Bringing Bioethics to the Natural Sciences Classroom: A Case Study Approach

Catherine Cooke, Amelia Hubbard

ABSTRACT

The value to students of discussing and evaluating bioethical scenarios has been widely demonstrated, yet relatively few natural science courses incorporate this topic as part of the curriculum. This paper presents an activity to introduce bioethics into a college introductory-level, general education natural science course. The objective of this activity is to help students critically analyze and evaluate bioethics scenarios across a wide range of topics (e.g., animal testing, gene therapy, ownership of human remains) that incorporate common bioethical concepts. At the end of the activity, students reflect on their given scenario and the broader implications of science on society.

Key Words: bioethics; case studies; teaching of ethics; natural sciences; biological anthropology.

Introduction

The Association of American Colleges and Universities (2018) identifies the importance of higher education in fostering values and ethical sensibilities among students. Many disciplines (e.g., business, law, premedicine) include ethics in their core curriculum (Olick, 2001). However, given the time constraints most college faculty already face regarding content, an extended unit on ethics is not feasible. Some other perceived obstacles to including a bioethics component in introductory courses could include instructors feeling inadequately trained or instructors lacking the materials to address bioethical issues (Dean & Beggs, 2006; Kormondy, 1990; Reiss, 1999; Willmott et al., 2004; Smith et al., 2007; Zaikowski & Garrett, 2004). Therefore, nonmedically-oriented natural science courses often exclude these concepts, particularly at the undergraduate level (Johansen & Harris, 2000). If ethics are discussed, professional ethics are often referenced (e.g., study design, plagiarism, misconduct) but not the greater ethical implications of science in society (Barden et al., 1997; Downie & Clarkeburn, 2005). College undergraduate students are required to take some form of natural science course for graduation regardless of their field of study. Therefore, this is an opportunity to expose students to thinking critically about ethical dilemmas related to natural science topics that they may encounter in their lives or future careers. At the precollege level, several initiatives resulted in ethics being broadly adopted into science curriculum (National Institute of Health, 2009). However, many of these activities span weeks and delve into moral philosophy. Here we present a case study activity to integrate bioethics into introductory-level college courses in natural science designed to be delivered within one to two class meetings with minimal instructor preparation.

Background

The importance of teaching ethics in higher education has been widely discussed (Jecker et al., 2012; Penslar, 1995; Reiss, 1999; Shannon, 1993). Along with providing practical application of course subjects, ethical engagement promotes self-reflection and empathy. The field of bioethics provides a baseline of principles and guidelines for moral reasoning (Beauchamp & Childress, 2001). Therefore, a discussion of bioethics provides students the opportunity to critically evaluate the implications of obtaining and applying scientific knowledge and to incorporate differing viewpoints on these applications (Dean & Beggs, 2006). The goal of discussing ethical dilemmas in the natural sciences is not to indoctrinate students or provide any concrete solutions but instead to review and apply course concepts to real world situations. Indeed, many of these issues may arise as students pursue careers in biology, health, and medicine. Students may also be introduced to careers directly involving bioethics such as medical ethics law and medical ethics consulting.

How to Incorporate Bioethics Using a Case Study Approach

The National Institute of Health designed a curriculum that specifically addresses bioethics and how to implement lessons in the high school
classroom (2009). These materials can be adapted for an introductory college course, but the materials are designed to be delivered over three class meetings. Alternatively, a “case study approach” is an adaptable and easy way to incorporate bioethical decision making into natural science courses (Barden et al., 1997; Penslar, 1995; Smith et al., 2007).

The goal of the case study approach is to get students to consider the broader impacts of science, scientific research, and technology while also exposing them to a wide range of viewpoints. When designing case studies, they should be realistic and relevant to the subject matter, and they can be based on actual situations or reasonable scenarios (Barden et al., 1997; Savery & Duffy, 1995). Methods to implement the case study approach include having one group argue multiple points of an issue or having different groups take opposing positions. Another technique is the “stakeholder” approach where students adopt a specific perspective and consider how an individual would react based on their values and interest (Chowning, 2005). Regardless of the method, scenarios should be explored from all applicable ethical perspectives (Kabasenche, 2014).

