Teaching and Research Statement

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Interplay of teaching and research

> The metaphor I like to use ... is that of a hiking trip in which we trek through a large wilderness area. When I start, I know to a small degree what lies ahead and vaguely where I am headed. I never know, however, precisely what we will encounter, and nor can I anticipate the decisions that we will make.
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> M.H.H. Stevens (2008)

For what part of my academic life is the above quote a metaphor? Is it about interdisciplinary research? individual research in biofuels? mentoring student researchers? teaching a non-majors 100-level course? service on a community organization? I think that it works perfectly well for all of these activities, because these endeavors are all quite similar: they constitute adventures.

I believe that the skills of investigation, creative and critical thinking, understanding contexts, collaborating with others, and making decisions are essentially the same for research and teaching. These skills are honed in each activity, and I try to bring these skills to everything I do, whether I am part of a research team from Mathematics, Engineering, Zoology, Microbiology and Botany, or on the Liberal Education Freshman Summer Reading Committee.

I am lucky because my research, teaching and service cover an interesting range of areas beyond plant ecology, to include areas such as mathematics and cell biology, which cover all the taxonomic divisions (or kingdoms), and include education of science majors, non-majors, and Oxford citizens. These diverse activities have included advising the city of Oxford about the negative impacts of white-tailed deer, mentoring undergraduate research in anaerobic digestorion for energy recovery, helping select the Miami University Summer Reading Book, or judging papers submitted to the Association of Southeastern Biologists' Senior Research Awards Committee on topics across all biological disciplines.

My use of the hiking metaphor above (taken from one of my 2008 syllabi), I believe, is an example of how a little creativity can enhance our communication and our perspective on what we do.

Teaching Philosophy

Background

I have taught in a wide variety of class settings, including in community college, graduate classes in a research university, and continuing education for K-12 teachers, and a wide variety of courses have spanned the range from radiobiology and Human anatomy to general biology and theoretical ecology. As much as anything else, however, two additional experiences have given me my greatest appreciation for the *difficulties and frustrations of being a student*: fatherhood and the tenure process.

As a father, I have seen how I influence young people. I have learned the importance of keeping a *positive perspective, maintaining patience, and building trust.* In all that I do in the academic classroom, I keep in mind that these three factors are the most important factors determining student performance and satisfaction.

As a untenured faculty member, I learned how important it is to have *evaluation criteria spelled out clearly* in writing and articulated by those doing the evaluation. I had the great fortune to have wonderful departmental chairs. They have been absolutely clear about the hoops through which I needed to jump to acquire tenure and to succeed at my institution long into the future. I am deeply indebted to their honesty and forthrightness. Given this experience, I now have complete empathy with students who ask "What's going to be on the test?" I now continually strive to clarify my goals, expectations, and specific methods of evaluation in all my classes. Perhaps it is the continued re-evaluation of my own goals for each course and for each lecture that benefits my students the most. For this, I owe my gratitude to my colleagues at Miami University.

Learning science

I believe that science education for undergraduates must reflect, in part, *the nature of scientific inquiry.* Students should do science, in addition to reading or hearing about it. This approach may start anywhere, perhaps with fundamental questions about how organisms function, or with an applied problem to solve. Students must actively collect and analyze scientific evidence and must also follow up with the communication of their results to peers. Students should learn science by doing science.

In addition to doing science, students should see how scientists do science. Toward this end, I do several things. First, I introduce my research whenever possible (my research is fairly diverse, see below). This need not be heavy handed, but I need to show them that this warm body (me) advances Science in some small degree. Second, I introduce details of the scientific studies that underlie the concepts they learn in of lectures and in books. Thus they see how experienced individuals (or teams!) go about formulating a question, designing experiments, and interpreting data. Last, I show them how I reason through answers toward more interesting scientific questions. I also am learning to link basic scientific concepts to applied issues of topical concern (global warming, loss of biodiversity), but I am trying to increase the degree to which I do this.

Biology is a tremendously dynamic, rapidly advancing field, and the amount of material students are expected to absorb grows each day. To deal with this exponentially swelling problem, I am forced to take two approaches. Like all teachers, I spend more time deciding what *not* to teach, than what *to* teach. In addition, I am striving to engage students more and more in knowledge creation.

Engaging students in large lectures

I have found several approaches helpful in large classes. In general, any task that is physically tangible helps people become and remain engaged in a cognitive process. Lab and field classes, of course, do this in spades. In lectures, however, it remains somewhat elusive for those of us pushing to tell students the mountains of facts we think they need to become successful. Therefore, in each lecture period, I try to do the following activities. Pedagogical and cognitive science research supports the use of these, and they are certainly not novel, but they work for me.

Ungraded writing exercise This brief task, often just a question, or a 60 second narrative, does a couple different things. First, the exercise can wake people up, increasing their alertness. Second, writing is frequently a process of discovery - we often don't know what we think until we try to state it or write it down. Third, it provides students greater comfort with their own thoughts; students feel more comfortable asking questions or contributing to discussion if they can read their own writing rather than speak off the cuff. Fourth, I share anonymous student questions or comments. I often collect these and share them with the class. Used midway through a lecture period, the exercise breaks up the sedentary nature of a lecture; used at the end, it can help students pull together a long lecture, or alert me to questions they still have after a lecture.

Small group discussion Small groups, typically pairs or in three's, provide a forum in which students can teach each other. They gain new ideas and new perspectives, unavailable in isolation. Further, explaining something to another person functions like the writing exercise above, helping students to discover and clarify their own ideas. Some students feel more comfortable sharing with peers and in very small groups, than in the public setting of a lecture hall.

