in Introductory Physics: Introducing Ethics

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Assessing ABET ANSAC Learning Outcome (5) and EAC Learning Outcome (4) in Introductory Physics: Introducing Ethics

Abstract

The physics and engineering physics programs at our institution are currently in the process of preparing to apply for ABET accreditation through the Applied and Natural Science Accreditation Commission (ANSAC) and Engineering Accreditation Commission (EAC), respectively. These programs follow an "Introduce, Reinforce, Master" curriculum map as part of the assessment plan where each student learning outcome (SLO) is assessed in at least three courses of different levels, so that each SLO is assessed at each of the three levels (introduced, reinforced, and mastered). We seek to effectively assess, at the introductory level, the proposed ANSAC SLO (5) and the new EAC SLO (4) with a *series of case studies and a rubric* in our introductory physics course. There are two primary difference between the SLOs from the two commissions. Firstly, the EAC requires that the students *recognize* while the ANSAC requires that the students *understand* ethical and professional responsibilities. Secondly, the EAC requires the students to make informed judgments in engineering situations while the ANSAC requires the students to understand the impact of their technical and/or scientific solutions. With this in mind, we have implemented a series of case studies that are analyzed by students during the introductory physics lab. Because these SLOs are being assessed at the "Introduce" level, we are requiring students to recognize examples of unethical and/or unprofessional conduct in engineering and scientific situations. The "Reinforce" and "Master" levels will assess the students' ability to make informed judgments and their understanding of ethical and professional responsibilities in global, economic, environmental, and societal contexts.

In this paper, we discuss the details of the case studies and the rubric developed to assess the students. Additionally, we will discuss changes that will be implemented to the assignment and assessment processes so that student learning of the skills and concepts required of the SLOs will improve.

1. Introduction

Our department plans to seek ABET accreditation in the near future. As our department awards bachelor's degrees in both physics and engineering physics, we will have to seek accreditation through the Applied and Natural Science Accreditation Commission (ANSAC) for the physics program and Engineering Accreditation Commission for the engineering physics program. ABET's Criterion 3 - The Student Learning Outcomes (SLO) - for the two commissions are similar but different enough that if a department wants to assess SLOs that are similar across both commissions at the same time the performance indicators for the SLOs must be chosen carefully so they address both commission's criteria simultaneously. As an example, the 2019-2020 ANSAC SLO 5 and EAC SLO 4 are different but both address student learning of ethical and professional considerations [1]. These two learning outcomes are given in table 1.

ANSAC SLO 5	*an ability to understand ethical and professional responsibilities and the impact of technical and/or scientific solutions in global, economic, environmental, and societal contexts.*
EAC SLO 4	*an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts*

Table 1: Student outcomes related to ethics and professional responsibility for ABET's ANSAC

Furthermore, our program utilizes a three-tier assessment process where each learning outcome is assessed in at least three different classes once each at the "Introduce," "Reinforce," and "Master" levels and use Bloom's Taxonomy to create performance indicators at the correct level [2] [3]. More details about our program's assessment process can be found in [4]. Because we wish to assess both commissions' learning outcome simultaneously, we determined performance indicators at each of the three levels that address both learning outcomes. The performance indicators and the courses where they will be assessed are given in table 2.

Performance Indicator	**Course**	**Level**
1) Recognize and understand examples of unethical and/or unprofessional behavior of students in coursework	Introductory Physics 1 and 2 Lab	Introduce
2) Recognize and understand examples of unethical and/or unprofessional behavior of professional scientists and engineers in research and engineering situations.	Advanced Physics Lab	Reinforce
3) Apply professional code of conduct, as dictated by a relevant professional society, to make an informed judgment in which they must consider the impact of their scientific or engineering solutions in global, economic, environmental, and societal contexts.	Senior Research / Capstone	Master

Table 2: Performance indicators at the Introduce, Reinforce, and Master levels and in which courses they will be assessed for the student learning outcome related to ethics and professional responsibility.

The focus of this paper is on how our program assessed the ANSAC SLO 5 and EAC SLO 4 at the "Introduce level" in our introductory physics courses in the fall of 2019 and the results of the assessment process. To introduce ethics in our physics laboratories, we created a series of case studies and quizzes that our Introductory Physics 2 Lab students were required to take as part of their regular post-lab quizzes.

