REU Students' Initial Perceptions of Scientific Ethics

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Abstract. One goal of undergraduate research, particularly Research Experience for Undergraduates (REU) programs, is to help students become aware of the importance of ethical conduct in research. The Survey of Undergraduate Research Experiences (SURE) indicates that biology students believe they learn more about ethical conduct from their research experiences than physics students. Motivated by this, we initiated a study of both biology and physics REU students at Kansas State University consisting of pre- and post-interviews regarding their understanding of ethics with results to be compared to the SURE. This paper presents the students' initial perceptions (from the pre-interview) of how ethical issues impact science in general as well as their own specific work. We also discuss the differences in the interview responses of the two groups.

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INTRODUCTION

Ethical conduct in scientific research has become increasingly important in recent years. As stated in an announcement from the 2010 NSF Research Experiences for Undergraduates (REU) program, "The America COMPETES Act (42 U.S.C. 1862o-1) requires institutions to have a plan for training all students supported on an NSF award in the responsible and ethical conduct of research [1]." Beginning in 2010 ***all*** NSF programs must also contain an ethical training component for students [2]. Thus, we need to understand how students perceive both the ethics of science and their formal education in this topic.

One source of information on students' perceptions is the Survey of Undergraduate Research Experiences (SURE), which has been administered nationally for several years [3,4]. This instrument surveys undergraduate researchers on their perceptions of increased knowledge on 21 facets related to their research experience. The respondents report their perceived gains for each item on a five point Likert scale from "No gain or very small gain" to "Very large gain."

One of the items directly addresses ethics in research. In the 2009 data, biology and physics students recorded a rather large difference on this item. The average for biology REU students was 3.20 while that of physics REU was 2.39 [5]. This difference is well beyond the 95% confidence interval for the biology mean. This result led us to ask:

Why do the two groups report different perceived gains in learning ethical conduct on the SURE?

LITERATURE REVIEW

Ample material is available for teaching ethics in science [6,7,8,9]. Several papers describe specific efforts to integrate ethics training into REU programs [10,11] and to evaluate these efforts [12,13,14]. With the exception of Lopatto's work with the SURE survey [3], these efforts have addressed how a single group of students was affected by the ethics training received during their REU experience and did not compare perceptions across groups of students.

STUDY OVERVIEW AND METHODOLGY

The results from the SURE indicate that the REU students in physics and biology perceive different amounts of gain in learning ethical conduct. In order to investigate this effect, we need to understand students' views concerning ethical behavior in science and to determine if their REU experience changed that view. Therefore, entrance interviews were conducted with the REU students within the first week of their research experience. In addition to having the students complete the SURE survey at the end of the summer, exit interviews will also be conducted. Student responses from the two interviews will be compared and then related back to the results of the SURE survey. While the study is not yet complete, the initial interviews contain information of value to the study.

Demographics

For the purpose of this study, 14 physics and 14 biology REU students from Kansas State University were interviewed. The demographics of these two groups are shown in Table 1.

TABLE 1. Student demographics.

Field of Study	Gender		Year in School			Research Experience	
	M	F	So	Ju	Se	Y	N
Physics	10 71%	4 28%	2	6	6	8	6
Biology	4 28%	10 71%	1	7	6	9	5

For comparison, the distribution by gender reported by Lopatto for undergraduate researchers on the SURE survey for biology was 174 (34%) male and 333 (66%) female and for physics was 49 (75%) male and 16 (25%) female [3]. Thus, the gender distribution of our sample is fairly consistent with the overall distribution of undergraduate researchers. Lopatto does report seeing some gender differences which are entangled with type of institution [3].

The distributions of our two samples are similar in terms of year in school and previous research experience. For the purposes of this study, we are defining research experience as research that takes place outside of the classroom environment.

Data Collection

The entrance interviews were conducted by both authors over three days during the first week of the REU program. Murphy interviewed 9 biology and 7 physics REU students while Zollman interviewed 5 biology and 7 physics REU students.

During the interview, all the students were asked two questions on the topic of ethics: "What are the most important issues that physicists/biologists must consider in order to behave ethically?" and "How do ethics impact physics/biology?" In addition, Zollman asked his interviewees about ethics in their own research. Seven of Murphy's interviewees also were asked this question. In total, 10 biology REU students and 9 physics REU students commented on this topic.

The ethics questions came at roughly the midpoint in the interview. Prior to these questions, the students answered questions relating to demographics, the REU program, and scientific knowledge.

Data Analysis

A number of scientific professional organizations and governmental offices offer guidelines regarding the Responsible Conduct of Research (RCR) or scientific ethics. Often these guidelines are broken into broad categories. Table 2 shows the nine categories used by the U.S. Department of Health and Human Services Office of Research Integrity (ORI) [15, 16, 17]. These categories are:

1. Research misconduct
2. Human subjects
3. Animal welfare
4. Conflict of interest or commitment
5. Data acquisition, management, sharing and ownership
6. Mentor/trainee responsibilities
7. Collaborative science
8. Publication practices and responsible authorship
9. Peer review

In the data analysis, we first adopted the above categories since they represent accepted areas of concern for scientific ethics. We then coded the interview responses according to these categories. If a response contained ideas from multiple categories, it was coded into all representative categories. Also, an "other" category was added to indicate the expressed ideas outside the nine ORI categories.