The most applicable bioethical concepts for the natural sciences are listed in Table 1. This list includes the “basic ethical principles” outlined in the Belmont Report (1978) as well as ancillary principles that are applicable to natural science discussions. These bioethical concepts can guide discussion of ethical dilemmas that tie directly into topics typically covered in introductory undergraduate natural science courses such as biotechnology, animal research, and the study of human remains (Beauchamp & Childress, 2001). While there is an aspect of opinion in student responses, their discussions should be supported on both an ethical and factual basis. For this activity, students are expected to explicitly refer to and contextualize their responses per the basic bioethical concepts introduced and subject matter knowledge from the entire semester.

The activity described below is used in an introductory biological anthropology lab taught by both authors. Each section usually has around 25 students that are divided into groups at the start of the semester. Therefore, the students are familiar with each other, and hopefully by the end of the semester the classroom is viewed as a supportive environment for students to discuss their informed opinions. These materials accompany a lecture unit and lab covering bioethics that conclude the semester.

Table 1. Bioethical concepts applicable to introductory undergraduate natural science courses.

| Bioethical Concept | Definition |
|--------------------|------------|
| Autonomy           | The informed and actual ability to accept or refuse and implement a course of action (Shannon, 1993) |
| Beneficence        | The obligation to help others in their pursuit of welfare (Shannon, 1993) |
| Distributive justice | The fair distribution of benefits and burdens of goods and services (Beauchamp & Childress, 2001) |
| Informed consent   | “[T]he knowledge of and consent to a particular form of treatment before that treatment is administered” (Shannon, 1993, 10) |
| Nonmaleficeance    | The obligation to do no intentional harm (Shannon, 1993) |

○ Instructor Preparation

In addition to Table 1, examples of three broad topical areas (human biology and DNA, animal research, and deceased humans/fossils) that are relevant to a natural science curriculum are presented in Table 2. Case study examples and the associated bioethical concepts are also provided.

○ Student Preparation

Students complete a short reading reviewing how they, consciously or not, are introduced to ethical dilemmas daily (e.g., undercharging for an item at the store), and how their choices are deeply informed by societal norms and cultural differences (e.g., Is the undercharge seen as a freebie or something you must report?). Students are then introduced to the bioethical concepts from Table 1.

○ Lecture Component

During the class prior to the lab activity, the instructor explicitly introduces the concepts from Table 1 and discusses the assigned reading. This brief lecture and discussion prepares students for the lab activity and provides a bioethical framework to formulate responses. If possible, a guest lecture by a bioethicist or subject matter expert would enhance student perspectives.

○ The Case Study Ethics Activity

This discussion-based activity is designed for a one- to two-hour lab. In the two-hour version, students are asked to choose one of five case studies to explore with guided questions. Student groups are given 45–60 minutes to read, discuss, and prepare a short overview of the scenario, ethical dilemmas, and their answers to each question. The remaining hour is spent reviewing their analyses of the scenarios with time for discussion and to complete a before and after written reflection. Ideally, students will be offered full credit for participation in the activity if they relate the bioethical concepts in their reflection.

Learning Outcomes

- Provide an experiential application of course concepts
- Encourage critical thinking
- Synthesize major course topics
- Encourage empathy in unfamiliar or ethically challenging situations

Logistics Summary

1. Prepare four to five case studies covering various bioethical concepts that relate to course topics (Table 2).
2. Divide students into groups of four or more individuals.
3. Reinforce that the classroom is a safe space to share opinions and everyone will remain respectful. The instructor should also stress that this activity is different from previous exercises where there is one correct answer. Students should be encouraged to examine the problems from multiple perspectives (e.g., individual, societal).
Pan paniscus
Continued use of monkeys as human-wildlife conflict, climate change, and extreme poverty which hampers efforts at bonobo research and conservation. Other threats facing the bonobos are habitat destruction and poaching.

Imagine you are a graduate student in animal behavior and are interested in studying wild bonobo behaviors. A nongovernmental organization (NGO) is opening a branch in the DRC and wants to focus on bonobo conservation, and they have contacted you to work with them. However, the local people are suspicious of the animals “used” to human presence so they don’t flee upon sight). Your graduate advisor and several other prominent primatologists have voiced their support for the bonobo project.

Given this information, think about the following:

1. What bioethical concepts might apply to this scenario and why?
   - **Note for instructor:** Asking what bioethical concepts apply as the first question in the case study activity sets the framework for the entire discussion.

