A two-stage review activity for the first day of class

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Two-stage review: Context

• CHEM 311: Instrumental Analysis
• Demographics:
  – Chemistry majors and honours (~90 students)
  – Bachelor of Medical Lab Sciences (~25 students)
• **Challenge:** Significant variation in students’ background knowledge
  – Differing levels of achievement and differing emphases in the common prerequisite course
  – Students’ background in Electricity & Magnetism is generally weak

• First day of class would typically include only a brief introduction to new material
Why use a two-stage review?

We agreed to use the two-stage review activity to address the following goals:

1. Capture a snapshot of students' understanding of key concepts
2. Provide students with immediate feedback & clarification on their background knowledge
3. Give students a low-stakes opportunity to experience the dynamic a group test (in prep for two-stage midterm)
4. Mix the two student cohorts
5. Have a productive first day of class!
Developing the two-stage review activity

1. Identify the topics and key concepts
   – Brainstorming with instructor, lecture TA, and STLF
   – Topics and concepts from 2nd-year prerequisite and 1st-year physics (E&M)

2. Develop a set of multiple-choice questions (18 Qs)
   – targeted at a "quiz" level rather than "final exam" level

Example:
Which of the following changes will increase the intensity of the light beam reaching the detector of a standard absorbance spectrophotometer?

a. Decreasing the intensity of the light source
b. Diluting the analyte solution
c. Using a sample cuvette with a longer path length
d. Reducing the slit widths of the monochromator
e. More than one of the above
The first day of class: Organization

- Students assigned to groups of 5
  - rearranged into groups during a 5-minute break
- We explained the activity and repeatedly emphasized it was not for marks, but to help them assess their background understanding

- Individual review:
  Scantron sheets, 15 min

- Group review: same questions, “Immediate Feedback Assessment Technology” (IF AT) cards, 15 min

The first day of class: How did it go?

- Groups appeared engaged in good discussions about concepts
- Despite being slightly rushed, nearly all groups finished
- Attitudes during and afterwards were generally positive ("That was fun!")
**What we learned:** Strengths and weaknesses

![Bar Chart](chart.png)

- Precision & accuracy
- Figures of merit
- Sample matrix
- Sensitivity
- Velocity of photons
- Energy of photons
- Light in different media
- Destructive interference
- Molecular excitation
- Fluorescence emission
- Beer's law (predict)
- Electrochemical potentials
- pH electrode
- Chromatography (infer)
- Chromatography (predict)
- Basic electrostatics
- Ohm's law

*Note: The bar chart shows the percentage of individual and group learning for each topic.*
What we learned: Strengths and weaknesses

by Topic:

- key terms (N=4)
- properties of light (N=4)
- spectroscopy (N=3)
- electrochemistry (N=2)
- chromatography (N=2)
- E&M (N=2)

by Bloom’s level:

- knowledge (N=6)
- comprehension (N=7)
- analysis (N=4)
What we learned: Strengths and weaknesses

3 major categories of questions:

1. Majority correct - students receive feedback from peers →100%

2. Majority incorrect - target for clarification by instructor

3. Majority of groups incorrect - identify widely-held misconceptions
What we learned: Persistent misconceptions

Which of the following statements about glass pH electrodes is/are **FALSE**?

<table>
<thead>
<tr>
<th>Individual</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>a) The glass membrane acts as a salt bridge</td>
<td>17</td>
</tr>
<tr>
<td>b) Hydronium ions (H$_3$O$^+$) from solution are in equilibrium with hydronium ions bound to the glass surface</td>
<td>18</td>
</tr>
<tr>
<td>c) The glass electrode must be filled with a solution of fixed pH</td>
<td>5</td>
</tr>
<tr>
<td>d) The relationship between pH and voltage is linear</td>
<td>38</td>
</tr>
<tr>
<td>e) More than one of the above</td>
<td>18</td>
</tr>
</tbody>
</table>
What we learned: Lessons to carry forward

• Consider your class composition when setting groups
  – Very important in our case to maximize heterogeneity

• Be persistent in prompting students to sit in a formation conducive to group discussion

• Follow-up with students:
  – We provided the questions and detailed explanations of correct AND incorrect answers on Connect
  – In the future: use Connect gradebook feature to tailor feedback for students

• Overall, the activity was easy to prepare and implement, and provided both us and our students with valuable information