Transforming an Ecology Class to Focus on Key Ecology Concepts and Practices using an Assessment-Driven Design Approach

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Outline for my talk

Deciding on key course learning outcomes

Teaching and curriculum development

Assessing student mastery of learning outcomes

Course revision and improvement
Four learning outcomes:

1. Using models to describe and predict population dynamics
2. Interpreting and explaining primary data
3. Constructing scientific arguments using evidence
4. Utilizing peer editing to improve scientific writing
Nuts and bolts of overall scientific process

• Set up a study or review to answer a question
  • Does Earth orbit the sun?
  • What’s the effect of rain on student use of public transit?
• Collect data
• Interpret the data:
  • **Claim**: a statement of conclusion that responds to the original question
  • **Evidence**: appropriate scientific data that support the claim
  • **Reasoning**: a justification that links the claim and evidence
Advantages of assessment rubrics

• When students don’t meet expectations what are they doing wrong?
• Are there common misunderstandings amongst students?
• What specific aspects of an argument are difficult for students to master?
<table>
<thead>
<tr>
<th>Criteria</th>
<th>Did not meet expectations</th>
<th>Partially met expectations</th>
<th>Met expectations</th>
<th>Exceeded expectations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Design a claim for observed data</strong></td>
<td>Claim is false, vague, or not present</td>
<td>Claim is accurate but not ecologically realistic and writing lacks clarity</td>
<td>Claim is accurate and logical but more subtle elements are ignored</td>
<td>Claim is accurate, logical and well developed</td>
</tr>
<tr>
<td>Points</td>
<td>0</td>
<td>0.5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Provide evidence to support claim</strong></td>
<td>Evidence is inaccurate, vague, or not provided</td>
<td>Evidence is accurate but interpretation is inaccurate (e.g. not ecologically realistic)</td>
<td>Evidence is accurate and logical but sentence structure is somewhat difficult to read</td>
<td>Evidence is accurate, logical and explained properly</td>
</tr>
<tr>
<td>Points</td>
<td>0</td>
<td>0.5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Use reasoning to link claim and evidence together</strong></td>
<td>Reasoning for why evidence supports claim is vague, inaccurate, or missing</td>
<td>Reasoning technically links evidence to claim but is illogical</td>
<td>Reasoning links or explains why evidence supports claim but sentence structure is somewhat difficult to read</td>
<td>Reasoning links or explains why evidence supports claim accurately and logically</td>
</tr>
<tr>
<td>Points</td>
<td>0</td>
<td>0.5</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
Final exam prompt based on assessment rubric

Explain the following results (be sure to specify your claim, provide evidence to support your claim, and use reasoning to logically link your claim and evidence). (3pts)

<table>
<thead>
<tr>
<th>Abalone abundance</th>
<th>Otter abundance</th>
<th>Site</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>200</td>
<td>Alaska</td>
<td>1995</td>
</tr>
<tr>
<td>50</td>
<td>100</td>
<td>Alaska</td>
<td>2000</td>
</tr>
<tr>
<td>60</td>
<td>200</td>
<td>California</td>
<td>1995</td>
</tr>
<tr>
<td>120</td>
<td>400</td>
<td>California</td>
<td>2000</td>
</tr>
</tbody>
</table>
Think about your ability to construct a scientific argument **before** and **after** you took this class and then rate the following...

<table>
<thead>
<tr>
<th></th>
<th>Very poor</th>
<th>Poor</th>
<th>Fair</th>
<th>Good</th>
<th>Very good</th>
<th>Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Your ability to develop a clear claim.</td>
<td></td>
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<td></td>
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<tr>
<td>Your ability to use evidence to support your claim.</td>
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<td></td>
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<tr>
<td>Your ability to logically link a claim with the supporting evidence.</td>
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</tr>
</tbody>
</table>
Students’ self-assessment of abilities to design a clear claim

![Bar chart showing self-assessment of design abilities at the start and end of the course.](Image)
Students’ self-assessment of abilities to interpret evidence

- **Very poor**: 9% at start, 9% at end
- **Poor**: 32% at start, 32% at end
- **Fair**: 41% at start, 41% at end
- **Good**: 5% at start, 5% at end
- **Very good**: 14% at start, 14% at end
- **Excellent**: 37% at end
Students’ self-assessment of abilities to logically link claim and evidence

![Chart showing self-assessment of abilities at start and end of course.](chart.png)
Conclusions

• Essential scientific practices can be successfully taught and assessed in a classroom setting

• Assessment results allow instructors to diagnose (and improve) particular aspects of a course students still struggle with
  • E.g. connecting evidence to a claim with adequate reasoning

• Overall, the students as a group tended to *over-estimate* their abilities to construct a scientific argument.
  • Allows instructors to ask where is their a disconnect in what my students *think* they know
  • E.g. explicit instruction (and evaluation) of a scientific argument was new to students and resulted in over-estimation of this new found skill

• A copy of my full assessment report can be found online at: jordanruybal.sites.ucsc.edu