Teaching the Broad, Interdisciplinary Impact of Evolution

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Abstract: As perhaps the most encompassing idea in biology, evolution has impacted not only science, but other academic disciplines as well. The broad, interdisciplinary impact of evolution was the theme of a course taught at Marian College, Indianapolis, Indiana in 2002, 2004, and 2006. Using a strategy that could be readily adopted at other institutions, professors from other, non-biological disciplines were asked to speak with the class regarding the impact of Darwin specifically or evolution more broadly on their field of study. A political scientist, literature expert, language professor, historian, theologian, art historian, and sociologist have all participated in this course. Student comments have been overwhelmingly positive and suggest the course format affected their thinking with respect to both the humanities and the science of evolution.

Keywords: art, Darwin, evolution, history, interdisciplinary, language, literature, sociology, theology

Introduction

Since the 19th century, evolutionary theory has had an enormous impact not only on science, but on Western society as a whole. The "honors evolution" course described here was designed as an educational tribute to the all-encompassing influence of evolution.

Recent studies indicate that although state standards for the teaching of evolution are improving (Lerner, 2000) college students are still not well grounded in evolutionary theory (Alters and Nelson, 2002). Many writers have proposed methods for teaching evolution in college that allow students to understand the process of science (DeSilva, 2004), discuss case studies (Farber, 2003), and gain experience in the field (Zervanos and McLaughlin, 2003). These methods offer important improvements to the teaching of evolution today. However, in today's interdisciplinary academic environment, while pedagogical changes are important, it is equally important to modify and enhance course content to benefit biology majors and non-majors alike. For example, evolutionary theory in biology also has far-reaching implications in the disciplinary studies of language, art, literature, political science, history, and theology.

One-hundred and fifty years after Darwin proposed a mechanism for evolution it has permeated all but the most blind corners of biology. That evolution and Darwin's mechanism have affected the study of biology may not be surprising to university students. However, the examination of how Darwin's idea has impacted disciplines outside of biology will open students' eyes to the broad, interdisciplinary impact of this biological theory. This, in turn, may help students understand the biology behind the theory more fully.

This was the premise for a course one of the authors (D. Benson) taught with the help of many of his colleagues (the other authors) in the fall 2002, 2004, and again in 2006. The class began as a typical, although short, introduction to the science of evolution. We covered the usual topics of natural selection and other mechanisms of evolution, Hardy-Weinberg, speciation, sexual selection, evidence, and human evolution. To give students a sense of the power of Darwin's argument, they read several chapters of *The Origin of Species*, (Darwin, 1859). The point of this portion of the course was to give students a good grounding in the biology behind the theory. Without this background, the diverse discussions that followed would have been uninformed.

The second half of the course involved colleagues from non-science disciplines explaining how Darwin, the ideas of common ancestry, evolution, and natural selection have impacted their disciplines. This allowed the students a chance to see the breadth of "Darwin's dangerous idea" and the profound impact it has had across the board. It also allowed the *students* to be the experts on evolutionary theory. By this point in the course, they knew as much or more about the science of evolution as the guests from other

disciplines. This empowered the students to think critically and constructively about what was being presented.

We believe the basic idea behind this course could be adapted to any situation in which a science professor is surrounded by a reasonably engaged faculty and could be used in either a stand-alone course or as a unit within a larger course such as a first-year introduction to biology. In the section that follows, we describe our course as an example of what could be presented in a course of this design. The content of your own course will, of course, be guided by the willing faculty around you and their own areas of expertise. Most of the professors who contributed to this project did not have any special background in or knowledge of the intersection of evolution and their area of expertise. What they presented was a brief view of evolution from their perspective.

