

Colorado Learning Attitudes about Science Survey for Experimental Physics (E-CLASS)

Report for Physics PHYS 1140, Experimental Physics, University of Colorado

Spring 2015

Thank you for participating in the Colorado Learning Attitudes about Science Survey for Experimental Physics (E-CLASS). We hope you find this report helpful for learning more about how your students think about experimental physics. If you have questions about the survey or the results, or if you would like to make suggestions to improve the usefulness of the survey and report, we have two ways to hear your voice:

- Complete the six-question E-CLASS report feedback survey at <http://tinyurl.com/E-CLASS-Feedback>.
- Email your questions or thoughts directly to our research team at eclass@colorado.edu.

Sincerely,

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A sample E-CLASS question

The E-CLASS survey asks students to express their beliefs about doing experimental physics. As in the example shown in Fig. 1, most statements have three parts:

1. What do YOU think when doing experiments in class? (a personal statement)
2. What would experimental physicists say about their research? (a statement about how students perceive professional physics)
3. How important for earning a good grade in this class was...? (a statement about how students perceive their laboratory course)

We ask "What do YOU think when doing experiments in class?" and "What would experimental physicists say about their research?" in both the pre-survey and post-survey, while the question about earning a good grade is asked only during the post-survey. By asking all three questions we can evaluate how personal views change during a course, how their view of a professional physicist changes, and how those changes correlate with what students thought was important for earning a good grade.

When doing an experiment, I try to understand how the experimental setup works.

	Strongly Disagree	1	2	3	4	5	Strongly Agree
What do YOU think when doing experiments for class?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/> not answered
What would experimental physicists say about their research?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/> not answered

	Unimportant	1	2	3	4	5	Very Important
How important for earning a good grade in this class was understanding how the experimental setup works?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/> not answered

FIG. 1 A set of three example questions around one key statement in the survey.

An example of how we process students' responses to get pre-post changes...

One key aspect of the E-CLASS survey is being able to look at how much laboratory courses shifted students' attitudes over the course of a semester. There are many ways to visualize such a shift, but one of the easiest is shown in Fig. 4. This section goes over how students' responses are processed to make such a plot and to explain what it means.

First, we restrict our analysis to the subset of students who completed both the pre and post surveys. Figure 2 represents these data as a 2D histogram, which shows the number of students in your class who fell in to each possible paired (pre, post) response.

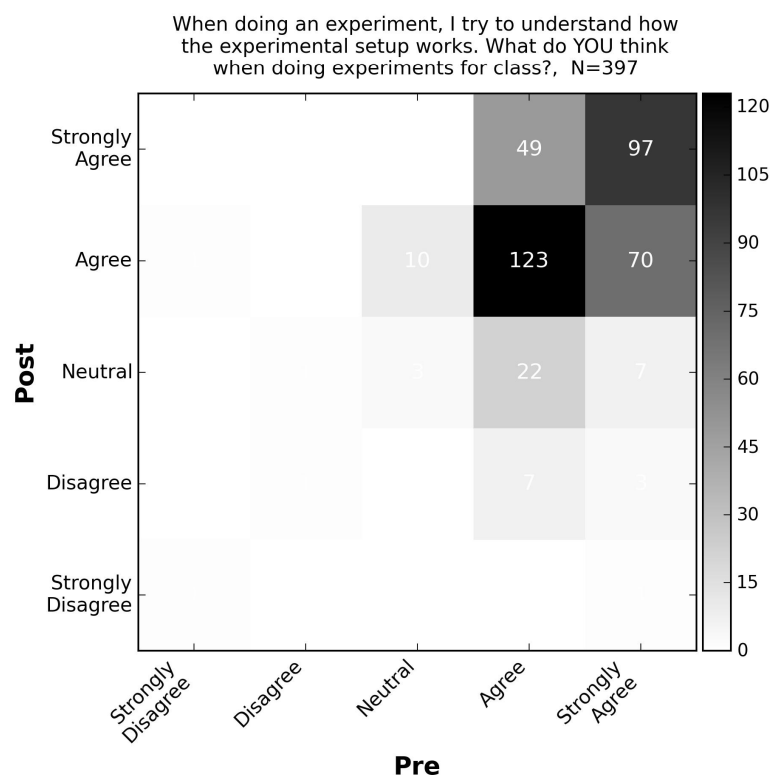


FIG 2. A 2D histogram showing the number of students with each possible pair of pre and post responses.

We can reduce the amount of data to visualize by comparing side-by-side histograms of the pre and post distributions. This amounts to summing up along the rows to get the post distribution, and summing up along the columns to get the pre distribution.

When doing an experiment, I try to understand how the experimental setup works. What do YOU think when doing experiments for class? N=397

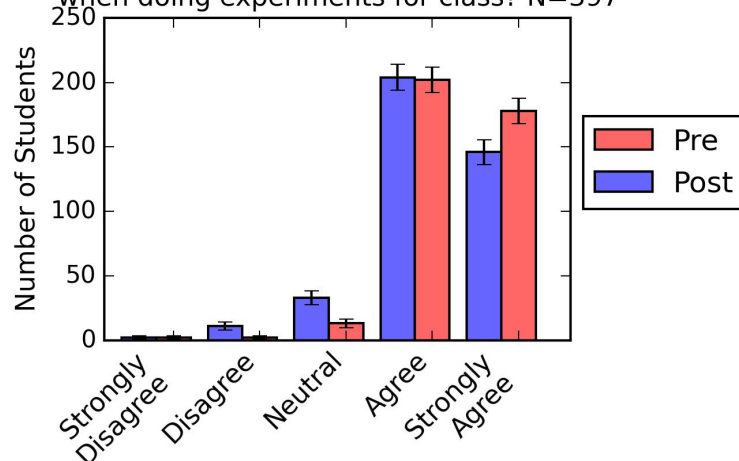


FIG. 3. A histogram showing the distribution of students responses on the pre and post surveys.

