AC 2007-133: A STUDY OF STUDENT-REPORTED OUT-OF-CLASS TIME DEVOTED TO ENGINEERING TECHNOLOGY COURSES

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A Study of Student-Reported Out-of-Class Time Devoted to Engineering Technology Courses

Abstract

Students report a wide variety of perceptions of workload in their courses. To provide data for better understanding of student perceptions of workload in engineering technology (ET) courses at the authors' institution, students were required to complete time sheets documenting the out-of-class time they spent on activities related to several specific engineering technology classes. Data were obtained for students in six different ET classes taught by three instructors, over a total of 17 course-semesters. Out-of-class activities were broken down in categories related to review of reading assignments and lecture notes, completion of graded assignments, and individual and group study time. The relationship between reported out-of-class time and grades was examined as was correlation between reported out-of-class time and aggregate ratings of course difficulty on end-of-semester course evaluations. Analysis of the data showed that reported out-of-class time devoted to course work was not significantly correlated with course grade for typical students. Of the parameters investigated, a student's overall cumulative grade point average (GPA) was the best predictor of a student's final course grade. There was no significant relationship between reported out-of-class time and workload ratings from student course evaluations.

Introduction

It is well recognized that college-level course work requires a significant commitment of out-of-class time devoted to reading, study, and homework. Often-quoted rules of thumb generally recommend two to three hours out-of-class time per week for every credit hour of college courses[1, 2, 3]. Thus, a student taking a 15-credit hour load should expect to spend up to 45 hours outside of class per week on activities related to his or her courses. Generally, the study-time recommendations make no distinctions among the different disciplines of which a student's selection of classes might be composed. Given the highly technical content of typical engineering technology (ET) courses, it might be expected that required out-of-class study time would exceed that of the average college course. Reading assignments frequently require scrutiny of detailed example problems. To encourage deeper levels of understanding as outlined in Bloom's taxonomy[4], considerable emphasis is usually placed on active learning in the form of problem sets, laboratories, and design projects.

On end-of-semester course evaluations, ET students at the authors' institution frequently rate the time commitment to their ET courses as considerably above average. Students direct comments to instructors indicating that they perceive their course work loads to be heavy. At the same time, instructor observations suggest that some students make inefficient use of their out-of-class time. This study was initiated to accomplish two primary objectives:

1. To provide a learning experience for students to encourage them to observe and to think critically about their time management practices,

2. To provide real data that can be used to determine if a relationship exists between course grade and reported student effort in terms of out-of-class time, and
3. To examine student perceptions of workload and how those perceptions relate to reported out-of-class time students actually devoted to their ET course work.

The focus of this report will be on the second and third objectives.

Methods

An Excel spreadsheet was developed that was modeled after time sheets typically used by employees of consulting engineering firms to report billable hours. Though there were some variations from course-to-course, the conventional procedure for collection of the data asked students to keep written records of their out-of-class time devoted to the course. Students were required to update and submit the Excel time sheet containing their out-of-class "billable hours" on a regular basis. The out-of-class activities tabulated in the spreadsheets were broadly categorized under the following three headings:

1. Completion of Graded Assignments,
2. Review of Class Notes and Reading Assignments, and
3. Study Time for Tests and Quizzes.

A category of "Other" was also available; however, students seldom recorded activity under "Other." To simplify analysis of the data, the occasional time entries for the activity "Other" were compiled under item 2.

Students were asked to report out-of-class time in three courses beginning in 2002. Three additional courses were added in 2006 for which single semesters of data exist. Descriptive information for these courses and the data for each are summarized in Table 1.

The semester consisted of 15 weeks, including a week for finals. Some students did not report a full 15 weeks worth of time data, and some courses did not have activity during the final exam period. These courses represent a range of topics from computer programming, surveying, and electronics through hydraulics and hydrology. Laboratory periods or topics were present in all six courses but emphasis on laboratory data collection and analysis ranged from large (courses A and C) to small (course E). One instructor taught most of the courses, but there are also data for two courses taught by two different instructors.

