Evolution across the biology curriculum at UWL: Design and Assessment of Evolution content modules in Organismal Biology Courses

Gretchen Gerrish, Mike Abler, Anita Baines, Lee Baines, Tisha King-Heiden, Kathryn Perez, Anton Sanderfoot

University of Wisconsin-La Crosse; Biology Department

Objectives

The Evolution Across Curriculum initiative at UWL was implemented using student-centered learning modules in each of our core courses (General, Organismal, Plant, and Animal Biology, Cell, Ecology, Genetics, Anatomy and Physiology). Modules included student exploration and activities to reinforce presented content. Modules were originally tested among control and experimental sections (when possible). Here we present examples of modules used in our 200 level organismal courses.

Course specific approach:

Evolutionary topics were assigned to each course based on a cross departmental evaluation of evolution content in our core courses. (* see Kathryn Perez et al.'s poster for more!)

Steps:

1. Course specific learning objectives for assigned evolutionary topics were developed.
2. Following a workshop on student-centered teaching, individual faculty worked on developing content modules that included student engagement and activities that link real-world examples to concepts they are learning. Once modules were drafted, faculty presented their modules to the team for peer review.
3. Modules were deployed in control and treatment sections (when possible) and learning gains were assessed in Fall 2012 and Spring 2013 semesters.

Objectives:

e.g. Geologic Time for Organismal Biology

Students should be able to:

- place major events in animal evolution on a timeline paired with those in plant and fungal evolution.
- recognize evolution of complexity repeatedly in multiple lineages.
- grasp how long life has existed/evolved and that rates of divergence vary.

e.g. Evolution & Development for Animal Biology

– *Evolution can occur by changes in regulation:* Given that developmental processes are often shared, novel phenotypes often evolve via changes in regulation (e.g., co-option or deployment of gene regulatory networks to different tissues or stages of development).

– *A small number of mutations can make a large evolutionary difference*: It is possible for novel phenotypes to evolve as the result of the fixation of a small number of mutations that cause significant changes in the regulation of developmental processes.

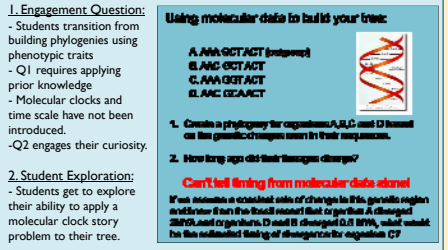
– *Development can bias evolutionary outcomes*

Examples of Student-Centered Modules

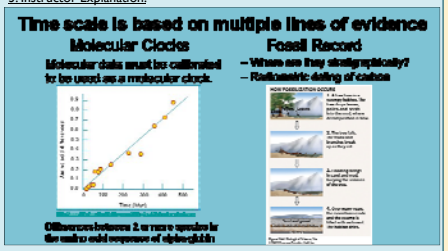
Geologic Time Scale:

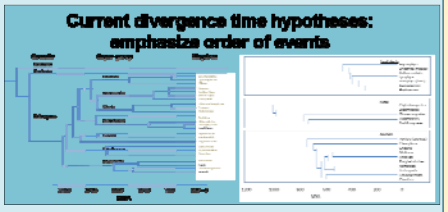
1. Engagement Question:
- Students transition from building phylogenies using phenotypic traits
- Q1 requires applying prior knowledge
- Molecular clocks and time scale have not been introduced.
-Q2 engages their curiosity.

2. Student Exploration:
- Students get to explore their ability to apply a molecular clock story problem to their tree.

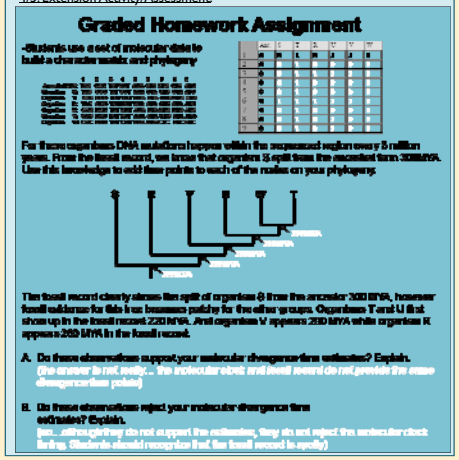


3. Instructor Explanation:





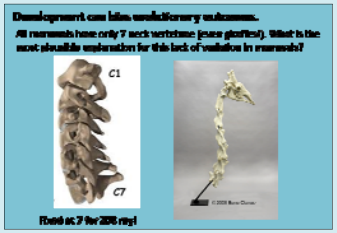
4/5. Extension Activity/Assessment:



