Reflections on student-generated questions

Utilising the generation, testing and self-explanation effects

CDIO
European Regional Meeting
Reykjavik University, Iceland
5th – 6th February, 2015

PeerWise
peerwise.cs.auckland.ac.nz

Paul Denny
Department of Computer Science
The University of Auckland
paul@cs.auckland.ac.nz
Kiwi meat workers have 17,000km commute to Iceland

5:00 AM Friday Nov 21, 2014

Anthony Russell (fourth from left) says his fellow meat workers (from left) Victor Te Paea, Ross Gibbons, Kaine Saunders, Wayne Hamlin, Shawn Parkinson, Antony Pike and (rear) Aaron Nohakau (left) and John Murdoch at Keflavik Airport in Iceland, are "the best you can get".
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VS.

CDIO Standards 2.0

Standard 8 — Active Learning

Teaching and learning based on active experiential learning methods

Description

Active learning methods engage students directly in thinking and problem-solving activities. There is less emphasis on passive transmission of information, and more on engaging students in manipulating, applying, analyzing, and evaluating ideas. Active learning in lecture-based courses can include such methods as partner and small-group discussions, demonstrations, debates, concept questions, and feedback from students about what they are learning. Active learning is considered experiential when students take on roles that simulate professional engineering practice, for example, design-implement projects, simulations, and case studies.

Rationale

By engaging students in thinking about concepts, particularly new ideas, and requiring them to make an overt response, students not only learn more, they recognize for themselves what and how they learn. This process helps to increase students' motivation to achieve program learning outcomes and form habits of lifelong learning. With active learning methods, instructors can help students make connections among key concepts and facilitate the application of this knowledge to new settings.
Reflections on student-generated questions

Overview

Technology

Motivation

Challenges

Evaluation

What is a “student-generated question”?
A frame structure consisting of 3 columns, connected by beams, are supported by a pin support (left), a roller support (middle), and another roller support (middle). The frame is subjected to a downward load, which is placed on the beam, between the middle and right columns.

Ignoring self weight, determine the deflected shape the load causes to the structure:
A student creates:

- A set of answer options

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image A" /></td>
<td><img src="image2.png" alt="Image B" /></td>
<td><img src="image3.png" alt="Image C" /></td>
<td><img src="image4.png" alt="Image D" /></td>
<td><img src="image5.png" alt="Image E" /></td>
</tr>
</tbody>
</table>

E: None of the above.
Option A: a pin and roller support does not produce moments, so the columns near the support should not be rigid while the rest of the columns are bent. The roller supports should have slid horizontally (hence roller support), as they cannot produce horizontal forces to counteract the result of the deflection (with the columns being right angled with the beam). They can only produce vertical forces. And a pin support can only produce vertical and horizontal forces, no moments.

Correct answer is: C

Option B: Incorrect - due to the left beam not being deflected, using the figure I have drawn, we can see that on the second beam produces a "smile" deflection shape due to the load, and the portion of the beam on the left does not deflect and is parallel to the tangent of the deflected portion of the beam at the left support. But using a 3 support beam, the left side is now held down by a pin support, so the left portion is now deflected, is a "frown" shape. Translating this to the frame deflection, the left portion should have have a "frown" deflection, but rather, it is not deflected so it is incorrect.

Option C: correct! Again, using the figure I have drawn, we can clearly see that the beam at the top follows the correct deflection. Now, for the orientation of the columns. Using the analogy of the simple 3-support beam example in my drawing, we can see that the deflection on the left portion produces a "frown" shape, meaning that the centre of deflection is at the bottom of the beam, meaning that the left and middle supports should be closer than in the initial set-up (the middle support can move horizontally). While on the right portion, it produces a "smile" shape, meaning that the centre of deflection is above the beam, meaning that the middle and right supports should be farther apart than in the initial set-up (the middle and right support can move horizontally). Hence C is correct.

Option D: Incorrect. Almost correct except the positioning of the left support and the orientation of the left column. As I have discussed, the support should be closer together (as the rolling support can move horizontally), and that the left and middle support should point towards the centre of deflection. However, the left and middle support are of the same distance and the left column is not pointing towards the centre of deflection, so it is incorrect.

Option E: Incorrect. Because Option C is correct, meaning there IS an answer above E, making the statement false, thus incorrect.
Motivation

“Active” engagement with the course material

“From Brohn methods you can guess the deflected shape and thus moments, reaction and their directions.

