Development and Validation of an Open Ended Assessment - Creative Exercises

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Development and Validation of an Open Ended Assessment—Creative Exercises

Jessica Orvis, Georgia Southern University
Deborah Sauder, Georgia Gwinett College
Creative Exercises

- What are they?
- Why bother?
- Data so far
- Misconceptions discovered
- DIY - Do It Yourself
Assessment practices influence how students direct their efforts in a class.\(^1\)

Creative Exercises

• First proposed by Trigwell and Sleet in 1990
• Consists of a brief prompt
• Students write distinct, correct, and relevant statements about the prompt.
• Example.. 2.2 g of NaCl
Why is this a good idea?

- Provides an opportunity for students to select and present their own knowledge
- Allows students to draw conceptual relationships
- Allows instructors to find misconceptions
- Similar to concept mapping
- Quick
Questions that Need to Be Answered

• Are CEs an accurate measure of chemistry knowledge?
• Are CEs scored consistently across different classrooms? Across institutions?
• Do students gain useful information?
• Do instructors gain useful information?
Correlations of CEs with ACS Exams

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Grader 1, ACS Exam</th>
<th>Grader 2, ACS Exam</th>
<th>Grader 3, ACS Exam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework CE’s Average Correlation</td>
<td>0.232</td>
<td>0.222</td>
<td>0.186</td>
</tr>
<tr>
<td>Exam CE’s Average Correlation</td>
<td>0.521</td>
<td>0.506</td>
<td>0.483</td>
</tr>
<tr>
<td>Overall Average Correlation</td>
<td>0.361</td>
<td>0.349</td>
<td>0.318</td>
</tr>
</tbody>
</table>

95% confidence limit = +/- 0.151

Lewis, S. E., Shaw, J. L. and Freeman, K. A. Establishing Open-ended Assessments: Investigating the Validity and Reliability of Creative Exercises, accepted for publication in Chemistry Education: Research and Practice.
Grading Reliability

Average Intra-Class Correlations - shows ranking reliability

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Grader 1, Grader 2</th>
<th>Grader 2, Grader 3</th>
<th>Grader 1, Grader 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework CE’s</td>
<td>0.764</td>
<td>0.844</td>
<td>0.763</td>
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<tr>
<td>Average Correlation</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Exam CE’s</td>
<td>0.886</td>
<td>0.845</td>
<td>0.858</td>
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<tr>
<td>Average Correlation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall Average</td>
<td>0.818</td>
<td>0.844</td>
<td>0.805</td>
</tr>
<tr>
<td>Correlation</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Grading Reliability

Cohen’s Kappa values- shows consistency of actual score

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Grader 1, Grader 2</th>
<th>Grader 2, Grader 3</th>
<th>Grader 1, Grader 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework CE’s Average Kappa</td>
<td>0.435</td>
<td>0.475</td>
<td>0.435</td>
</tr>
<tr>
<td>Exam CE’s Average Kappa</td>
<td>0.458</td>
<td>0.391</td>
<td>0.415</td>
</tr>
<tr>
<td>Overall Average Kappa</td>
<td>0.445</td>
<td>0.438</td>
<td>0.426</td>
</tr>
</tbody>
</table>
Misconceptions

Early in the semester:

Prompt: 31.5 g of $\text{K}_2\text{S}$ (alternate: 55.4 g of $\text{Na}_2\text{O}$)

Some student responses:

• Students identify the compound as ionic, but use covalent naming rules
• Students will mislabel charges, indicate charge of $\text{K}_2$ as +2
• Students refer to $\text{K}_2$ molecules and S molecules
• Students assign an incorrect charge to the entire formula unit, “it has a charge of -1”
• IF given $\text{Na}_2\text{O}$, identify compound as containing N atoms.
In discussing chemical reactions:

Prompt: \( \text{MgCl}_2(\text{aq}) + \text{K}_2\text{CO}_3(\text{aq}) \rightarrow \)

Students will correctly predict the products of this reaction,

\( \text{MgCl}_2(\text{aq}) + \text{K}_2\text{CO}_3(\text{aq}) \rightarrow 2\text{KCl}(\text{aq}) + \text{MgCO}_3(\text{s}) \)

but then solve for the moles and mass of KCl formed even though they have correctly labeled it as aqueous in the balanced reaction.

When given a double displacement reaction in solution (complete with reactants and products), a number of students indicated one of the reactants as the solute and the other reactant as the solvent, in spite of the (aq) label on each reactant.
Misconceptions 3

The thermodynamics of chemical reactions:

Prompt: $2\text{BF}_3 + 3\text{Cl}_2 \rightarrow 2\text{BCl}_3 + 3\text{F}_2$ \hspace{0.5cm} $\Delta H = 1466 \text{ kJ/mole}$ and given a mass of $\text{Cl}_2$ and excess $\text{BF}_3$

Students will try to determine $\Delta H$ of an individual component by dividing the $\Delta H_{\text{rxn}}$ by the stoichiometric coefficient

Ex: $\Delta H$ for $\text{Cl}_2 = 1466/3$

Students will label $\text{BF}_3$ and $\text{BCl}_3$ as ionic (indicating a cation and anion) then name them using the covalent naming scheme

Students will solve for $\Delta T$ of the reaction using $\Delta H$, mass of $\text{Cl}_2$ and the Specific heat of water (even though no water is present.)
Misconceptions 4

In quantum mechanics:
Prompt:  \( n=3 \)  \( l=1 \)

Students correctly identified the two quantum numbers: \( N \) is the principle quantum number, \( l \) is the angular momentum quantum number

but that they did not link the two values together
\( n \) is principle QN and possible \( l \) values for this \( n \) value would be 2, 1, and 0

Students will list electron configurations and quantum numbers for molecules, even though that has never been discussed.  \( \text{Ex. } \text{Cl}_2 \)
Project Participants

Scott Lewis, Kennesaw State University

Tim Howell, Gainesville State College

Patricia Todebush, Clayton State University

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