We can further simplify the data representation by reducing the distribution in Fig. 3 to a single number - the fraction of the class with an expert-like response, as is shown in Fig. 4. In Fig. 4, the circle shows the fraction of the class with an expert-like response to the statement (i.e., "Agree" or "Strongly Agree") on the pre-survey. The arrow in Fig. 4 shows the shift between the pre- and post-survey. The shaded bar shows a 95% likelihood interval. Given the observed distribution of pre-responses, we would expect the expert-like fraction to lie within that band 95% of the time. The larger the arrow is compared to the shaded bar, the less likely the change could have occurred by chance.

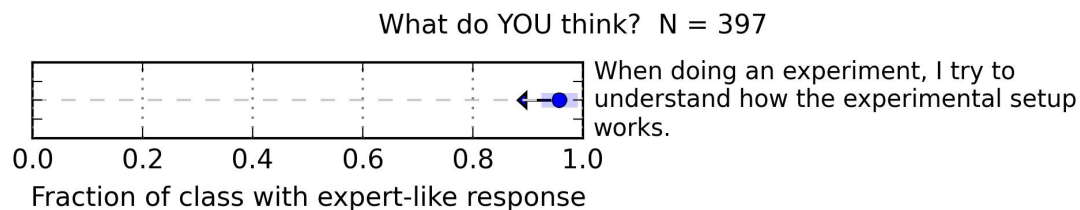


FIG. 4. A simple representation of the change in students' attitudes during the semester. The circle shows the pre-survey values. The arrow indicates the pre to post change. The shaded bar indicates a 95% confidence interval.

Results from your class

Summary of class participation

Number of valid pre-responses	509
Number of valid post-responses	448
Number of matched responses	397
Reported number of students in class	625
Fraction of class participating in pre and post	0.64

TABLE 1. Summary of class participation.

Overall E-CLASS results for your class

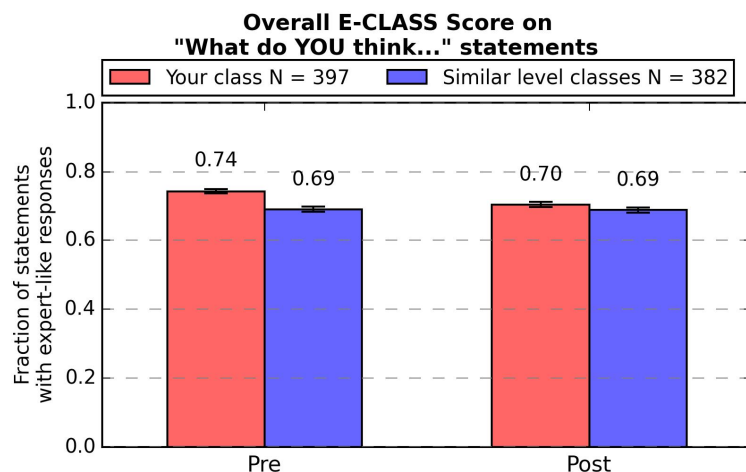


FIG. 5. Comparison between overall pre and post scores for students' responses to *"What do you think when doing experiments for class?"* **Your class** (Red) is compared with all students in **similar level classes** (Blue), (i.e., Advanced-level physics labs). The error bars indicate a 95% confidence interval. The overall mean shown here averages over all students and all statements on the survey.

How do students' personal views change in your course compared to other courses?



FIG. 6. Pre/Post changes in students' personal views about "What do you think when doing experiments for class?" for **your class** (Red) and all students in **similar level classes** (i.e., Advanced-level) (Blue). Figures 6 and 7 should be viewed together. The circles show the pre-survey values. The arrows indicate the pre to post changes. The shaded bars indicate a 95% confidence interval. The responses are ordered by the expert-like fraction in the pre-survey.