2. Based on those concepts, what are the possible outcomes and implications of bonobo habituation?
   - **Note for instructor:** From information covered during the semester in our Introduction to Biological Anthropology course, students might consider that researchers know very little about the behavior of bonobos, which are the closest living relative to humans. If we learn more about their behavior and ecology, not only can we help conservation efforts but also we can learn more about human evolution. However, given the

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**Case Study Example 1: Noncaptive Animal Research**

In this scenario, students are introduced to the habituation of wild animals and human-wildlife conflicts to demonstrate the principles of beneficence, distributive justice, and nonmaleficence. Students are asked to identify applicable bioethical concepts, consequences, human impacts, and a reflective question that places the student within the ethical quandary. Each question also includes notes for the instructor.

Bonobos (*Pan paniscus*), a type of great ape, are close relatives of humans along with common chimpanzees (Fleagle, 2013). Although little is known about wild bonobo populations, researchers have found that they are highly intelligent and practice unusual behaviors such as having sex outside reproduction and living in female dominated societies. Unfortunately, bonobos are also highly endangered (an estimated 100,000 survive), and they are only found south of the Congo River in the Democratic Republic of Congo (DRC). The DRC suffers from civil unrest, disease epidemics, and extreme poverty which hampers efforts at bonobo research and conservation. Other threats facing the bonobos are habitat destruction and poaching.

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**Table 2.** Topic areas within natural sciences, potential case study issues, examples, and the corresponding bioethical concepts.

| Topic Area                        | Case Study Issue                                                                 | Examples                                                                 | Bioethical Concepts                                                                 |
|-----------------------------------|----------------------------------------------------------------------------------|----------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| Human biology and DNA             | Genetic testing (e.g., diseases, DNA kits)                                       | Testing for heritable genetic diseases, commercial DNA kits                | Autonomy, beneficence, distributive justice, informed consent, nonmaleficence     |
|                                   | Gene therapy / gene editing                                                      | Crispr                                                                    | Autonomy, beneficence, distributive justice, informed consent, nonmaleficence     |
|                                   | Bodily integrity                                                                | Cord blood banking, fetal stem cell use in vaccines, antivaccination movements | Autonomy, beneficence, distributive justice, informed consent         |
|                                   | Assisted reproductive technology (e.g., freezing embryos, egg donation, surrogacy) | Freezing embryos, egg donation, surrogacy, anonymous sperm donation        | Autonomy, distributive justice, informed consent                                |
| Animal research                   | Biomedical testing                                                              | Continued use of monkeys as test animals, retiring former lab chimpanzees  | Beneficence, nonmaleficence                                                      |
|                                   | Habitation of wild animals                                                       | Human-wildlife conflict, climate change                                     | Distributive justice, nonmaleficence                                              |
|                                   | Behavioral studies (in the wild and captivity)                                   | Captive ape language studies, human-wildlife conflict, climate change      | Beneficence, distributive justice, nonmaleficence                                  |
| Deceased humans and fossils       | Ownership of ancient remains                                                     | Kennewick man, NAGPRA                                                       | Distributive justice                                                             |
|                                   | Ownership of fossils and artifacts                                               | Repatriation of museum collections                                         | Distributive justice                                                             |

4. Assign case studies and have students write a short reflection of their opinion of the scenario that incorporates the relevant bioethical concepts.

5. After completing their reflections, students discuss among their groups.

6. Each group presents and leads discussion for the class on their assigned case study.

7. Students add to their initial reflection and note if their perception of the issue changed after the group/class discussions or any additional comments.

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*Note for instructor:* From information covered during the semester in our Introduction to Biological Anthropology course, students might consider that researchers know very little about the behavior of bonobos, which are the closest living relative to humans. If we learn more about their behavior and ecology, not only can we help conservation efforts but also we can learn more about human evolution. However, given the...
history of poaching in the region, researchers run the risk of further endangering the population.

3. The DRC is one of the poorest countries in the world and lacks basic infrastructure, clean water, and safety for its citizens. How should NGOs approach funding for conservation projects given the identified bioethical implications?

- **Note for instructor:** Students will have their own opinions and reasoning for their responses. The instructor might point out the mistrust for external agencies among the local people and ask why this occurs. In our course, we discuss the residual impact of colonialism on scientific research and conservation throughout the semester.

4. Explain if you would or would not continue with bonobo habituation if you were the graduate student?

- **Note for instructor:** Students will have their own opinions and reasoning for their responses.

