Developing Concept Inventories for Biology

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Project Goals
Decades of science education research have demonstrated that students do not arrive in science classes as blank slates without any knowledge or beliefs about the subject under study. Instead, they often hold deeply rooted misconceptions, beliefs and ideas that may diverge widely from scientific consensus (Duit, 2003). These fundamental misconceptions are often a significant barrier to learning. The goal of this project is to develop concept questions for biology that address common student misconceptions in fundamental areas of biology, and are validated to help students focus their learning while helping instructors focus their teaching.

Concept Inventory (CI)

What is it?
“A CI is an outline of core knowledge and concepts for a given field and a collection of multiple choice questions designed to probe student understanding of these fundamental concepts.” (Redish, 2000)

How is it different from student assessment?
- CIs probe students’ conceptual understanding.
- CIs are based on research into student misconceptions.
- CIs’ distracters are chosen to reflect common student misconceptions.
- CIs use language suggested by students and based on their feedback.

How can it be used?
- Diagnosing misconceptions
- Assessing teaching techniques
- Measuring learning gains
- Checking student understanding
- Establishing a baseline for further instruction

Methodology

1. Identification of key concepts

2. Qualitative research into student misconceptions

3. Development of a multiple choice questions in which student misconceptions are used as distracters

4. Validation of multiple choice questions through think aloud interviews with students, and expert validation

5. Administration as pre (before instruction) and post-test (after instruction), and statistical analyses of the data.

Project Outcomes

<table>
<thead>
<tr>
<th>Inventory</th>
<th>Team</th>
<th>Development Phase</th>
<th>Courses</th>
<th># of Students Involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>0. General Student Misconceptions in Biology</td>
<td>Joan Sharp</td>
<td>Reviewed student misconceptions and questions designed to address them (preliminary work).</td>
<td>BIOL 121 BIOL 334</td>
<td>~800</td>
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<tr>
<td>1. Meiosis</td>
<td>Pam Kalas, Carol Pollock, Jennifer Klenz, Angie O'Neill</td>
<td>18 questions were validated through student interviews and were classroom tested.</td>
<td>BIOL 121 BIOL 334</td>
<td>~800</td>
</tr>
<tr>
<td>2. Operon</td>
<td>Jared Taylor, Elizabeth Imrie, Karen Smith, George Spiegelman</td>
<td>25 questions were validated through student interviews and were classroom tested.</td>
<td>BIOL 112</td>
<td>~1700</td>
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<td>3. Population and Community Ecology</td>
<td>Malin Hansen, Thomas Deane, Greg Bole, Brett Couch</td>
<td>19 questions were validated through student interviews and were classroom tested.</td>
<td>BIOL 121 BIOL 230 BIOL 304</td>
<td>~800</td>
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<tr>
<td>4. Speciation</td>
<td>Erica Jeffery, Michelle Tseng, Greg Bole</td>
<td>16 questions were validated through student interviews and were classroom tested.</td>
<td>BIOL 121</td>
<td>~600</td>
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<td>5. Transcription and Translation</td>
<td>Rosemary Oh-McGinnis, Jared Taylor, Sunita Chowrira</td>
<td>27 questions are currently being developed. Classroom testing will be done in BIOL 112 and BIOL 200.</td>
<td>BIOL 112 BIOL 200</td>
<td>~10</td>
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<td>6. Experimental Design</td>
<td>Thomas Deane, Kathy Nomme, Carol Pollock</td>
<td>25 questions are currently being developed. Classroom testing will be done in BIOL 140.</td>
<td>BIOL 140</td>
<td>~25</td>
</tr>
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<td>7. Microevolution</td>
<td>Michelle Tseng, Greg Bole</td>
<td>15 questions are currently being developed. Classroom testing will be done in BIOL 121 and BIOL 336.</td>
<td>BIOL 121 BIOL 336</td>
<td>~25</td>
</tr>
</tbody>
</table>

Two Example Applications for Meiosis Inventory

Assessing Teaching Techniques
We tested 3 lecture sections:
A: pre-test, no lecture, no activity, post test (n=80)
B: pre-test, lecture, no activity, post test (n=148)
C: pre-test, lecture, activity, post test (n=133)

Two Example Applications for Meiosis Inventory

Acknowledgements
We thank the UBC Teaching and Learning Enhancement Funds (TLEF) for financial support in 2009/2010 and 2010/2011 academic years, the UBC Science Centre for Learning and Teaching (Skylight) and the Carl Wieman Science Education Initiative (CWSEI) for in-kind contributions. We also thank the students and instructors who participated in focus groups, interviews and classroom testing of the questions.