Using multiple choice questions to identify student misconceptions

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15th September 2019
Using multiple choice questions

Purpose:

- To gain an insight into the writing of multiple choice questions
- Learn how to use statistical evidence to reveal areas of misconception and error
- Explore how to use multiple choice questions in the classroom to identify and address specific areas for development
Writing multiple choice questions
Why multiple choice questions?

- **In summative assessment:**
  - For wide syllabus coverage
  - Contribute to reliability
  - Quick and easy to mark electronically
  - Easy to create similar but different questions (sibling items)
- **In formative assessment:**
  - To reinforce learning
  - To identify misconceptions
  - Easy to create sibling items to re-test misconceptions
  - Quick and easy to mark
The circuit of a motor racing track is 3.0 km in length. In a race, a car goes 25 times round the circuit in 30 minutes.

What is the average speed of the car?

A 75 km / hour   B 90 km / hour   C 150 km / hour   D 750 km / hour
### Jargon

**Sibling** – a closely related item

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The circuit of a motor racing track is 3.0 km in length. In a race, a car goes 25 times round the circuit in 30 minutes.

What is the average speed of the car?

<table>
<thead>
<tr>
<th>A 75 km / hour</th>
<th>B 90 km / hour</th>
<th>C 150 km / hour</th>
<th>D 750 km / hour</th>
</tr>
</thead>
</table>

The circuit of a motor racing track is 7.0 km in length. In a race, a car goes 12 times round the circuit in 36 minutes.

What is the average speed of the car?

<table>
<thead>
<tr>
<th>A 84 km / hour</th>
<th>B 252 km / hour</th>
<th>C 140 km / hour</th>
<th>D 432 km / hour</th>
</tr>
</thead>
</table>
What makes a good multiple choice item?

- There is a unique correct answer that is on syllabus
- The key is correct no matter how much science is known beyond the syllabus
- All options are plausible
- All distractors are on syllabus
- It is neither too easy nor too difficult
- The language is clear and technical terms are on the syllabus
- There is no trickery, or gender, racial or cultural bias of any kind
When dilute sulfuric acid is electrolysed using inert electrodes, two gases are produced.

What are these two gases?

A hydrogen and oxygen
B hydrogen and sulfate
C hydrogen and sulfur dioxide
D oxygen and sulfur dioxide
Distractors – calculation questions

Distractors for calculations can all be reached using the data given, ideally with just one mistake in the process.

A 2.0 g sample of sodium chloride is dissolved in water to give a solution of volume 80 cm³.

What is the concentration of this solution in g/dm³?

A 80 ÷ 1000 = 0.08 dm³  
2.0 ÷ 0.08 = 25 g /dm³

Key: 80 ÷ 1000 = 0.08 dm³  
2.0 ÷ 0.08 = 25 g /dm³

What could be good distractors?

- not converting to dm³ = 0.025 (g/cm³)
- fraction wrong way up = 0.04 (dm³/g)
- multiplying instead of dividing = 0.16 (g dm³)
A 2.0 g sample of sodium chloride is dissolved in water to give a solution of volume 80 cm$^3$.

What is the concentration of this solution in g/dm$^3$?

A  B  25  C  D

- Other possible distractors
  - not converting to dm$^3$ and wrong way up = 40 (cm$^3$/g)
  - multiplying 80 x 2 = 160
  - adding 80 + 2 = 82
  - random answer e.g. 33
Distractors for calculations can all be reached using the data given, ideally with just one mistake in the process.

Ohm’s Law: \( V = I \times R \)

where \( V \) is voltage, \( I \) is current in amperes (A) and \( R \) is the resistance in ohms (\( \Omega \)).

Rearrange: \( R = \frac{V}{I} = \frac{6.0}{3.0} = 2.0 \ \Omega \)

The potential difference across a resistor is 6.0 V, and the current in it is 3.0 A. What is the resistance of the resistor?

- **A** 0.50 \( \Omega \)
- **B** 2.0 \( \Omega \)
- **C** 9.0 \( \Omega \)
- **D** 18 \( \Omega \)
Statistics – item facility

○ Facility = the proportion of students that answered correctly
○ Target range is 0.25 – 0.80
○ An extremely high value indicates the question is too easy
○ An extremely low value indicates the question is too hard
○ 0.25 is the “guessing rate” in a four-option question
Proportion endorsing = the proportion choosing each option

The diagram shows a ray of light striking a plane mirror.

What is the angle of reflection?

A  20°  B  40°  C  70°  D  140°
Look at the proportion of candidates in the upper 27% of the test score distribution who gave the correct answer to the item, and the same proportion in the lowest 27% group.

Should find that the proportion endorsing the key is greater for the stronger group than for the weaker group

AND the proportion endorsing for the distractors is greater for the weaker group than for the stronger group
Statistics

Statistics for the question:

<table>
<thead>
<tr>
<th>Proportion correct</th>
<th>Option</th>
<th>Proportion endorsing</th>
<th>Key</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>0.36</td>
<td>A</td>
<td>0.56</td>
<td>0.63</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>0.03</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>0.36</td>
<td>0.25</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>0.04</td>
<td>0.06</td>
</tr>
</tbody>
</table>

PE report: This question on reflection of light proved challenging. The majority of candidates chose option A; it should be noted that the angle of reflection is always measured between the ray and the normal.
Using the statistics

- Use the facility to identify which topics are generally well understood and which are less well understood.
- Use the proportion endorsing to identify specific misconceptions and identify which topics weaker candidates struggle with.
Using multiple choice questions in the classroom
Use in the classroom

- At the beginning of the topic to assess prior knowledge
- During a topic to assess progress
- During a lesson to check understanding
- As homework
- At the end of a topic to plan targeted revision
Sources of questions

- Past papers
- Test-maker
- Text books
- Online
- Write your own
Writing multiple choice questions - tips

- Keep notes of ideas as teaching
- Identify topic/learning outcome to test
- Start by writing a question with correct answer
- Consider distractors to test common misconceptions/mistakes
- Ask someone else to review
Summary
Using multiple choice questions

Outcomes:

- Gained an insight into the writing of multiple choice questions
- Learned how to use statistical evidence to reveal areas of misconception and error
- Explored how to use multiple choice questions in the classroom to identify and address specific areas for development
Assessment

We recognise that assessment has two important roles: to prove and improve – to prove what students are learning, and to suggest how they can improve their understanding and skills.
Thank you
Any questions?
Learn more!
Getting in touch with Cambridge is easy

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