Learning Chemistry Content through Automated Peer Review of Writing

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Overview

• Making writing feasible in large intro courses

• Tailoring writing prompts and rubrics for productive peer review

• Understanding the connection between review and revision
Making Writing Feasible in Large Intro Courses

- Organic Chemistry: 1400
- Molecular Biology: 1200
- General Chemistry: 1800
- Economics: 3200
- Statistics: 4000
- Physics: 900
- Computer Science: 1500
- Materials Science Engineering: 150

*numbers correspond to annual enrollment*
Tailoring writing prompts and rubrics for productive peer review

Read and Write
• Students read and write about Lewis paper

Peer Review
• Students read and respond to 3 other students writing

Revise
• Students received feedback and revise writing

Shultz, G.; Gere, A.R. Journal of Chemical Education 2015, 92 (8) 1325-1329
Content-directed prompt and peer review rubric

Objectives (aligned between prompt and rubric):

I. Can you use your understanding of Lewis structures, nearly 100 years later, to summarize it more clearly and concisely than Lewis did? What are the most important points that Lewis proposed in the nine pages he published in 1916?

II. How did Lewis improve on previous theories of molecular structure and bonding?

III. How are the ideas that Lewis proposed in 1916 different from how we understand bonding and molecular structure today?

Shultz, G.; Gere, A.R. Journal of Chemical Education 2015, 92 (8) 1325-1329
Lewis D1-D2 ranking

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Mean Score (N = 58)</th>
<th>t-Test</th>
<th>Effect Size</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Draft 1</td>
<td>Draft 2</td>
<td></td>
</tr>
<tr>
<td>I. Summary of important themes</td>
<td>5.2155</td>
<td>5.6207</td>
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<td>II. Discussion of pre-Lewis theories</td>
<td>3.1983</td>
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<td>III. Comparison to conventional theory</td>
<td>2.6379</td>
<td>3.5345</td>
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- Expert ranking on a 7-point scale
- All differences are significant between $p<0.01$ and $p<0.001$ levels
How does participation in peer review contribute to learning?

• Reading the writing of others and receiving peer feedback contributes to *learning to write*

• What about *learning from writing*?

Analysis

• Tracked and analyzed revisions Draft 1 to Draft 2

• Categorized peer review comments using existing framework – adapted from “learning to write” to “writing to learn” context
# Tracking Revisions

<table>
<thead>
<tr>
<th>Revision Category</th>
<th>Rank (3 point scale)</th>
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| Degree            | 0 = no change  
                        | 1 = 2-3 sentences  
                        | 2 = paragraph or more |
| Content           | 0 = no change to content  
                        | 1 = minor changes to content (i.e. new terms added, clarification of existing terms)  
                        | 2 = substantial changes to content (i.e. new topic introduced and elaborated on) |
| Structural        | 0 = no change to structure  
                        | 1 = sentence level change  
                        | 2 = global changes to draft |
“You did not discuss how Lewis' conclusions are different from how we depict molecules now.....”

is completely ionized, while diagrams B and C represent a molecule that is covalently bonded.

The way Lewis depicted covalent bonding in 1916 is vastly different that how we draw Lewis structures today. Lewis structures today are not drawn in cube formation because it is difficult to comprehend when trying to explain the bonding of more...
What was the nature of students’ revisions?

Note: structural changes were not emphasized in the rubric and papers were 350-500 words in length.
# Revisions connected to peer review comments

- 21% of all comments made were connected to a specific revision

![Bar chart showing percent comments related to revisions](chart.png)

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## Does the type of comment matter?

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<th>Definition</th>
<th>Example</th>
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<td><strong>Verification</strong></td>
<td>Identifies that rubric criteria was addressed</td>
<td>“yes, it does.”</td>
</tr>
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<td><strong>Summary</strong></td>
<td>A list of topics, a description of claims, or an identified action</td>
<td>“The paper cited VSEPR and molecular orbital theory as two new additions that have improved our understanding of bonding and molecular structure.”</td>
</tr>
<tr>
<td><strong>Praise</strong></td>
<td>A complimentary comment of identification of a positive feature</td>
<td>“Did a good job of touching on the shortcomings of 2-d vs. 3-d models of today.”</td>
</tr>
<tr>
<td><strong>Problem/solution</strong></td>
<td>Identifies what needs to be fixed and/or suggests a way to fix issue</td>
<td>“The paper does not provide a clear and concise summary of Lewis structures. You use all the necessary terms that Lewis used in his theory, but you do not necessarily explain what they mean.”</td>
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What type of feedback is more frequently associated with changes?

- **Verification**: 32 Overall, 0.4 Connected to revision
- **Summary**: 5 Overall, 0.3 Connected to revision
- **Praise**: 20 Overall, 1.0 Connected to revision
- **Problem Solution**: 41 Overall, 13.2 Connected to revision
Summary and Implications

• WTL approach: *content-directed* prompt *and* rubric

• Many students did not give useful feedback, make substantial revisions, or employ useful feedback

• Fewer students gave useful feedback on more difficult content objective

• When automated peer review is used students need in class instruction on effective *content-based* peer review and revision

• A more nuanced understanding of the content as it relates to peer review is needed
Acknowledgments

Analysis
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