

# How Accurately Can Students Estimate their Performance on an Exam and how does this Relate to their Actual Performance on the Exam?

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**Abstract.** Research has shown students' beliefs regarding their own abilities in math and science can influence their performance in these disciplines. I investigated the relationship between students' estimated performance and actual performance on five exams in a second semester calculus-based physics class. Students in a second-semester calculus-based physics class were given about 72 hours after the completion of each of five exams, to estimate their individual and class mean score on each exam. Students were given extra credit worth 1% of the exam points for estimating their score correct within 2% of the actual score and another 1% extra credit for estimating the class mean score within 2% of the correct value. I compared students' individual and mean score estimations with the actual scores to investigate the relationship between estimation accuracies and exam performance of the students as well as trends over the semester.

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## INTRODUCTION

Physics education research has recognized the importance of investigating students' beliefs about their own learning and expectations about their physics class. Knowledge of these constructs can provide useful insights into how students learn and might even be a predictor for student success in a physics class. Most of this research has focused on the use of surveys to gain insights into these issues [e.g. 1, 2]. While these surveys can provide useful information about our students, they do not capture how confident students are about their own abilities in physics, more specifically their ability to perform well in the physics course that they are taking.

In this paper I present the results of a simple experiment that I conducted in a large enrollment introductory physics course. The goal of the experiment was to determine the extent to which students would be able to successfully estimate how well they had performed on an exam in the class as well as the performance of the class as a whole. I was also interested in whether students' ability to estimate their own performance on an exam both in absolute terms, and also relative to the rest of the class, was in any way correlated with their actual performance on the exam. To investigate students' ability to estimate their own absolute performance on the exam, I asked

them to estimate their score on the exam. To investigate students' ability to estimate their performance relative to the rest of the class, I also asked them to estimate the class mean score.

Specifically, I sought to answer the following research questions

- 1) How accurately can students estimate their score on an exam after they have taken it? How accurately can they estimate the class mean score on the exam?
- 2) How does the accuracy with which students estimate their own exam score vary with their actual performance on the exam? In other words do students who better estimate their performance on the exam, actually perform better on the exam?

## METHODOLOGY

### Data Collection

Students in a second semester calculus-based physics course were told after completing each of their class exams that they had the opportunity to login to an online survey site where they could type in an estimate of their own score on the exam they had just taken as well as an estimate of the class mean score.

They were given about 72 hours to respond to the survey, after which the survey was closed.

As incentive to participate in this experiment, students were told that they would get one (1) extra credit point (out of 100) on the exam if they could estimate their score correct to within +/- 2 points (out of 100). They would get an additional one (1) extra credit point (out of 100) if they were able to estimate the mean score of the class on the exam correct to within +/- 2 points (out of 100).

### Data Analysis

To address our two research questions I first determined the accuracy of estimation. The accuracy of estimation is a measure of how closely students were able to estimate their own score or the class mean score. I also calculated the accuracy of estimation for each student and compared the accuracies of students who were high performing on the exam with those who were low performing on the exam.

## RESULTS & DISCUSSION

Out of the five exams in the class, I present data for exam 4. I chose exam 4 because students can be expected to reach a level of comfort with the class at this point in the semester and can be better expected to estimate their performance than on earlier exams in the semester. Although I collected data for exam 5 as well, because students were allowed to drop the exam with their lowest score, I felt that using data from exam 5 in our analysis could be skewed. Thus, I decided not to use data from exam 5 in our analysis.

A total of 222 students were enrolled in this class. Out of these N=191 students (about 86%) participated in this experiment after exam 4. I present data for these students and do not comment on other students.

### Accuracy of Estimation

To determine the accuracy of estimation for all (N=191) participating students I computed the average estimated individual scores of all students and the average estimated class mean score of all students. I also computed the actual mean score for the class. Table 1 below shows these values and their standard deviation. All scores are out of 100.

I also completed a paired two sample t-test for means to establish whether there was a statistically significant difference between students' estimated scores and their actual scores. Results of this analysis are shown in Table 2 below.

**TABLE 1.** Average  $\pm$  S.D. of the estimated and actual scores. The average is over N = 191 students.

Measure	Average $\pm$ S.D.
Estimated Individual Score	81.7 $\pm$ 10.3.
Actual Individual Score	79.1 $\pm$ 11.5
Estimated Class Mean Score	77.8 $\pm$ 4.4

**TABLE 2.** Results of paired two sample t-test for means of the estimated and actual scores.

	Estimated Score	Actual Score
Mean	81.685	79.138
Variance	106.985	132.053
Observations	191	191
Pearson Correlation	0.6630	
Degrees of freedom	190	
t Stat	3.9015	
P(T<=t) one-tail	6.62998E-05	
t Critical one-tail	1.6529	
P(T<=t) two-tail	0.0001326	
t Critical two-tail	1.9725	

The results show a statistically significant difference between the distributions of the estimated and actual scores on the exam, with the estimated scores being higher than the actual scores.

Results shown in Table 1 and Table 2 indicate that students typically tend to overestimate their own performance on the exam and underestimate the class mean performance.

### Comparing Accuracy with Actual Exam Performance

In addition to determining students' accuracy in estimating their own score and the class mean score I was also interested in finding out the relationship, if any, between students' actual exam performance and the accuracy of their estimations.

