Using concept inventory questions to measure student understanding and assess teaching methodologies

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Outline

- What is a concept inventory?
- Differences from Student assessment
- How are used and created?
- Implementation in Biology 108 Blended Learning Project
What is a concept inventory?

❖ “Series of questions designed to determine whether a student has an accurate working knowledge of a specific set of concepts for a given field.” Wikipedia

❖ “A Concept Inventory 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.” Radish 2000
Differences from student assessment

- Norm-referenced test
- Student assessment
- Criterion-referenced test
- Concept Inventory
Differences from student assessment

- Norm-referenced test
- Criterion-referenced test
- Concept Inventory

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- Understanding

- Concept Inventory

Student assessment
## Differences from student assessment

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<tr>
<th><strong>Concept Inventory</strong></th>
<th><strong>Student Assessment</strong></th>
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<tr>
<td>Student’s conceptual understanding</td>
<td>Tests knowledge but not necessarily understanding</td>
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<tr>
<td>Distractors use common student misconceptions.</td>
<td>Distractors not necessarily based on misconceptions.</td>
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<tr>
<td>Based on peer review. Research component.</td>
<td>Not based on research.</td>
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Uses of concept inventories

- 1. Assessing student understanding
- 2. Assessing learning gains
- 3. Assessing misconceptions
- 4. Assessing teaching methodologies
Constructing concept inventories

- 1. Determine key concepts that are essential for area of study
- 2. Determine common misconceptions
- 3. Develop multiple choice questions
- 4. Create test
- 5. Validate
Constructing concept inventories

1. Determine key concepts that are essential of area of study
   - Based on survey of literature. E.g. Concept inventory of Natural Selection (Anderson 2002) or Force Concept Inventory (Hestenes 1992)
   - Based on learning outcomes/objectives for course
2. Determine common misconceptions
   - Past exams.
   - Published concept inventories.
   - Student interviews.
   - Opened ended questions.
Constructing concept inventories

- 3. Develop multiple choice questions
  - Questions can come from published concept inventories
  - Or where questions do not exist create new ones
  - Include correct answer as well as common misconceptions
Constructing concept inventories

- 4. Create test
  - Factual knowledge
  - Mechanisms and beliefs
Constructing concept inventories

5. Validate:
   - Discriminability
   - Consistency amongst test groups
   - Internal consistency of test
Assessing efficacy of Biology 108 Blended Learning

- Blended Learning Award 2015 - PDLC
- Converting six topic areas
- Assess the efficacy of the conversions
- Does blended learning improve learning gains in Biology 108?
Assessing efficacy of Biology 108 Blended Learning

- Cross over Experimental Design
- Blended learning vs Traditional learning
- between sections
- within section

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Assessing efficacy of Biology 108 Blended Learning

- CI questions at the start of each module.
  - Online or in-class clicker questions
- Short CI test after each module
  - Learning gains
- Surveys at the end of some of the modules
  - Engagement and satisfaction
- Interviews with a subset of students
Assessing efficacy of Biology 108 Blended Learning

- Relationships amongst:
  - 1. Learning gains (understanding)
  - 2. Satisfaction
  - 3. Engagement
  - 4. Grades
Developing Concept Inventories

![Table showing concept inventories in biology](image)

- **UBC Biology**
  - Multiple concept inventories in biology developed or developing.

Birol et al, 2012
Developing Concept Inventories

1) NATURAL SELECTION

*Conceptual Inventory of Natural Selection (CINS) (20 MC items, scenarios)*


2) MACROEVOLUTION

*Measure of Understanding of Macroevolution (MUM) (28 items: 27 MC items, plus one open-ended item, diagrams)*


3) EVOLUTIONARY RELATIONSHIPS


4) GENETICS LITERACY

*Genetics Literacy Assessment Instrument (GLAI) (31 MC items)*


Developing Concept Inventories

5) GENETICS


additional future tests to be posted online at www.colorado.edu/sei/departments/mcdb_assessment.htm

6) GENETICS


7) INTRODUCTORY BIOLOGY

Biology Concept Inventory (BCI) (30 MC items)
ITEMS PROVIDED ON-LINE at http://bioliteracy.colorado.edu/


8) ANIMAL DEVELOPMENT

Types of assessment

❖ Satisfaction - USRI
❖ Engagement - NSSE
❖ Student assessment - Tests and exams
❖ Understanding - Concept inventories
Summary

❖ What is a concept inventory?
❖ Differences from Student assessment
❖ How are used and created?
❖ Implementation in Biology 108 Blended Learning Project
Thanks to

- Norma Nocente - Center for Teaching and Learning
- Tracy Onuczko - Center for Teaching and Learning
- Heather Proctor - Dept Biological Sciences
- Lien Luong - Dept Biological Sciences
- Provost Digital Learning Committee