

Student Performance and Perception on Conceptual and Quantitative Physics Problems

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Topic

Description:

- We want to understand how well students do on quantitative versus qualitative exam questions, and how they perceive they did for each type of question.
- Through experience as learning assistants, we have found that some students who excel in conceptual understanding do not possess strong mathematical skills, and vice versa. We were interested in how these two competencies relate to each other in terms of performance on exam questions. Additionally, we have noticed that students tend to underestimate their performance on exams, and we were wondering if this effect was different for conceptual versus quantitative problems.

Context

- Who:**
- The students who are currently enrolled in PH 20X and future students in the course as well.
- Background:**
- "It is not sufficient for students to 'know' the relevant correct statements of physics. They also have to have methods of evaluating to be certain that the result they have called up is truly relevant" (Redish 798).
 - We used Redish' corollary in influencing our curiosity on student performance on conceptual versus quantitative physics problems.

Research Questions and Hypotheses

- Question:**
- How does a given student's performance on conceptual questions relate to their performance on quantitative questions in PH201?
 - How did student's expectations of their score for each type of question (conceptual or quantitative) compare to their actual performance?
- Hypotheses:**
- Students who perform well on conceptual questions will do well on quantitative questions.
 - Students who underestimate their performance will perform higher on both types of exam questions.

Methods of Inquiry

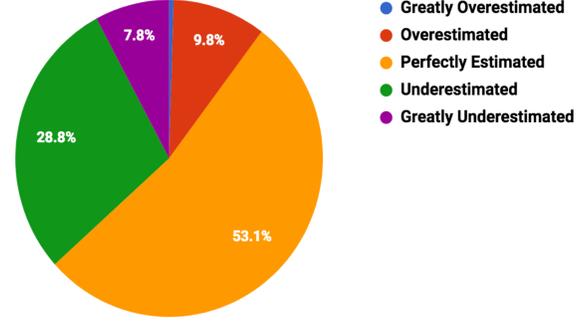
What & How:

We selected two quantitative and two conceptual questions from midterm two. Next, we spoke to Dr. Walsh to create a survey asking students how well they perceived they did on the four questions by predicting in which range (0-33%, 34%-66%, or 67%-100%) of the total points they think they will received. The four survey questions were asked to the students in Physics 201 through Learning Catalytics. Furthermore, class assigned readings were used to help guide our research questions and formulate the background context.

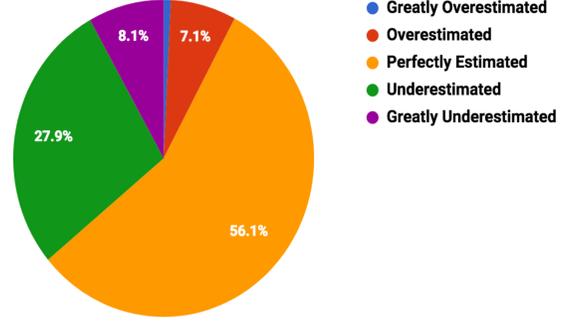
Data and Findings

- We found a weak, positive correlation ($r=0.329$) between student performance on the conceptual questions and the quantitative questions ($p<0.01$). A t-test was performed on the data and a p-value of 9.545×10^{-11} was generated.
- The correlation in performance on quantitative problems was stronger than the correlation in performance on conceptual questions.
- Students who underestimated their performance for both conceptual and quantitative problems scored higher on those problems.
- There was a non-significant trend towards more accurate evaluations of performance on quantitative questions.
- Overall, a majority of students were able to accurately estimate their own performance on quantitative and conceptual problems.

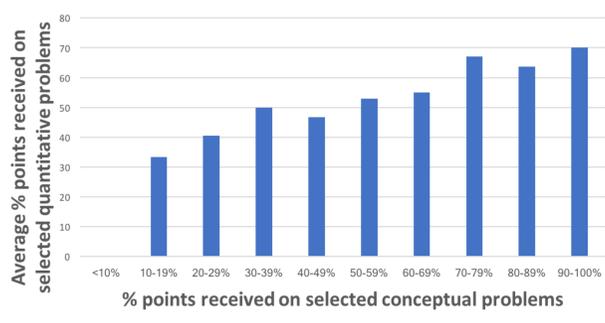
Student's Ability to Predict Score on Conceptual Questions



Student's Ability to Predict Score on Quantitative Questions



Student performance on conceptual versus quantitative exam questions

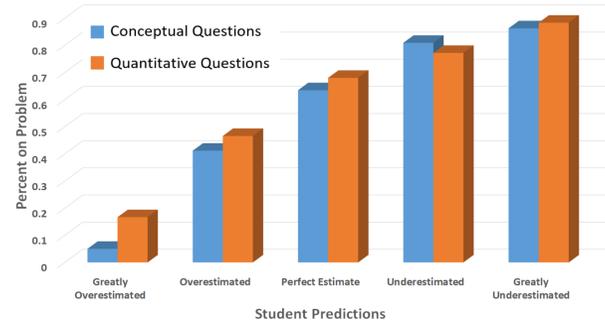


Correlations in performance on selected problems

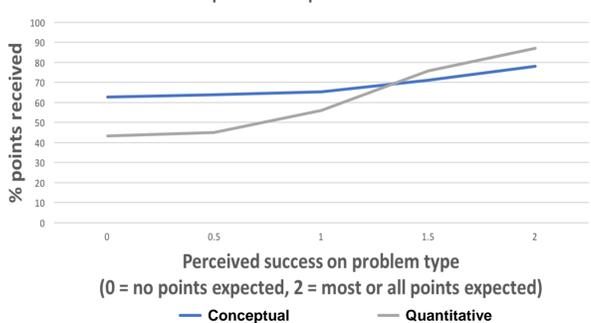
	1: Conceptual, forces during rotation	2: Quantitative, 2D summation of forces	3: Conceptual, force and acceleration	10: Quantitative, multiple tension forces
1: Conceptual, forces during rotation	1	0.299	0.132	0.246
2: Quantitative, 2D summation of forces	0.299	1	0.176	0.301
3: Conceptual, force and acceleration	0.132	0.176	1	0.195
10: Quantitative, multiple tension forces	0.246	0.301	0.195	1

Correlation coefficients (r) for relationships between student performance on selected quantitative and conceptual problems from Midterm II.

Relationship Between Prediction and Actual Score



Perceived versus actual performance on conceptual and quantitative problems



Synthesis and Next Steps

- As the correlation between performance on conceptual and quantitative questions is relatively weak, it is likely that a large number of factors affect how well a student will perform on a particular type of question.
- Based on the small correlation for conceptual performance, it is possible that there is a high degree of variation in mastery of individual concepts within physics.
- Our study analyzes preliminary data that was collected. We can perform a further study that evenly distributes the number of points per question to further support or reject our findings.

Conceptual question example:

3. The net force on an object is in the northern direction. Which of the following quantities also necessarily point north?

[T] (a) acceleration
 [F] (b) change in position
 [F] (c) force of acceleration
 [F] (d) centripetal force
 [T] (e) change in velocity

Quantitative question example:

2. (3 points) The figure shows two forces that are acting on an object. The magnitude of F_1 is 6.0 N and the magnitude of F_2 is 2.7 N. What would be the magnitude and direction of a third force that would put the object into equilibrium?

Acknowledgements:

- Dr. Devon Quick and Dr. Kenneth Walsh for providing assistance in data analysis
- Dennis Bennett for writing revisions

References

Redish, E. (1994), Implications of cognitive studies for teaching physics; *American Journal of Physics*, (62) 9.