**Case Study Example 2: Human Biology & DNA**

In this scenario, students are introduced to the principles of autonomy, beneficence, and informed consent. Students are asked to consider who can consent to such actions, what factors complicate umbilical cord banking, and a reflective question that places the student within the ethical quandary. Each question also includes notes for the instructor.

Among most mammals, fetal development occurs inside the placenta in the uterus. The placenta forms from the uterine wall and, along with the umbilical cord, provides the fetus with nourishment, eliminates waste, fights infections, and produces hormones related to growth and development. Cultures have various methods of disposing of the placenta and umbilical cord. For example, some cultures bury the placenta (to protect the child and the mother or prevent the mother from taking the child’s spirit) and, occasionally, some cultures eat the placenta or umbilical cord (Young & Benyshek, 2010). In the United States, the placenta is typically incinerated after birth; however, this practice is changing. Physicians recognize that the placenta and umbilical cord contain stem cells. These cells can be used to produce red and white blood cells to treat a variety of diseases in children, including sickle-cell and leukemia (Shearer et al., 2017).

Parents now have the option of depositing umbilical cord blood cells or tissues in public or privately run “cord banks.” The public cord banks make the blood available for anyone who might need them, whereas private cord banks store cord blood for individual use. Private cord bank companies charge a fee for collection, transport, and yearly storage. For example, one cord bank company charges a lifetime fee of nearly $5000, or $1600 for initial cord blood collection and $185 for storage after the first year (www.cordblood.com). These for-profit companies market their services as “biological insurance.” However, estimates suggest that only 1 in 15,000 children will ever need to use their stored blood (Sullivan, 2008).

Given this information, think about the following in terms of bioethical principles:

1. Who do you think owns the cord blood?

   - **Notes for instructor:** This scenario prompts students to think in terms of autonomy, beneficence, and informed consent. Students might consider the uniqueness of human female reproduction, fetal development, and genetics.

2. What happens if the family donates fetal cells for public use and later needs them for their child? What if the cells were used for research and led to the development of a lucrative pharmaceutical product?

   - **Notes for instructor:** Students will have their own opinions and reasoning for their responses. The second part of this question can potentially tie in with a previous discussion of Henrietta Lacks and other racial justice issues.

3. Is it ethical to conceive another child with the intent of donating the child’s cord blood to an ill sibling?

   - **Notes for instructor:** Although this is a somewhat “loaded” question, the authors have found students engage with this question and produce valuable conversations.

4. Are cord banking companies providing a valuable resource for people? Would you choose to store or donate your child’s cord blood as “biological insurance”?

   - **Notes for instructor:** Students will have their own opinions and reasoning for their responses. An important concept to elicit is potential socioeconomic barriers to using this service, which brings in the concept of distributive justice.

**Assessment**

The primary method of assessment is a written reflection. Reflection-based exercises, such as this one, have demonstrated benefits for student learning because they allow students to “slow down” and process what they have learned (e.g., Rogers, 1969), develop scientific literacy (Sadler & Zeidler, 2004), and be more mindful of the learning process as opposed to following prescriptive steps to complete a task (e.g., Main, 1985). The opportunity for reflection is particularly valuable in a natural science course where knowledge of facts and theories is usually the end goal rather than an understanding of the broad applicability of these facts and theories.

**Conclusions**

Incorporating ethics into undergraduate natural science courses increases scientific and ethical literacy and challenges students to examine alternative perspectives with an understanding that science impacts society. Unfortunately, despite strong consensus among biology students (e.g., Downie, 1993) and faculty (e.g., Kolarova & Denév, 2012; Sadler & Zeidler, 2004), bioethics is not a common component of undergraduate natural science courses (Booth & Garrett, 2004).

Case studies encourage student discussion on the complexities of ethical thinking and are an easy method incorporating ethical reflection into undergraduate courses. Ultimately, the addition of bioethics doesn’t necessarily require discussion of philosophy and ethics theory, and case studies are a summative and analytical approach to reviewing biological and practical concepts.

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Catherine Cooke (catherine.cooke@slu.edu) is an adjunct faculty member and the distance education manager at Saint Louis University, St. Louis, MO. Amelia Hubbard (amelia.hubbard@wright.edu) is a professor emeritus at Wright State University, Dayton, OH.