I calculated the difference between the individual estimated score and the actual score. A positive difference for a student indicated that that student had overestimated her/his score on the exam, whereas a negative difference indicated that that student had underestimated her/his score on the exam.

I performed a regression analysis and ANOVA of this difference versus the actual score. Results of the regression analysis and ANOVA are shown in Table 3 and Table 4 respectively.

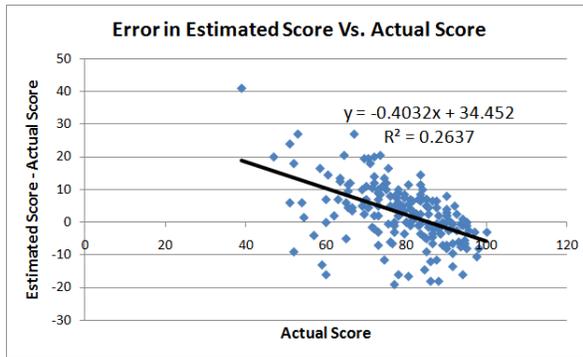
**TABLE 3.** Regression statistics for difference between estimated and actual scores vs. actual score.

Multiple R	0.513469287
R Square	0.263650709
Adjusted R Square	0.259754681
Standard Error	7.762867306
Observations	191

**TABLE 4.** ANOVA for difference between estimated and actual scores vs. actual score.

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Sig F</i>
Regress.	1	4078.03	4078.03	67.6	3.06E-14
Residual	189	11389.5	60.2621		
Total	190	15467.5			

A graph of the error in estimated score, i.e. the estimated score minus the actual score, is shown in Fig. 1. Students with a positive error have overestimated their score and those with a negative error have underestimated their score.



**FIGURE 1.** A graph of the error in estimated score plotted versus actual score. The trend line and R-squared values are shown on the graph.

From this graph and the tables above it is clear that a statistically significant negative correlation exists between the estimation error and the actual exam score.

In other words students who perform better, often tend to underestimate their score, whereas those who perform worse on the exam tend to overestimate their score on the exam.

To further confirm this notion, I divided the N = 191 students into three groups based on their exam performance – top third, middle third and bottom third. I conducted an ANOVA on the estimation error of these three groups. The average estimation error for each of these three groups is shown in Table 5 below and the results of the ANOVA are shown in Table 6.

**TABLE 5.** Average  $\pm$  S.D. of the estimation error (estimated score – actual score) averaged over students in each of the three groups based on exam performance

<b>Group (Exam Mean <math>\pm</math> S.D.)</b>	<b>Avg. Error <math>\pm</math> S.D.</b>
Bottom Third (65.9 $\pm$ 8.06)	8.37 $\pm$ 10.1.
Middle Third (80.5 $\pm$ 2.93)	2.29 $\pm$ 7.04
Top Third (90.6 $\pm$ 3.63)	-2.85 $\pm$ 5.06

**TABLE 6.** ANOVA for difference between the estimation errors of the top, middle and bottom third of the class.

<i>Source</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
B/w Groups	4038	2	2019	33.2	4E-13	3.04
Within Groups	11429	188	60..8			
Total	15467	190				

As expected the ANOVA shows a statistically significant difference between the three groups, with the lowest scoring group showing the greatest overestimate of their score and the highest scoring group showing the greatest underestimate of their score.

## CONCLUSIONS

I have sought to determine the extent to which students can accurately estimate their performance on an exam that they have just taken and how the accuracy of their estimate varies with their exam score.

I have found that in general, students tend to overestimate their exam performance and underestimate the performance of their peers, i.e. the class average. Further, I have found that students who perform better on the exam tend to underestimate their score, while those who perform worse on the exam tend to overestimate their score.

These results seem to indicate that students in general are overconfident of their exam performance. Further, students who perform worse are more overconfident while those who perform better tend to be more under confident of their abilities in the course.

These results are consistent with the notion that students who accurately predict their performance in a class are typically the more mature learners who are more likely to engage in self-reflection and therefore also perform better in the class.

## IMPLICATIONS

It is widely accepted that improving learners' ability to reflect on their own learning can also improve their ability to learn new concepts and become better problem solvers.

Although this study was not designed to be an intervention that would facilitate student self-reflection, the results of this study can be used in such efforts. For instance, one can ask students to explain the reasoning for their estimate and also the reasoning for the discrepancy between their estimated score and actual score. By asking the low performing students,

who typically tend to overestimate their performance, to reflect on why they might have overestimated their performance, it might be possible to facilitate such learners to become more reflective about their own learning, recognize the reason for their low performance on the exams and thereby improve their performance in the course.

## **FUTURE WORK**

I asked students to estimate their score after they completed their exam. However, it would also be interesting to investigate the accuracy with which students could predict their score before they took the exam. Such a prediction might shed more light on how prepared they think they are to take the exam and how well they think they know the material. I plan to extend our study in the future by asking students to make such predictions about their exam performance before taking the exam.

This study was completed with calculus-based physics students. It is not certain that similar results would be found if the study were completed with other populations of students, such as algebra-based physics students, conceptual physics students or students in a physics class for future elementary teachers. As part of our future work, I plan to extend these studies to other populations in introductory physics courses, as well as to students in intermediate and upper-division courses.

## **REFERENCES**

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