PeerWise and Contributing Student Pedagogy

John Hamer
with Paul Denny and Andrew Luxton-Reilly
Department of Computer Science
University of Auckland

Talk given at Monash University, 10 December 2007
Introduction
Contributing Student Pedagogy

- Students create and share learning resources; e.g. notes, visualisations, instructional videos, quiz questions, reading lists

- Web-based collaboration tool (e.g. wiki) used to store work-in-progress and share course material

- Peer feedback and evaluation

- Related theories: flexible learning (Collis), constructivism, community of practice (Wenger), ZPD (Vygotsky)
What is PeerWise?

- An online bank of multiple choice questions
- All content is student generated

**Your question**

Which of the following C expressions does NOT evaluate to 7?

<table>
<thead>
<tr>
<th>OPTION</th>
<th>ALTERNATIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1 + 2 * 3</td>
</tr>
<tr>
<td>B</td>
<td>(int)(6.6 + 0.5)</td>
</tr>
<tr>
<td>C</td>
<td>(int)6.6 + (int)0.5</td>
</tr>
<tr>
<td>D</td>
<td>7 % 10</td>
</tr>
<tr>
<td>E</td>
<td>15 / 2</td>
</tr>
</tbody>
</table>
Not just questions and answers

- explanations

Explanation

You provided the following explanation relating to this question:

Expression (C) evaluates to 6, not 7. The reason for this is that the cast to an int truncates the fractional part of the number, so:

\[
\begin{align*}
(int)6.6 + (int)0.5 \\
\implies 6 + 0 \\
\implies 6
\end{align*}
\]

All of the other expressions do evaluate to 7:

In (A), the multiplication is performed first, giving 1 + 6 = 7
In (B), the expression 6.6 + 0.5 evaluates to 7.1, which is then cast to (int) giving 7
In (D), when you divide 7 by 10, the answer is 0 and there is 7 remainder
In (E), 15 / 2 gives the int value 7 because both operands are ints.
Not just questions and answers

- explanations
- responses

### Alternatives

<table>
<thead>
<tr>
<th>OPTION</th>
<th>ALTERNATIVE</th>
<th>RESPONSES</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1 + 2 + 3</td>
<td>9 (2.42%)</td>
</tr>
<tr>
<td>B</td>
<td>(int) (.6 + .5)</td>
<td>6 (1.03%)</td>
</tr>
<tr>
<td>C</td>
<td>(int) 6.6 + (int) .5</td>
<td>70 (68.46%)</td>
</tr>
<tr>
<td>D</td>
<td>7 + 10</td>
<td>22 (17.74%)</td>
</tr>
<tr>
<td>E</td>
<td>15 / 2</td>
<td>24 (19.35%)</td>
</tr>
</tbody>
</table>

*You suggested C is the correct option*
Not just questions and answers

- explanations
- responses
- discussion threads

Features

Introduction
Contribution
Student Pedagogy
What is PeerWise?
Features
Learning
For instructors
Results
ENGGEN 131
PCA
Gender data
Questions?
Not just questions and answers

- explanations
- responses
- discussion threads
- difficulty and quality ratings
Features

Not just questions and answers

- explanations
- responses
- discussion threads
- difficulty and quality ratings
- leader-boards

**Most popular contributor**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Total number of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>421</td>
</tr>
<tr>
<td>2</td>
<td>416</td>
</tr>
<tr>
<td>3</td>
<td>378</td>
</tr>
<tr>
<td>4</td>
<td>325</td>
</tr>
<tr>
<td>5</td>
<td>256</td>
</tr>
</tbody>
</table>

**TOP FIVE**

Total number of responses to all questions you have contributed: 325
Learning

- Designing a question
  - focuses attention on learning outcomes
  - encourages reflection on course material

- Choosing distractors
  - misconceptions are considered
  - promotes deep understanding

- Writing explanations
  - students express understanding in their own words
Learning

- Answering questions
  - useful practice / revision
  - reinforces learning

- Evaluating quality
  - requires critical analysis

- Providing feedback
  - encourages peer dialogue around learning
Probably setting up my multi-choice question. This was pretty hard given that I had to think of the possible wrong solutions students would fall for and required a lot of thinking from me, which in the end was a lot of help because I was just about able to answer any question that was on the same topic as my question.
That was the biggest learning experience for me!
— OE4/205
Large question bank developed at low cost

- ENNGEN 131 (introductory programming course)
- 570 students
- 1,700 questions
- 35,000 responses
- Sept 9th – Nov 1st

Can be used as a basis for exam questions
■ assists staff in identifying weaknesses
■ reveals how well students are engaging with certain topics
Results
Five courses used PeerWise in 2007

- Varied in: coursework marks awarded for the activity (Worth), questions to write and answer, use of MCQs in exam and tests, and whether the PeerWise authors taught the course.

