AT&T FACULTY-STAFF AWARDS IN INSTRUCTIONAL TECHNOLOGY
2013-2014 Faculty-Staff Competition
Course APPLICATION FORM

Course Identifier: ZOL 890-601

Course Name: Evolutionary Biology for Non-Life Scientists

Department: Zoology College: Natural Science

Primary contact name, phone number, and email (normally this will be the lead instructor)

Dr. Louise Mead, 510-928-6598, lsmead@msu.edu

Faculty and Staff Involved in Developing and Offering the Course please list full name, position at MSU, email address, and project role for each person

<table>
<thead>
<tr>
<th>NAME</th>
<th>MSU Affiliation</th>
<th>PROJECT ROLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emily Weigel</td>
<td>Graduate Student</td>
<td>Co-Instructor</td>
</tr>
<tr>
<td>Caroline Turner</td>
<td>Graduate Student</td>
<td>Co-Instructor</td>
</tr>
</tbody>
</table>

Which Competition Are You Entering (select one):

___ FULLY ONLINE COURSE (no required face to face component)
___ BLENDED/HYBRID OR FLIPPED COURSE (some face to face learning is replaced by online learning)
/X TECHNOLOGY-ENHANCED LEARNING INNOVATION (one specific technology innovation in a face-to-face, blended, flipped, or online course)

Semester(s) offered in 2013-2014 and number of students enrolled:

<table>
<thead>
<tr>
<th>SEMESTER</th>
<th># STUDENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall 2013</td>
<td>5</td>
</tr>
</tbody>
</table>
I. Course Description (400 word limit)

This graduate-level course is designed to give computer science and engineering graduate students a working understanding of biological evolution. Students in the course are members of the multi-institutional Biocomputational Evolution in Action CONsortium (or BEACON Center), where computer scientists, engineers, and biologists work together to both understand and harness the power of evolution for practical applications. Thus, this course is critical to developing a basic understanding of evolutionary biology and fostering a common language from which productive collaborations with evolutionary biologists will later form. This requires that students learn much more than just the ‘facts’ of evolutionary biology – students will need to be able to ‘think’ like evolutionary biologists. Life-scientists in general, and evolutionary biologists more specifically, have a particular way of looking at the world, a perspective that may seem unfamiliär or counterintuitive to those outside of science. The students are thus tasked with beginning to view the world from this perspective.

The course is structured around three core modules, each lasting about four weeks:

Module 1: Genotype to Phenotype

This module covers the nature of genetic material, how it generates the observable characteristics of an organism, and how variation in genotype leads to variation in these characteristics.

Module 2: Mechanisms of Evolutionary Change: Change Within Populations

Here we discover how genetic variation is transmitted through a population of organisms the process that influence this transmission, and how these processes result in evolution (sensu stricto).

Module 3: The Consequences of Evolutionary Change

This final module allows us to explore how evolutionary change generates new adaptations and new species, and how we can use evolutionary change to reconstruct evolutionary history.

This course includes several assessments to develop both the collaborative and scientific skills of the students. Because the course is co-registered through the University of Idaho, classrooms are connected via Google Hangout to foster group discussion, allow for group presentations, and some in-class laboratories.

Additionally, students are assessed through outside of class activities via:

- online ‘Evo-Beaker’ laboratory exercises,
- individual homework exercises and problem sets,
- exploratory laboratory exercises using digital evolution software, Avida-Ed, and
- their ability to write and peer-review Evo101 blog posts—short narratives
describing, in lay terms, some concept within evolutionary biology for the general public.

II. Learning and Interaction Goals

For this application, we are focusing on the innovative use of Evo101 blog posts on the National Science Foundation (NSF) Science and Technology Center Blog, the BEACON Blog, as well as the Facebook Pages of BEACON and NSF Science and Technology Centers. Students were asked to generate posts for class, which were then peer-reviewed and shared via these social media outlets. The sharing of posts allowed for comment from the scientists which directly work in these fields, as well as the opportunity for our students to clearly and simply convey to the public the meaning and value behind work in evolutionary biology.