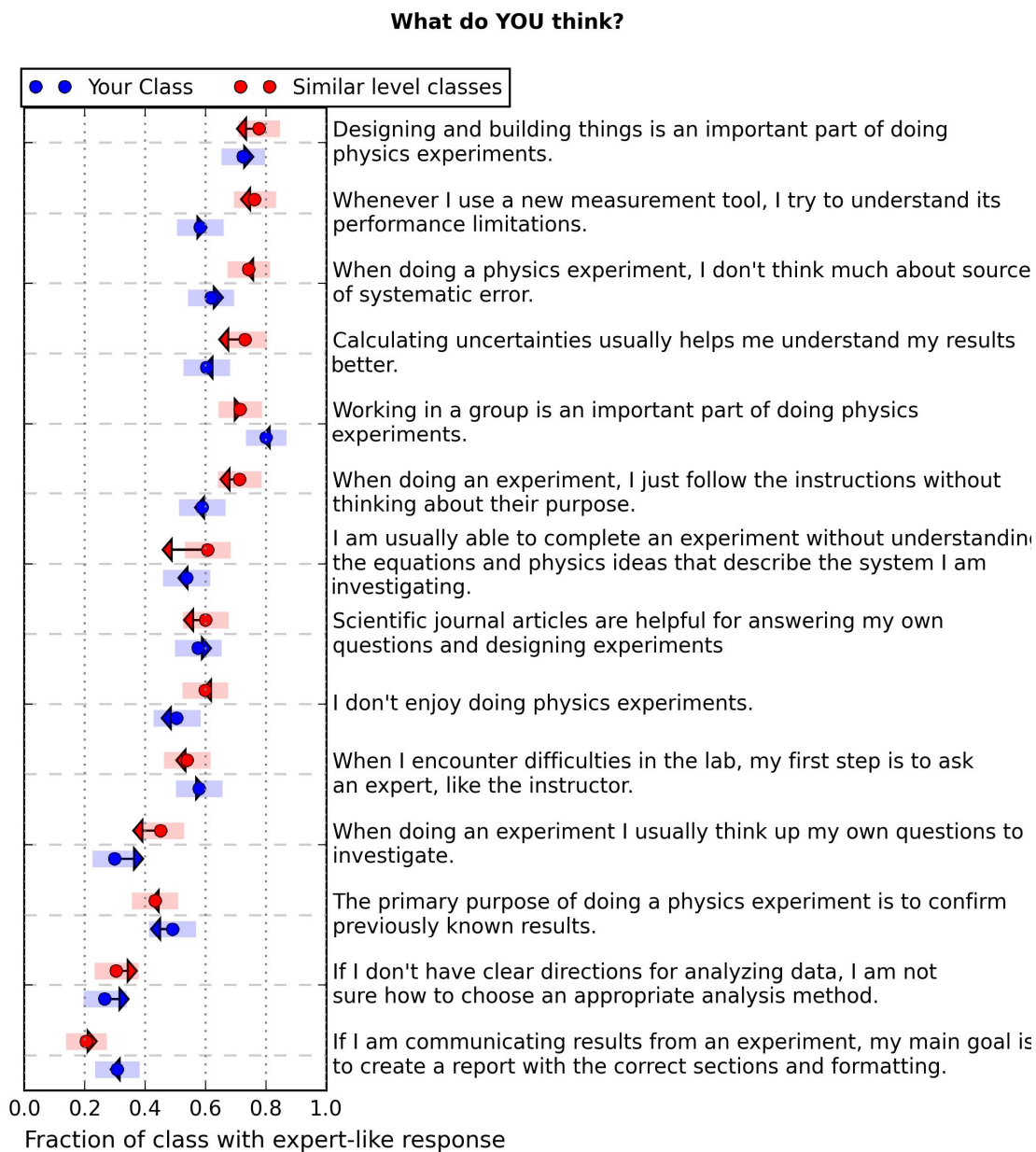


FIG. 7. Pre/Post changes in students' personal views about *"What do you think when doing experiments for class?"* for **your class** (Red) and all students in **similar level classes** (i.e., Advanced-level) (Blue). Figures 6 and 7 should be viewed together. The circles show the pre-survey values. The arrows indicate the pre to post changes. The shaded bars indicate a 95% confidence interval. The responses are ordered by the expert-like fraction in the pre-survey.

What did students think was important for earning a good grade in your course and other similar courses?