2. Teaching and Assessing Ethics

It is difficult to find an objective way to teach and assess ethics. For resources, we used the Academic Integrity Policy from the Arkansas Tech University (ATU) Student Handbook and case studies that we created. Because we were teaching and assessing ethics in our Introductory Physics 2 Lab, we used examples related to lab behaviors. For our case studies, we tried to use

examples of behavior from previous students that we wanted our current and future students to avoid. Two occasional "problem areas" we had noticed in previous semesters were 1) some students not learning to collect and analyze their own data and 2) not properly citing their inspiration for a design project. We created a case study for each scenario, where we tried to set-up the situation and teach students the correct or Instructor-expected response. We created three ethics related assignments.

2.1 Assignment 1 and Quiz 1

In the first assignment, the students were asked to read the Academic Integrity Policy for our university. The policy is available in the ATU Student Handbook and we created a link to it in Blackboard for the students. The policy lists types of academic integrity violations and includes definitions and examples for cheating, plagiarism, collusion, impersonation, fabrication, and forgery. The students were asked to read the policy and then answer 5 questions. The complete assignment is given in figure 1.

Ethics Quiz 1

According to the ATU *Student Handbook 2019-20 Academic Integrity Policy pages 85-86: "A violation of academic integrity refers to various categories of inappropriate academic behavior with respect to a course. Students must refrain from cheating, plagiarism, fabrication, impersonation, forgery, collusion and or other dishonest practices." Examples and definitions are provided in the handbook. Please read* ATU*'s Academic Integrity Policy on pages 85-86 in the Student Handbook and then correctly answer the following questions.*

1. *True or False: According to the student handbook, collusion is the act of collaborating with one or more students or others on coursework.*
2. *True or False: According to the student handbook, collusion is the act of collaborating with one or more students or others on coursework when the professor has not expressly approved collaboration or group work on the assignment.*
3. *True or False: Hiring someone to write your paper or complete some other assignment is an example of impersonation.*
4. *Which of the following situations were included in the handbook as examples of cheating? (Select all that apply.)*
    a. *Copying from the examination or quiz of another student*
    b. *Using classroom notes, messages, or crib sheets in any format which gives the student extra help on the exam or quiz, and which are not approved by the instructor of the class*
    c. *Completing the assigned readings for the course*
    d. *Attending the instructor's office hours*
    e. *Obtaining advance copies of exams or quizzes*
    f. *Soliciting of unethical academic services, including purchasing of research papers, essays or any other scholastic endeavor*
5. *Which of the following situations were included in the handbook as examples of violations of academic integrity by fabrication or forgery? (Select all that apply.)*
    a. *Furnishing false information, data, or research findings on coursework*
    b. *Fabricating or altering information or data and presenting it as legitimate*
    c. *Shape a piece of metal for a project*
    d. *Putting your name on another person's exam or assignment*
    e. *Altering a previously graded exam or assignment for purposes of a grade appeal or of gaining points in a regrading process*

Figure 1: The first ethics related quiz administered to Physics 2 lab students.

Three of the questions were “True or False” and two of the questions asked students to choose multiple correct answers from a list. The questions were based on the definitions, and the quiz was administered via BlackBoard as an out of class assignment. Students were given unlimited attempts for quiz 1 and were encouraged to take it as many times as they needed until they earned a 100%. Of the 47 students who took quiz 1, 25 students scored 100% on the first attempt. Two students missed question 1 on the first attempt but chose not to retake the quiz. The remaining 20 students retook the quiz until they also scored 100%. Figure 2a shows the number of students and their number of attempts to complete quiz 1.