The use of course blogs has been successfully done in the past, however, what sets this particular use apart is that the forum is quite different. Here we have students communicating cross-disciplinarily and going through the peer-review process prior to posting entries, and once posted, these students’ work is then subject to scrutiny from the scientific community and the public via the BEACON and NSF Facebook pages that share them. This kind of attention not only prepares these graduate students for public dissemination of their work (as many of them plan to and will need to publish their theses) and helps them establish a professional digital identity online, it also provides an approachable, digestible piece of work that can describe complex phenomena in evolutionary biology in a way that is both interesting and understandable to the public.

The completion and peer-review of posts within the course factored into the assessment of students for our course, however many of the students who have posted to the BEACON Blog have since wanted to know how their posts ‘stacked up’, that is, they wanted to see how often their blog posts were read, ‘liked’, and shared on Facebook relative to posts that were shared by other posters, many of whom were writing about their own research. As it turns out, their posts are as popular (read and shared as often), if not more so, than posts posted by scientists discussing their own work. This has fostered a reflective and analytical look at how our students discuss evolution and make it accessible to the general public.

In terms of reinforcing general course goals, the posting of blogs and associated ‘sharing’ data has been beneficial. Of course, we want students to 1) Understand and remember the key concepts of evolutionary biology, and 2) Relate evolutionary concepts to patterns of biological diversity, but we have seen more: students have been able to 3) Construct hypotheses, determine methods to experimentally test these hypothesis, and anticipate and evaluate the expected results from experiments using not only the in-class lab exercises, but also the data and factors around what creates a widely-shared, scientifically-accurate article. The posted blogs have reinforced the goals that students 4) Be excited about evolutionary biology as a broad, complex and multifaceted field of study that has important implications to a wide variety of disciplines, and finally, through the peer-editing process and article
comments made by the scientists whose fields these posts describe, helped students recognize what they do not know about evolutionary biology and develop strategies to complete their knowledge.

III. Points of Interest and Innovation

This course is co-registered through the University of Idaho, thus classrooms at MSU and Idaho are connected via Google Hangout to foster group discussion and allow for group presentations and exercises. Given the challenges of conducting laboratories across large geographic spaces, we implemented individual homework and EvoBeaker exercises (see Fig. 1&2), which allowed students to experience digitally what it is like to conduct an experiment and test hypotheses through experimentation. Most importantly, as it is impractical (if not impossible) to truly view biological evolution within the duration of a semester, these computer-based exercises served as the best possible way for students to view evolution in action.

Figure 1. Example EvoBeaker online laboratory exercise, “Hardy-Weinberg Equilibrium”. This exercise taught the mathematical mechanics and assumptions behind biological evolution and served as the backbone to the second module.
Students completed these assignments outside of class as homework and received feedback individually and through a class debrief on their performance.

Introduction

Why Do Male Guppies Look Different in Different Streams?
With his theory of evolution by natural selection, Darwin proposed a mechanism for descent with modification. If a population of organisms has variation, inheritance, and differential reproductive success, then the composition of the population changes from one generation to the next.

Just because a theory works on paper, however, doesn’t mean that it works in the real world. This lab will challenge you to design a study that would allow you to document evolution by natural selection in nature. The EvoBeaker simulations you will use are based on a classic study by John Endler (1980) of natural selection in guppies. After you have designed and run your own experiments, you will have a chance to analyze some of Endler’s experiments and results.

Color Variation in Guppies
Most of us know guppies only as dramatically patterned aquarium fish (right). But the domesticated guppies we see in fish tanks are descended from wild ancestors. Wild guppies, Poecilia reticulata, live in mountain streams in the tropical forests of northeastern Venezuela, Margarita Island, Trinidad, and Tobago (below).

