Can Students Change Their Homework Behavior After The Midterm? Does It Help?

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Abstract

Using the Internet to administer homework allows us to determine if students change their homework habits during a semester and if this change results in an improvement in grades.

I. Introduction

In introductory physics courses at Central Michigan University, the Computer-Assisted Personalized Approach (CAPA) has been used to distribute, grade and administer homework over the Internet. [1-3] In previous articles[4-6] we described how CAPA was used to directly measure when college physics students do their homework. These articles showed how the Internet was used to examine student study patterns and gender differences in homework[4]; related homework behavior to performance in class[5]; and identified collaborative learning and other successful strategies for on-line homework.[6] In this paper we examine changes in students' homework behavior of over the course of a semester. In particular, we will look at changes following midterm grades.

At Central Michigan University midterm grades are given in all 100-level and 200-level classes. One of the arguments given in support of issuing midterm grades is a belief that students not doing well in a class will change their ways in an attempt to improve their grades. This hypothesis will be tested for three college physics courses. First, the nature of CAPA data is described and general homework patterns are identified in relation to the structure of the course. A significant amount of attention is then given to the formulation and analysis of two homework behavior parameters, "P-DayMean" and "D-DaySpread" values, in relation to students' performance. These variables will be used to quantify, respectively, the average day students do their homework and over how many days they spread out working on their assignments.

II. Description Of The Course And Students

The data collected in this study were taken from three introductory, algebra-based college physics courses taught in the spring of 1998, fall of 1998, and spring of 1999. Each course had enrollments of about 100 students. For each course, eleven CAPA problem sets were assigned and accounted for forty percent of each student's grade. Every time a student submitted an answer to a problem a record of the submission was appended to the CAPA log file. The log files recorded the date and time of submission, which problem was attempted, and the result of the attempt. All students in each of the classes were required to submit answers to their assignments using CAPA and every student was usually given twenty chances to correctly answer each problem. Each time a student submitted an answer to a problem the student was identified, the time and date of submission were recorded, and their answer was registered as correct (Y), incorrect (N), wrong units (U), or wrong significant figures (S). Any submissions that included attempts at a multiple number of problems were dissected into separate submissions so that every revised submission contained an attempt on only one problem. Throughout this study, each of these revised submissions is referred to as a "hit."

Table 1 displays a breakdown of the total hits for the Fall 98 class. The total number of attempts on all problems during the semester was 49,756 and there were, on average, 3.2 hits per problem for each student. Overall, seventy-five percent of all hits consisted of either correct or incorrect answers, while the remaining one-fourth were incorrect attempts due to wrong units or inaccuracy in significant digits. Table 1 also gives a general indication of the difficulty of each assignment in terms of the average number of hits per problem. For example, students appear to have had less difficulty with set 10 (2.4 hits per problem) and appear to have had more difficulty with set 5 (3.8 hits per problem). The hit summaries for the Spring 98 and Spring 99 semesters were similar; however, the students in those sections, who were in their second semester of physics, appear to have had less difficulty with significant digits.

Table 1. Summary of all CAPA hits for fall 98.
The last column lists the average number of attempts on a problem per student.

	# Probs	"Y" Hits	"N" Hits	"U" Hits	"S" Hits	Total Hits	HPP
Set 2	22	1916	3569	186	1390	7061	3.0
Set 3	14	1299	2979	300	1140	5718	3.8
Set 4	19	1580	3511	262	1227	6580	3.3
Set 5	13	936	1949	426	1262	4573	3.8
Set 6	19	1450	2537	355	1296	5638	3.3
Set 7	12	1010	2297	80	760	4147	3.6
Set 8	19	1582	1976	254	1261	5073	3.0
Set 9	14	1219	1063	110	644	3036	2.6
Set 10	16	1394	1650	139	407	3590	2.4
Set 11	16	1353	1869	181	937	4340	3.0
Total	164	13739	23400	2293	10324	49756	3.2
		28%	47%	5%	21%		

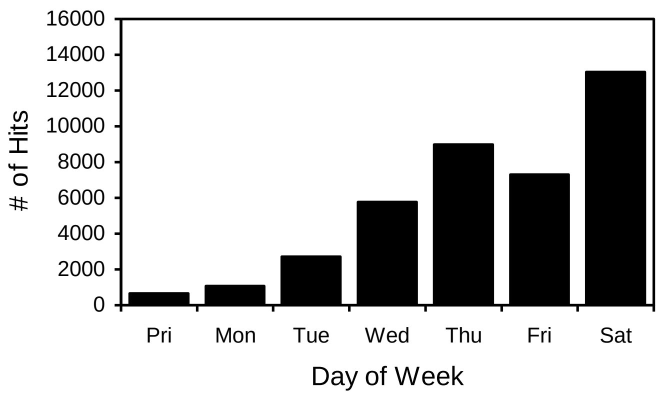
While a more detailed breakdown of the hits can offer insight into where students may be having difficulty, the primary focus of this study was to use CAPA data to assist in determining students' homework behavior. In Figure 1, the total hits for each class are distributed by day of the week, revealing an overall picture of when students did their work. The reader should be reminded here about the structure of the course. Assignments were always due on Sunday at 3:00 AM, and were handed out either on the previous Monday (odd numbered sets) or ten days prior (even numbered sets). Each day in this study is defined as a twenty-four hour period beginning at 5:00 AM. For even numbered sets, all of the hits registered prior to Monday are grouped into a category labeled "Prior".

