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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 Gwinnett 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?
Nationally Standardized American Chemical Society (ACS) Exam

Correlations of CE’s 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</td>
<td>0.232</td>
<td>0.222</td>
<td>0.186</td>
</tr>
<tr>
<td>Average Correlation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exam CE’s</td>
<td>0.521</td>
<td>0.506</td>
<td>0.483</td>
</tr>
<tr>
<td>Average Correlation</td>
<td></td>
<td></td>
<td></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>
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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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<td>Average Correlation</td>
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<tr>
<td>Overall Average</td>
<td>0.818</td>
<td>0.844</td>
<td>0.805</td>
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<tr>
<td>Correlation</td>
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</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</td>
<td>0.435</td>
<td>0.475</td>
<td>0.435</td>
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<tr>
<td>Average Kappa</td>
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<tr>
<td>Exam CE’s</td>
<td>0.458</td>
<td>0.391</td>
<td>0.415</td>
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<tr>
<td>Average Kappa</td>
<td></td>
<td></td>
<td></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 $K_2S$ (alternate: 55.4 g of $Na_2O$)

Some student responses:

• Students identify the compound as ionic, but use covalent naming rules
• Students will mislabel charges, indicate charge of $K_2$ as +2
• Students refer to $K_2$ molecules and $S$ molecules
• Students assign an incorrect charge to the entire formula unit, “it has a charge of -1”
• IF given $Na_2O$, 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 \text{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.
The thermodynamics of chemical reactions:

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

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.)
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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