Figure 2. Example EvoBeaker Lab Manual Page. The lab manuals included introductions to several real-life biological systems and workbook pages for data collection and both formative and summative assessment questions throughout the lab. Students not only completed these online exercises in their lab manuals, but were also introduced to the basic best practices of maintaining a lab notebook in which to record data and observations.

In addition to classwork centered on ‘doing’ real science through digital laboratories, we implemented an assignment designed to help students think critically about the concepts they were learning: Evo101 blog posts. These are short narratives describing, in lay terms, a concept within evolutionary biology. Students wrote
several Evo101 blog posts individually and were able to model the peer-review process prior to sharing their posts with broader audiences through social media.

So, what steps go into making an Evo101 blog post (visible on the BEACON blog here: http://beacon-center.org/)? How does it resemble the publishing process, and how do the public and scientific community receive these posts?

Step one is picking the Evo101 post topics. The course instructors and BEACON scientists develop a list of topics that are widely researched in BEACON and, in many cases, topics which are not well described for the general public. From these lists, students pick two topics which coincide with a module’s content. From material to be covered in the course and their own research, students then amass the content necessary for the posts.

Step two is writing and reviewing Evo101 blog posts. To begin this process, students are given a two-part lecture, “How to Write Science for the Public” and “How to Review,” which included language to avoid, how to structure articles, and how to find accompanying open-access media (videos, pictures, sound files, etc.) to enrich posts designed to reach the public. Much like the paper submission process, the students were to write the posts and trade with 3 classmates who would review the blog posts for clarity, interest, and accuracy based on what the course covered. A sample screenshot of the submission and review process is provided in Figure 3.

![Figure 3. Example Instructor (‘Editor’) View of the Evo101 Submission and Review Process on Desire2Learn. Students were assessed both on their submitted draft posts and revisions, as well as their submission of quality review of others’ work.](image-url)
After writing their posts and submitting for peer-review, we move to step three: the students would then receive feedback on their posts from their ‘reviewers’ as well as the course instructors who served as both content ‘experts’ and ‘editors’ for the blog. Students were then tasked with integrating all of the reviewer and editor comments to resubmit a post for consideration for publication, i.e. to be considered for posting on the BEACON Blog.

Figure 4. Example Evo101 Post to the BEACON Blog. This post addressing digital evolution was created by one of our students and posted to the blog through a collaboration with BEACON’s Managing Director, Danielle Whittaker.

After posting to the BEACON Blog, the posts were then shared via Facebook to both BEACON and the National Science Foundation (NSF) Science and Technology Centers pages (Fig. 5-7). These media allowed for comment from the scientists which directly work in these fields, as well as the opportunity for these students to clearly and simply convey to the public the meaning and value behind work in evolutionary biology. Furthermore, these posts could be shared more broadly, as the links on the pages were set up to be ‘liked’ and further shared by the public.
Figure 5. BEACON Center Facebook Page. Evo101 posts are shared via this page with over 321 people directly and to third parties with whom posts are shared.

Figure 6. Example BEACON Center Facebook Post. Here, the Evo101 post on Digital Evolution, is being shared directly with group members and to third parties with whom posts are shared.
After posting to Facebook, an interesting thing happened: the students continued to engage with their posts even after our course ended. Our students wanted to know the statistics behind the shared posts and how many people they were reaching. The average posts reached 50 people outside of our course (5X the class size!) just from the BEACON Facebook page alone (Fig. 8). Furthermore, not only were the posts reaching many people, they often were read by more people than similar articles written by the scientists who research these topics!
Due to the effectiveness of the course and these posts, our students are motivated and have the skills to reach both other scientists and the general public when they speak about evolutionary biology. In terms of reinforcing general course goals, our students are 1. understanding and remembering (and writing about!) key concepts of evolutionary biology and 2. relating those to patterns of biological diversity. They are also 3. constructing and testing hypotheses, and evaluating results using not only the in-class exercises, but also the social media data from sharing their posts. Perhaps most importantly, the posted blogs have reinforced the goals that students 4. be excited about evolutionary biology, and 5. recognize what they still need to know. We are extremely proud of our students for achieving these goals and very pleased that, in addition to teaching each other, our class has been able to also educate the public on the wonders of evolutionary biology.