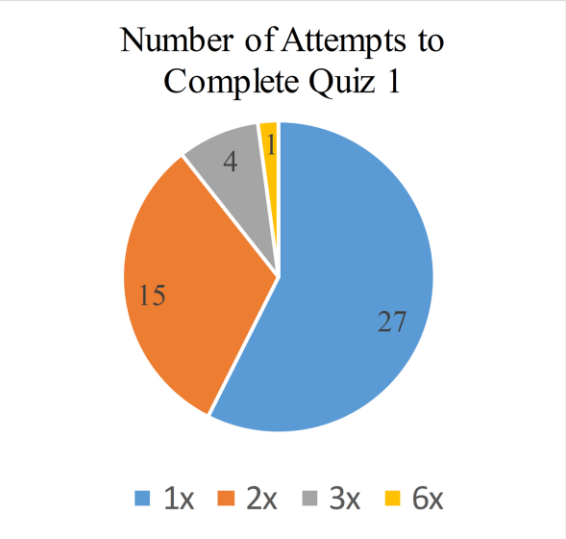


Figure 2a: The number of students who took the first quiz 1, 2, 3, or 6 times are shown. (No students had only 4 or 5 attempts.)

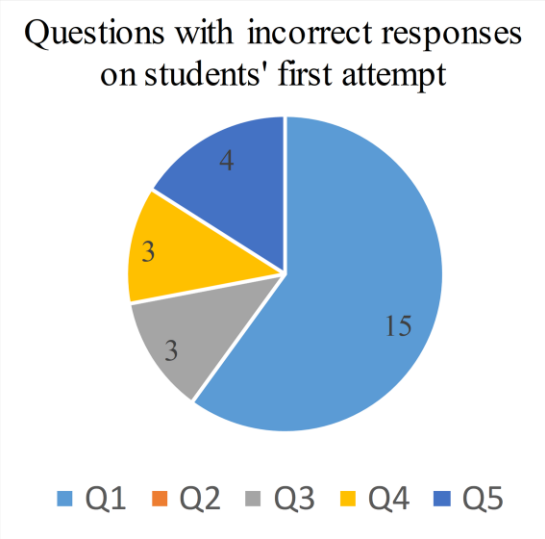


Figure 2b: The number of students who missed each question on their first attempt are shown. (No students gave an incorrect answer for question 2.)

The number of incorrect responses given for each question during the students’ first quiz attempt are shown in Figure 2b. Note that everyone answered question 2 correctly. For the students who didn’t initially make 100%, the most missed question was question 1. This question was included (in combination with question 2) to make sure that students understood that working with others wasn’t always an Academic Integrity violation. The real issue is working with others when the work should be independent.

Six students missed questions 4 and/or 5, which were multiple answer questions. Of the students who missed question 4, the most common mistake was not including “Soliciting of unethical academic services, including purchasing of research papers, essays or any other scholastic endeavor” as an example of cheating. The students who missed question 5 most often didn’t include “Furnishing false information, data, or research findings on coursework” as a correct answer. Two students included “Shape a piece of metal for a project” as a correct answer to question 5.

2.2 Assignment 2 and Quiz 2

For the second and third assignments related to ethics, students were asked to read a short lab scenario and to answer a few questions in response to the situation. Both scenarios were written based on past instructor experiences in the lab. Students read the case study and answered the questions on BlackBoard as an out of class assignment. Assignment 2 is shown in figure 3.

Ethics Quiz 2

Bob, Alice, and you are in a physics lab group. The three of you have a math exam tomorrow and want to complete the lab as quickly as possible so that you can study.

After your group collects a set of data, the lab instructor tells you to try to connect the circuit again, because your data shows that the circuit is incorrectly wired.

After two unsuccessful attempts to collect your own data, Bob says he has a copy of his friend's lab manual that took the class last semester and suggests using his friend's data, since he already successfully completed the lab. Alice says that wouldn't be right. Instead, Alice suggests calculating the theoretical values and using those numbers as your data so that you and the group can answer the remaining Lab Questions. You say that both suggestions would violate ATU*'s Academic Integrity Policy that you just had a quiz over. Alice and Bob disagree with you and ask "How the academic integrity policy would be violated by their suggestions?"*

Question 1: In 3-5 sentences, write how you would respond.

Question 2: In 3-5 sentences, write what you would suggest that the lab group do instead of following Alice's and Bob's suggestions.

Figure 3: The first case study and second ethics quiz administered to Physics 2 Lab students.