A possible source of error was that out-of-class times were self-reported, but they were so by necessity. Some students may not have been diligent in recording their times accurately while others may have intentionally distorted them. Students were advised repeatedly that the hours reported would have no bearing on their grades – submittal of their hours was the key grading requirement. Nonetheless, several students submitted dubious claims of hours spent on courses. One student, for example, reported an average of over 21 hours per week devoted to a 3-credit course yet was consistently unfamiliar with basic concepts and terminology from lectures and reading assignments and managed only a D- overall grade. Such distortions did seem to be the exception, however. Overall, the data appear to be representative of true student time spent on the courses.

For the sake of comparison amongst courses of different credits, all times were converted to units of hours per week per credit. For courses included in this study prior to Fall 2006, it was possible to obtain student course evaluation aggregate data on course workload ratings. Cumulative Grade Point Averages (GPAs) at the end of the term in which a course was offered were also available for ET majors for semesters prior to Fall 2006.

Table 1. Course and Data Characteristics.

Course ID*	Brief Description	Semesters of data	Number of Students	Student-Weeks of Time Data
A	First year course, laboratory only, required submittal of lab notebook and problem sets (1 credit)	5	65	888
B	First year, lecture and lab, required submittal of projects, lab reports, and problem sets (4 credits)	1	19	285
C	Second year, lecture and lab, required submittal of lab notebook and problem sets (3 credits)	4	37	541
D	Third year, lecture and lab, required submittal of lab reports and problem sets (3 credits)	1	7	96
E	Third year, lecture and lab, required submittal of problem sets and semester design project (4 credits)	5	72	1037
F	Fourth year, lecture with lab exercises, required submittal of problem sets and projects (3 credits)	1	6	76
* Courses A, C, D, and E taught by the same instructor. Course B taught by a second instructor, and Course F taught by a third instructor.				

Results and Discussion

Table 2 lists statistical data for out-of-class time by course. Data were analyzed using analysis of variance provided by the GLM routine in SAS[5] with the LSMEANS and PDIF options and Bonferroni adjustment specified. Weeks of data reported by each student were used as the observation weights. Note that total out-of-class time for course F is the only value significantly different from those of the other five courses. Also note that in courses B and F, there are no examinations, only weekly quizzes, which may explain the lower indicated study time. Preliminary analysis of the data in Table 2 indicated that time spent on graded assignments was the only variable positively correlated with course grade, albeit at an insignificant level.

No statistical tests were used for the medians, but the median does have an advantage over the mean when there are large outliers. The medians for total time are all somewhat smaller than the mean values, though probably not significantly so. The small differences between means and

medians are most likely the result of the occasional instances of inflated total times reported by a few students. With no upper limit for outliers on the high side, but a limit of zero for outliers on the low side, the median would typically be smaller than the mean. The frequency distribution of all reported total times is displayed graphically in Figure 1. Thirteen students out of 206 reported out-of-class times in excess of 5 hours per week per credit.

Table 2. Out-of-Class Time Data for Courses.

	Out of Class Time (hours/week/credit-hour)				
		Weighted Least Square Means			
Course	Median Total Time	Total Time	Completion of Graded Assignments	Review of Class Notes and Reading Assignments	Study Time for Tests
A	2.48	2.68^{F}	1.48	0.83	0.37
B	2.28	2.40^{F}	$1.91^{C, F}$	0.37	0.13
C	2.05	2.14^{F}	1.02	0.80	0.32
D	1.45	1.74^{F}	1.14	0.31	0.29
E	2.26	2.55^{F}	1.52	0.69	0.33
F	0.86	0.90	0.51	0.39	0.00

- Superscripts are course letters of significantly different courses within the column at the 5% level.