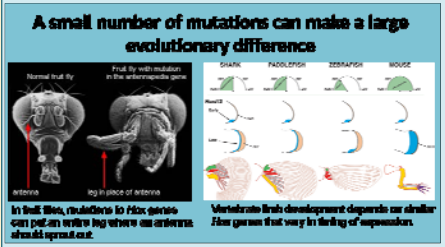
Evolution of Development:

1. Engagement Question:
- Students transition from discussing basic developmental pathways.
- Discussion question engages students to answer 'Why is the number of neck vertebrae fixed in mammals but variable in birds?'

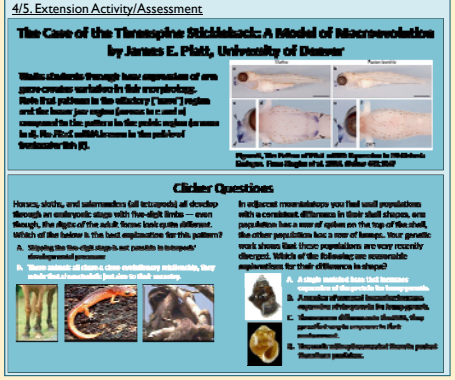
2. Student Exploration:
Students answer the question out loud or discuss with a neighbor to explore possible answers. Hopefully, they will come up with evolutionary constraints on their own.



3. Instructor Explanation:



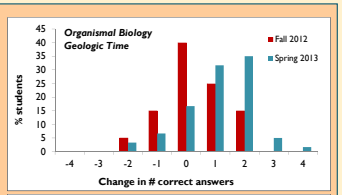
4/5. Extension Activity/Assessment

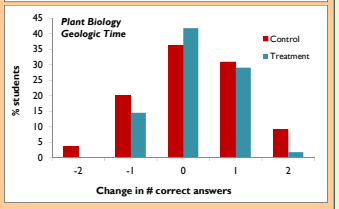


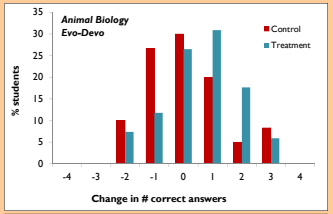
Assessment

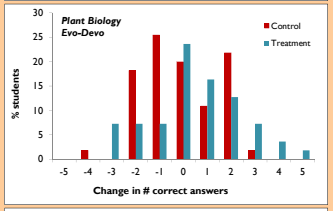
Geologic Time:

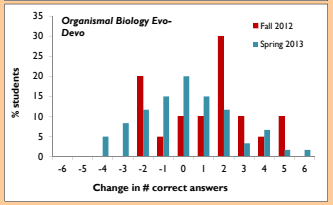
- For Organismal Biology the largest gains were in student understanding of the sequence of divergence among organisms.
- Plant Biology also showed gains but they were not significantly higher in the treatment vs. control.











Evolution of Development:

- In both Animal Biology and Plant Biology, students had higher gains in the treatment vs. control.
- Organismal Biology students also performed better on post tests both semesters.
- Gains were highest in Animal Biology and Organismal Biology, Fall 2012. This is likely due to implementation of the Stickleback Case study for all students in those sections.

Conclusions: Modules that were paired with large scale in-class or out of class activities (e.g. stickleback case study, clock assignment) showed the largest student gains. Certain topics like evo-devo and geologic time scale/molecular clocks have large potential gains when compared with better known topics like co-evolution and sexual selection.

UNIVERSITY of WISCONSIN LA CROSSE