We can split this up into its reactive and active components.

“You don't really understand how much or how little you know about a concept until you try to devise a good, original question about it”

“The aspect I found truly useful was the creation of questions, which reinforced much of [my] understanding while also actively making me clarify and solidify my thought processes (especially the explanation parts)”

Student feedback
Motivation

- High stakes exams
- Exam preparation strategies
  - Re-reading coursebook and lecture notes
  - Highlighting/underlining
  - Creating summaries
  - Forming mental imagery of text materials
  - Self-explanation
  - **Practice testing**

“Can we have the answers to last year’s exam?”

There is a macaron vending machine which sells macarons of the following varieties of combinations. There are 3 different flavours of macaron shells which are green-tea, vanilla, and strawberry. There are 4 different flavours of creams which are chestnut, chocolate fudge, buttercream, and mixed berries.

This macaron vending machine does not let you choose which combination you want to get. The following graph shows the outcomes of different combinations of macarons the machine has every 251 macarons.

<table>
<thead>
<tr>
<th>Flavours for Macaron fillings</th>
<th>Flavours for Macaron shells</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chestnut cream</td>
<td>Green Tea</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Vanilla</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Strawberry</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>27</td>
</tr>
<tr>
<td>Chocolate fudge</td>
<td>Green Tea</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Vanilla</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Strawberry</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>88</td>
</tr>
<tr>
<td>Buttercream</td>
<td>Green Tea</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Vanilla</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>Strawberry</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>74</td>
</tr>
<tr>
<td>Mixed Berries</td>
<td>Green Tea</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Vanilla</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Strawberry</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>62</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td></td>
</tr>
<tr>
<td></td>
<td>96</td>
<td></td>
</tr>
<tr>
<td></td>
<td>104</td>
<td></td>
</tr>
<tr>
<td></td>
<td>251</td>
<td></td>
</tr>
</tbody>
</table>

Jared came to the vending machine to buy himself a macaron. Answer in 2 decimal places and find the possibilities of Jared getting a macaron he wants if:

a) Jared wants the macaron to have some sort of berries flavour in it (either with the strawberry flavoured shells or mixed berries cream or both).

b) Jared is happy with anything as long as the macaron does not have buttercream.

c) Jared is fine with anything other than the combinations of green-tea flavoured shells with any cream except chestnut cream.

d) Jared is fussy and only wants vanilla flavoured shells with chocolate fudge.
With questions like this, it is important to read carefully and correctly identify the requirements. I will be going through the working out for all 4 cases.

I will be using the equation

$$P(E) = \frac{n(E)}{n(S)}$$

which means the probability of an event = the number of the event in ratio to the total number in the sample space.

In the case of a macaron vending machine, the sample space is 251.

**Part A**

a) Jared wants the macaron to have *some sort of berries flavour* in it (either with the *strawberry flavoured shells* or *mixed berries cream* or *both*).

Jared doesn’t mind what the filling is as long as the shells are *strawberry flavoured*.

Jared doesn’t mind what the shells are as long as the filling is *mixed berries cream*.

Either way, Jared will be happy, and of course, Jared will certainly be happy if he got *strawberry macaron shells with mixed berries cream*.

The highlighted area below shows macarons Jared will be happy with.

<table>
<thead>
<tr>
<th>Macaron Fillings</th>
<th>Green Tea</th>
<th>Vanilla</th>
<th>Strawberry</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chestnut cream</td>
<td>20</td>
<td>7</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
<td>Chocolate fudge</td>
<td>18</td>
<td>31</td>
<td>44</td>
<td>83</td>
</tr>
<tr>
<td>Buttercream</td>
<td>15</td>
<td>37</td>
<td>32</td>
<td>84</td>
</tr>
<tr>
<td>Mixed Berries</td>
<td>3</td>
<td>21</td>
<td>38</td>
<td>62</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>51</strong></td>
<td><strong>96</strong></td>
<td><strong>104</strong></td>
<td><strong>251</strong></td>
</tr>
</tbody>
</table>

There are 104 macarons with *strawberry flavoured shells* and 62 macarons with *mixed berries cream*. There are 36 macarons with both strawberry flavoured shells and mixed berries cream. (This is the overlap).

$$n(E) = 104 + 62 - 36$$

$$n(S) = 251$$

$$P(E) = \frac{n(E)}{n(S)}$$

$$P(E) = \frac{251}{251}$$

$$P(E) \simeq 0.51 (2dp)$$

If you chose Option B or Option C, you might have missed the fact that Jared doesn’t mind getting *green-tea flavoured shells with chestnut cream*.