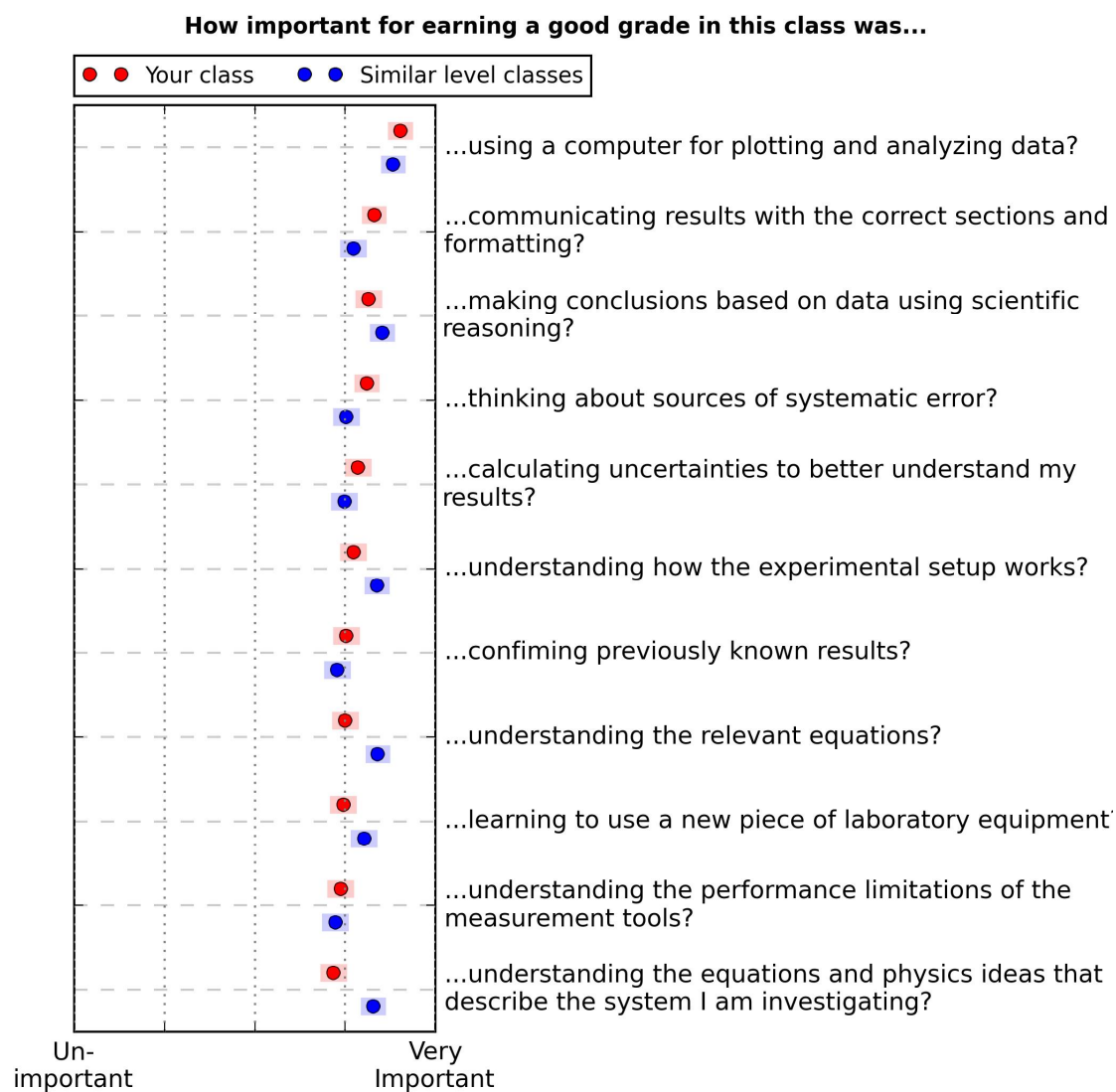


FIG. 8. An ordered plot of students' views of importance of different activities for earning a good grade in **your class** and in **similar level classes**, which refers to the set of students in other Advanced-level classes. Figures 8 and 9 should be viewed together.