Language and Evolution, Patrick Kiley, French program. Dr. Kiley discussed and gave examples of some of the forces acting on language. For example, migration affects language by adding, and perhaps removing, certain words to a vocabulary by "borrowing." For instance, "boef," "porc," and "veau" in French were borrowed by English – "beef," "pork," and "veal." Social acceptability is another mechanism of language evolution that may, in fact, relate to the previous example. In 1066, the Normans (French speaking), conquered England and imposed their language upon the vanquished foe. Therefore, although English is a Germanic language and not closely related to French, it contains a lot of borrowings from French in a case of "social acceptability by force." Misunderstandings and metaphor are other forces acting on the evolution of language.

We also discussed cognates, like "hund" in German and "hound" in English – words that share a common origin. And, false cognates like "preservative" in English and "preservatif," meaning "condom" in French. Isoglosses are regional shifts within language such as the word "skillet" and "frying pan" used to mean the same kitchen item in southern and northern Indiana, respectively.

The students were then asked how all this relates to what we know about biological evolution? Are the forces acting on language similar to the mechanisms of evolution? How is linguistic variation injected into a population? Can it be selected for or against? Is it in some way, heritable? By exposing students to evolution from a different perspective, they were empowered to think critically about how their knowledge of evolution related to the ideas presented.

Art and Evolution, Jamie Higgs, Art History Program. Dr. Higgs discussed instances where Darwin's influence on specific subject matter is evident. For example, pre-Darwinian, flower art such as in Rachel Ruysch's *Flower Still-Life* (1700) was often quite contrived, showing beautiful, vase-bound arrangements. The flowers depicted did not bloom at the same time and could never have been assembled in one vase, but were simply meant to be aesthetically pleasing forms. Darwinian thinking, however, emphasizes the importance of environment including interactions among species. It also emphasizes the importance of form; flower form evolved for reasons other than simply for humans to find aesthetically pleasing. In the post-Darwinian flower art of artists such as Martin Johnson Heade (*Orchids and Hummingbirds,* late nineteenth century) and John La Farge (*Water Lily and Linden Leaves*, 1862), flowers are depicted as part of a natural setting including such aspects as pollinators and anatomically correct flower form (Foshay, 1980).

German graphic artist, Max Klinger was likewise influenced by Darwin as seen in his 1875 pen and ink drawing entitled *Darwinian Theory*. This work depicts an ape holding a human child in one arm with its other hand on a scientist's (Darwin's?) shoulder. The scientist's hands are resting on a large tome and an ape skull flanked by a human skull. In the background, a cleric is glaring at the three of them. The cleric's look is mirrored by the look on the scientist's face (Morton, 1992). The students had a great time analyzing the underlying meaning of this piece: the ape as an intimate relation of the human child, the skulls explaining how we know of this relationship, and the cleric's and the scientist's facial expressions as displays of animosity between science and the Church.

Finally, in *Sunday Afternoon on La Grande Jatte* (1884-1886), Georges Seurat depicts a scene on a famous island where the ladies and gentlemen are dressed in their Sunday finest and are behaving decorously. What the modern viewer does not realize, is that during the nineteenth century this island was famous for its wild and unruly Sunday afternoon crowd. Some interpretations of this work theorize that Seurat placed the small monkey in the foreground of this painting as an appeal for humans to act civilized, not like the apes from which they evolved (Stokstad, 1995).

Evolution and Literature, Jamey Norton, English program. For Dr. Norton's section of the course, the students read *War of the Worlds*, by H.G. Wells (1898). Wells, as a science prodigy and student of Thomas Huxley, is often considered the "grandfather" of the science fiction genre. In War of the Worlds and other novels, Wells used the paradigm of Darwinian evolution to push the reader to question what might be

the result if evolutionary theory is pushed to the limits of our imagination.

