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Transferring a Course Developed for Honors Students to Non-Major Biology Students: Lessons Learned

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The honors program, in distinguishing itself from the rest of the institution, serves as a kind of laboratory within which faculty can try things they have always wanted to try but for which they could find no suitable outlet. When such efforts are demonstrated to be successful, they may well become institutionalized, thereby raising the general level of education within the college or university for all students. In this connection, the honors curriculum should serve as a prototype for educational practices that can work campus-wide in the future.

—Basic Characteristics of a Fully-Developed Honors Program

ABSTRACT

Honors colleges offer the opportunity for faculty to teach small classes to motivated, academically gifted students. One possible benefit offered by teaching honors courses is the opportunity to experiment with new teaching approaches. Thus, one goal of honors colleges is to act as a "lab" for developing novel educational approaches that can be applied across the university. Here I report on the lessons learned from my experience transferring a course developed for honors students to the general student population.

A LITTLE BACKGROUND

Teaching science to non-science majors involves a special set of problems. For example, many students are not interested in science (the most depressing definition of science I have ever received from a non-major biology student was that "science is the study of things that are boring to me") or are fearful of science. It is important to motivate non-science majors if we expect them to learn about science. We want to motivate them positively by interesting them in the subject, challenging them at the appropriate level, and showing them how learning about science can be useful to their everyday lives. Similarly, we want to avoid negatively motivating students, i.e., we want to avoid boring, frustrating, or hopelessly confusing these students. Thus, I try to cover material that is both interesting and relevant to them. Luckily for me I teach biology, so it is easy to include "sexy", interesting, and relevant topics.

In my opinion, the lab component is a major weakness of many science courses for non-majors. A significant problem with many introductory science labs is the use of "canned labs," where the students simply follow a recipe that will lead them to the desired result. Any scientist would tell you that this is not how we really do science. So what are these types of labs really teaching the students?

There are three main uses for a lab course that is associated with a lecture course for non-science majors. First, the lab can reinforce information covered in lecture. Second, the lab can provide students with hands-on experiences that are not possible in the lecture. Third, the lab can introduce students to the process of science through investigative activities. Although these are each valid uses of a lab course, I have chosen instead to develop a lab that focuses on exposing the students to the process of science. First, I believe that an understanding of the process of science will be more useful to students in their future life than being able to name all of the parts of a flower, to illustrate the process of meiosis using play dough, or to know whether food first passes through the large or small intestine. Second, I hope that exposing students to the excitement of discovery will increase their appreciation of and interest in science.

In the "Process of Science" lab, I cover: (1) what is science? (2) the scientific method, (3) sampling and experimental design, and (4) hypothesis testing and statistical analysis (including t-test, linear regression, and chi-square test). The ultimate goal of the course is to prepare students to design, conduct, analyze, and report on their own independent research projects. Because these are non-science majors, typically they lack the background necessary to ask sophisticated questions about biology. Thus, it is unrealistic to expect that these students will be able to ask good questions independently about botany, zoology, or ecology. However, because college students have been alive on this planet for at least eighteen years, they have had significant experience interacting with human beings and observing human behavior. Because my original research training is in behavioral ecology, I recognize animal behavior as a valid and extremely interesting field of study. Additionally, I believe that humans exhibit some of the most interesting behaviors. Thus, in my opinion human behavior is an ideal subject for study by non-science students. First, all students should be interested in some aspect of human behavior. Second, all students should have experience thinking about and observing human behavior. Thus, all students should be able to think about human behavior in a "sophisticated manner." In my lab course, I have encouraged students to conduct their research projects on any aspect of human behavior that they find interesting.

I conceived of this lab while teaching "Honors Integrated Science," a two-semester sequence for non-science majors in the Honors College at Texas Tech

University that is team-taught by a biologist, a chemist, a physicist, and an earth scientist. When I initially tried this lab in the honors class, I was pleased with the results, and so I have continued to use this approach in the honors class for a number of years. In general, student responses have been positive, and I think that the honors students have enjoyed and benefited from the class.

My experience teaching this course to honors students suggested that this was an effective alternative to more traditional approaches to teaching labs. Thus, I volunteered to develop and coordinate labs for the non-majors science classes in my home department (the Department of Biological Sciences). In the fall semester 2001, I offered the "Process of Science" Lab for first time to all non-major students in our department (> 800 students with over 30 sections). To my complete surprise and dismay, I soon learned that approaches and activities that appeared to be successful when working with honors students were much less successful when applied to the non-majors biology course. The students quickly became frustrated and hostile! I was at a loss to understand how activities that honors students found to be fun and valuable had suddenly become "totally stupid" and "a complete waste of time" according to non-major biology students (I wish that they would tell me what they really thought!). The students were in a near mutiny by mid-semester, and only a superhuman effort by the teaching assistants allowed us to survive the semester. The result was not a positive experience for students, the teaching assistants, or me.