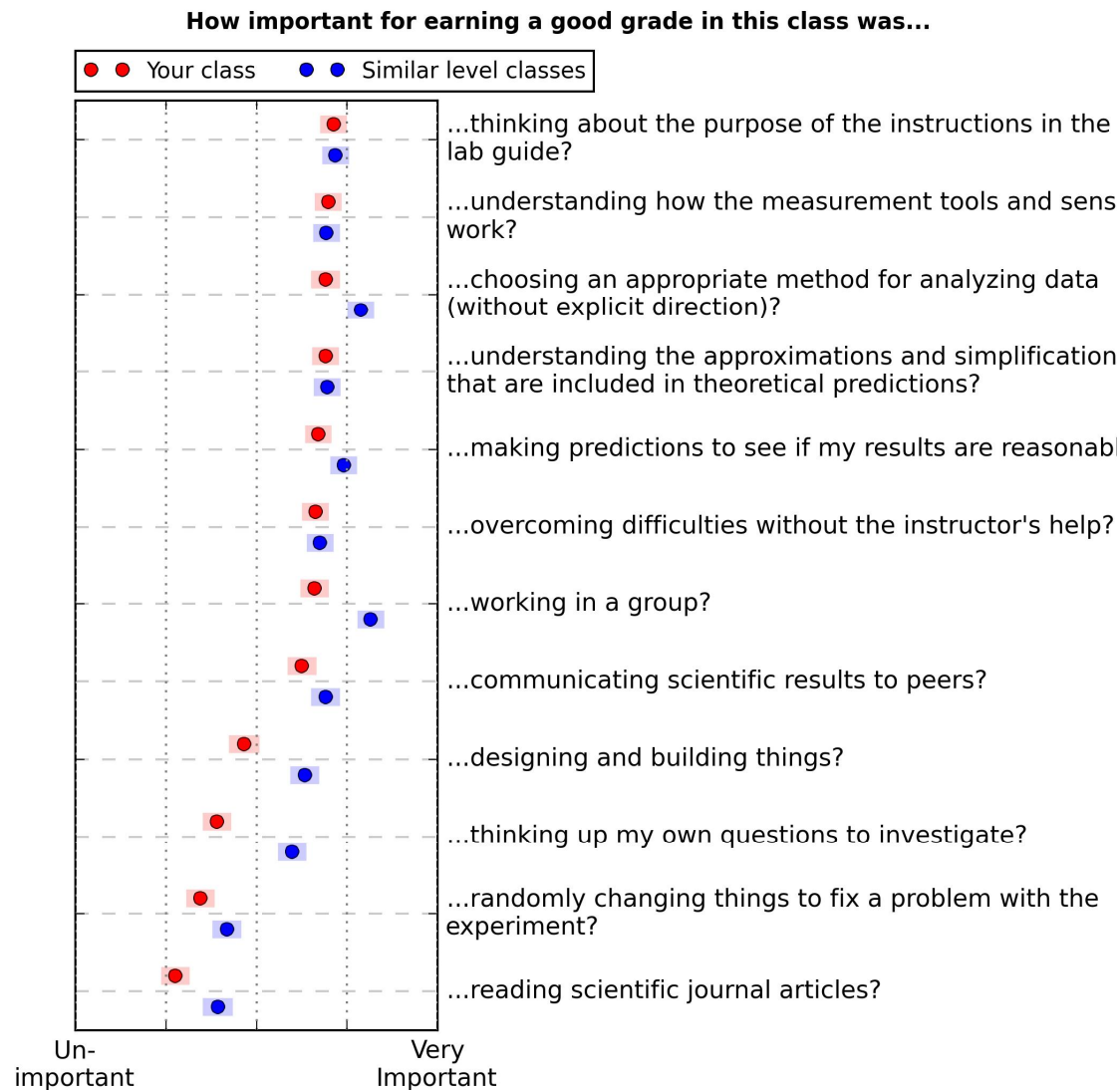


FIG. 9. An ordered plot of students' views of importance of different activities for earning a good grade in **your class** and in **similar level classes**, which refers to the set of students in other Advanced-level classes. Figures 8 and 9 should be viewed together.

How do changes in students' personal views correlate with what helped for earning a good grade?

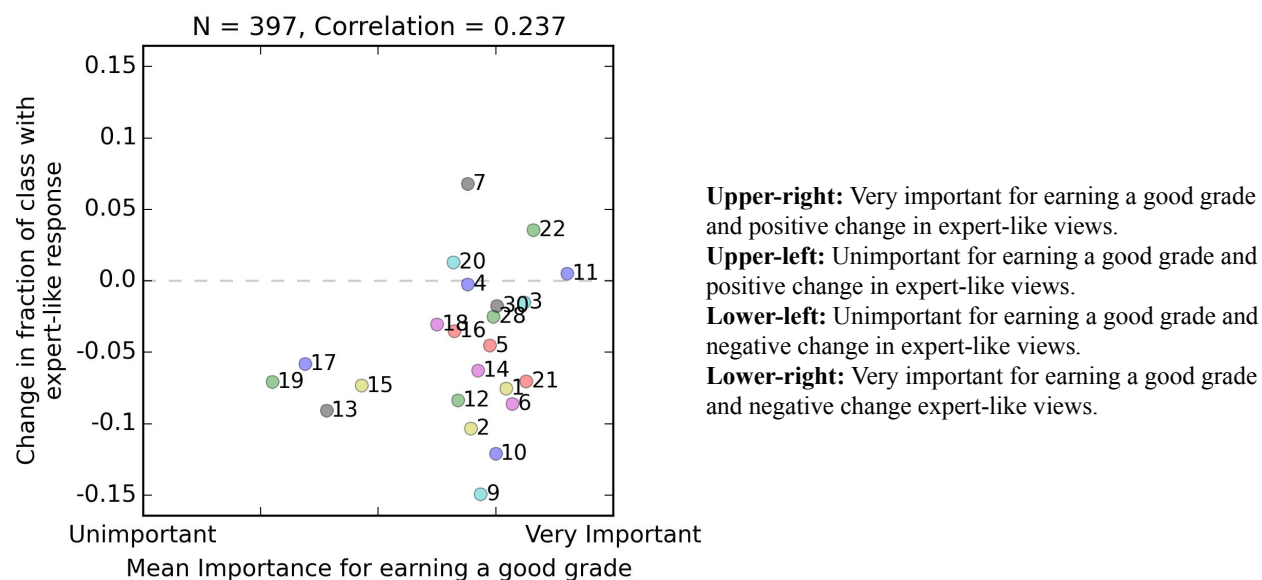


FIG. 10. Correlation between changes in expert-like views and earning a good grade in the course. Each point represents one statement in the E-CLASS survey. The question number and statement text can be found in Table 2 in the Appendix. The horizontal coordinate for each point is the mean value, which is the same data as in Table 1. The vertical coordinate is the fraction of class with expert-like responses in the pre-survey, which is the same data shown in Figs. 5 and 6. The correlation value refers to the Pearson's R correlation coefficient, which ranges between 1 (fully correlated) and -1 (fully anti-correlated).

Differences between "What do YOU think?" and "What would experimental physicists say...?"



FIG. 11. Comparison for your class between changes in students' personal views versus their views about professional physicists. **What do YOU think...** (Red) shows the change in students' response to "What do you think when doing experiments for class?" This red data is the same as the red data in Figs. 6 and 7. **What would experimental physicists say...** (Green) shows the change in students' response to "What would experimental physicists say about their research?" Figures 11 and 12 should be viewed together. The circles show the pre-survey values. The arrows indicate the pre to post changes. The shaded bars indicate a 95% confidence interval.



FIG. 12. Comparison for your class between changes in students' personal views versus their views about professional physicists. **What do YOU think...** (Red) shows the change in students' response to *"What do you think when doing experiments for class?"* This red data is the same as the red data in Figs. 6 and 7. **"What would experimental physicists say..."** (Green) shows the change in students response to *"What would experimental physicists say about their research?"* Figures 11 and 12 should be viewed together. The circles show the pre-survey values. The arrows indicate the pre to post changes. The shaded bars indicate a 95% confidence interval.

