Duke University
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PHY143 Laboratory

The Correlation Between Lab Report Grades and Time and Length: A Survey Based Analysis

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Abstract:

In this experiment, we investigate the correlations between effort put into the lab report and grade in PHY143 through a survey. The data shows that the optimal length is between five and nine pages. Also, there is a positive correlation between time spent working on the lab report and the grade, with a first order approximated grate to time ratio of 0.37±0.035 points per minute. The first order approximation is not a good fit for grades as a function of time.

Motivations and Method

The undergraduate college experience can be a challenging time. Grades are, for most students, of the utmost importance. While the potential abilities of a student may have no measurable bounds, the available time for that student is very bounded. Therefore, homework strategies become a matter of optimization. To optimize grades, time should be distributed among the homework activities to give the highest possible GPA. If the grade on an assignment can be given roughly as a function of the time spent on that assignment, it would be possible to solve for the best possible use of time using differential equations. Assuming such a function, $g(t)$, exists for each grade component, we can optimize the time apportioned to each activity, based on the weightings in the course. We will derive this.

Let *G* be the final grade on the course. We will assume that exam studying time is separate from homework assignment and lab report time, and is not affected by how much time is devoted to lab reports and problem sets. We denote $g_{lab}(t)$ and $g_{ps}(t)$ as the grade functions for lab reports and problem sets, respectively. Our goal is to maximize *G*. The weighting constants for lab and problem sets are w_1 and w_2, respectively.

$$G = w_1 g_{lab}(t_1) + w_2 g_{ps}(t_2)$$
$$t_1 + t_2 = T$$
$$G = w_1 g_{lab}(t_1) + w_2 g_{ps}(T - t_1)$$
$$\frac{dG}{dt_1} = w_1 \frac{dg_{lab}(t_1)}{dt_1} + w_2 \frac{dg_{ps}(T - t_1)}{dt_1} = 0$$

The final line is a function of t_1 only, and is an equation which, assuming the grade functions are simple enough, can be solved for t_1. For these reasons, finding these grade functions is important. For our purposes, this function can assumed to be approximately linear.

In many cases, time may not be the optimal way to measure the grade potential of a lab report. For example, a lab report where the student spends twelve hours writing the cover page is unlikely to score very well, despite the enormous time put into it. Therefore, we also will attempt to calculate the optimal length for a lab report as well.

The procedure for finding grades, page count, and writing time is as follows. First, the plan to conduct this lab was announced to the Phy 143 lab section 4 a week before the lab report was due. The students were asked to keep track of the total time spent writing the lab report during the week. To ensure accurate data, it was specified that time for calculations, additional research, analysis, and writing would be included in the count, but group meeting time and data taking time would not be included. On the day the labs were returned to the students, an anonymous survey was distributed to all students, and then collected. A diagram of this apparatus is shown in Figure 1.

Page Length:________

Time Spent Working* (hh:mm): _____:_____

Grade Received (out of 60): ________

Was the paper handwritten or typed in any format other than double spaced 8 ½ x 11"? (Y/N): ______

*Do not include group meetings and data taking

Figure 1: Diagram of the experimental apparatus, the survey sheet.

A total of 24 surveys were received, but four immediately had to be discarded because one or more questions were not answered. Additionally, five more had to be discarded, as they did not follow the preferred format of typed with double spacing. Including these would produce a large systematic error in the optimal page length calculation. Also, cover pages were included in the page counts here.

Results

The data taken and not rejected is shown in Table 1.

T (minutes)	L (pages)	Grade (points/60)	G/T (points/minute)
90	3	28	0.31
150	7	36	0.24
60	4	43	0.72
120	7	44	0.37
230	13	46	0.20
85	4	47	0.55
160	9	48	0.30
115	6	49	0.43
120	5	51	0.43
180	8	53	0.29
165	8	54	0.33
120	6	57	0.48
235	9	58	0.25
175	7	59	0.34
210	7	60	0.29

Table 1: Data collected on work time, report length, and grade. The ratio of grade to time is shown in the final column.

The average grade was a 48.9 and the standard deviation for all grades is 8.8. First, it is apparent that the length of the highest scoring paper was seven pages. The length of the paper calculations will be handled so as to find the average (mean) grade for a paper of a given length. The grades as a function of page length would most closely be described by a Poisson distribution, as this is effectively an exercise in counting rare events. The fact that no grade is repeated in the entire data set makes this clear. The preferred method of determining the standard error from the mean, that being direct calculation of the standard deviation, would not work for all the data here, as the number of grades for a given page length are often too low to produce a standard deviation (at least two events are required). Thus, for page lengths with only one measurement, we will use the Poisson distribution calculated standard deviation; for page lengths with multiple measurements, we will use the smaller of the Poisson distribution measurement and the directly calculated standard deviation. The Poisson distribution based standard error on the mean is given by

$$\sigma_{g(L)} = \sqrt{\frac{< g(L) >}{N}}$$

and the directly calculated standard error on the mean is given by

$$\sigma_{g(L)} = \frac{< g(L)^2 > - < g(L) >^2}{\sqrt{N}}$$

where N is the number of measurements for the given lab report length, and the <bracket> notation indicates a mean value. This method of calculating error is not ideal, but the low number of data points has necessitated it. The results for this are displayed in Table 2.