III. Homework Behavior And Performance

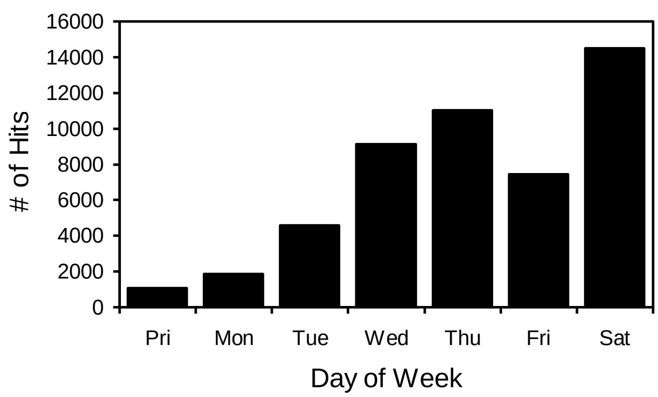
The primary interest of this paper is to examine homework data in relation to how students performed in the course and to determine if midterm grades have an influence on either. This section introduces how the hit data can be used to formulate various types of values that describe when students did homework.

Figure 2 displays the normalized hit distributions for five groups that are based on final grade. The 1st quarter group consists of the top twenty-five percent of the students who completed the class, while the bottom twenty-five percent constitutes the 4th quarter group. The seventeen students who, at some point in the semester, withdrew from the class make up the fifth group labeled "W." Figure 2 clearly illustrates differences in the hit distributions between groups. Students in the top half of the class submitted seventy-five percent of their total hits by Thursday. Forty-one percent of the hits from the students in the bottom quarter occurred on Saturday, and students who ended up withdrawing did nearly sixty percent of their work on the last day.

(a) Spring 98



(b) Fall 98



(c) Spring 99

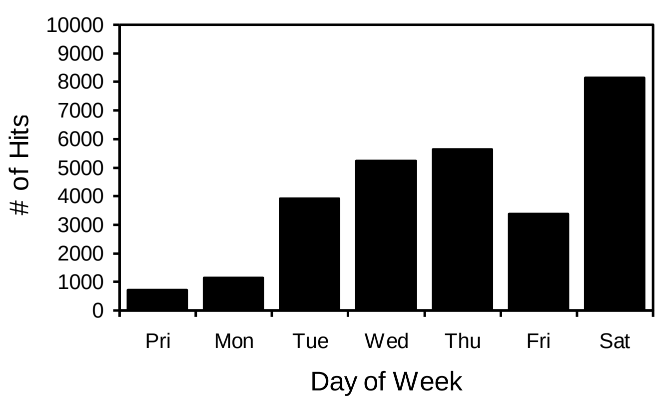


Figure 1. Total hits distributions by day of the week.