Follow-up questions about course interest and career plans

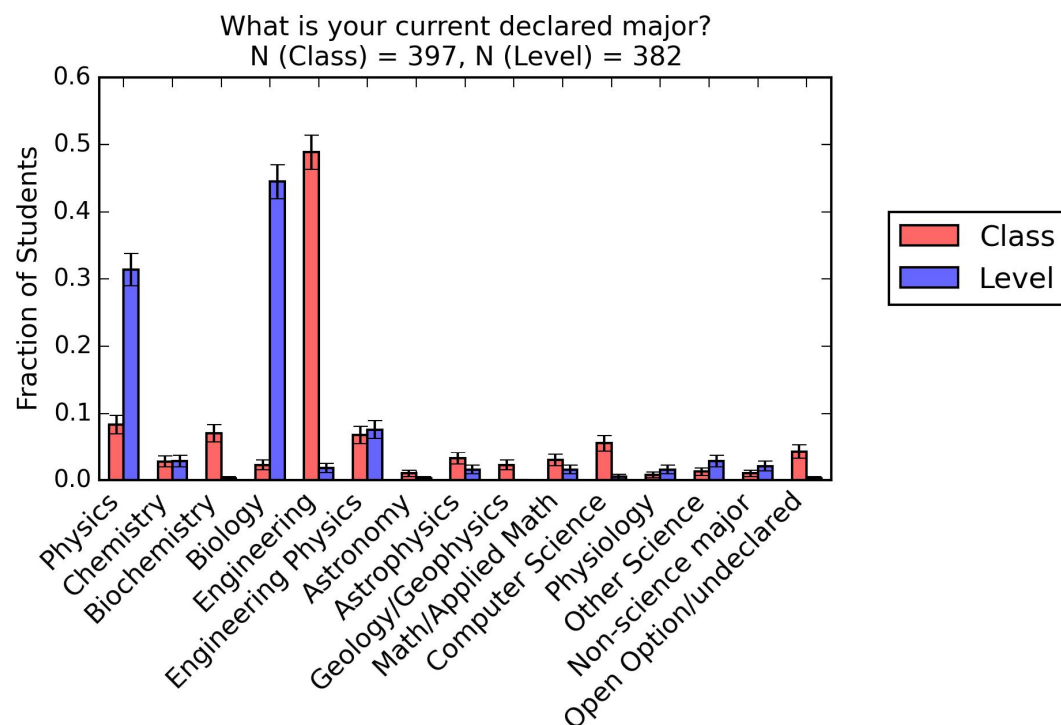


FIG. 13. Distribution of students by current declared major. **Your class** (Red) refers to your own course. **Similar level classes** (Blue) refers to a set of students in all classes at the Advanced-level.

u plan to change your major, please choose the major you intend to switch to.

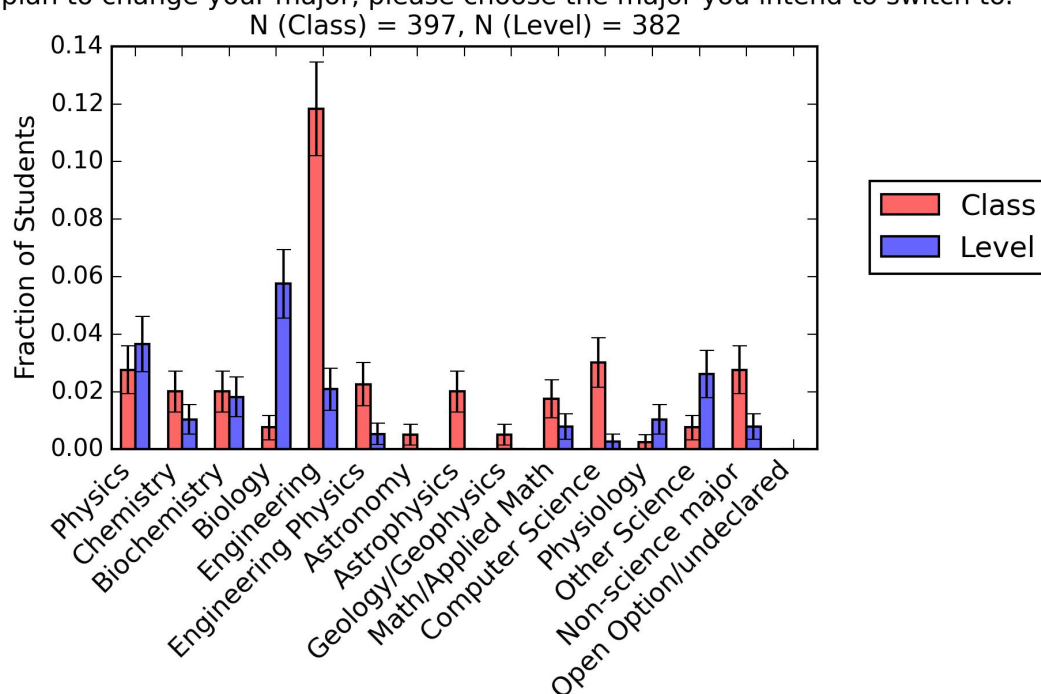


FIG. 14. Distribution of students intending to change to a new major. **Your class** (Red) refers to your own course. **Similar level classes** (Blue) refers to a set of students in all classes at the Advanced-level.

Currently, what is your level of interest in physics?

