From Three Courses to One: Outcomes from Redesigning the 200-level Biology Curriculum

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Department identified need and committed to change → Course learning objectives developed → Lecture/lab learning objectives developed → Lecture/lab materials developed → Implementation → Assessment

At the Fall 2012 Biology Department retreat, discussions focused on the problems associated with having alternative course progressions for majors in different concentrations. Based on those discussions a committee of 200-level instructors was formed for initiating a revision.

- Unanimous support for change and streamlining.
- 1 vs. 2 course options discussed, 1 course option selected.
- Gained departmental approval for 1 course model.

Level	Pre redesign options	
100	General Bio.	General Bio.
200	Plant Bio (3 cred.)	Old Organismal Bio (4 cred.)
	Animal Bio (3 cred.)	
300	Ecology, Cell Bio., Genetics	Ecology, Cell Bio., Genetics
	(Other conc. requirements)	(Other conc. requirements)
400	Varied Electives	Varied Electives

AND THEN … how do 14 faculty take three courses and create one?

As a large committee we developed overall course objectives. We considered:

- overall curriculum objectives.
- across curriculum efforts (Evolution and writing)
- reinforcing BIO 105
- creating knowledge and skills for 300 level courses.

Biodiversity Systematics and evolution

- Draw a tree of life and map major evolutionary adaptations/events on the tree.
- Explain how evolutionary adaptations arose at a molecular and evolutionary level.
- Define the roles of the environment, organismal interactions in driving/shaping evolution of biodiversity (including humans).
- When given an organismal process/characteristic/trait be able to compare and contrast analogous and homologous traits across the tree of life.
- Be able to ask the proper questions about a given organism to distinguish its domain, major clade or phyla (for certain kingdoms).
- Answer questions about how different organisms solve major problems and opportunities.

Learn to think like a scientist

- Depict differences among organisms via illustration
- Read and create trees.
- Read and create graphs, interpret and analyze data.
- Distinguish between popular and scientific literature and the different types of scientific literature.
- Be able to do your own background research when presented with a biology research question.
- Be able to design a testable empirical research project.

ANIMAL, PLANT, AND ORGANISMAL BIOLOGY had lectures, labs, exercises, exams, and instructor effort that needed recognized and utilized. In **small groups** with representative instructors from each course, alternative syllabi with lecture/lab content were developed. By breaking into small groups, all faculty were engaged and contributed to the discussion.

A Curricular Redesign Grant provided motivation for working on lecture objectives through spring semester and funded instructors to develop and review materials over summer.

1. We worked together to develop lecture objectives

Why?

- The course has shared instruction. Objectives unify learning outcomes while allowing for instructor variation.
- Instructors have flexibility to experiment with active learning and alternate teaching techniques.
- Can be shared with students for pre-lecture preparation and exam review.

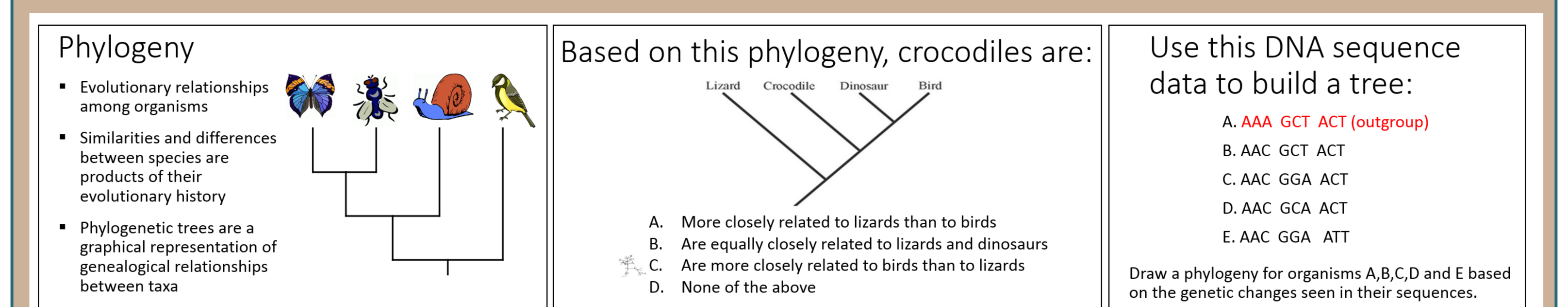
For this lecture you should be able to:

- Interpret relationships among taxa as visualized on a phylogenetic tree: start at individual level and work the way up to hierarchical clusters.
- Identify characters as homoplasious or homologous.
- Identify clades as monophyletic.
- If given a character matrix draw the corresponding phylogenetic tree.
- Use correct terminology to discuss different parts of the trees or for tree inference

How?

- 3-6 clearly written objectives / 55 minute section
- We wrote objectives as active tasks to facilitate usefulness to students.

2. Individuals took the objectives and developed new or modified existing lectures to emphasize objectives.



Promoted student engagement during content development

- clicker questions 3-4/lecture.
- individual, pair, and small group activities.

BENEFITS

STREAMLINED CURRICULUM: 203 full but waitlist eliminated within 2 semesters of implementation (moved bottleneck to 300 level ☹). No seniors in 200 level courses.

KNOWN STUDENT POPULATION AT 300 LEVEL: exposure to content and skills are the same for all Biology majors as they move into 300 level.

ADDRESSES DEPARTMENTAL LEARNING OBJECTIVES: see Assessment section.

