INTEGRATING APPLIED ETHICS INTO A COLLEGE-LEVEL NON-MAJORS BIOLOGY COURSE

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INTRODUCTION

The 21st century has been labeled by some as “the century of biology” most likely because of the explosion of new biological information and applications during the past 50 years and the subsequent need for people to make informed decisions about these new biotechnologies. One of the major challenges facing college-level instructors of introductory non-majors biology courses is how to synthesize all this new information into a traditional one semester introductory course as well as deal with the ethical issues that are a part of modern biology. Although many of the topics that are covered as part of a non-majors introductory biology course have ethical dimensions—including genetic testing, stem cells, cloning, genetic engineering and gene therapy, global warming, preserving biodiversity, evolution, human population growth and modern food production—the inclusion of ethical content in a non-majors introductory biology course could be problematic because of time constraints involved. One common reason science faculty give for not including discussions of ethics in science courses is that “there is no room” (Davis 2006).

A second major challenge facing college-level instructors of introductory non-majors biology courses is engaging undergraduate students in the course material when they may have little prior interest in science. Many students enrolled in college-level introductory non-majors biology courses are fulfilling some type of science general studies requirement and often view the selection of biology as the least or easiest of the possible alternatives. Introducing students to the important applied ethical dimensions of modern biology could serve as a method of engaging students by helping students understand why it is important to understand basic biological concepts and by making biology learning more relevant (Chamany et al., 2008). Although most of the published
materials on teaching of bioethics at the undergraduate level are focused on the instruction of technical or science majors, engaging non-major undergraduate students in the ethical considerations of modern biology is no less important. These students, as citizens, will need to make decisions about these issues and their political impact (Johansen and Harris, 2000). In addition, consideration of the ethical issues involving emerging biotechnologies such as personalized medicine and gene therapy will give students tools and skills to make informed personal decisions about these areas in the future (Miller, 2008).

This paper describes the effort to develop and incorporate course materials about applied ethics topics into a one semester non-majors biology course offered at Arizona State University for Science General Studies credit. This course was adapted to the Polytechnic campus in 2006 to emphasize scientific methods and how these methods are applied to scientific problems. The general goal of the course is to promote scientific literacy in non-major undergraduate students rather than the rote memorization of a body of factual information. Topics are covered that allow the students to develop a working understanding of major biological concepts with an emphasis on topics that will impact their daily lives now and in the future. Because of the nature of the course, short units on applied ethics could be incorporated or inserted throughout the semester. Approximately 72 students currently enroll in this course each semester. This project was completed as part of the Lincoln Polytechnic Applied Ethics Teaching Fellowship program at Arizona State University during the 2009-2010 academic year.

INTEGRATING APPLIED ETHICS

Before course materials could be developed, several decisions needed to be made regarding the overall goals and learning objectives for integrating applied ethics materials into the course. In addition, decisions needed to be made about the strategies and methods to be used in the teaching of applied ethics.

Goals and Outcomes

At the beginning of the project, my stated overarching goal was to help students recognize and analyze ethical issues in modern biology. This goal was in line with common goals developed at the Hastings Center in the late 1970s for the teaching of ethics in higher education (Pritchard, 2006) and by the National Institutes of Health (NIH) for
teaching bioethics (NIH, 2009). For example, the goals developed by the Hastings Center include stimulating student's moral imagination, helping students to recognize moral issues, aiding students to analyze key concepts and principles and eliciting a sense of responsibility in students. NIH (2009) emphasizes several student outcomes that I adopted when developing course materials including: 1) understanding that “the process and discoveries of science have social and ethical implications that an informed public and scientists need to address;” and 2) developing critical-thinking skills so that students can justify an ethical position. With regard to this last outcome, many authors note that the objective in teaching applied ethics should not be to teach students what to think about a given issue (indoctrination) but rather to teach students how to think through ethical issues (Downie and Clarkeburn, 2005; Pritchard, 2006). In this regard, I decided it was important for students to be able distinguish between professional and personal ethics (Downie and Clarkeburn, 2005) or microethics and macroethics (Herkert, 2005) with regard to modern biology. With this in mind, a beginning unit on research ethics was incorporated into the beginning of the course so that students would have a good understanding of professional ethical standards applied to scientists and how professional research ethics differs from dealing with personal ethical considerations regarding policy issues such as stem cells, cloning and genetic testing.