N (Class) = 397, N (Level) = 382

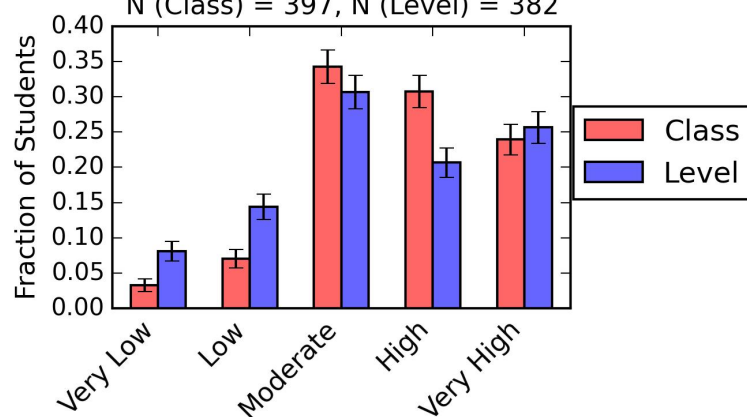


FIG. 15. Students' current interest in physics. **Your class** (Red) refers to your own course. **Similar level classes** (Blue) refers to a set of students in all classes at the Advanced-level.

During the semester, my interest in physics?

N (Class) = 397, N (Level) = 382

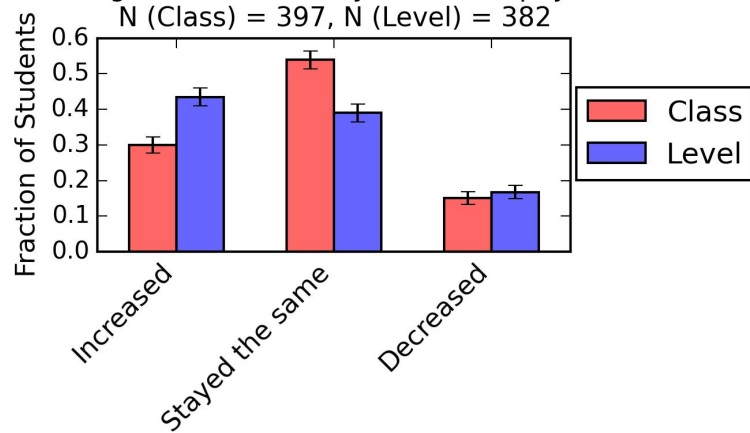


FIG. 16. Change in students' interest in physics. **Your class** (Red) refers to your own course. **Similar level classes** (Blue) refers to a set of students in all classes at the Advanced-level.

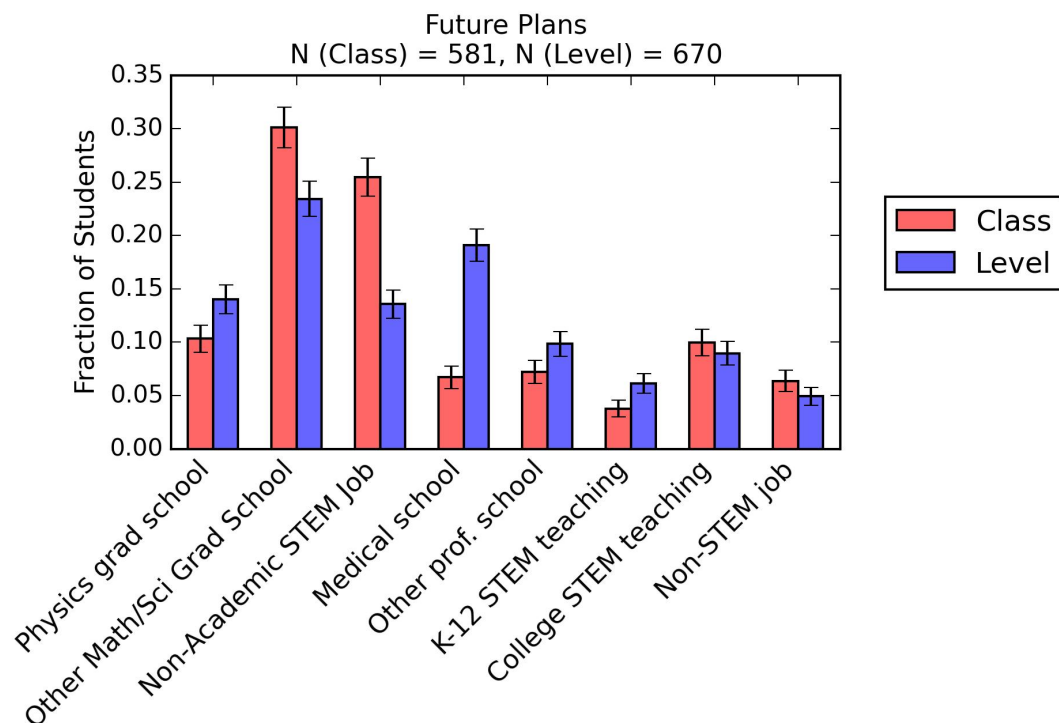


FIG. 17. Students' future plans after completing their degree program. **Similar level classes** (Blue) refers to a set of students in all classes at the Advanced-level.