WHAT WENT WRONG?

Clearly, I made mistakes when designing and implementing the lab for non-major biology students. But how could an approach that had proven effective with honors students be so unsuccessful with non-major biology students? The answer may depend on differences between honors students and non-majors biology students. My hypothesis to explain my failure is that efforts I used to motivate the students backfired, i.e., approaches that positively motivated honors students negatively motivated non-major biology students.

The "ideal" honors student (a) is bright, inquisitive, and enjoys learning, (b) is academically focused, and (c) has a strong academic background. At the other extreme, the "nightmare" non-major biology student (a) is not motivated to learn, (b) may consider a fraternity/sorority, going to the gym, working, or partying to be more important than school, and (c) is taking a science lab only because it's required. Moreover, non-major biology students may have poor math and science backgrounds from high school (in Texas we call this the "coach effect").

When I initially conceived my approach to teaching science labs, I focused my efforts on attempting to interest and excite students. In my mind the best strategy was to distance my approach from the traditional labs that my previous research had shown were unpopular with students. Thus, I intentionally introduced the course with an unusual activity. For example, we have examined whether students are able to find water using a dousing rod, whether any students in the class have ESP, or whether they could tell if someone was staring at the back of their neck. My hope was to show students from the very first day that this lab was going to be different from any science experience they had had before.

I followed the introductory lab activity with a lecture about mating behavior and sexual selection, a topic that I have always found to be of interest to students. I wanted to discuss a topic that students found inherently interesting and where science could be extrapolated to everyday life (what is more on the mind of the typical college student than attracting a mate?). Finally, I wanted to introduce a potential topic for students to study in their independent lab activities. This lecture was followed up by a series of non-traditional lab activities designed to excite students' interest in science by allowing them their own way of doing things (i.e., no cookbook labs). During the meat of the course, we spent several weeks discussing hypothesis testing and statistics (including t-test, linear regression, and chi-square test). The lab finished with students designing and conducting their own studies.

When I taught this lab to students in "Honors Integrated Science," it appeared that the honors students understood that I was trying something "different" and they quickly got in the spirit of things. Thus, honors students appeared to be positively motivated by the less-traditional approach. First, they were interested in the material. Second, it appeared that their interest was enhanced by the freedom that was associated with this approach. Third, they appreciated and accepted the challenge of learning new and difficult material (i.e., hypothesis testing and statistics). Finally, most honors students enjoyed designing and conducting their own projects. Because they found the course to be interesting, challenging, and fun the motivation level of these students was very high. Thus, it appears that positive motivation was synergistic. That is, providing the students with a course that was rewarding in a number of new ways resulted in a motivation that was more positive than the sum of its parts.

In contrast, non-major biology students were not positively motivated by the less traditional approach. Rather than accepting the challenge of this approach, the non-major biology students quickly became frustrated. First, they were frustrated by the apparent lack of structure. In science labs in high schools they always had a recipe to follow whereas now they had to come up with their own research project! Second, they were frustrated by the "strangeness" of the subject matter because it was so unlike anything they had ever done before ("when are we going to cover real biology?!"). Third, because they were expecting the lab to be "hands-on," any amount of time spent lecturing in lab was clearly unexpected and thus unacceptable to them. Fourth, they were frustrated by the difficulty of the subject matter ("statistics is math!"; "it's too hard!"). Finally, and most surprising to me, they became frustrated because they didn't understand why they needed to learn any of this ("When am I ever going to use any of this?"). It appeared that frustrating students in so many ways simultaneously resulted in a disastrous negative synergism!

Moreover, there appeared to be a threshold level of negative motivation that, when crossed, caused students to become bitter, negative, and irrational (for many students the fact that we were not allowing them to memorize all of the different types of fruits or to dissect an annelid worm was cheating them out of the most relevant and interesting educational experience of their college careers!). Once the threshold level of negativity was crossed, it proved to be difficult to turn the lab around to a positive experience.

IF AT FIRST YOU DON'T SUCCEED, TRY AGAIN

Thus, it appears that there are differences in the ways that Honors students and non-major biology students were motivated by the activities that I tried. If my hypothesis is true, then I should be able to predict what I need to change to improve the course for the non-major biology students. First, if the frustration level of the students is multiplicative, then I need to avoid frustrating the students in more than one way at a time. Thus, I predict that overall negative motivation will be decreased if I (1) initially increase lab structure to avoid being too "bizarre" early in the semester, (2) decrease the amount of lecture time in class, (3) provide more time for traditional hands-on activity, (4) make sure that students understand the application of the statistics prior to showing them the math behind the stats, and (5) show them how this relates to their life.