**Part B**

b) Jared is happy with anything as long as the macaron does *not have buttercream*.

The only thing Jared cares is if the macaron has buttercream or not. Jared is happy as long as the fillings are *chestnut cream, chocolate fudge, or mixed berries cream*. Jared is happy with any shells for his macaron.

The highlighted area below shows macarons Jared will be happy with.

<table>
<thead>
<tr>
<th>Macaron Fillings</th>
<th>Green Tea</th>
<th>Vanilla</th>
<th>Strawberry</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chestnut cream</td>
<td>20</td>
<td>7</td>
<td>0</td>
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<tr>
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<td>3</td>
<td>21</td>
<td>38</td>
<td>62</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>51</strong></td>
<td><strong>96</strong></td>
<td><strong>104</strong></td>
<td><strong>251</strong></td>
</tr>
</tbody>
</table>

There are 74 macarons with *buttercream filling* which Jared does not want.

$$n(E) = 51 - 74$$

$$n(S) = 177$$

$$P(E) = \frac{n(E)}{n(S)}$$

$$P(E) = \frac{51}{177}$$

$$P(E) = 0.29 (2dp)$$

If you chose Option E, you might have misread the case, and thought Jared only wanted macarons with buttercream, while in fact, Jared wanted the complimentary macarons without buttercream.

**Part C**

c) Jared is fine with anything other than the combinations of *green-tea flavoured shells* with any cream. *Chestnut cream*.

Jared is fine with any macaron as long as the shells are either *vanilla flavoured* or *strawberry flavoured*.

Jared is also fine with another type of macaron which has *green-tea flavoured shells with chestnut cream*, and Jared does not like any other fillings with *green-tea flavoured shells*.

The highlighted area below shows macarons Jared will be happy with.

<table>
<thead>
<tr>
<th>Macaron Fillings</th>
<th>Green Tea</th>
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<tr>
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<td>31</td>
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<td>37</td>
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<td>84</td>
</tr>
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<td>3</td>
<td>21</td>
<td>38</td>
<td>62</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>51</strong></td>
<td><strong>96</strong></td>
<td><strong>104</strong></td>
<td><strong>251</strong></td>
</tr>
</tbody>
</table>

There are 96 macarons with *vanilla flavoured shells* and 104 macarons with *strawberry flavoured shells*. There are 20 macarons that are *green-tea flavoured shells with chestnut cream*.

$$n(E) = 96 + 104 + 20$$

$$n(S) = 251$$

$$P(E) = \frac{n(E)}{n(S)}$$

$$P(E) = \frac{251}{251}$$

$$P(E) = 1 (1dp)$$

If you have chosen Option D, you might have missed the bit that Jared doesn’t mind getting *green-tea flavoured shells with chestnut cream*.

**Part D**

d) Jared is fussy and only wants *vanilla flavoured shells with chocolate fudge*.

This is fairly straightforward. Jared only wants to have vanilla flavoured shells with chocolate fudge filling and nothing else.

The highlighted area below shows macarons Jared will be happy with.

<table>
<thead>
<tr>
<th>Macaron Fillings</th>
<th>Green Tea</th>
<th>Vanilla</th>
<th>Strawberry</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chestnut cream</td>
<td>20</td>
<td>7</td>
<td>0</td>
<td>27</td>
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<tr>
<td>Chocolate fudge</td>
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<td>84</td>
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<td>3</td>
<td>21</td>
<td>38</td>
<td>62</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>51</strong></td>
<td><strong>96</strong></td>
<td><strong>104</strong></td>
<td><strong>251</strong></td>
</tr>
</tbody>
</table>

There are 31 macarons that are *vanilla flavoured shells with chocolate fudge filling*.

$$n(E) = 31$$

$$P(E) = \frac{n(E)}{n(S)}$$

$$P(E) = \frac{31}{251}$$

$$P(E) \simeq 0.12 (2dp)$$

If you chose Option C or Option E, you have misinterpreted the question and thought Jared wants any macaron as long as it has *vanilla flavoured shells or chocolate fudge*.

These are the 11 different macarons the vending machine offer. Which would you want?
Motivation

Lipopolysaccharides are only ONE component of gram -ve bacterial cellwalls.