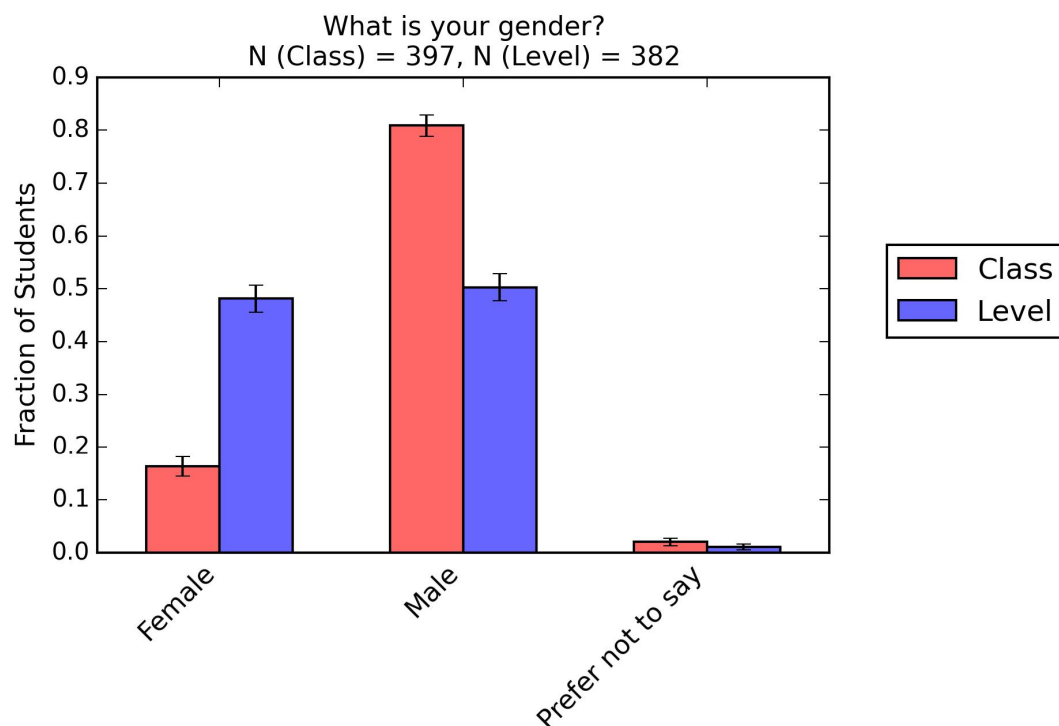


FIG. 18. Gender distribution of respondents. **Your class** (Red) refers to your own course. **Similar level classes** (Blue) refers to a set of students in all classes at the Advanced-level.

Appendix: List of all statements by question number

Number	Personal/Professional Statement	How important for earning a good grade in this class was...
1	When doing an experiment, I try to understand how the experimental setup works.	... understanding how the experimental setup works?
2	I don't need to understand how the measurement tools and sensors work in order to carry out an experiment.	... understanding how the measurement tools and sensors work?
3	When doing a physics experiment, I don't think much about sources of systematic error.	... thinking about sources of systematic error?
4	It is helpful to understand the assumptions that go into making predictions.	... understanding the approximations and simplifications that are included in theoretical predictions?
5	Whenever I use a new measurement tool, I try to understand its performance limitations.	... understanding the performance limitations of the measurement tools?
6	Calculating uncertainties usually helps me understand my results better.	... calculating uncertainties to better understand my results?
7	If I don't have clear directions for analyzing data, I am not sure how to choose an appropriate analysis method.	... choosing an appropriate method for analyzing data (without explicit direction)?
9	I am usually able to complete an experiment without understanding the equations and physics ideas that describe the understanding the equations and physics ideas that describe the system I am investigating?
10	When doing an experiment, I try to understand the relevant equations.	... understanding the relevant equations?
11	Computers are helpful for plotting and analyzing data.	... using a computer for plotting and analyzing data?
12	When I am doing an experiment, I try to make predictions to see if my results are reasonable.	... making predictions to see if my results are reasonable?
13	When doing an experiment I usually think up my own questions to investigate.	... thinking up my own questions to investigate?
14	When doing an experiment, I just follow the instructions without thinking about their purpose.	... thinking about the purpose of the instructions in the lab guide?
15	Designing and building things is an important part of doing physics experiments.	... designing and building things?
16	When I encounter difficulties in the lab, my first step is to ask an expert, like the instructor.	... overcoming difficulties without the instructor's help?
17	A common approach for fixing a problem with an experiment is to randomly change things until the problem goes away.	... randomly changing things to fix a problem with the experiment?
18	Communicating scientific results to peers is a valuable part of doing physics experiments.	... communicating scientific results to peers?
19	Scientific journal articles are helpful for answering my own questions and designing experiments	... reading scientific journal articles?
20	Working in a group is an important part of doing physics experiments.	... working in a group?
21	If I am communicating results from an experiment, my main goal is to make conclusions based on my data using scienti...	... making conclusions based on data using scientific reasoning?
22	If I am communicating results from an experiment, my main goal is to create a report with the correct sections and f...	... communicating results with the correct sections and formatting?
23	I enjoy building things and working with my hands.	NA
24	I don't enjoy doing physics experiments.	NA
25	Nearly all students are capable of doing a physics experiment if they work at it.	NA
26	If I try hard enough I can succeed at doing physics experiments.	NA

Number	Personal/Professional Statement	How important for earning a good grade in this class was...
27	If I wanted to, I think I could be good at doing research.	NA
28	When I approach a new piece of lab equipment, I feel confident I can learn how to use it well enough for my purposes.	... learning to use a new piece of laboratory equipment?
29	I do not expect doing an experiment to help my understanding of physics.	NA
30	The primary purpose of doing a physics experiment is to confirm previously known results.	... confirming previously known results?
31	Physics experiments contribute to the growth of scientific knowledge.	NA

TABLE 2. List of all statements in the E-CLASS survey.