<table>
<thead>
<tr>
<th>Course</th>
<th>Worth</th>
<th>Write</th>
<th>Answer</th>
<th>Exam</th>
<th>PW taught?</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS101</td>
<td>2%</td>
<td>2</td>
<td>10</td>
<td>Both</td>
<td>Yes</td>
</tr>
<tr>
<td>CS111</td>
<td>1%</td>
<td>2</td>
<td>2</td>
<td>None</td>
<td>Yes</td>
</tr>
<tr>
<td>CS105</td>
<td>2%</td>
<td>2</td>
<td>10</td>
<td>None</td>
<td>No</td>
</tr>
<tr>
<td>CS220</td>
<td>1%</td>
<td>2</td>
<td>10</td>
<td>Both</td>
<td>No</td>
</tr>
<tr>
<td>EG131</td>
<td>7%</td>
<td>2</td>
<td>20</td>
<td>Exam</td>
<td>Yes</td>
</tr>
</tbody>
</table>
## Overall use

<table>
<thead>
<tr>
<th>Course</th>
<th>Mean Questions</th>
<th>Mean Answers</th>
<th>Mean Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS101</td>
<td>2.9/2</td>
<td>37.5/10</td>
<td>13.5</td>
</tr>
<tr>
<td>CS111</td>
<td>1.9/2</td>
<td>60.7/2</td>
<td>5.0</td>
</tr>
<tr>
<td>CS105</td>
<td>2.4/2</td>
<td>47.0/10</td>
<td>9.2</td>
</tr>
<tr>
<td>CS220</td>
<td>1.6/2</td>
<td>36.0/10</td>
<td>7.2</td>
</tr>
<tr>
<td>EG131</td>
<td>3.0/2</td>
<td>62.6/20</td>
<td>19.1</td>
</tr>
</tbody>
</table>
ENGGGEN 131

Course details
Grade distributions for MATLAB and C
C vrs. MATLAB Model
Observations
Gain by quartile
Gain by median
PCA
Gender data
Questions?
Course details

- Compulsory for all first-year engineering students
- Two independent 6-week sections: MATLAB, C
- PeerWise introduced only in the C section
- MCQs in C section of the exam
- Collected individual data on: number of questions written (Qs); questions answered (As); length of comments (NC); average comment length (AvgC); MCQ (i.e. C programming) mark; MATLAB mark
Grade distributions for MATLAB and C

Introduction

Results

ENGGEN 131
Course details

Grade distributions for MATLAB and C
C vrs. MATLAB
Model
Observations
Gain by quartile
Gain by median
PCA
Gender data

Questions?
Grades in the two sections are similar
identical mean $p = 0.11$
Linear regression model for participation

Predicting MCQ grades from As+Qs+NC+AvgC

Predicted MCQ = 0.12As + 12Qs − 0.14NC + 0.33AvgC
The linear regression model came up with the prediction

\[ MCQ = 0.125\text{As} + 12.05\text{Qs} - 0.14\text{NC} + 0.33\text{AvgC} \]

The largest contribution comes from Qs, then AvgC, followed by As and (negligibly) NC. The ratios for an average student are: 31 : 16 : 8 : −3

Writing questions is the single most significant predictor of exam performance, followed by the average length of comments.
Gain in MCQ–MATLAB by participation quartile

Q1 (low)  Q2  Q3  Q4 (high)
High/low participation C-MATLAB gain

PeerWise participation correlates with gain
95% interval = 1.6–5.5, p = 0.0004
PCA

Introduction
Results
ENGGEN 131
PCA
Factor map, all data
Individuals, all data
Individuals,
minimum Qs
Gender data
Questions?
Factor map, all data

Variables factor map (PCA)

Dimension 1 (36.29%)
Dimension 2 (24.56%)

MQExam, NC, Qs, As

Questions?
Individuals, all data

Introduction

Results

ENGGEN 131

PCA

Factor map, all data

Individuals, all data

Individuals, minimum Qs

Gender data

Questions?
Individuals, minimum Qs

Introduction

Results

ENNGEN 131

PCA
Factor map, all data

Individuals, all data

Gender data

Questions?
Gender data

Males slightly outperform females
No gender difference in PeerWise participation

Questions?
Males slightly outperform females

Men outperformed women in C
95% interval = 2.7–9.4, p = 0.0005
Males slightly outperform females

Men do better in MATLAB, but not to the same extent
95% interval = 1.3–6.2, p = 0.003
No gender difference in PeerWise participation

Men and women both contributed Qs equally
$p = 0.7$

Gender data
Males slightly outperform females
No gender difference in PeerWise participation
No gender difference in PeerWise participation

Introduction

Results

ENGGEN 131

PCA

Gender data
Males slightly outperform females

No gender difference in PeerWise participation

Questions?
No gender difference in PeerWise participation

Men and women both posted comments equally

\[ p = 0.27 \]
No gender difference in PeerWise participation

Men and women both wrote similar length comments
\( p = 0.13 \)
Questions?