Yes however it is the permeability of LPS which causes crystal violet to stain 'negative' which is what distinguishes the two generic types of bacteria.

The thick cell walls of gram positive bacteria are what trap the violet stain, in gram negative bacteria the violet stain washes out in the alcohol rinse and they are stained a different colour, usually pink.

So what came first the chicken or the egg? Is it the LACK of peptidoglycan trapping crystal violet in or is it the pemeability of ADDITIONAL LPS layer, allowing crystal violet out, which distinguishes gram -ve bacteria.

Gram-negative bacteria still have cell walls of peptidoglycan, though much thinner than Gram-positive bacteria. A thinner cell wall would still get stained by the crystal violet and really have nothing to do with how they are distinguished using a Gram stain. The outer membrane of Gram-negative bacteria are not permeable to crystal violet, that's why the crystal violet does not stain their cell walls and how they can be distinguished from Gram-positive bacteria. Not sure what you mean by the outer membrane "allowing crystal violet out."?

LECTURE 6, at 14min 30s, just to clarify: Gram positive bacteria are positive due to more peptidoglycan, a protein in their cell wall which is impermeable to crystal violet => stained purple.
Gram negative bacteria have lipopolysaccharide outer layer in addition to petidoglycan (although much less) which comprises its cell wall, it is permeable to crystal violet thus allowing it to be rinsed from wall => pink.
Motivation

The “generation” effect:
- Individuals remember information better if they take an active role in producing it, rather than if it is provided to them [Slamecka & Graf, 1978]

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The “testing” effect:
• Being tested on previously studied material is more beneficial to long-term retention than either not being tested or even restudying the material [Roediger, 2013]

---

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The “self-explanation” effect:
• Students who explain instructional materials to themselves learn better and make more accurate self-assessments [Chi, 1989]

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All supported by multiple classroom studies

Challenges

Not perfect

OHHH, YOU FINISHED PEERWISE?

WHY DON'T I LET YOU WRITE MY EXAM EVERY YEAR?
Challenges

Not perfect

“Trick” questions
A function has been written:

```matlab
function [r] = Calculation (a,b,c)

r = (a + b) / c;

if (r > 10)
    disp ('The number is greater than 10');
elseif (r == 10)
    disp ('The number is 10');
else
    disp ('The number is less than 10');
end
```

What will be displayed when the function is run if the input values are:

\[ a = 5 \]
\[ b = 7 \]
\[ c = 2 \]

<table>
<thead>
<tr>
<th>OPTION</th>
<th>ALTERNATIVE</th>
<th>FIRST ANSWERS</th>
<th>CONFIRMED ANSWERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>The number is greater than 10</td>
<td>1 (9.09%)</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>The number is 10</td>
<td>1 (9.09%)</td>
<td>0</td>
</tr>
<tr>
<td>C</td>
<td>The number is less than 10</td>
<td>8 (72.73%)</td>
<td>0</td>
</tr>
<tr>
<td>D</td>
<td>None of the above</td>
<td>1 (9.09%)</td>
<td>0</td>
</tr>
</tbody>
</table>
A function has been written:

```matlab
function [r] = Calculation (a,b,c)

r = (a + b) / c;

if (r > 10)
    disp ('The number is greater than 10');
elseif (r == 10)
    disp ('The number is 10');
else
    disp ('The number is less than 10');
end
```

---

**Comment:**

In a hurry and in the font its in it is hard to spot the mistake, good one

---

**Comment:**

Nice one :)

---

**Comment:**

Good question
Challenges

Not perfect

“Trick” questions

Poor questions
How must this mathematical equation be written in Matlab?

\((3 \times 7^2) \div 2\)

<table>
<thead>
<tr>
<th>OPTION</th>
<th>ALTERNATIVE</th>
<th>FIRST ANSWERS</th>
<th>CONFIRMED ANSWERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>((3 \times 7^2) \div 2)</td>
<td>7 (70.00%)</td>
<td>1 (50.00%)</td>
</tr>
<tr>
<td>B</td>
<td>((3 \times 7 \times 2) \div 2)</td>
<td>0 (0.00%)</td>
<td>0 (0.00%)</td>
</tr>
<tr>
<td>C</td>
<td>((3 \times 7^2) \div 2)</td>
<td>3 (30.00%)</td>
<td>1 (50.00%)</td>
</tr>
<tr>
<td>D</td>
<td>((3 \times 7^2) \div 2)</td>
<td>0 (0.00%)</td>
<td>0 (0.00%)</td>
</tr>
</tbody>
</table>
Challenges

Not perfect

“Trick” questions

Poor questions

Wrong answers
Challenges

Question

Which of the following pieces of code would correctly find the minimum value from a set of three variables, a, b and c?