War of the Worlds is Wells' well known story of the invasion of earth by Martians and is rife with allusions to evolutionary theory. For example, a common misconception at the time (and still!) is that humans are the "pinnacle of evolution." Wells plays with this idea in War of the Worlds by introducing the Martians, an obviously more advanced civilization. The narrator apparently does not grasp even the possibility that Martians could be more advanced and is dumbfounded by them until it is too late. Wells also uses the Martians to explore how evolution might have acted within an environment different from Earth. The Martians are very unhuman-like sacks of protoplasm that seemed to have evolved in tandem with the machinery in which they are confined. Cultural evolution has apparently proceeded along a different course on Mars, too, as seen by the fact that the wheel was never developed, something thought to be foundational to our advancement as a civilization.

Darwin's struggle for existence is played out on an interplanetary level in *War of the Worlds* between the Martians and humans, with humans destined to lose. By the end of the novel the humans have thrown all their military might at the Martians to no avail and their fate as food for the Martians seems secure, when, out of no where, Natural Selection comes to the rescue! The Martians succumb to an earthly disease and die; the conquest is ended.

Evolution and Political Science, Pierre Atlas, Political Science Program. Darwin had a profound effect on politics. For example, Social Darwinism grew out of attempts to apply Darwin's ideas of natural selection to human behavior. In the late 19th Century, Yale sociologist William Graham Sumner became America's most articulate advocate of social Darwinism (e.g. Sumner, 1963). He proposed that as long as everyone had equal liberty and therefore, equal opportunities, what people do with those opportunities is up to them. Sumner suggested that there will be a "struggle for existence" among people with winners and losers, and the winners are the heroes. He stated that the winners are the wealthy, the captains of industry, and they owe nothing to the unfit, the poor, because the wealthy used their own initiative and skills to acquire their wealth and become winners. Further, Sumner thought that, because the poor or "unfit" are a dead weight to society, any kind of altruism is a despicable act, blocking the advancement of society.

Sumner also felt that the marketplace is the arena where natural selection and survival of the fittest take place and where inequality (like variation in a population) is good, necessary, and natural for the advancement of society. Therefore, he thought there should be no government intervention or regulation of the marketplace at all, to allow the best competitors to survive and prosper.

But, what of the poor? Obviously, they will not do well in the struggle, but according to Social Darwinists, that is their own fault. They felt that the poor are responsible for their own status and fate. To Sumner, it is the duty of government to protect the opportunity of all to succeed, but there are no guarantees. He felt the equal liberty provided by the government provides for choices, but does not guarantee results. Results will be proportional to the merits of each individual.

Our students were at once intrigued and repulsed, but, also could see familiar pieces of contemporary thinking in these ideas. This section led to a discussion of social justice. They also were asked to relate social Darwinism to modern evolutionary theory. Should we really be cold, heartless, pawns in an evolutionary game?

Within the discipline of political science, evolutionary theory has informed contemporary debates over the process of institutional development. One point of contention among scholars of the state concerns explaining change: do institutions change gradually over time, or do they remain relatively stable for long periods, and then change rapidly and only in response to crises? Beginning in the mid-1980s, some political scientists introduced the concept of "punctuated equilibrium" into the literature (Krasner 1984), borrowed from evolutionary biologists, Stephen Jay Gould and Niles Eldredge (Eldredge and Gould, 1972). In the class, examples from American history were offered, including the New Deal expansion of government in response to the "punctuated" crisis of the Great Depression, and the post-9/11 reorganization of government agencies into the Department of Homeland Security. Such changes were not "gradualistic." They would have been inconceivable prior to the crises that sparked them. Here, the concept of punctuated equilibrium provides a compelling metaphor for institutional development.

Evolution and modern culture, Raymond Haberski, History program. Dr. Haberski used the "Scopes Monkey Trial" as a vehicle for discussing the intersection of science and religion. As the first televised trial in America (1925), the Monkey Trial was truly the trial of the century. Clarence Darrow, a famous criminal attorney, was brought in by the ACLU to defend John Scopes who was charged with teaching evolution in public school in Tennessee. Although the discussion of this well known trial and its aftermath was not related to particular evolutionary concepts, it was enlightening to contrast this trial with current controversies regarding the teaching of evolution over

80 years later, and provided an excellent segue into the discussion of evolution and theology.