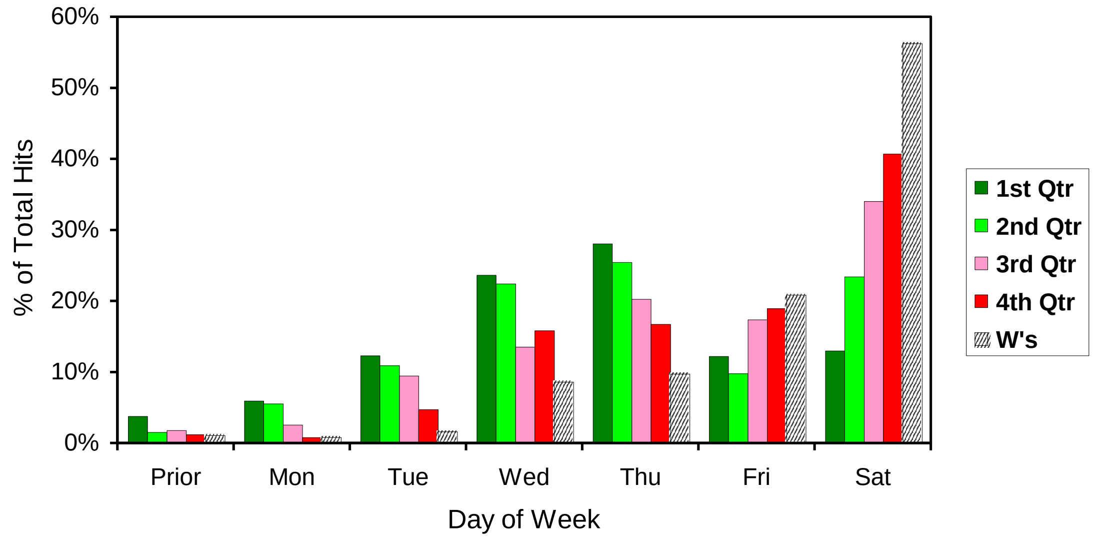


Figure 2. Fall 98 normalized hits distributions based on final grades. The top 25% of the class constitutes the 1st Quarter Group; the 5th group labeled 'W' is comprised of the 17 students who withdrew from the course.

In order to analyze the differences in homework behavior between groups, it is necessary to quantify the hit distributions. There are several ways to use the hit data to develop values that describe an individual student's homework behavior. For example, the "DayMean" value depicts the mean day for which a student submitted answers to CAPA. A student's composite DayMean value (μ_{tot}) for the semester is computed by averaging the day values (see Table 2) over all of the student's hits (n_{tot}) for the entire semester:

$$\mu_{tot} = \frac{\sum_{n=1}^{n_{tot}} d_n}{n_{tot}}$$

Table 2. Day values assigned to individual hits.

Day of Week	Day Value (d)
Prior	1
Monday	2
Tuesday	3
Wednesday	4
Thursday	5
Friday	6
Saturday	7

Likewise, a student's DayMean value for a particular assignment is computed by averaging the day values over all hits submitted for the particular assignment.

An underlying assumption in the use of the DayMean value as an estimate of when a student did homework is that some degree of work was associated with each hit (i.e. some computation, re-computation, and /or some thought process involved with solving a physics problem). However, if one were concerned with a weighting effect due to differences in the hits per problem ratio, then an alternate method would be to use "p-hits". A single p-hit occurred when a student attempted a particular problem, regardless of the number of attempts associated with the problem. There was one p-hit possible for each day of the week for each problem. For example, if a student incorrectly answered problem #4 two times on Wednesday, and it took five attempts on Thursday to correctly answer the problem, then one p-hit (for problem #4) was recorded for Wednesday and another was recorded for Thursday. Using p-hits, the "P-DayMean" value is defined as

$$\mu_p = \frac{\sum_{n=1}^{n_p} d_n}{n_p}$$

where n_p is the total number of p-hits for a student.

Figure 3 displays the average P-DayMean value for each of the five groups based on final grades. An analysis of variances with various post-hoc tests shows that significant differences ($p<.05$) exist between every other group. For example, The 1st Quarter group achieved significantly lower μ_p values than did the bottom half of the class. Likewise, students in the bottom 25% of the class achieved significantly higher μ_p values than did students in the top half of the class. There was also a marked difference when students in the top half of the class did their homework and when students who withdrew from the course did their homework.

The P-DayMean value can be regarded as a statistic of central tendency. An additional measure of when a student did homework would be the extent to which he or she did homework on a daily basis. Unlike with most statistics of variability, the standard deviation cannot be used as a measure, since the measure should not concern itself with which day(s) homework was done. Instead, the "D-DaySpread" value for a particular assignment is simply taken as the number of days for which CAPA activity was recorded. The composite D-DaySpread value (σ_d) for the entire semester is taken as the average of the spread values for each assignment. A composite D-DaySpread value $\sigma_d = 2.0$, for example, indicates that a student had, on average, worked on homework two days for each assignment, regardless of which days of the week. Figure 4(a) displays the distribution of σ_d values for the Fall 98 class. As the graph illustrates, a majority of the students had spent two days on their homework, while less than a third had spent three or more days on their assignments.

The relationship between σ_d and final grade for the Fall 98 class (Fig. 4(b)) was observed to be statistically significant and nearly as strong as the relationship between μ_p and final grade. Students in the top 25% of the class clearly spent more days doing homework (σ_d=2.6) than did students in the bottom fourth of the class (σ_d=1.7).

The reader should be reminded here that 60% of a student's final grade was based on five exam scores, while 40% was based on homework scores. While it has been shown that moderate relationships exist between final grades and when students did homework, differences were observed with respect to performance on homework and exams. For the Fall 98 class, P-DayMean was strongly correlated with homework scores ($r=-.67$). Although students with lower μ_p values tended to do better on exams as well, the relationship was not statistically significant (when all students were included). On the other hand, D-DaySpread was correlated with both homework scores ($r=.50$) and exam scores ($r=.20$). A moderate relationship was observed between homework scores and how students did on exams. Table 3 summarizes the Fall 98 correlation data.