I made these changes before using this approach for the second time in the spring semester of 2002. First, to increase the amount of structure in the course and to minimize the amount of lecture time during the lab period, I rewrote my lab manual in a format that required students to read the chapter and answer a series of review questions before coming to lab (McGinley, 2003). We started each lab period by reviewing the material covered in the review questions prior to each student's taking a quiz. Students are required to pass every quiz, so if they fail a quiz they need to retake it at an out-of-lab time. Thus, the amount of lecture time required in class was greatly reduced. Moreover, students came to the lab knowing what they are confused about so that their time in class served to reduce rather than increase their anxiety level.

Second, I tried to avoid being too "bizarre" too early in the semester. Rather than talking about animal mating behavior and how that might relate to human behavior early in the semester, I waited until students were more comfortable with the purpose and the flow of the lab. I also chose to leave out some of my favorite activities because the non-major biology students found them to be too strange and unstructured.

Third, I added more hands-on activities in class. For example, I made sure that they had to measure various things as we learned about sampling and the various statistical tests rather than simply providing them with the necessary data. I myself think of this as being busy work, but it was clearly more satisfying to the non-major biology students.

Fourth, I tried to introduce hypothesis testing and statistics in bite-sized packages. I tried to make sure that they made sure that they understood why we need statistics and how we use statistics prior to showing them the math behind the stats. Where possible I tried to show how we could use statistics to help us answer questions in everyday life.

These changes improved the lab experience of the students greatly. Students "enjoyed" the lab more (I actually heard students laughing rather than complaining during the lab periods). Although I don't have the necessary data to quantify this, it appeared that students understood the application of statistics much better than the previous semester. Concepts, such as the null hypothesis, which seemed too difficult for many students to grasp during the first semester, were grasped fairly quickly by students in the second semester. In addition, students were able to conceive, design, conduct, and analyze their own investigations more effectively. Not only did they enjoy these activities more, but I observed an increased level of sophistication in their investigations. Thus, the improvements that occurred in the second semester provided support to my hypothesis that non-major students are motivated differently than honors students.

LESSONS LEARNED

The purpose of this paper is not to convince you that my approach to teaching lab courses is the best or that I have been effective at designing a lab course that meets my objectives. Instead, I would like to discuss some of the lessons that I learned attempting to follow the urgings of the National Collegiate Honors Council to use honors courses as a laboratory to experiment with new ways of teaching courses that, if successful, can serve as models across the curriculum.

1. Take care when extrapolating directly from honors classes to other classes across the university. If an honors college admission staff is doings its job, then most students in honors classes should be capable, interested, and motivated. As I have discussed above, techniques that work for motivated, academically gifted students may not be as effective for less motivated, less well-prepared, or less academically gifted students. Thus, we need to be aware background and interest level of students so that we can design each course most appropriately.

2. Similarly, we should take care when attempting to apply courses that we have developed with the traditional student body to honors students. Honors students may be stimulated by levels of challenge and innovation that make regular students uncomfortable. Thus, teaching courses that are effective for non-honors students may fail to challenge and motivate honors students, and causing them to learn much less than they could. We may be able to go at a faster pace, in more detail, and with less structure. Teaching "traditional" courses to honors students may be limiting the educational opportunities that we could offer them.

3. Classroom dynamics may be different in honors courses than in traditional classes. Because the proportion of inherently motivated students should be

higher in honors classes than in traditional classes, I have found that a few unhappy students in a group of generally happy students have little effect on the overall attitude in an honors class. Because the failure to motivate all students in a class does not bring the entire course down, instructors can design the course to motivate students at the top end.

However, the presence of a few unhappy students in a group of neutral or negatively motivated traditional students may have a strong negative effect on the overall attitude of the class. Our experience suggests that a few vocal unhappy students can quickly incite the neutral students to move to the dark side (as we observed in the great "WE MUST DISSECT FETAL PIGS!!" riot of fall 2001). Thus, when teaching a course for non-science majors the instructor might want to pay more attention to the lower end of the distribution in an attempt to reduce the proportion of unhappy students who can have a large effect on the overall experience of their classmates.

CONCLUSION

I consider myself to be a good teacher, but I was caught totally off guard by the response of non-major biology students to the lab I had taught successfully in the Honors College. I was disappointed, disillusioned, and depressed throughout the semester. Fortunately, the past success that I had had with the honors students kept me thinking that there was something to this new lab approach, so I kept on trying. Thus, my experience in the Honors College motivated me to continue when I otherwise might have given up.

We need to be willing to experiment. Unfortunately, if we are going to experiment, then we have to be willing to fail (and from experience I can assure you that failure is no fun). What we learn from our failures will allow us to develop better courses. However, don't forget that sometimes your experiments might succeed and allow you to improve the education of all students across the university!

REFERENCE

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