For question 1, all 47 students responded. In their response about how the Academic Integrity Policy would be violated by Bob's and Alice's suggestions, some students didn't use vocabulary from the Academic Integrity Policy to specifically state how Alice and Bob were violating the policy. We might need to be more specific in our question, which is difficult to do without being too leading. Only 15 of the 47 students gave a correct answer for Alice and Bob that used specific terms from the Academic Integrity Policy. Thirteen students used a specific term such as plagiarism or cheating for Bob's suggestion but did not have a correct answer for Alice. Four students correctly identified the violation for Alice's suggestion but did not have a correct answer for Bob. Fifteen students did not include a specific term for the suggestions made by Bob or Alice. Instead, the students used words like "wrong" and "lying". General information about their responses and changes we might make to the question in the future include:

1) Some students only answered about Bob or Alice but not both. We will consider separating the question and asking for the student response to Bob as one question and response to Alice as a separate question.

2) Many students responded that the suggestions made by Alice and/or Bob would be generically wrong, but they didn't use specific words such as cheating, plagiarism, falsifying data, or fabrication. Also, Alice is cheating in the everyday meaning of the word but not in

the examples of cheating in the handbook. We will consider creating a multiple answer section where they choose the violation and how that violation applies.

3) Many students correctly identified Bob as plagiarizing another's work. Strangely, many students also accused Alice of plagiarism. Students might have misunderstood the definition of plagiarism or were perhaps being "lazy" with their responses. This is an additional reason to consider creating a multiple answer section where they choose the violation and how the violation applies.

For question 2, students were asked what they would suggest that the lab group do instead of following Alice's and Bob's suggestions. This question has two purposes. Firstly, it serves as a reminder to students that they can ask their Lab Instructor or TA for help. Secondly, it allows us to see what the students think are acceptable answers to this question. It is possible the students might have suggestions that are both acceptable and unknown to us.

Forty-six students responded to question 2. One student left the question blank but answered this question as part of their answer to question 1. Thirty-six students said "ask" for help and listed professors, TA, and others as sources of help. The student who included their answer for question 2 as part of question 1 said "we should ask the teacher for help so we can complete the lab honestly." The nine students who didn't include asking for help made suggestions such as redoing the procedure, rewiring the circuit, working together. Only one student wrote a response that did not really answer the question. The student's response was "we can do this easy fam. follow my lead. ya dig?"

2.3 Assignment 3 and Quiz 3

The third ethics assignment was created and administered in the same way as the second assignment. During the two prior semesters that students were asked to do a final project in Physics 2 Lab, it was observed that many students were taking their project ideas from a YouTube video, making no changes, and not citing the source for their ideas. For the third assignment, a case study related to citing the ideas for a project was created. The third ethics activity was assigned two weeks before project reports were due. The complete assignment is given in figure 4.

Forty-six students answered all three of the questions for quiz 3. On question 1, 17 students said "yes" it is plagiarism even if you cite your source, 25 students said "no" it is not plagiarism as long as you cite your source, and 4 students didn't commit to a "yes" or "no" about whether plagiarism had occurred.

Question 2 had a variety of responses. Students suggested changes such as using a different battery or power supply, different strength magnets, different base materials, and a different layout for the motor.

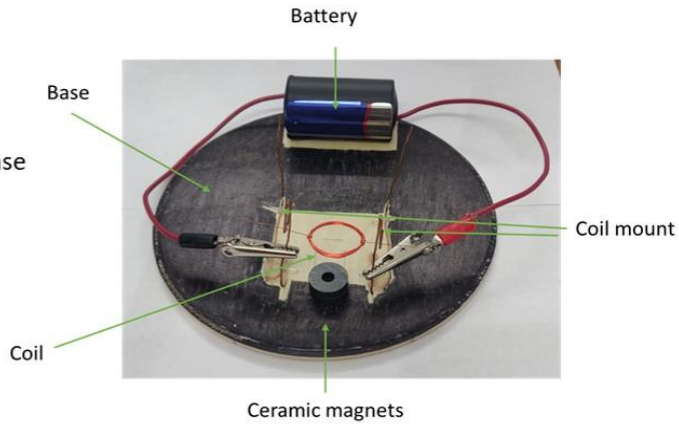
For question 3, most students (44/46) correctly answered that the source of inspiration should still be cited even after changes were made. The responses also included one "no" but their answer was "No, you do need to still cite your sources.", and one student said "I would if they are similar".