Next, the relationship between reported class hours and course grade was examined. Preliminary investigations of the effects of course and term using the SAS[5] GLM procedure with class variables for course and term indicated no significant effects or interactions, so a linear model of grade vs. time was considered first. There were a total of 206 observations. Results are shown in Table 3, row 1. The model was not significant at the 5% level and produced an R^2 value of under 0.001. A quadratic time term was added (Table 3, row 2). The model just failed to reach significance with a p-value of 0.0502, but the $R^2 = 0.03$ value was still poor.

The effects of GPA were next considered. The data set was reduced to include only those students for whom cumulative GPA was available. This reduced data set included matriculated ET students only and a total of 165 observations. A model of grade versus time including linear and quadratic time parameters without a GPA term was run first on the reduced data set (Table 3, row 3). This model was significant with a p-value of 0.0055, but the R^2 parameter was still low at 0.062. GPA by itself was found to be correlated with course grade at an R^2 level of 0.35 (Table 4, row 1).

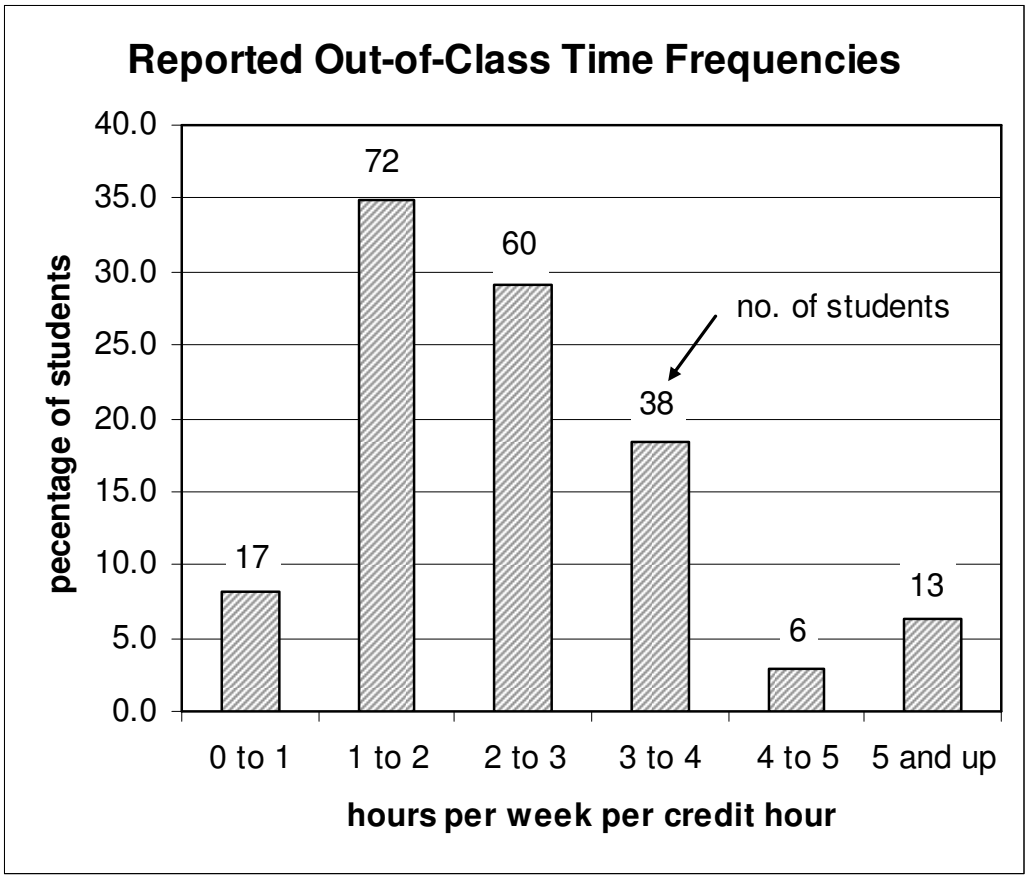

Figure 1. Histogram depicting frequencies of out-of-class time reports for all classes.

