Brian W. O'Shea – Teaching Philosophy

It has long been understood that there is a fundamental difference between how a novice physics student and an expert physicist approaches problem solving. A novice looks at physics as a large collection of unrelated equations and ideas, whereas an expert physicist knows that the behavior of the Universe and everything within it can be understood by a small set of interconnected concepts. Given this knowledge, an expert realizes that the key to solving a specific problem is to identify the fundamental concepts involved and their connections. As an educator, my primary goal is to get my students to look past the details of a situation and see these overarching connections and, in the process, learn how to think and to teach themselves. While my students will not necessarily retain all of the details of Newtonian mechanics several years after they have taken my courses, I aim to provide them with concepts and skills that will help them navigate the storms of a complex, rapidly changing world, and to become thoughtful, scientifically literate citizens.

This difference between beginner and expert is not unique to physics – *as with learning in general, the key to transitioning from a novice to an expert is to make and understand the connections between ideas.* This belief is supported by research that suggests the making of connections is an incredibly important part of learning. No idea stands in isolation, but is only understood in relation to prior knowledge. In this way, learning is the process of building a coherent mental model of a subject by making logical connections between prior knowledge and new information, and forming theories based on these connections.

Based on my understanding of how learning works, I believe that my role as a teacher is to assist students in discovering new concepts and to guide them in making coherent connections between newly acquired information and prior knowledge. One example of how I do this is embodied in the recent curricular changes that I have made to the Lyman Briggs College introductory physics sequence as part of my Lilly Teaching Fellowship project. Motivated by the realization that my students, who are largely life science majors, were having a difficult time connecting physics to their majors and to their interests, I converted our fairly typical physics course sequence to a "Physics of the Life Sciences" curriculum. I chose a new textbook and developed a wide range of examples of physical situations that explicitly draw connections between physical principles and the life sciences, and, more generally, to phenomena encountered in students' everyday lives. Students participated actively during lectures, solving both conceptual and quantitative problems individually and in small groups, and were asked to engage in the modeling of various scenarios relating to biological systems in their laboratory sessions (for example, the students were asked to identify and calculate the forces, torques, and stresses exerted on the muscles, tendons, and bones of the human arm when picking up a heavy object). The experiment was a great success – high levels of conceptual learning were maintained, and student enthusiasm and interest rose considerably compared to previous years – and we plan to continue with, and expand upon, this curriculum in the future.

As hinted at in my description of the LBC introductory physics courses, the courses I teach are heavily influenced by an idea that was pithily expressed by Benjamin Franklin:

"Tell me and I forget. Teach me and I remember. Involve me and I learn." I challenge my students to take the lead in making logical connections between concepts and to exercise their newly acquired skills through a variety of active-learning techniques, including think-pair-share questions (implemented with iClicker response devices) and individual and small-group problem solving, all of which are often tied to demonstrations of physical phenomena that help to solidify their understanding. While the students are collaborating, I circulate around the classroom and step in when necessary to identify and correct physical misunderstandings as well as to suggest connections that the students may have not thought of on their own. Multi-modal active learning helps to reach a diversity of audiences, and my students generally find that they enjoy such techniques, which also give them instantaneous formative assessment of their understanding of the material. Two additional advantages of interacting with my students in this way are that it helps me to identify students who are ill-prepared mathematically for my courses (the root cause of most students' challenges in introductory physics courses) so that I can direct them toward appropriate remedial resources, and it also helps students to become more comfortable with physics as a subject by seeing a sympathetic face.

One of the key ways that I get students actively involved in their own learning is through the use of educational technology. As an example, the LON-CAPA course management system is a keystone of my course design. The LON-CAPA course website is a place for students to grapple with online homework assignments (including "reading essays" that are due before a topic is discussed in class and more extensive homework assignments due afterward) and to use message boards to discuss issues relating to the course with other students. The site also provides supplemental materials that expand upon the materials discussed in lecture or in the textbook and resources to assist struggling students with study skills and conceptual challenges (extensive links to online physics simulations have proved to be particularly helpful to students that are challenged by some of the newer physics concepts). The LON-CAPA site is deeply integrated into the course, with students accessing it many times a week, and their use of this forum helps to drive home to students that they are expected to be active participants in their own education.

Since becoming a professor, I have experienced a profound shift in my understanding of teaching and learning, and as a result have grown tremendously as an educator. I have been introduced to research-based teaching methods, and more generally to the scholarship of teaching and learning. These ideas resonate strongly with my identity as a scientist, and attempting to implement what I have learned inspires me to apply the same level of rigor to my teaching that I do to other areas of my scholarly work. I have also learned about useful strategies such as *backwards course design*, where one first articulates the overall goals for a course, and then works backwards to design assessments, teaching methods, and content that are well-aligned with course goals. At present, I am working to more tightly integrate my understanding of research-based teaching methods and science of how learning occurs together with my teaching practice. In the future, I hope to further increase my understanding of both of these topics and more deeply integrate it into my teaching. By doing so, I will more effectively address the needs of the diverse range of students that have chosen to take my courses.