B

\[
\begin{align*}
M &= a; \\
\text{if } (b < M) & \quad M = b; \\
\text{elseif } (c < M) & \quad M = c; \\
\text{end} \\
\text{disp } (M)
\end{align*}
\]

<table>
<thead>
<tr>
<th>OPTION</th>
<th>ALTERNATIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>M = a;</td>
</tr>
<tr>
<td></td>
<td>if (b &lt; M)</td>
</tr>
<tr>
<td></td>
<td>M = b;</td>
</tr>
<tr>
<td></td>
<td>else (c &lt; M)</td>
</tr>
<tr>
<td></td>
<td>M = c;</td>
</tr>
<tr>
<td></td>
<td>end</td>
</tr>
<tr>
<td></td>
<td>disp (M)</td>
</tr>
<tr>
<td></td>
<td>9 (16.56%)</td>
</tr>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>M = a;</td>
</tr>
<tr>
<td></td>
<td>if (b &lt; M)</td>
</tr>
<tr>
<td></td>
<td>M = b;</td>
</tr>
<tr>
<td></td>
<td>else (c &lt; M)</td>
</tr>
<tr>
<td></td>
<td>M = c;</td>
</tr>
<tr>
<td></td>
<td>end</td>
</tr>
<tr>
<td></td>
<td>disp (M)</td>
</tr>
<tr>
<td></td>
<td>13 (23.04%)</td>
</tr>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>C</td>
<td>if (b &lt; M)</td>
</tr>
<tr>
<td></td>
<td>M = b;</td>
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<td></td>
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</tr>
<tr>
<td></td>
<td>M = c;</td>
</tr>
<tr>
<td></td>
<td>end</td>
</tr>
<tr>
<td></td>
<td>disp (M)</td>
</tr>
<tr>
<td></td>
<td>2 (0.04%)</td>
</tr>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>D</td>
<td>M = a;</td>
</tr>
<tr>
<td></td>
<td>if (b &lt; M)</td>
</tr>
<tr>
<td></td>
<td>b = M;</td>
</tr>
<tr>
<td></td>
<td>else (c &lt; M)</td>
</tr>
<tr>
<td></td>
<td>c = M;</td>
</tr>
<tr>
<td></td>
<td>end</td>
</tr>
<tr>
<td></td>
<td>disp (M)</td>
</tr>
<tr>
<td></td>
<td>6 (10.91%)</td>
</tr>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>E</td>
<td>None of the above.</td>
</tr>
</tbody>
</table>
Challenges

**Question**

Which of the following pieces of code would correctly find the minimum value from a set of three variables, a, b and c?

```matlab
M = a;
if (b < M)
    M = b;
elseif (c < M)
    M = c;
end

disp (M)
```

**Comment 1**

Written: 8:47pm, 08 Aug

What happens if C is less than B, and B is less than A?

**Comment 2**

Written: 12:18pm, 09 Aug

If you want to make B correct, you should use if instead of elseif:

```matlab
M = a;
if (b < M)
    M = b;
end;
if (c < M)  % <= if 'elseif' is used, and b<M, your script wouldn't examine the relationship between c and M
    M = c;
end

disp (M)
```
Should there be a comma there:

disp(['The area is of the rectangle is: ', num2str(area)])

Written: 10:58am, 05 Aug
Yes, Thank you. I have edited the question.

Add a reply to this comment

Isn't the 3rd column the one starting with 1, and the 4th column the one starting with 4..? surely this would be the case if the same logic that defined row 2 & 3 as italicized numbers 1 and 3 respectively is applied?

Written: 5:37pm, 07 Aug
Yes, thank you for pointing that out. It was my bad as I had done it in a hurry. I shall change it now :)

Add a reply to this comment

I thought for a function the outputs are surrounded by square brackets? eg. \([k] = \text{CelciusToKelvin}(c)\)

Written: 6:58pm, 07 Aug
yes you are right. even i didnt notice. i will change it. thank you for pointing out!

