Overview of Session

- Critique examples of student writing
- Discuss importance of scientific explanations and argumentation
- Use rubrics to assess students’ writing
- Observe videoclips from science classrooms

Context: 7th Grade Chemistry Unit

- Substances and Properties
  - Describe observable properties of fat and soap.
  - Determine the density, solubility, and melting point of fat and soap.
  - Key learning goal: Different substances have different properties

- Chemical Reactions
  - Investigate three different chemical reactions, boiling, and mixing.
  - Use molecular models to explore whether new substances are produced.

- Conservation of Mass
  - Investigate if mass changes in chemical reactions.
  - Use molecular models to explore why mass is conserved during chemical reactions.

Activity: Critique Students’ Writing

- Examine the two students’ explanations

Questions:
- How would you assess these responses?
- What are the strengths of each example?
- What are the weaknesses of each example?
What are Explanation and Argumentation?

- **Explanation**
  - *make sense* of how or why a phenomenon occurred
  - Examples:
    - Explain why the biodiversity decreased
    - Explain what has happened to the pitch of bird song in cities

- **Argumentation**
  - *Defend or support* knowledge claims through evidence, warrants and backing
  - Examples:
    - Argue for your explanation for why the biodiversity decreased
    - Argue for your experimental design to study what is happening to the biodiversity

Importance of Scientific Explanation and Argumentation

- Science is about explaining phenomena
- Stressed in the science education standards
- Students should generate and evaluate scientific evidence and explanations
- Change students’ image of science
- Enhance students’ understanding of the nature of science
- Foster deeper understanding of important science concepts

National Science Standards

- Present a brief scientific explanation orally or in writing that includes a claim and the evidence and reasoning that supports the claim. (AAAS, 12D/M6**)
- Notice and criticize the reasoning in arguments in which the claims are not consistent with the evidence given (AAAS, 12E/M5b*)
- *Inquiry and the National Science Education Standards* (NRC, 2000)
  1. Engaging in scientifically-oriented questions
  2. Giving priority to evidence
  3. Formulating explanations from evidence
  4. Connecting explanations to scientific knowledge
  5. Communicating and justifying explanations.

CER Framework

Adapted from Toulmin (1958)

- **Claim**
  - a conclusion about a problem
- **Evidence**
  - scientific data that is *appropriate* and *sufficient* to support the claim
- **Reasoning**
  - a justification that shows why the data counts as evidence to support the claim and includes appropriate scientific principles
- **Rebuttal**
  - describes alternative explanations and provides counter evidence and reasoning for why the alternative is not appropriate.
Liquids 1 and 4 are the same substance. (Claim) They both have a density of .93 g/cm³, have no color, and start to melt at -98°C. (Evidence) Density, color and melting point are all properties while mass is not a property. For substances to be the same, they must have the same properties. Since Liquids 1 and 4 have the same properties, they are the same substance. (Reasoning)

Activity: Assessing Students’ Writing

- Examine student example and record responses to the questions below on the chart paper.
- Assess student explanation
  - Using the rubric, how would you assess this student’s response in terms of claim, evidence and reasoning?
- Provide feedback and strategies
  - What feedback would you provide this student? Why would that feedback be helpful?
  - What strategies might you use to help this student construct a stronger explanation?
### Base Rubric

<table>
<thead>
<tr>
<th>Level</th>
<th>Claim</th>
<th>Evidence</th>
<th>Reasoning</th>
<th>Rebuttal</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>A statement or conclusion that answers the original question/problem</td>
<td>Scientific data that supports the claim. The data needs to be appropriate and sufficient to support the claim</td>
<td>A justification that connects the evidence to the claim. If the evidence is insufficient, the explanation using appropriate and sufficient scientific principles.</td>
<td>Accepts and criticizes alternative explanations, and provides alternative explanations for why the alternative explanation is or is not appropriate.</td>
</tr>
<tr>
<td>5</td>
<td>Almost a complete claim, or makes an inaccurate claim. Does not provide evidence or only provides inappropriate or insufficient evidence (does not support claim).</td>
<td>Does not provide reasoning or only provides inappropriate reasoning.</td>
<td>Does not recognize that alternative explanation exists and does not provide a rebuttal or makes an inaccurate statement.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Makes an inaccurate and incomplete claim.</td>
<td>Makes an inaccurate and incomplete claim.</td>
<td>Makes an inaccurate and incomplete claim.</td>
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<tr>
<td>3</td>
<td>Makes an inaccurate and incomplete claim.</td>
<td>Makes an inaccurate and incomplete claim.</td>
<td>Makes an inaccurate and incomplete claim.</td>
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<tr>
<td>2</td>
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<td>Makes an inaccurate and incomplete claim.</td>
<td>Makes an inaccurate and incomplete claim.</td>
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<td>1</td>
<td>Makes an inaccurate and incomplete claim.</td>
<td>Makes an inaccurate and incomplete claim.</td>
<td>Makes an inaccurate and incomplete claim.</td>
<td></td>
</tr>
</tbody>
</table>

### Activity: Assessing Students’ Writing

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### Providing Students Feedback

- **What to Comment on:**
  - Components of the explanation - claim, evidence, and reasoning
  - Science content of explanation
  - Holistic quality of explanation
- **How to Comment:**
  - Explicit and clear feedback
  - Point out strengths and weaknesses
  - Provide suggestions on how to improve
  - Ask questions to promote deeper thinking

### Teaching Strategies

1. Discuss the framework ➞
2. Connect to everyday examples ➞
3. Provide a rationale ➞
4. Connect to other content areas ➞
5. Model and critique examples ➞
6. Provide students with feedback ➞
7. Have students engage in peer critique ➞
Conclusion

- Make the framework explicit (claim, evidence and reasoning)
- Use rubrics to evaluate student writing
- Provide students with feedback
- Incorporate multiple teaching strategies in your classroom instruction

Contact Information

- E-mail
  - kmcneill@bc.edu
- Powerpoint from today
  - http://www.katherinelmcneill.com/workshops.html

Hyperlinked Slides

Discuss the Scientific Explanation Framework
Connect to Everyday Examples

Provide a Rationale

Connect to Everyday Examples

Connect to Other Content Areas
Model and Critique Examples

Providing Students With Feedback

Have Students Engage in Peer Critique