Move, ask questions, ask for restatements This is not novel at all, but is certainly helpful for me. I keep physically active in class, getting in close proximity to different students just to shake them up and keep them alert. Of course, I present problems and ask them to provide some answers to questions with which we begin lectures. I ask people to restate important concepts that I have just stated. I always impresses me how poorly I have been in communicating a concept after only a first pass at a topic. Asking students to attempt immediate regurgitation of concepts I have just lectured on keeps me in tune with how they are keeping up.

Of freshman, seniors, and graduate students

I believe that the difference in "teaching"[1] freshman, seniors, and graduate students is, in part, one of degree. In a classroom setting, I assess the general current knowledge base of a group of students, noting individual variation, and help them come up to a common level of understanding and a new knowledge base. Over time, I help students develop aspects of critical thinking, for instance, problem idenitfication, personal point of view, use of supporting data, or incorporating multiple perspectives. I am developing greater awareness of the individual differences in students abilities to handle both course content and critical thinking; some of these differences may be due to physical maturity, but I do my best to bring all students along.

Research Areas

I study the causes and consequences of biodiversity, at ecological and evolutionary time scales, using a wide variety of organisms. Several projects illustrate the wide scope of my current research interests.

Effects of biodiversity on carbon storage in experimental prairies: toward sustainable biofuels This project is my current primary research focus. We are seeking to understand how biofuels will influence agroecosystems. For instance, the use of more land for energy production appears to lead to increased food prices and more rapid forest destruction. However, intelligent management decisions can lessen the negative the impacts of biofuels, and can minimize the "train wreck" that over reliance on biofuels would bring. For instance, intelligent harvesting of native plant communities in marginal lands could increase native plant and animal biodiversity and enhance Ohio farmers' incomes. See our research web sites at

- http://www.cas.muohio.edu/∼stevenmh
- http://www.cas.muohio.edu/∼stevenmh/BFResearch.html
- http://www.cas.muohio.edu/∼stevenmh/FieldHistory.html

[1] i.e., facilitating students' own acquisition of knowledge and wisdom

Our overarching goal is to understand how the biophysical realities of the environment intersect with human economics. A key component of this intersection is to take advantage of local SW Ohio market forces to drive local sustainable biofuels production. A part of this research also seeks to provide a simple theoretical basis for understanding plant productivity and carbon storage in a successional context (see 2007 ESA Symposium abstract, and 2008 ESA Biofuels Conference poster).

Primer of Theoretical Ecology with R! I am writing a simple introduction to theoretical/mathematical ecology (e.g., Gotelli 2008, Roughgarden 1998) that also provides an introduction to R, the Open Source language for statistical and dynamical modeling (http://www.r-project.org/). It is part of Springer Publishers' *Use R!* series for the natural and social sciences.

Effects of resource availability on food webs Effects of resources on food webs depends critically on the details of the food webs. We are using mathematical models to investigate the potential short term and long term effects of both omnivory and resource pulses on the stability of food webs.

Causes of biodiversity Gradients of resource availability and of temperature can increase, decrease, or have no effect on biodiversity, and biologists are only just beginning to try to figure out the conditions that determine the specific effects. Our lab is currently engaged in several projects to further investigate the effects of resource availability on biodiversity.

Global patterns in vascular plant diversity Recent meta-analyses have provided the clearest picture yet of the relations between environmental factors and plant diversity. I am trying to add my perspective to this emerging picture by linking water, temperature and soil nutrient content in a single model predicting and explaining these large scale patterns.

Evolutionary dynamics of biodiversity We studying the evolutionary emergence of a resource availability - genetic diversity pattern in in long-term stationary phase Escherichia coli populations. We are now beginning to uncover mechanisms contributing to the emergent patterns.

Effects of environmental color The world is variable, and yet we rarely study the effect of that variability. This pattern of temporal variability of an environmental factor can be characterized as the *color* the pattern, deriving designations of white, blue, red referring to spectral density distributions that are flat (random white noise), or skewed toward higher frequencies (blue = relative uniform) or toward lower (relatively correlated red noise). Reddened patterns of environmental variability (pink spectra) are thought to be relatively common in natural systems. Further, their seem to be systematic differences in different environments, for instance, with marine environments relatively red compared to terrestrial environments. In collaboration with Joel Cohen (Columbia University), Owen Petchey (Sheffield University), and Steve Finkel (University of Southern California), we have been using long-term stationary phase *Escherichia coli* to investigate the effects of variation in environmental color on population dynamics, competitive ability and genetic diversity. and interactions in *Escherichia coli.*

Statistical methods I have been helping the growth of **R** (www.r-project.org) in ecology. One recent project has been a new **R** help listserv, R-MU. Two methods that I am particularly interested in are a nonparametric multivariate analysis of variance (MANOVA) and Bayesian approaches to mixed models. I have implemented a relatively new version of MANOVA described by Anderson (2001, Austral Ecology) and McArdle and Anderson (2001, Ecology). Unlike classic MANOVA, it is capable of handling any number of response variables, i.e. samples with very large numbers of species (or genes), that is, very, very wide response matrices, relative to the number of observations. I believe (emphasis on the subjective and unsupported) that this implementation brings transparency to multivariate analyses (ESA 2008 Poster). It is implemented with the `adonis` function in the `vegan` package in **R**. I am also currently engaged in a Bayesian mixed models project here at Miami University and the University of Florida, to (i) further validate existing methods, and (ii) develop functionality to facilitate understanding and correct implementation by non-experts. I am also co-authoring a statistics book with Brian McCarthy (Ohio University).