Ethics Quiz 3

You and your lab partner, Tesla, are working to design and build a motor for your physics class project. Neither of you has built a motor before and are really not sure how to design one. Understandably, you go to the internet for inspiration and find an awesome design to use. See the figure below for the diagram and parts list for the awesome design.

https://simplemotordesign.com

Materials
- 1x D cell battery
- 1x 6.5 inch diameter wooded disk for base
- 2-3 x ceramic magnets
- 2 x paper clips for coil mount
- 1x roll of coated copper wire for coil
- 2x alligator clips
- Electric tape and hot glue



Question 1: After reading about how the motor was designed, Tesla and you discuss what to do next. ***In 2-3 sentences, answer the following:*** *Is it plagiarism to simply copy the design as long as you cite it? Why or why not? (If you need a reminder of the definition of plagiarism, refer to the ATU Academic Integrity Policy.)*

Question 2: Tesla insists that it is not ethical and that you must make some changes because the project is to ***"design"*** *and build a motor.* ***List 2-3*** *changes that can make it your own design: You can base your answer to this question solely on the information provided in the design information from question 1. [You will not be graded based on the quality or feasibility of your suggestions.]*

Question 3: After making changes and creating your motor, you and Tesla are working on your reports. ***In 2-3 sentences, answer the following:*** *Based on the design changes you suggested in Question 2, do you need to cite the internet source that provided you with the idea for your final design? Why or Why not?*

Figure 4: The second case study and third ethics quiz administered to Physics 2 Lab students.

3. Effectiveness

In order to assess the program's effectiveness at teaching the students to "recognize and understand examples of unethical and/or unprofessional behavior of students in coursework", the performance indicator was broken into four components that are assessed with the three quizzes. The components, the methods for assessing, and criteria for meeting expectations or needs improvement are listed in the rubric shown in table 3. Component 1 is assessed in quiz 1, components 2 and 3 are assessed in quiz 2, and component 4 is assessed in quiz 3.

For component 1, 96% (45/47) of our students met expectations by scoring 100% on quiz 1. When answering question 2 in quiz 2, only 32% (15/47) of students met expectations for component 2. On component 3, 98% (46/47) our students met expectations by identifying an ethical solution to a lab difficulty as their answer to question 2 in quiz 2. This percentage

includes the student whose answer combined component 2 and component 3. Component 4 required students to correctly apply the definition of plagiarism to a class project. Ninety-six percent (44/46) of students met expectations by recognizing that they need to cite the source of inspiration for their class project.

Component	**Method**	**Needs Improvement**	**Meets Expectations**
1) Demonstrate an understanding of the ATU Academic Integrity Policy	Students will be asked to read the ATU Academic Integrity Policy and then correctly answer definition level questions about key terms. (quiz 1)	Did not complete the quiz/ did not score 100%	Complete quiz 1 with 100%
2) Identify unethical behavior in a lab exercise	Students will be asked to read a case study of a lab group having difficulties. Then the students should correctly identify any ethics violations using terms from the ATU Academic Integrity Policy. (quiz 2)	Did not identify any violations	Identifies violations with reasonable attempt to use terms from student handbook
3) Apply ethical behavior to a lab exercise	Students will be asked to identify ethical solutions to a lab difficulty discussed in a case study. (quiz 2)	Did not identify an ethical solution	Identify an ethical solution
4) Apply ethical behavior to a class project	Students will be asked to apply the definition of plagiarism to a class project. (quiz 3)	Does not recognize lacking citation is plagiarism	Recognizes lacking a citation is a form of plagiarism

Table 3: Rubric for performance indicator 1 “Recognize and understand examples of unethical and/or unprofessional behavior of students in coursework”

In addition to analyzing student responses to the case studies, it is interesting to run similarity reports on project reports for the semester that students were introduced to ethics and for the semesters before the ethics quizzes were implemented. Similarity reports run by the plagiarism checker software Plagiarism Checker X on the Physics 2 Lab project reports for students that had (experimental group) and had not been introduced to ethics (control group) show that 22% of students that submitted project reports the semesters before the ethics quizzes and case studies were introduced submitted reports that had a 40% or greater similarity with at least one other report. A similarity report of 40% or greater is a strong indication of collusion. A similarity report of less than 40% is likely due to students being asked to answer the same questions in their reports and many students restated the questions. Students worked in teams of two and all the reports that were flagged with a similarity greater than 40% were between students in the same group. Only 11% of students that participated in the ethics case studies had a 40% or higher similarity report. Details for other similarity percentages are shown in figure 5. The control and experimental groups are rather small, but this data suggests that participation in the ethics activities decreased the amount of collusion between students in groups on their project reports.