Add a reply to this comment
A genuine review resource
- use of repository to prepare for summative exams, even when voluntary

**A typical large course**
(n = 1,031)

High accuracy, even amongst the most active students
- 136 students submitted > 300 answers
- 86,430 out of 188,590 total answers
Evaluation

How good are the student authored questions?

Do students learn by authoring questions?
What proportion of questions are “good”?

We know that at least some are!

Physics 1A
The University of Edinburgh

Jack Sparrow (mass 65kg) has to flee from his ship to the land because he knows that he will be attacked by the Flying Dutchman. He stands on top of mast 1, point A. The rope he is holding is tied to mast 2 at the same height as Jack Sparrow, which is 25m above the sea. He drops himself and lets the rope go at the lowest point, point B, where he starts a free fall as shown in figure 1 and 2. Assume that there is no friction involved. The rope is 10m long, the gravitational acceleration is 9.8m/s² and the distance to the land is 70m.

How far away from mast 2 will Jack Sparrow hit the water?

Arnold the Stunt Cat jumps horizontally out of the top of a tall tree height (h), onto the centre of a trampoline from the base of the tree. He is then sprung in a perfectly elastic bounce onto his skateboard which is in line with the tree and the trampoline.

Given that he lands at an angle of 60 (degrees) from the horizontal on his skateboard, with a component of vertical velocity of 10m/s. Find the height of the tree which he jumped out of (h). Assume the whole system is perfectly frictionless and that g = 10m/s².
What proportion of questions are “good”?

Unscaffolded activity

- 617 questions
  - Correct (92%)
  - Incorrect (12%)

- 528 questions
  - Correct (91%)
  - Incorrect (9%)

- Around 1 in 10 questions incorrect
- Different institutions and subjects

What proportion of questions are “good”?

Unscaffolded activity

- 617 questions
- Correct: 528 (91%)
- Incorrect: 91 (12%)

Scaffolded activity

- 528 questions
- Correct: 485 (91%)
- Incorrect: 43 (8%)

Questions classified according to 6 categories:

<table>
<thead>
<tr>
<th>Measure</th>
<th>Criteria details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taxonomy category</td>
<td>At least level 2 or higher (understand or above).</td>
</tr>
<tr>
<td>Explanation category</td>
<td>At least level 2 or higher (minimal or better).</td>
</tr>
<tr>
<td>Clearly worded question</td>
<td>Unambiguous vs unclear (binary measure).</td>
</tr>
<tr>
<td>Distractors</td>
<td>At least 2 feasible and plausible distractors.</td>
</tr>
<tr>
<td>Correctness</td>
<td>Most likely correct (binary measure).</td>
</tr>
<tr>
<td>Plagiarism</td>
<td>Not obviously plagiarized (binary measure).</td>
</tr>
</tbody>
</table>

• Around 1 in 10 questions incorrect
• Different institutions and subjects

• Around 1 in 20 questions incorrect
• Around 1 in 10 inadequate explanation
• Virtually no obvious plagiarism
• More than 75% beyond simple recall

Do students learn by authoring questions?


Very robust correlations between student activity and exam performance

More than a dozen papers report this using PeerWise alone (four published in 2014)
Do students learn by authoring questions?

Only experimental group could author – all students could answer

Novice programming students

randomised

“Authoring”
$n = 364$

Create 3 questions
Voluntary answering

“Non-authoring”
$n = 365$

Voluntary answering
Performance on summative test by group

“Authoring” group performed significantly better (although a small effect size)

<table>
<thead>
<tr>
<th></th>
<th>Authoring</th>
<th>Non-Authoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>729</td>
<td>712</td>
</tr>
<tr>
<td>( \mu )</td>
<td>7.64</td>
<td>7.31</td>
</tr>
<tr>
<td>( \sigma )</td>
<td>1.84</td>
<td>2.10</td>
</tr>
<tr>
<td>p-value</td>
<td>0.0197</td>
<td>0.0360</td>
</tr>
</tbody>
</table>
Performance on related test items

- All 1139 questions were coded for topic
  - logical and relational operators
  - while loops
  - matrix manipulation
- Students authoring on a given topic much more likely to answer related test questions correctly

Conclusions

- PeerWise is a simple way to support a student-generated question activity
- Students value practice questions authored by their peers, answering them voluntarily prior to exams
- Students are capable of authoring a repository of relevant, high quality questions
- Generating and answering practice questions can be an effective learning strategy

Thank you
paul@cs.auckland.ac.nz