DEBATES

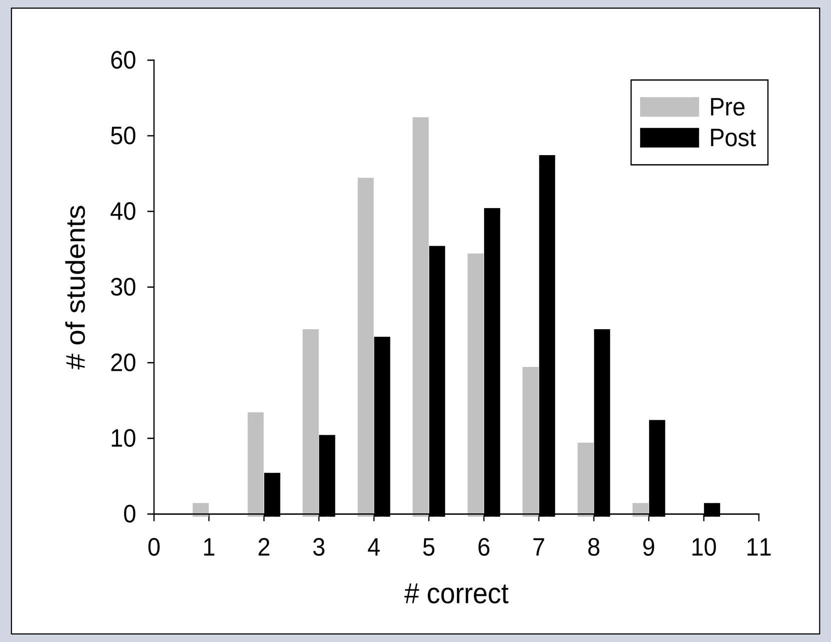
BREADTH VS. DEPTH: the course covers a huge range of organisms (huge breadth!). Depth on any one lineage is limited. Depth exists in evolutionary history and comparative thinking but is not specific within groups of organisms.

CONTENT and SKILLS: The class has a lot of content. Students also develop critical thinking, scientific process, quantitative and writing skills. Is it too much?

The new course began in Fall 2013 with ~250 students enrolled in four sections. Ten instructors participated in lab and/or lecture and met weekly to discuss instruction and revise materials. Assessment materials were developed for Spring 2014. We assessed evolution concepts using assessment materials previously tested by the evolution across the curriculum committee (Gerrish et al. in press, Perez et al. 2013). A quantitative skills assessment was modified from Speth et al. (2010). Assessments were administered through pre and post D2L quizzes. 196 students across four sections consented to participate in the assessment. In the text below we present results as increase in percent correct (pre/post) on specific questions; we present overall student learning gains in the figures.

Evolution concepts:

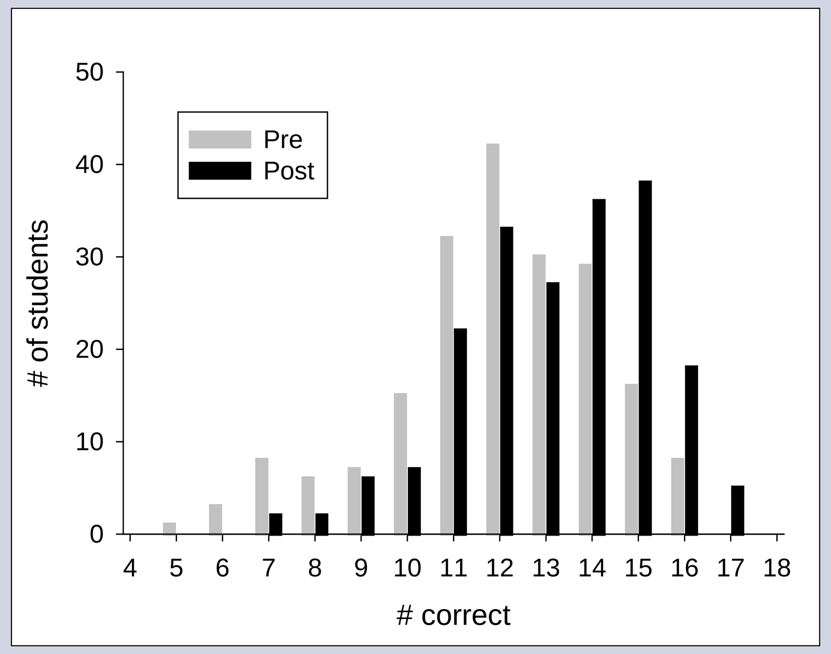
- Tree building – Improvement on reading trees. No longer reading across the tips (27%)!
- Molecular clock – Understand clock is an estimate (23%) and the relative order of major group diversification (18%).
- Evo-Devo – Changes in gene activation are more likely than major mutations/gene gain or gene loss (13% and 16%). (But we made them all activation genes are HOX genes [-28%]!)



Students improved their understanding of target evolution concepts by the end of the semester. In pre-post assessment students showed a 13.9% learning gain overall.

Quantitative concepts:

- Experimental Design – Pretest shows a strong understanding of dependent and independent variables (>85%) (way to go BIO 105!!). Replication still confusing.
- Statistics/graphing – Standard error calculation/interpretation and selection of the proper graph all showed the largest gains (45% improvement pre-post)!!
- Interpretation and Causation vs. Correlation – Interpretation was strong in the pretest questions (>75%) leaving little room for improvement. We may have scared students from ever saying we test causation, even in a carefully designed experiment.



Students improved their understanding of target quantitative concepts and skills by the end of the semester. In pre-post assessment students showed a 11.9% learning gain overall. The majority of improvement was observed in standard error calculation/interpretation, and graph selection.

Gerrish et al. *In press*. Building the impetus for change: an across curriculum initiative in Biology, Journal of College Science Teaching.
Perez et al. 2013. The Evo DevoCI: a concept inventory for gauging students' understanding of evolutionary developmental biology. CBE: Life Sciences Education 12: 665-675.
Speth et al. 2010. Infusing quantitative literacy into introductory biology. CBE: Life Sciences Education 9:323-332.