IV. Accessibility

Science is wonderful, but understanding what scientists do on a daily basis can be difficult for those who cannot ‘see’ what it looks like. The BEACON Blog, as well as the BEACON and NSF Science and Technology Centers Facebook pages, help to demystify what it is that scientists do, and help to break down the assumption of “What a Scientist Looks Like” (check out this wonderful project here: [Link to project]

Figure 8. Example BEACON Blog Post Sharing Data As It Appears on Facebook. Circled in red are the posts written for Evo101. Uncircled posts are those submitted by BEACON scientists chronicling their own research.
http://lookslikescience.tumblr.com/). These posts help to expand the mental image of who exactly is a scientist, and for those that do not interact with scientists regularly due to a myriad of reasons (geographic proximity, socioeconomic status, etc.), it helps bring science into the home, and even onto your phone. Furthermore, the plain, sleek design of BEACON blog itself, as well as Facebook pages, are readable through Screen Reading software, contain large links for ease of clicking, and the images displayed within the blogs contain captions which allow the visually-impaired to still connect with the media used within each post.

V. Evidence of Effectiveness with Students

A pre- and post-assessment (~15 questions) was designed for this course to establish a baseline for what students already knew about evolutionary biology, and why they were interested in taking out course. Questions on the assessments were designed to target specific evolution misconceptions as documented in the assessment literature. Although our class size is small, by the end of the course, as compared to the same assessment questions asked to undergraduate natural science majors (Weigel, Mead, and McElhinny, in prep), our course of engineers and computer scientists scored 30% better than the undergraduates across all questions. Specifically, when addressing the major 3 misconceptions shared between the two groups in the pre-test, students in our course were able to ‘unroot’ all three, whereas the undergraduates remained unchanged after taking undergraduate Evolution. This is extremely telling, as for many of our students, the last course they had in biology was in high school, up to a decade ago!

In addition to continued engagement via the Evo101 posts after the course completed, the students also indicated strong interest during the course itself. In response to holding the course via Google Hangout for discussion, one student said, “I really liked the open discussion style of the class. It not only increased my motivation but also gave me the feeling of a solid understanding of the subjects discussed.” (Achieved Course Goals: 1, 4, &5). In response to the EvoBeaker digital labs, another student said, “They greatly reinforced the concepts in a comprehensive manner. Having them out of class was also a bonus, as it allowed more time to complete them accurately and really analyze/understand the experimental results.” (Achieved Course Goals: 1, 2, 3, & 5). Finally, students found the variety in types of assessments beneficial; specifically, one said, “By spreading the graded assignments throughout the semester, and varying them, it made the class more enjoyable without, in my opinion, diminishing its academic value.” (Achieved Course Goals: 4 & 5). Thus, we achieved all 5 overarching course goals in an effective, enjoyable manner for the students that encouraged further engagement after the courses’ close.

VI. Plans for Sustainability

This course is offered regularly during fall semester to graduate students, and judging by the success of the use of Evo101 posts for the course and generating accessible content for the BEACON blog, it is likely that the Evo101 course element will remain a fixture of the course. In addition, the companion course, taught by computer scientists
where biologists learn about computer science initiatives that incorporate evolution, has indicated interest in incorporating the same Evo101 schema. We have also discussed the possibility of trading draft posts between the courses for the ‘expert’ review to be done by the students in the opposite, companion course—the budding scientists and engineers researching in these fields. This way review will not only incorporate student views on interest and accessibility, but deepen the level of accuracy review that students are able to do and mimic the anonymity and targeted expert reviewing of the peer-review process.