Using research to improve education

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Introduction

Unskilled and Unaware of It:

How Difficulties in Recognizing One's Own Incompetence Lead to Inflated Self-Assessments

Introduction

Less skilled individuals...

overestimate their ability

can’t recognize competence

only gain insight by becoming more competent

Introduction

Humor

Students ranked 30 jokes based on humor

Expert rankings from professional comedians

Ranked own “ability to recognize what’s funny” with that of the average student using % ranking

Introduction

Humor

Introduction

Logistical Reasoning

Introduction

Logistical Reasoning

1) Trained half of participants
2) Re-rated their performance

Untrained

Bottom students

Top students

Trained

Less skilled individuals overestimated ability

More knowledge = better evaluate own ability
Outline

• Qualitative results

• Quantitative results

• Implications for teaching
Qualitative results

Introductory physics course at Harvard

mostly pre-medical students

approximately 100 students enrolled

interactive teaching
Qualitative results

• Analysis of pre-class reading assignments

• Two questions on subject material
  – Not easy, must have some understanding
  – Not graded, get credit for effort

• One question asking:

  “Is there anything you found difficult or confusing in the reading?”
Qualitative results

1. Consider a capillary rise of a liquid in a glass tube. How does the pressure at point P at the surface of the liquid compare to the pressure at point Q at equal height?

2. Two identical balloons are connected to a tube as shown below. Balloon B is inflated more than balloon A. Which way does the air flow when valve P is opened?
3. Please tell us briefly what points of the reading you found most difficult or confusing. If you did not find any part of it difficult or confusing, please tell us what parts you found most interesting.
Qualitative results

1. Capillary action is due to the cohesion between water molecules, and the adhesion of water to the surface of the glass tube. Negative pressures can result from the cohesive forces of water. At the same height, the pressure inside the tube is much less due to negative pressures.

2. The air flows from high pressure to low pressure. The fully blown up balloon has higher pressure than the 1/2 blown up balloon. So the air flows from the fully blown balloon to the half filled balloon.

3. Nothing was difficult or confusing. The sections on the surfactant in the lungs and the heart as a pump were interesting because they relate physics to biology.
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Qualitative results

1. The water rises because of an interaction between the water and the walls of the tube, which creates an upward force which causes the water to rise... The pressure at the point inside the tube must be the same as the pressure at the point of equal height outside the tube, because if there was a pressure difference, then there would be a net flow of water.

2. Laplace’s law tells us that it requires a greater pressure difference to maintain a small sphere than a larger one. So, the pressure in the small balloon must be greater, and the air will flow from the small balloon into the large one.

3. I found the explanation of Laplace’s law to be inadequate, and while I can understand the conclusion drawn, I don’t understand the reasoning which led to the conclusion.
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Qualitative results

Coding of responses

- Q1 and Q2: correct/incorrect
- Q3: confusion on topic of Q1/Q2

Correlate confusion with correctness
## Qualitative results

<table>
<thead>
<tr>
<th>Capillarity</th>
<th>Correct</th>
<th>Incorrect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confused</td>
<td>44%</td>
<td>56%</td>
</tr>
<tr>
<td>Not confused</td>
<td>25%</td>
<td>75%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Laplace</th>
<th>Correct</th>
<th>Incorrect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confused</td>
<td>49%</td>
<td>51%</td>
</tr>
<tr>
<td>Not confused</td>
<td>21%</td>
<td>79%</td>
</tr>
</tbody>
</table>
Qualitative results

Students who are confused may actually understand the material…

...students who are NOT confused may not understand at all!
Quantitative results

Use the following scale to rate your comprehension of the concept of ________

1 - I am totally lost (I really have no clue at all)
2 - I am pretty confused -- many things don't make sense to me
3 - Some aspects confuse me, but it's beginning to make sense
4 - I understand it mostly, but I still have some questions
5 - I think I have a solid grasp of the concept
# Quantitative results

- Electrostatics
- Gauss’ Law
- Potential Difference
- Capacitance
- Magnetic Interactions
- Ampere’s Law
- Lenz’s Law
- Interaction of Electric and Magnetic Fields
Quantitative results

Students rate their understanding throughout the learning process

- Pre-class reading
- Lecture
- Tutorial
- Homework
- Exams

Compare rating with understanding
Quantitative results

Indicates strength and direction of a linear relationship

www.uwsp.edu/psych/stat/7/correlat.htm
Quantitative results

Indicates strength and direction of a linear relationship

http://noppa5.pc.helsinki.fi/koe/corr/cor7.html
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Stage in learning process

Confidence

RA 1  Lect 1  RA 2  Lect 2  PSet  Exam 1  Exam 2  Exam 3  Final

3.05  3.24  2.71  3.29  3.32  3.55  3.53  3.47  3.67
Quantitative results

Stage in learning process

Confidence

RA 1  Lect 1  RA 2  Lect 2  PSet  Exam 1  Exam 2  Exam 3  Final

3.05  3.24  2.71  3.29  3.32  3.55  3.53  3.47  3.67
Quantitative results

- First exam: $r=0.26$
- Second exam: $r=0.34$
- Third exam: $r=0.46$
- Lecture: $r=0.25$
- Reading assignment: $r=0.15$
- Final exam: $r=0.29$
Students are not good at evaluating their own understanding,

BUT, they get better with greater knowledge and more feedback!
Introduction

Logistical Reasoning

1) Trained half of participants
2) Re-rated their performance

Implications for teaching

What do these results mean for teaching?
Implications for teaching

Anecdotal evidence of resistance to new teaching methods

Study on student feedback to innovations…
– Mostly positive
– Still, some students thought they didn’t need the “hassle”

Implications for teaching

“I hated this class when it first started. I hated going to lecture, I hated going to lab.”

“I actually learned a lot in lab this semester.”

Implications for teaching

When implementing new teaching methods, if students tell me that it is not working, I will change my strategy. (n=69)
Implications for teaching

If I believe that a new teaching method will negatively affect my student evaluations of teaching, I am more hesitant to use it. (n=69)
Student feedback can be flawed...

Need research to help evaluate our traditional assessments!
Confusion...

- does not correlate with understanding
- is not (necessarily) the result of poor teaching
- is part of the learning process

Lack of confusion could be lack of understanding.
Thank you

Mercedes Lorenzo
Jessica Rosenberg
Doug Van Wieren
Martin Vogt
Mazur Group

mazur-www.harvard.edu
Quantitative results

The chart shows the confidence levels of males and females throughout different stages of the learning process. The stages include RA 1, Lect 1, RA 2, Lect 2, PSet, Exam 1, Exam 2, Exam 3, and Final. Male and female confidence levels are represented by orange and blue diamonds, respectively.
Quantitative Results

![Graph showing average 'grade' by stage in learning process for female and male students.]

- **Stage in learning process**: RA 1, Lect 1, RA 2, Lect 2, Exam 1, Exam 2, Exam 3, Final
- **Average 'grade'**
- **Legend**:
  - Female
  - Male