



Review paper

Teaching ecology at university—Inspiration for change



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HIGHLIGHTS

- Inspiration for change for researchers teaching ecology at university.
- Holistic scope and aims to present an overview of suggestions.
- Ideas and suggestions based on several different teaching philosophies and methods.
- Teach students how to think and act like a professional ecologist.

ARTICLE INFO

Article history:

Received 26 April 2016

Received in revised form 28 June 2016

Accepted 29 June 2016

Available online 19 July 2016

Keywords:

Active learning

Ideas for change

Education

Student-centred teaching

Learning activities

Higher education

ABSTRACT

How do you, as a university lecturer, change from teacher-centered teaching to a more student-centered, active teaching? This paper aims to inspire you to make a change, big or small, to increase your students' engagement and learning, by presenting suggestions on what you can do. The ideas and suggestions synthesized here are based on several different teaching philosophies and methods, which are well tested and shown to be effective in the right setting. The selection of suggestions is believed to be specifically suitable for ecology.

The paper includes suggestions on how to plan a course or a lecture by setting a good learning environment. Both pre-lecture activities and during lecture activities are included, with a focus on activities to engage students and encourage increased discussion and reflections, as well as what to think about when choosing learning activities and how and why it is important to teach students to think and act like professionals in ecology. While changing teaching methods takes investment of time, time that is limited for many researchers, even small changes in your teaching can make big differences in learning, and the investment will hopefully pay back by making teaching more fun and rewarding. The suggestions presented are understandable without being conversant in the 'education literature', but will provide you with a vocabulary of teaching activities that will be useful if you are inspired to find more information and learn more about teaching.

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<http://dx.doi.org/10.1016/j.gecco.2016.06.008>

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1. Introduction

Science education is transforming, and a large shift in pedagogical approach has taken place during the last 30 years. The traditional model, in which the teacher lectures, the students listens and takes notes, with little time to reflect or seek clarification, is outdated, and in contrast with current knowledge of effective science teaching. Research shows that the change to more engaged scientific teaching techniques which involve active-learning strategies to engage students in the process of science, and use teaching methods demonstrated to reach different students, is a widely-accepted reform, but adoption is slow (Handelsman et al., 2004). This needed shift in teaching practice from students just learning a knowledge-base of scientific facts to developing deeper understandings of major concepts within a scientific discipline (Tanner and Allen, 2005), brings many challenges, not least for the individual lecturer. Many universities also retain lectures as their central instructional method, maybe because it is economically effective, tradition, the design of the university, or that lectures can be good (Lom, 2012). Thus, traditional lectures are the way most of us teach, have taught, or were taught when we attended university.

This paper is especially focused on researchers teaching ecology at university. Many researchers that are teaching have had only a few weeks of pedagogical training, if any, which adds to the challenges of advancing and developing one's scientific teaching. I think many recognize what Patricia Pérez-Cornejo is saying in her recent *Science* article; "My later scientific training left me well equipped to work in a lab.... But it never prepared me for another responsibility that is now part of my job as a professor: teaching". or "I wondered how I could teach them anything valuable" (Pérez-Cornejo, 2016). She had the opportunity to work with a mentor, a researcher in education, to develop her teaching skills. These types of collaboration between researchers teaching ecology and researchers in University teaching should be encouraged and facilitated as a means to improve University teaching, and make teaching more rewarding. In many cases funding for teaching is mostly for undergraduate teaching, even in many 'research-focused' universities. Further, many ecologists that are engaged in higher-level teaching have little exposure to research on teaching and learning (D'Avanzo, 2003) and the amount of institutional support and access to literature to improve teaching and learning varies greatly across the globe. These might be reasons why many researchers are unaware of new teaching strategies and methods, while others might feel intimidated or insecure on how to change (Handelsman et al., 2004). It takes time to deepen the knowledge in teaching (D'Avanzo, 2003), therefore time constraint is another factor that may affect the ability to change and use new teaching strategies and methods. Further, many faculty do not teach students how to use scientific/ecological principles and to think like practicing biologists/ecologists, likely because this is automated thinking among researchers or assumed to be already understood by the students (D'Avanzo et al., 2008). Most students in biological sciences are required to attend at least one ecology class; teaching ecology at university therefore ranges from large introductory classes, with sometimes up to 300 students, to very specific topics with very few students. The most effective teaching takes class size into account and is tailored to the situation.

So, are there ways to shift to a more active, student-centered teaching – just as one individual – even if there is little support from the department or the university?

This paper has a holistic scope and aims to present an overview of suggestions, big and small, high- and low-tech, which can increase students' engagement and learning, ranging from changing small elements to how to plan a whole course or lecture. These suggestions may be useful for both junior and more senior lecturers interested in change. Maybe the change is to insert one new element in your presentation or to include many new ideas and techniques. This "change" or interest in change may hopefully also stimulate teachers to think and learn more deeply about teaching and learning ecology.

2. Context

Active, student-centered learning and teaching have been shown in multiple research lines to be more effective than traditional lectures (Bransford, 2000; Freeman et al., 2014; Handelsman et al., 2004). It also seems that more extensively student-centered teaching with many active-learning pedagogies, consistent formative assessment, and cooperative groups improves learning compared to more moderate student-centered teaching in biology (Connell et al., 2016).

This paper is by no means an original description of active student-centered learning and teaching, as the ideas and suggestions gathered here are well-tested and described in the literature, see e.g. Handelsman et al. (2004) and Dirks (2011), but these suggestions are chosen to be included in this paper for their potential relevance and value while teaching ecology. The amount of available literature in biology and ecology education in higher education is steadily increasing (DeHaan, 2010; "Introductory Biology Project"). There are plenty of general resources for improved teaching at university available, see for example the book 'Teaching for Quality Learning at University: What the Student Does' by Biggs and Tang (2011). Other suggested literature especially focused on biology and ecology are: the book by Pickett et al. (2007) about ecological

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