked reasons are given. There may also be a simple judgement</td>
<td>3-4</td>
</tr>
<tr>
<td>Level 1:</td>
<td>Relevant points are made. They are not logically linked.</td>
<td>1-2</td>
</tr>
<tr>
<td>No relevant content</td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

Session feedback

It’s easy to leave feedback on this session via the online programme Sched. Go to the session’s page and pick your emoji!

aseannualconference2020.sched.com

Conference feedback

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

ase.org.uk/conf-survey