L (pages)	Mean Grade	Standard Error of the Mean
3	28.0	5.3
4	45.0	1.4
5	51.0	7.1
6	53.0	2.8
7	49.8	5.1
8	53.5	0.4
9	53.0	3.5
13	46.0	6.8

Table 2: Average grades with standard errors of the mean for a given length of lab report

The formula for grade as a function of time spent working on the assignment is assumed to be of the form

$$g(t) = a_0 t \ .$$

This form is assumed because the $t = 0$ point obviously gets a grade of zero, and because a linear function would be the first order approximation; that is the goal of this experiment. A first order approximation gives us the value for how many points are earned for every minute spent working.

Calculations of a_0 for each paper are shown in the final column of Table 1. A plot of grades vs. time spent working on the lab is shown in figure 2. Also included in that figure is the plot of the function $g(t)$.

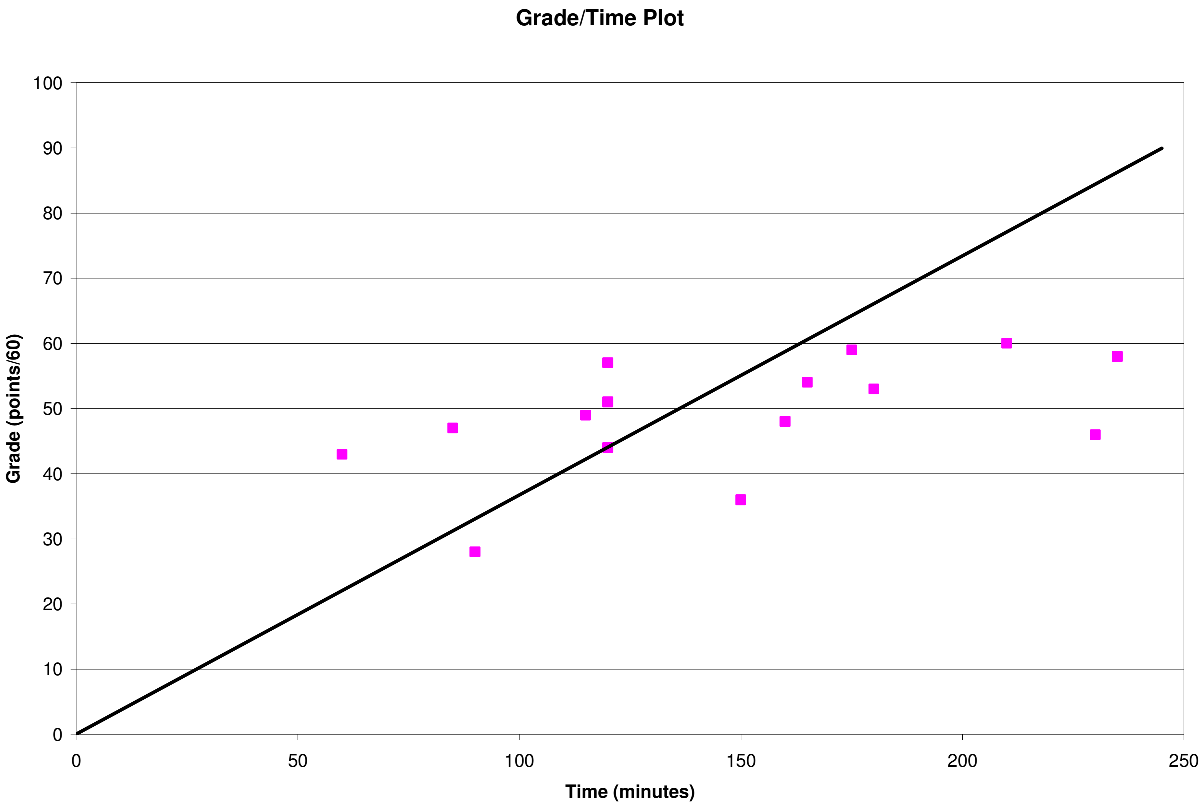

Figure 2: A plot of grade earned vs. time spent working on the lab report.

The mean value for a_0 is 0.37 points/minute, and the standard deviation on that value is 0.14 points/minute. Thus, the standard error of the mean is 0.035 points/minute. The more significant result here is that the first order approximation of the grade function is not a good fit. The result is downright non-physical for values of time greater than around 160 minutes, as it is impossible to get a grade of higher than 60 points.

Discussion

The results obtained here show that the optimal number of pages may be anywhere between five and nine pages, inclusive. All of these values for the mean grade for a given page count are within one standard error of the mean of the highest mean value, 53.5. Thus, it is impossible to say with any certainty that one of these page lengths is better than another. While a seven-page lab report received the only perfect score, this could be a statistical fluctuation. It is likely that high marks can be obtained for a lab report of anywhere from five to nine pages in length. This is perfectly in line with the recommendations found on the syllabus for PHY143. There, lab reports of 4-8 pages are required. This page count does not include the cover page, whereas the page counts in our experiment do.

The analysis to produce a first order approximation of the grade as a function of time seems to be ineffective. The measured value of a_0 = 0.37±0.035 points/minute is, to first order, accurate, but it has a serious shortcoming. The resulting function $g(t)$ produces unrealistic values for values of t greater than 160 minutes. This is most likely caused by a problem with the assumption that the function $g(t)$ should be linear with $g(0) = 0$. Further analysis of this data may produce a better $g(t)$, this one somewhat more complicated. It is, however, important to recognize that an interpolating function, which catches all the data points, would not be accurate, as there is a large amount of random error in the score distribution.

There is clearly a positive correlation between time spent working on the lab report and grade. The mean grade for the seven lab reports with smallest t is 45.6. The mean grade for the seven lab reports with the largest t is 54.0. The difference between these two scores is unlikely to be statistical fluctuation, as it is nearly as large as the standard deviation of the entire score range.