Strategies

The second major decision was to decide if students needed to be introduced to a technical knowledge of philosophical terms like utilitarianism and Kantian theory or if it would be sufficient to introduce students to a conceptual framework to use in approaching ethical issues in biology (discussed in Johansen and Harris, 2000; Downie and Clarkeburn, 2005). Because of the introductory nature of the course and time limits involved, I decided to use the conceptual framework recommended by NIH (2009) that introduces students to a problem-solving approach for use in ethical decision making related to biological issues. This approach utilizes several ethical principles with wide acceptance and applicability in bioethics, including respect for persons, harms and benefits (non-malificence/beneficence) and fairness/justice. (Kormondy, 1990)

The second major decision was to decide whether to incorporate applied ethics materials using short (1-2 weeks) units, for example a unit on stem cells or cloning, or to use “ethics minutes” (Davis 2006) to insert
small units on ethics into a wide range of topics. I made the decision to use a combined approach mostly leaning toward a “micro-insertion” approach (Davis, 2006) where ethics was integrated into the biological subject material without substantial changes to the course.

Methods

The final decision that needed to be made was what types of methods should be used to insert ethical content into the course. Several methods have been suggested as useful for inserting ethical content into existing biology courses. These include using traditional lectures, group discussions, case studies, problem solving, videos and “bioethics labs” (Chamany et al. 2008; Couglin, 2008; Downie and Clarkeburn, 2005; Smith et al. 2007). Downie and Clarkeburn (2005) suggest that in their experience interactive work achieves greater benefits than traditional lectures in teaching bioethics based on student achievement. Since this non-majors biology course already utilized in-class group work and individual homework assignments, most of the materials developed involved either in-class group activities or individual homework assignments, although one laboratory exercise was modified to include ethical content. In most cases, there was a dual purpose for assignments; solidifying biological concepts presented in lecture and helping students recognize and analyze ethical dimensions of the topic.

RESULTS

Course materials related to the discussion of ethics in biology where developed in 3 separate modules (Table 1). In the first introductory module, students learn about the methods of biology and are also introduced to the methods of bioethics inquiry with an activity that emphasizes research ethics. The second instructional module of the course concentrates on cellular and molecular biology and activities relating to ethical issues such as genetic testing, cloning, gene therapy and genetic engineering were modified or developed. The last instructional module of the course focuses on diversity, evolution and ecology. Activities focusing on environmental ethics and the nascent area of ecological ethics (Minteer et al. 2008) were developed and added to the course.

The first module of the course is a short unit on scientific methods and their applications to biology, including information on hypothesis testing and research design. As part of this unit, a section on research
ethics and the use of humans as research subjects was expanded. In lecture, students are exposed to the concept that research using human subjects can have widespread benefits but can also lead to abuse and harms if certain protections are not in place. A short group activity was developed to expose students to core ethical considerations (respect for persons, harms and benefits, and fairness). Students watch a short video on “Infectious Obesity” that is part of the “Biology in the News” Series developed by Prentice Hall. The video presents preliminary research that tests the hypothesis that viruses are a cause of human obesity. Students then work in groups to answer questions pertaining to hypothesis testing and types of scientific evidence presented. They also consider whether it would be ethical to use human subjects in controlled experiments to test the hypothesis that viruses cause obesity based on the concepts of harms and benefits.

Three group lecture activities and one individual internet assignment were developed or modified as part of the second instructional module on cellular and molecular biology. Short videos and case studies were used as the basis for most of the activities. In the first group lecture activity, students watch a portion of the PBS Nova video “Cracking the Code of Life” (http://www.pbs.org/wgbh/nova/genome/program.html) entitled “A Family Disease”. The video presents the dilemma of women in a family that has members with an inherited genetic mutation linked to breast and ovarian cancer. Students then participate in a group activity that considers ethical aspects of genetic testing for cancer and other genetic mutations. In the second lecture activity, students watch a short Nova ScienceNow video entitled “Personal DNA Testing” (http://www.pbs.org/wgbh/nova/sciencenow/0302/01.html) and then split up into groups to discuss a series of questions on the technical aspects of DNA testing and ethical considerations. In the final lecture activity for this section, I adopted an exercise from the Instructors Resource Guide for the course textbook (Belk and Borden, 2007) entitled ‘Student Opinions of Human Cloning’. In this activity, students split up into groups to take votes on what types of human cloning activities (including therapeutic or reproductive examples) they would consider to be ethically permissible. They then discuss ethical considerations of the future biotechnology applications including the ramifications of modifying germlines and enhancing human genes. In the final activity for this section, students complete a homework assignment that considers three case studies that present ethical dilemmas related to DNA sequencing and testing. These case studies were adapted from educational materials prepared as part of
the Human Genome Project (Online Education Kit/Ethical, Legal & Social Implications of Genetic Knowledge, [http://www.genome.gov/25019880](http://www.genome.gov/25019880)).