DATA SUMMARY

Student responses were coded into the ten categories defined above. An example biology student response

to the first question (ethical behavior) is: "Well, whether… what sorts of impacts their research will have on research subjects – so animal, animal cruelty type considerations. If it's human subjects, then what sorts of methods would be reasonable. And, also what the results of their research could lead to —an example would be the Manhattan Project." The categories present in this response are human subjects, animal welfare, and "other" for the portion on the Manhattan project.

To the impact of ethics question, a response given by a physics student was: "It doesn't impact physics per se but does impact how we go about finding physics. So, I mean, there are ethical decisions like in the lab… be conscious of the fact to not be stealing other people's work and stuff like that." This response is categorized into "other" for the initial thought and research misconduct for the comment on not stealing others work.

In commenting on ethics in her own work a biology student's response was: "Try not to disturb the ecosystem is the main one. Being gentle with the birds we're handling. Making sure our data is accurate so that it is not misleading. I'm not really sure what else." This response falls into the categories of animal subjects and research misconduct.

Table 2 summarizes the student responses to the interview questions. To all three interview questions physics students tended to focus more on ideas related to research misconduct with seven of them commenting on ideas associated with data falsification or manipulation and plagiarism. The biology students commented more often on the proper treatment, care, and use of animals during research. This is most likely related to the field of study – in general, biology deals with animals and physics does not. While neither field typically deals with research involving human subjects, every interview began with reading and signing an informed consent form. Yet, few students in either field commented on ethical issues relating to research with human subjects. (One who did is working in the physics education group this summer.)

Why did the biology students not comment in categories outside of animal welfare is troubling? Do they not see topics related to research misconduct as part of biology or do they simply see them as too simple to comment on? Some evidence indicates that it might be the latter. For example the response of a physics student on the impact of ethics to the study of physics included, "…simple ethics involving data encryption, plagiarism, stuff like that. Simple stuff like that that is not directly related to physics."

A majority of the students in both fields expressed ideas outside the standard RCR categories [17]. These responses are summarized in Table 3, with ideas outside the 6 named categories omitted. In answering the question on ethical behavior, four students in each field (eight total) were concerned with ideas related to the future use of the research. For example, one biology student remarked: "Consider if what you are doing could lead to weapons that could wipe out humanity." A physics student remarked: "We don't want to be making things with the intent to harm – don't want to make weapons and such." Three physics students commented on the role of ethics in science. "Ethics should not inform the explanation or hypothesis." "I don't think anything should limit us."

When asked about ethics in their own field, four physics students and five biology students only commented about ideas categorized as "other." Thirteen students responded in ways consistent with ethics influencing the way science is conducted.

TABLE 2. Summary of student responses on the three interview questions.

	Ethical Behavior		**Impact of Ethics**		**Ethics in Own Work**	
Category	**Biology**	**Physics**	**Biology**	**Physics**	**Biology**	**Physics**
Research misconduct	4	10	2	9	2	4
Human subjects	5	5	2	1	1	1
Animal welfare	9	3	8	3	5	0
Conflict of interest	0	0	0	0	0	0
Data management	0	2	0	1	1	1
Mentor/Trainee responsibilities	0	1	0	1	0	1
Collaborative science	1	0	0	0	1	0
Publication practices	1	1	0	1	1	1
Peer review	0	0	0	0	0	0
Other	9	9	10	11	4	5

TABLE 3. Summary of "other" responses on the three interview questions.

	Ethical Behavior		Impact of Ethics		Ethics in Own Work	
Category	**Biology**	**Physics**	**Biology**	**Physics**	**Biology**	**Physics**
Concerns over future use of research	4	4	0	0	0	0
Influence way science is conducted	4	1	7	6	0	0
Mention of larger issue (stem cell, etc)	5	4	3	4	0	0
Personal view, opinion, or discomfort	4	1	1	0	0	0
Unsure, minimal or none	0	0	0	0	3	3
Important	0	1	1	0	0	0

For example, a physics student remarked that ethics "prevents certain kinds of research from being done" while another said ethics do not "impact physics but impacts the way of finding physics." A biology student remarked that ethics "restricts what can be done but that is not necessarily bad." Another commented that "you don't want ethics to hinder the forefront of acquiring scientific knowledge."

To the question on the impact of ethics in their own work, one student from each field believed that ethics did not impact their own research. Another physics student answered "Don't know. Don't care." Another biology student felt that few ethical dilemmas existed in mycology.

CONCLUSIONS AND FUTURE WORK

Student responses' to the three ethical questions fell, along categories consistent with their fields. The biologists, most likely because they are more often work with animals, commented more often on the need for ethical treatment of animals. There was a large number and variety of ideas that fell outside the accepted categories of scientific ethics. Given the gender distribution of our populations, it is possible that the differences we see are due to gender and not related to field of study.

This work is preliminary to a larger study, we do not yet have the ability to determine what, if any, gain these REU students will perceive from their experience this summer. At the end of the summer, we will be conducting exit interviews with this same group of REU students. The exit interviews will cover their opinions of the training they have received in addition to re-probing the questions discussed herein. They will also be asked to complete the SURE survey. We will be looking at how the students' responses change over the course of the summer and comparing to the results of the SURE survey. We will also be using this information to guide the ethics training received by future KSU REU students.

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