When GPA was introduced as a linear term in the model containing the quadratic time component (Table 3, row 2), the results shown in Table 4, row 2 were obtained. Overall, the model is significant, but the only significant variable is GPA. Row 3 in Table 4 show results for a models having an interaction term between GPA and time. The only significant parameter is the GPA term. Note that all models having a time parameter in Table 3 and 4 have at least one negative time parameter coefficient.

The model described in row 3 of Table 3 may provide some further clues about the relationship between out-of-class time and course grade. The model is significant even though the small R^2 indicates it explains little of the variability in the data. It too has time parameters with negative coefficients. In equation form, the model in row 3 of Table 3 is:

$$g = 1.953 + 0.529(t) - 0.0885(t^2) \qquad [1]$$

Table 3. Regression models of Grade vs. Out of Class Time.

t = hours outside of class per credit hour per week, c = cumulative GPA, g = course grade				
Row #	Model	Parameter	Estimate of Parameter's Coefficient	Probability Coefficient = 0
1	$g_i = a_o + a_1 t_i$ $R^2 < 0.001$, P = 0.70 Full data set, n = 206	a_o a_1	2.675 –0.021	<.0001 0.697
2	$g_i = a_o + a_1 t_i + a_2 (t_i)^2$ $R^2 = 0.03$, P = 0.0502 Full data set, n = 206	a_o a_1 a_2	2.137 0.408 –0.0664	<.0001 0.0278 0.0158
3	$g_i = a_o + a_1 t_i + a_2 (t_i)^2$ $R^2 = 0.062$, P = 0.0055 Reduced data set, n = 165	a_o a_1 a_2	1.953 0.529 –0.0885	<.0001 0.0058 0.0018

Table 4. Regression models of Grade vs. Out of Class Time and GPA.

t = hours outside of class per credit hour per week, c = cumulative GPA, g = course grade				
Row #	Model	Parameter	Estimate of Parameter's Coefficient	Probability Coefficient = 0
1	$g_i = a_o + a_1 c_i$ $R^2 = 0.35$, P <0.0001 Reduced data set, n = 165	a_o a_1	–0.520 1.231	0.124 <0.0001
2	$g_i = a_o + a_1 t_i + a_2 (t_i)^2 + b_1 c_i$ R^2 =0.36, P = <0.0001 Reduced data set, n = 165	a_o a_1 a_2 b_1	–0.672 0.245 –0.040 1.175	0.0787 0.1286 0.0989 <0.0001
3	$g_i = a_o + a_1 t_i + a_{11} (t_i c_i) + b_1 c_i$ $R^2 = 0.348$, P <0.0001 Reduced data set, n = 165	a_o a_1 a_{11} b_1	–0.294 –0.0857 0.0331 1.144	0.7262 0.7713 0.7944 0.0013

At face value, the quadratic term in equation [1] with the negative coefficient suggests that in a predictive sense, there is a time that optimizes grade in the course. Taking the derivative of equation [1] with respect to time and setting equal to zero yields an optimal time per week per credit hour of about 3 hours. A possible explanation for this phenomenon would be that, on average, students devoting less than three hours to the course could improve their grades by increasing effort. On average, students spending more than three hours may be less gifted with the material or less efficient in time management and as a result get a lower grade. Time spent above 3 hours tends to be negatively correlated with grade.

To further investigate the link between reported times above 3 hours and grades, a simple linear model of grades versus time was run for those students reporting more than 3 hours per week per credit hour. The constant term was estimated as 3.27 ($P < 0.001$) while the coefficient of the time term was estimated as – 0.174 ($P = 0.15$). This model produced a low R^2 value of 0.04 and was not significant at the 5% level with $P = 0.15$. The model is insignificant, but not strongly so. The moderately insignificant negative coefficient of time does suggest there may be some negative aspects associated with excessive time devoted to a course.

