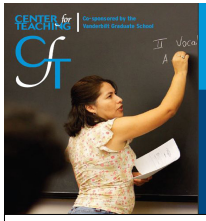

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Lecture vs. Laboratory Learning in Developmental Biology

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Cell & Developmental Biology
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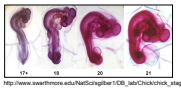
INQUIRY PHASE

Context For this project, I taught a section of the graduate course, Developmental Biology Bootcamp (CBIO 312). This course is a requirement for all new students in the Program in Developmental Biology, and thus most students have a genuine interest in basic developmental biology. This course was team taught by different Vanderbilt professors and I taught the section on chick embryology. This class has both a lab and lecture component, as students learn basic embryology and current techniques by conducting their own structured experiments. The goal of the course is to introduce new students entering a developmental biology laboratory to basic embryonic terms, concepts, and classical studies, and to provide them with a solid foundation in the developmental biology of different model organisms (frog, worm, fly, fish, mouse, chick). In their own labs, however, students will most likely focus on a specific scientific question, using a single model organism. With a baseline of knowledge of different model organisms, students will be able to compare and contrast how different organisms develop (e.g., cleave, gastrulate, and neurulate), thus providing insight into their own project. In nature, different organisms achieve these hallmark developmental states in similar ways, although the details can be quite different. Understanding these differences is essential for a career as a developmental biologist.



Development of the chicken embryo

Vanderbilt University Program in Developmental Biology

PDB Bootcamp 2009: An introduction to developmental biology

Questions Courses in the natural sciences typically have laboratory and lecture components that are both critical and necessary for learning scientific concepts. The lecture format can be viewed as a more traditional and somewhat passive way in which to impart knowledge to students. Laboratories, in contrast, are much more active, as students must engage the material to successfully conduct an experiment. Active learning in the natural sciences has been the subject of several research studies. One study showed that students receive slightly better grades and are less likely to fail when placed in an active learning setting as compared to traditional lecture based learning (Walker et al., 2008). However, large class size often times prohibits a solely active-based approach. So, how can active learning be strategically incorporated to maximize learning outcomes? Thus, will students be more likely to have stronger learning outcomes when first presented with new material in the laboratory or will students retain more if they are first taught the material in a lecture format.

Lecture Learning

versus

Laboratory Learning

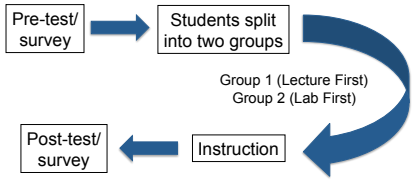
Do developmental biology students learn scientific concepts and methods better when presented first with the lab component *or* the lecture component when learning new material?

ABSTRACT

Active versus passive learning in the natural sciences has long been a topic of pedagogical research, and studies show that incorporating active learning results in more efficient learning outcomes. In developmental biology, both the passive and active components are essential to gain a fundamental understanding of the embryo and how it develops over time. However, it is not known if students learn more effectively in the classroom or at the bench. Thus, the question arises: do developmental biology students learn scientific concepts and methods better when presented first with the lab component *or* the lecture component when learning new material? To answer this question, two groups of students were exposed to both components, but in different orders to determine whether there was a significant difference in learning outcomes. Results indicate that learning is independent of the teaching format, suggesting both methods are sufficient for maximal learning. Survey data suggests that each group of students were satisfied with the format of teaching they were subject to, and that they thought they learned more from the component that was presented first (lecture or lab).

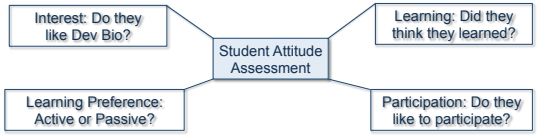
EXPERIMENTATION PHASE

Gathering Evidence To conduct this study, I administered a pre-test one week prior to the lectures on the developmental biology of the chick. The following week, the students were randomly split into two groups where Group 1 was taught the lecture first, and Group 2 conducted the lab first. The following class period, students took a post-test. Using this method, student knowledge before and after each class was tested to determine whether students learned more when first presented with the active based approach or the more traditional passive lecture setting.

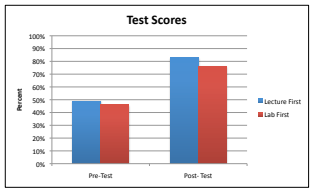


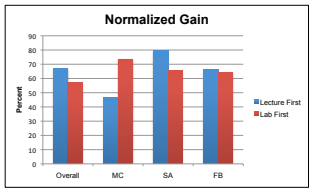
Chicken and quail embryos are common developmental biology model organisms

Pre- and post-surveys were also administered on the to assess the general attitudes and perceptions of the students in each class format. Four general attitudes were assessed:



Findings Test score Data: Overall, there was a significant difference between the pre-test and post-test scores of all the students (Group 1, $p < 0.0002$; Group 2, $p < 0.0005$), demonstrating that the students learned the material on the developmental biology of the chick. To further analyze the data, I calculated the overall normalized gain [(post-test - pre-test)/(100% - pre-test)] for each student, then took the average for each group. I also determined the average gain for three different test question formats to determine if one teaching format resulted in better scores on a particular type of question.





CONCLUSIONS

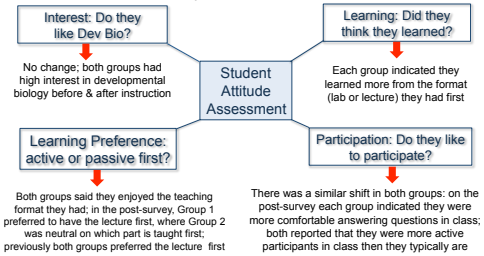
There was not a significant difference in the either the pre-test scores or post-test scores of Group 1 (lecture first) when compared with Group 2 (lab first). Although Group 1 did slightly better in the overall test (+4.1 points), this result was not statistically significant.
Students in Group 1 (lecture first) scored slightly better on both the short answer (+1.43 points) and the fill in the blank questions (+0.4 points). Again, these results were not significant. However, Group 2 students (lab first) did better (+2.69 point) on the multiple choice questions; this result was close to the statistical limit ($p < 0.058$), but still was not significant.
It is difficult to determine if the insignificant results are due to a small sample number (6 in each group), or if neither format is beneficial over the other in terms of learning outcomes. Additionally, because this is a rather homogenous group of students who all have a high level of interest in developmental biology (see survey results below), learning in both groups may be skewed towards favorable outcomes and therefore a difference may not be present in this population.

	Overall	MC	SA	FB
Lecture First	66.7	46.7	79.6	66.1
Lab First	57	73.6	65.3	64.2
Difference in Gain	9.7	-26.9	14.3	1.9

	Pre-Test	Post- Test
Lecture First	49%	83.30%
Lab First	46%	76%

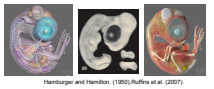
Findings Survey Data The survey results indicated that generally, the interest level in developmental biology was high. Student in both groups:

- Liked working in groups
- Thought they learned more if they were an active participant
- Enjoyed participating in class discussions
- Were comfortable answering questions out loud in class
- Thought the material learned in one component (lab or lecture) would reinforce what they learned in the other



Conclusions

- Students in both groups learned the intended material
- Increased test scores were independent of the teaching format
- Students thought they learned more from the class component they were exposed to first



Hamburger and Hamilton. (1950).Ruffins et al. (2007).