Prior to incorporating the case studies, nearly 100% of students did not cite any sources for their project ideas. This semester 100% of students cited at least one source. However, a line was added in the instructions reminding students to include citations in their final reports so we are not able to conclude if the ethics activities played any part in students citing their sources.

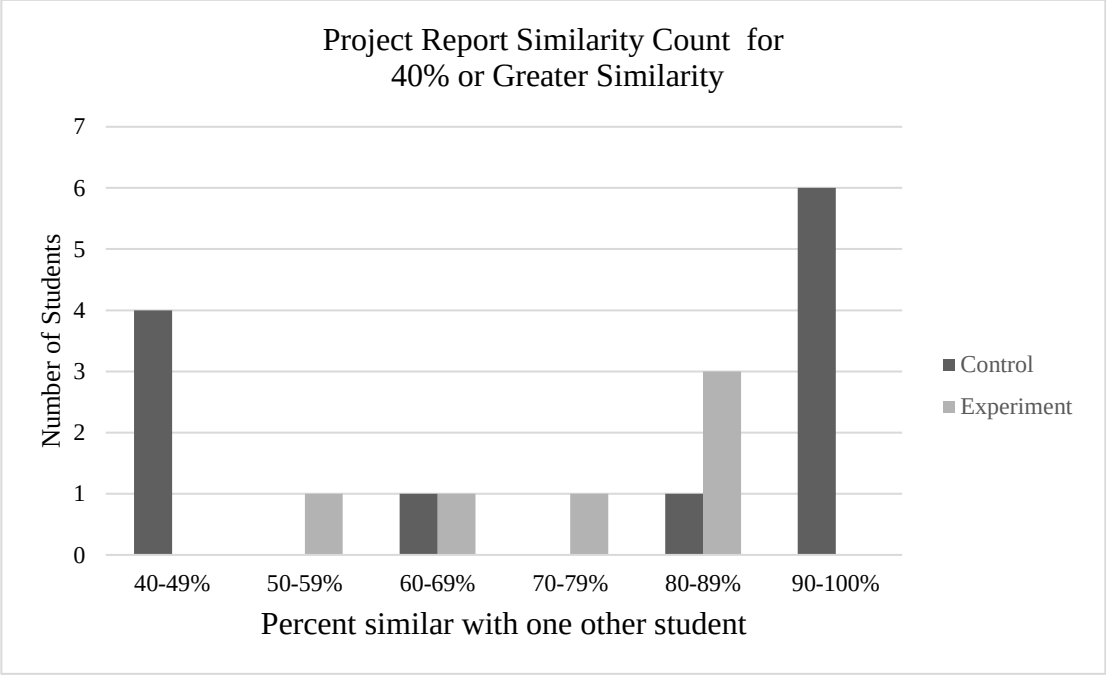


Figure 5: Histogram showing the number of counts of percent similarity between project reports for the control group (49 students) that did not participate in the ethics case studies and the experimental group (46 students) that did participate in the ethics case studies. Reports with less than 40% similarity are not included in this graph.

4. Conclusions and Future Work

Overall, the program "met expectations" for performance indicator 1. Our format of having three assignments, including two cases studies and three quizzes, is effective at introducing students to ethical considerations. Overall, students seemed to pay more attention to ethics related issues during class and when preparing their project reports.

There are a few changes that will be implemented in the future. First, we will convert some of the open response questions from quizzes 2 and 3 to multiple choice questions. The correct answers and distractors will be written based on student responses to the pilot run of the questions. Multiple choice questions will ease the grading burden for lab instructors and help streamline the program assessment process. Second, our pilot run was with our Introductory Physics 2 Lab students. In the future, we will create a similar set of case studies and quizzes for the Physics 1 Lab. Third, the first assignment, reading the Academic Integrity Policy for our university and the corresponding quiz, will be integrated with the week 1 lab quiz that is currently only over the lab syllabus. Finally, we will create rubrics to assess the performance indicators for the "Reinforce" and "Master" learning levels.

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