The effect on the models summarized in tables 3 and 4 of students who reported excessive out-of-class times was investigated. When data for the 13 students who reported in excess of 5 hours of outside class work per credit hour per week were excluded from the data set, ***no*** functions of time were found to be significant predictors of course grade. One should be cautious about reading too much into the observations regarding equation [1]. Models that are significant only in the presence of outliers are highly suspect – the model expressed in equation [1] is not very useful for "typical" students who report fewer than five hours out-of-class time per credit hour per week. In contrast, the linear model of course grade versus student GPA remained significant for this modified data set and produced an R^2 value of 0.34, nearly identical to that obtained for the data set including time outliers.

The statistical relationships obtained here should not be interpreted as causative links between out-of-class-time and grades; there are merely correlations that exist. With their low R^2 values, these models do not explain large portions of the data variability. It might be expected that there would be large variability in these data because there is no "average" student and no single strategy students use to cope with their workloads. Good students with high-level abilities grasp concepts quickly, have good time management skills, and presumably require less time for out-of-class activities. Some students may not have as much innate ability but compensate and get good grades by working hard outside of class. Others may have ability, but choose not to apply themselves fully and get only poor to middling grades. Students with less innate ability need more out-of-class time devoted to their courses just to get by.

The last relationship examined for these courses was between out-of-class hours spent on a course and student ratings of workload difficulty on end-of-semester course evaluations. A linear model of average workload rating versus course-median out-of-class time was examined for the available aggregate data displayed in Table 5. There was no significant relationship between course evaluation workload ratings and median reported out-of-class times spent on courses. The R^2 value was approximately 0.14. Data were also available for student-rated learning in the courses, and when that variable was added to the model, no improvement in

model performance resulted – the R^2 parameter increased only slightly to approximately 0.18, and neither work load nor student learning was found to be significant. If the out-of-class time data are truly representative, the student workload ratings for the courses may be arbitrary.

Summary and Conclusions

For the courses examined in this study, there was no simple relationship between student out-of-class time devoted to course activities and final course grade. Significant predictive models that were functions of just time did not explain much of the data variability with R^2 values in the range of 0.10 or less; and when outliers, defined as students who reported in excess of 5 hours per week per credit hour of out-of-class time, were excluded from the data set, reported out-of-class time was not found to be significantly related to course grade. For those students who reported spending in excess of 3 hours per week per credit hour on their classes, there was some weak but not statistically significant evidence of a negative correlation between time spent on a course and the course grade. A student's cumulative GPA was by far the most important factor in predicting course grade. Models that included cumulative GPA were highly significant (p-value < 0.0001) but still did not explain a large amount of the data variability with R^2 values in the range of 0.30 to 0.36.

The results of this study support the conclusion that students of differing abilities require unpredictably different amounts of time to achieve the same results. There are numerous considerations that influence student success in courses. Good students with high-level abilities grasp concepts quickly, use good time management skills, and consequently may require less time for out-of-class activities. Students with less innate ability may compensate by working hard outside of class to get good grades. Others may have ability, but choose not to apply themselves fully and get only poor to middling grades. Rules of thumb such as "2 to 3 hours of out-of-class time" for every hour of class time may be reasonable on average, but time needed by individual students can vary greatly. Finally, with no link detected between reported out-of-class time and course workload ratings on end-of-semester course evaluations, it would appear that such ratings may be arbitrary.

Table 5. Out-of -Class Time and Workload Ratings

course	median total out of class time reported hrs/week/credit hr.	course work load rating 5 - heavy 1- light
A	2.41	4.250
A	3.09	4.833
A	2.74	4.412
A	1.67	4.643
A	3.03	4.600
C	1.83	4.188
C	2.05	4.625
C	2.50	4.143
C	1.47	4.333
D	1.50	3.167
E	2.18	4.938
E	2.49	4.500
E	1.95	4.417
E	2.42	4.500
E	2.47	4.000

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