Evolution and God, Michael Maxwell, Jr., Theology program. Dr. Maxwell began his discussion with the question: "Is there an irreconcilable conflict between the scientific theory of evolution and the notion of God as creator of the world?" There are reasons on both sides to answer "yes" to that question. On the one hand, fundamentalist Christians might say that the theory of evolution simply cannot be reconciled with the biblical account of creation as stated very plainly in *Genesis*. On the other hand, some scientists have argued that the theory of evolution is a complete explanation of the biological diversity we see on earth including humans, and therefore, there is neither room nor need for God as creator.

Dr. Maxwell proceeded in an attempt to resolve these conflicts by probing the fallacies of a "literalist" approach to reading the Genesis account of creation. Is it possible to read Genesis "literally" in English when it was written in Hebrew? Maxwell suggested that attempts to read Genesis in a completely literal way ends in self contradiction: what is a day, literally when there is no sun? Or, if humans are created in the image of God, would that mean, literally, that God is a relatively ugly, naked biped?

Fortunately, for most of the Christian tradition including St. Augustine, Thomas Aquinas, and St. Justin Martyr, a literalist approach to interpreting the meaning of scripture has not been considered the exclusive way of understanding scripture. Catholics (Marian is a Catholic College) interpret *Genesis* 1 symbolically as an explanation of humans' relationship with God. The question is not necessarily, "is *Genesis* chapter one true?" but "In what sense is it true?" Maxwell proceeded to explain the Catholic stance on Evolution.

Evolution and Society, William Mirola, Sociology program. As an excellent wrap-up for the semester, Dr. Mirola led the class in a more general discussion of the effect of the creation/evolution debates on society. He posed questions such as: "Why, 150 years later, are we still having this debate?" A partial answer to this lies in the continuing cultural conflicts over the appropriate role of faith in society. How do we as a society negotiate the places where scientific theory and discovery seem to contradict or challenge our faith traditions? Of course, how these conflicts play themselves out will have direct impacts on religious, scientific, and educational institutions. We must consider, for instance, how the creation/evolution debate will affect the science literacy of students in states without strong science standards. We might also consider the impact of these debates on environmentalism. By examining these issues, Dr. Mirola left students to ponder how their own prior educational experiences with the creation/evolution debate affected their views of the class and what they themselves might want their own children to one day be taught.

Conclusion

The students, both biology majors and other liberal arts majors, were fascinated by the wide ranging application of evolutionary theory to a broad range of human endeavors. They were intrigued by the history of reaction to evolution. Class sizes have been small, but student comments voluntarily given in response to the following question are revealing: Did the structure of the course affect your thinking about the science of evolution?

Several (5 out of 19) students felt the course structure affected their thinking about the relationship between science and faith. They had comments similar to the following: "I liked how each discipline was affected by evolution. The one that had a drastic effect on me was theology and evolution. I learned that there is room for God in evolution." And, "I did enjoy theology and evolution because they appealed more to reason than evidence that is observed. It helped me to think the deepest about what evolution means for me."

Seven students commented they found that the class format helped them understand the science of evolution more thoroughly and had comments such as: "I thought this class was structured really well. Seeing evolution in the other disciplines helped me to appreciate it that much more." Three other students thought the course helped them gain insights into the humanities and had comments like, "I like the fact that class gave the opportunity to think outside the scientific world and apply that knowledge to other disciplines. I think this idea helped me to both understand evolution and the other disciplines better."

The rest of the students were, overall, very positive in their comments about the course, "Hearing from other professors from other departments made this the best class I have taken in my 3.5 years at Marian."

Even more so than the students, the contributors loved participating in this course. Several have attended lectures led by their colleagues and all have found this course design to be an excellent way to encourage students to think across the lines of discipline.

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