One group lecture activity, two individual homework assignments and one laboratory were modified or developed for the third module of the course, with focuses on diversity, evolution and ecology. Students are initially introduced to opposing views of the moral relationship between humans and the environment including the concept that humans value biodiversity for the material benefits organisms can provide to people (use value) and the view that elements of nature have value independent of their value to humans (existence value). This discussion is followed by an individual homework assignment that exposes students to controversies surrounding the issue of who owns living organisms and genetic resources. An in-class group activity on the biological concept of carrying-capacity with respect to human population levels and food supply was modified to incorporate consideration of bioethical principles of respect and fairness/justice with respect to limited resources. A second individual homework assignment was developed where students calculate their Ecological Footprint and consider how individual choices can have an impact on complex environmental issues. Finally, in a laboratory exercise that is part of a lab on Ecology, a predator-prey simulation demonstrating the dynamics of population growth was adapted to simulate the interaction between humans and fish and the consequences of overfishing. As part of the exercise, students consider the environmental ethical issues involved in resource management and the concept of the tragedy of the commons (Hardin 1968).

CONCLUSION

Integrating ethics into a non-majors introductory biology course was a challenging but interesting project. On the whole, embedding ethical content into the course added to student engagement in the course material and did not detract from the amount of course material covered. Most of the activities were field tested in the course during the Fall semester in 2009. I observed that the students’ interest in biology and the ethical dilemmas involved was the greatest in situations that presented stories about decisions that real people have to make currently or in the future. Several students mentioned in their written evaluation of the course that the videos and discussions that followed were their favorite part of the course. While most of the activities have been field
tested during the development phase, formal assessment of student learning objectives with regard to ethical content still needs to be done.

ACKNOWLEDGEMENTS

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REFERENCES


**Table 1:**

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<thead>
<tr>
<th>Module</th>
<th>Biological &amp; Ethical Issues</th>
<th>Activities</th>
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<tr>
<td>Scientific Method</td>
<td>Biological Topics: hypothesis testing, research design, types of studies (observational, intervention), controlled studies, placebos, randomization, blinding, the need for comparison (or control) groups</td>
<td>Lecture Activity: Is Obesity Caused by a Virus? -video and exercise on hypothesis testing and research ethics</td>
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<tr>
<td>Research Ethics, Bioethical</td>
<td>Ethical Issues: human experimentation, methods of bioethical inquiry including introduction to the core ethical considerations (respect for persons, harms and benefits, and fairness)</td>
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<td>Concepts, &amp; Skills</td>
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<th>Activities</th>
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| Cellular & Molecular Biology
Bioethics | Biological Topics: cell cycle and cancer biology, Mendelian genetics, DNA: structure and mutations, inherited and somatic genetic mutations, genetic testing: predictive vs. diagnostic, pedigree analysis, relationship between genes, proteins and traits, cloning, genetic engineering
Ethical Issues: benefits and harms of genetic testing, who should have access to genetic information, cloning of animals and humans, stem cell research, genetic modification of humans and other organisms for human purposes | Lecture Activity: A Family History- video and discussion questions on genetic testing for breast cancer
Lecture Activity: Personalized DNA Testing- video and discussion on predictive and diagnostic DNA testing
Lecture Activity: Cloning and Genetic Engineering- group activity on therapeutic and reproductive cloning and ethics of genetic engineering of humans |
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<tr>
<td>Diversity, Evolution, &amp; Ecology</td>
<td>Biological Topics: diversity and classification, evolution, natural selection, population and community ecology, conservation biology, ecological restoration, sustainability</td>
<td>Homework Assignment: Bioprospecting or Biopiracy: Who Owns Genetic Resources?</td>
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<td>Environmental Ethics</td>
<td>Ethical Issues: bioprospecting, moral relationship between humans and environment, human responsibilities to the rest of the natural world</td>
<td>Lecture Activity: Carrying Capacity: Human Population and Food</td>
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<td>Ecology Lab: Population Dynamics &amp; Fishing- a classic predator/prey simulation game was adapted to considering people and fish- students can see the consequences of overfishing and consider the environmental ethics concepts of the tragedy of the commons</td>
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<td>Homework Assignment: Ecological Footprint- students calculate their Ecological Footprint and consider how individual choices can impact our environment</td>
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