

A Darwinian Pedagogy

Brandon Sullivan
Graduate Student in Biochemistry
College of Biological Sciences

The Challenges

$2\text{NaOH} + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}$. How many molecules of sodium hydroxide does one dissolve in 40.0 milliliters of water to neutralize the pH of an Erlenmeyer containing 20.0 cubic centimeters of two molar sulfuric acid? Science can certainly look and sound like a foreign language! Many subjects are not visible without a microscope, and introductory courses are often hailed as “weed outs” for pre-health students. From the students’ perspective, learning in the sciences is a challenging feat, but one must also realize the challenges facing our instructors.

The majority of life and physical science professors and teaching assistants devote their early careers to mastering concepts in the classroom. As one progresses, the educational experience shifts from text books towards research. Most often, however, there is no required component which prepares students and faculty for the task of teaching undergraduates. In more recent years, there has been an increase in the number of programs and organizations that address these issues. The Council of Graduate Schools offers a national program, Preparing Future Faculty, and many universities offer faculty and teaching assistant development programs. Unfortunately, many of these programs are underutilized either from lack of advertisement, funding, or cultural stigmas within certain departments.

Despite the lack of formal educational training, many of our science professors and instructors transcend their technical skills and inspire their students. Perhaps many of our teachers have adopted their teaching philosophies from a more familiar subject: Nature.

Learning From Nature

The earth is 4.5 billion years old and has harbored life for the majority of those years. No one but nature has more experience and no one offers better lessons. Indeed, many of her examples have affected our lives. Velcro was designed from the interlocking pattern of burrs. The mimicry

of shark scales have produced low friction fabrics, and the behavioral analysis of flying geese have taught us about drafting and energy conservation. Likewise, Nature offers invaluable lessons that can guide teaching pedagogies.

In the 1830s, Charles Darwin traveled to the Galapagos Islands where he observed Nature's beauty and sophistication first hand. On these tours, Darwin describes the blueprint for success in nature. In short review, as organisms reproduce, their progeny have different physical features. If the alteration is beneficial, those progeny thrive and pass those genes to subsequent generations. If the trait is deleterious, Nature removes it from the gene pool. Consider a marine fish that must hide from predators. If the coral is orange, the fish benefits most by adorning those orange colors. A similar fish that wears purples may not fare as well. Nature helps this species survive and prosper due to her uncanny ability to evaluate and adapt. It was during these travels that the concepts of Evolution, Natural Selection and Survival of the Fittest were born.

Darwin's lessons are active within the classroom. Sometimes they guide, other times they warn, but in both cases the strength of these lessons is the ability to evolve for the better.

Diversity

Darwin's evolution requires diversity for Nature to overcome a myriad of obstacles. It is why fish have gills, birds have wings, and giraffes have long necks. These are all traits that allow survival in distinctive environments. Correspondingly, many text and laboratory concepts require entirely different teaching philosophies to reach the students. The responsibility lies with the instructor to constantly diversify and experiment (evolve) with his/her lesson plans. For example, when teaching complicated tasks or skills students may benefit in group environments where techniques and strategies are shared among peers. In the sciences, many concepts are not intuitive, such as the size of an atom, which is a trillion times smaller than a sentence period. Lessons that use analogies and model building to bridge the gap between what can be pictured versus what cannot be seen are often critical for mastering concepts. These approaches are often preferred to similar lessons that focus on lecturing or text reading. On the other hand, many lessons may best benefit from lecturing and dictation.

In the same regard, Nature does not solve any one problem with a single

solution. Instead, she is beautifully and functionally diverse. A rose employs bright colors to attract bees which distribute its pollen across the landscape. Alternatively, a dandelion disperses its seeds as fluffy white parachutes that carry in the wind. Every student has slightly different backgrounds, strengths and weaknesses. A good teaching philosophy should identify and allow for these differences.

Natural Selection

Diversity is only half the story in evolution. To complete Darwin's theory these diverse traits need to be evaluated and selected for fitness. As it is necessary in nature, evaluation and adaption are likewise critical in the classroom. A brief analysis of a class with 200 students shows that every hour spent in preparation for that session affects 200 student hours. This means that the students and university are incredibly invested in the instructor's ability to effectively communicate the material. Assessment (selection) is the root of the Darwinian Pedagogy.

Each lesson plan should be carefully analyzed to determine if it is accomplishing the desired goals and learning objectives. For the selective pressure to work fully, educators must assess early and often. An end-of-the-semester survey may provide valuable data for incoming classes, but will be received too late for the very students providing the records. Good instructors will monitor homework, quizzes, papers and exam scores, provide mid-semester surveys, and constantly observe and interact with their students. The great instructors will scrutinize this wealth of data and adapt their teaching approaches.

Evolution

The pairing of diversity and selection provides a canvas of life with unique and inspiring forms. This blueprint provides exceptional value within science classrooms, but it also extends to the arts, social sciences and humanities. As students and teachers one can continually learn from Nature, our eldest and eminent teacher. The final word: adopt a Darwinian Pedagogy for the evolution of education, and evolve for the better.