Rewarding the identification of uncertain and confident answers
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How can we help our students to thrive?
Preclinical medical student CBM self-test sessions 2010-2019

No. of sessions commenced

ICL
UCL

9/10  9/12  9/14  9/16  9/18
Education is about developing Metacognition

Learning how to acquire knowledge
Knowing what you do & don’t know
Strategies for inference and justification of conclusions
Knowing how & when to seek help

What (online) strategies aid this?

Questions to stimulate thinking, not rote learning
Questions that target relationships, not just facts
Motivate justification & questioning of answers. *(How?)*
Reward the identification of uncertain & sound answers
Certainty Based Marking (CBM)

<table>
<thead>
<tr>
<th>Certainty Level</th>
<th>Mark if Correct</th>
<th>Penalty if wrong</th>
</tr>
</thead>
<tbody>
<tr>
<td>C=3 (high)</td>
<td>3</td>
<td>-6</td>
</tr>
<tr>
<td>C=2 (mid)</td>
<td>2</td>
<td>-2</td>
</tr>
<tr>
<td>C=1 (low)</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>No Reply</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>

Obviously best if you are very sure

Obviously best if you are very unsure

NB the student gains:

EITHER by finding justification for high confidence

OR by seeing reasons for reservation about an answer
Students on average judge their confidence well in self-tests to optimise their scores.
What insights does this bring to students?

CBM Responses:

I don’t know this well, but I know where my main weaknesses are!

A mix of things I can and can’t answer, but I do know which bits are reliable!

C=3

C=2

I do get some things wrong, but overall am doing better than I’m giving myself credit for!

C=1

I have lots of negative marks alerting me to misconceptions. I need basic study to see why I don’t understand these!

Conventional Responses:

I’m no good!  Borderline!  I’m great!
Insights for staff – what CBM performance on individual questions can reveal

Rumsfeld’s Encapsulation

Qs answered with high accuracy and mid to high certainty. Knowledge/understanding OK.

Qs answered with reasonable accuracy but insecure knowledge.

Qs with certainty expressed for wrong answers: misconceptions, or poor Qs.

Qs eliciting uncertainty and errors: poor knowledge / understanding, or poor Qs.
Unusual (but important!) features of CBM selftest software

**Privacy**: students mustn’t think mistakes could in any way count against them
- mistakes are for learning from, not for humiliation

**Selection**: Students select topics and Qs to answer & are marked on these
- emphasises the value of challenge, and identifying areas of weakness

**Immediate feedback**: (computed locally for each Q – not by the server)
- important to think why you made a mistake

**Anonymous data submission** (optional)
- still helps staff, though it means students can’t review their data later

**Anonymous comments on Qs**: openly visible, with delivery to relevant staff
- improves Qs & explanations; staff responses added in context

**Simple editing and file creation**: much simpler than Moodle or Blackboard!
- edits are annotated in relevant comment files

**Mixed exercises**: Didactic sections interspersed with quiz sections
- together with answer explanations, provides a full learning structure

**Simple access**: direct URL links from web or LMS (optional authentication)
- e.g. tmedwin.net/st?words , ucl.ac.uk/lapt/ucl?words
Future Developments & possible collaborations

Ensure portability & self-contained installation –
- current software is on my own site (with some test files elsewhere)

Mobile Use – optimisation of software

Promote visibility & discussion – e.g. of published papers, ST & Moodle use

VocTech & Staff Training – a major market opportunity

Money - Grants / business opportunities / research projects

New topic areas: Uni & school topics, self-tests written by students & staff

Interested? – Contact me (a.gardner-medwin@ucl.ac.uk)

Take-home thoughts on CBM

• Lucky guesses are not knowledge.
• Confident errors are serious, even dangerous – worse than ignorance
• CBM is more reliable & more valid than accuracy in assessments

Students intuitively recognize these as obvious truths.
Teachers and examiners should recognize them too!
Rewarding the identification of uncertain and confident answers
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Abstract
We can learn facts individually by rote, or, much more efficiently, we can learn how facts inter-relate so that we can deduce new facts and check tentative ideas by seeing whether they fit with other knowledge. Efficient study and learning must develop these skills. But standard assessment and self-testing seldom address the metacognitive aspect of this: Am I sure? Does this fit with other things? A lucky guess at an answer is marked as if it were knowledge, and a strongly held misconception may never get flagged as dangerous, or as a potentially serious impediment to further learning.

Computerised confidence-based, or certainty-based marking (CBM) [1] was introduced 25 years ago at UCL and CXWMS (now Imperial) to reward students in self-tests for identifying uncertain and confident answers (on a certainty scale 1,2,3 yielding 1,2 or 3 marks if correct and 0,-2 or -6 if incorrect).

The session will discuss the past and future evolution of important features - mark schemes [2], student and staff feedback [3], self-test privacy, interactive comments, open access [5], and application to exams [4], with increased assessment reliability.

Collaboration would be welcomed for future development.
What is knowledge?

- **knowledge**
- **uncertainty**
- **ignorance**
- **misconception**
- **delusion**

Decreasing confidence in what is true,
Increasing confidence in what is false

Knowledge = justified true belief
Certainty = degree of belief
Justification requires understanding

What is understanding?

To understand = to link correctly the facts that bear on an issue.

(How you tell a student from a parrot!)

Nuggets of knowledge

Certainty
(Degree of Belief)

Inference

Choice

Certainty-Based Marking places greater demands on justification, thereby stimulating understanding
CBM in exam assessment

A

Average CBM Mark

% of max poss CBM Mark

0% 17% 33% 50% 60% 70% 80% 90% 100%

Simple Accuracy (= % Correct)

Benefit from good certainty judgments (0.27)

B

CB Accuracy (including Bonus)

Bonus (=2.7%)

50% 60% 70% 80% 90% 100%

Simple Accuracy (= % Correct)
CBM enhances reliability and validity of exam scores

When using the CBM method, the bonus factor used to calculate CB Accuracy is applied. This factor, expressed as $\frac{r}{1-r}$, is increased by a factor of $\frac{\text{Relative predictive power}}{\text{Mean + sem}}$ for the prediction of CB Accuracy on other questions. Similarly, the percentage correct is also enhanced by the same factor for prediction of percent correct on other questions.

* Factor by which $\frac{r}{1-r}$ is increased where $r$ is the rank correlation coefficient between scores on odd & even numbered Qs. Mean ± sem for 17 exams, each 250+ t/f Qs, 300+ students.
Failure rate on the January formative exam

Failure rate on the end-of-year exams