BRIDGING THE PATHWAY FROM INSTRUCTION TO RESEARCH

AAAS/AIBS Summit
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www.first.ecoinfomatics.org
Engage

What are your reasons for conducting educational research or not doing so?

1. Think individually
2. Write three reasons on the card provided.
3. Take a minute to discuss your reasons with a neighbor.
From expert teacher to teacher scholar/researcher

- Effective teacher - reflects on why students are not learning
- Designs the most stimulating and inspiring learning environment to help students overcome difficulty in learning
- Teacher scholar takes the next step.....
...Inquire into students’ learning

- What is the question?
  - What does students’ work tell you about their learning?
  - What are the assumptions and the variables you need to recognize to effectively interpret their work?
  - Observing and listening in classrooms....
What is the research design?

- Empirical Research
  - Design Research
- Case studies

Quantitative

Qualitative
Data collection, what types?

- High Ease of Assessment:
  - Multiple Choice, T/F
  - Diagrams, Models, Concept maps, Quantitative response
  - Short answer
  - Essay, Research papers/reports
  - Oral Interviews

- Low Potential for Assessment of Learning:
  - High
How to analyze data?

Quantitative data - statistical analysis

Qualitative data

- break into manageable units and define coding categories
- search for patterns, quantify
- interpret and synthesize

Valid and repeatable measures
Reporting the results…

- Statistical and PRACTICAL significance
- How results fit into the literature
- Problems and limitations of the study
- Is this research repeatable?
- Generalizable to another course? …another year? …another population of students?
Biology education is not local…

“Why do we never seem to share and pass down to succeeding generations anything we learn in physics education? What can we do to change this?”

Edward F. Redish
Milliken Award Lecture 1998
Overview of the FIRST Assessment Database
Two models of instructional design

Traditional pedagogy: informed by discipline-specific content knowledge

Discipline-based knowledge (textbooks) → Design course → Teach course → Assess student outcomes

Reformed pedagogy: informed by student-generated data

Discipline-based knowledge (textbooks) → Design course → Teach course → Assess student outcomes

Analysis of student data drives course modification

Analyze student learning outcomes
Biocomplexity Thesaurus
(http://thesaurus.nbia.gov)

Selection

- Evolution
  - Genetic drift
  - Group selection
  - Host selection
  - Kin selection
  - Natural selection
- Adaptations (biological)
- Ecophenes
- Fluctuating asymmetry
- Genetics
- Mutation
- Phylogeny
- Selective media
- Speciation

- Competition
  - Diversity indices
  - Dominant species
  - Environmental effects
  - Fitness
  - Genetic load
  - Genetics
  - Survival value
Examples of course- and assessment-level metadata captured by the FIRST Database

### Course-level Metadata
- Institution type/size
- Course format (lab, lecture, discussion, etc)
- Course size
- Targeted students (majors, non-majors, lower or upper level)
- Course Syllabus

### Assessment-level Metadata
- Type of assessment (e.g., in-class, open book, exam)
- Proportion of final grade
- Bloom’s level of understanding
- Concept category
Q2. Evolution is primarily dependent on which of the following biological processes?

a. mitosis  
b. meiosis  
c. respiration  
d. photosynthesis  
e. metabolism

1. The variation of the snails have many different phenotype traits.  
   color, size, shell pattern.  
   "Red to lime" could be highly advantageous for snails.  

2. Color: Red, Orange, Yellow, White  
   Light to dark could be highly advantageous for snails.  

3. Model to describe cause of variation in traits.  
   Start with DNA:  
   Tennessee DNA  
   Sequence DNA  
   "Yes!" codes for  
   codes for  

Example:  

4. Use a number 2 pencil.  
   DO NOT USE ink pens, ballpoints or felt tips.  
   MAKE NO STRAY MARKS: mark only in the appropriate response boxes.  
   Make heavy, black marks which fill the circle completely.
# Database Output

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<th>C</th>
<th>D</th>
<th>E</th>
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Rethinking of the Biology We Teach

- Requires interdisciplinary activities
  - Doing biology and understanding the cognitive psychology of understanding biology
- Conducting the research
- Disseminating the research
Instructional Research and Development Teams

- Who? senior faculty, junior faculty, postdoctoral and graduate students - intergenerational teams.

- What? scholarship of science teaching and learning is fully integrated into the professional culture along with discipline-based activities.

- Data (assessment) is critical to both practices.
Thanks and appreciation …

- Database Development Team
- Jenni Momsen - MSU
- Mark Urban-Lurain - MSU
- Elena Bray Speth - MSU
- Ryan McFall - Hope College
- Matt Jones - NCEAS
- Ben Leinfelder - NCEAS

- Faculty - throughout the US

- National Science Foundation
Obtain reliable and consistent measurements of students’ understanding of evolutionary concepts.

Assumption: use of multiple types of assessment provides a more powerful tool for analyzing the richness and complexity of student learning outcomes than a single type of assessment.

Elena Bray Speth, Postdoctoral Fellow Plant Biology, MSU
## Assessment Framework

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<th>Evolution Concepts</th>
<th>CINS (multiple choice)</th>
<th>Dino/tree (short answer)</th>
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<td>Variation is inherited</td>
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<tr>
<td>Fitness</td>
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<tr>
<td>Change in a population</td>
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Assessment Question

Explain the changes that occurred in the trees and animals. Use your current understanding of evolution by natural selection.