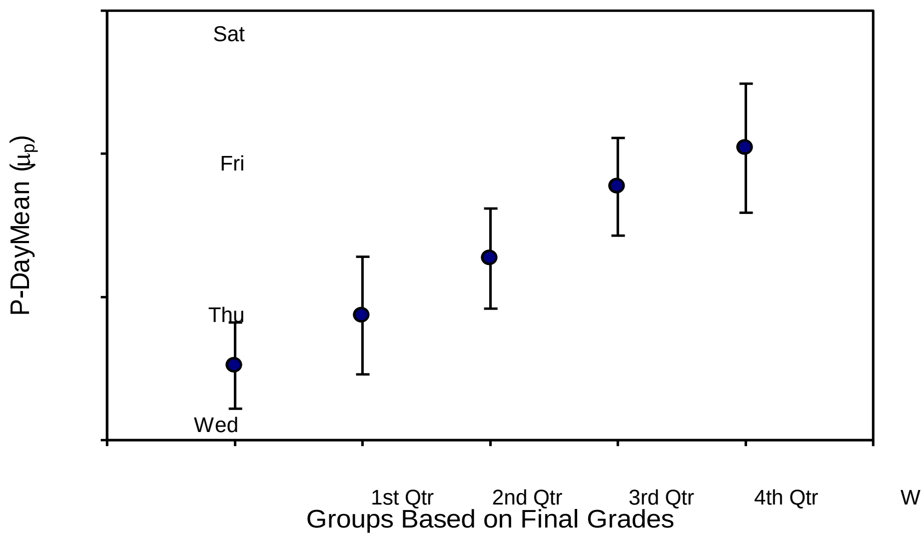
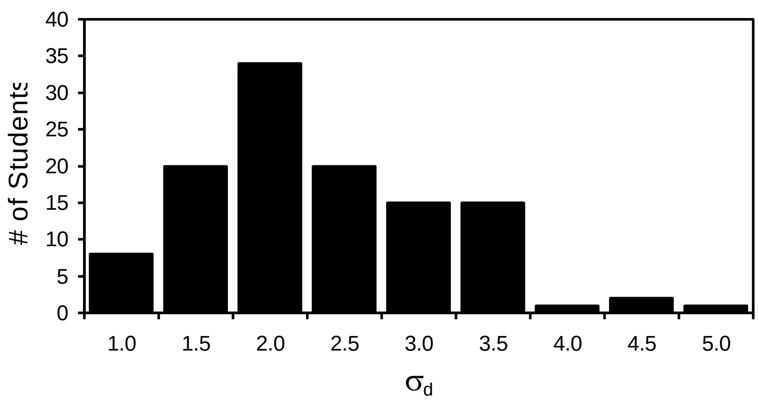


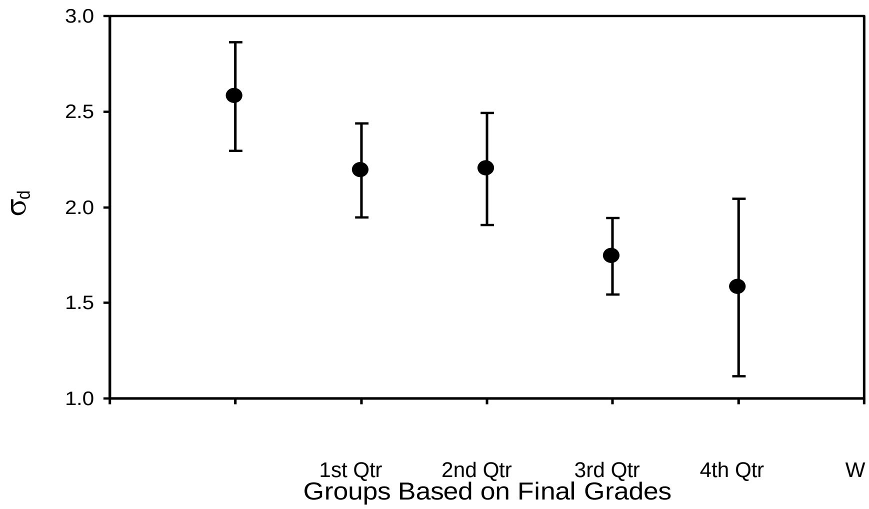
Figure 3. Average P-DayMean values for groups based on final grades. Included are 95% confidence intervals. Significant differences (p<.05) exist between every other group.

(a) D-DaySpread Distribution



The accuracy of the relationships observed above are of course dependent on how well the P-DayMean and D-DaySpread values reflect when individual students actually did their homework. Self-report data indicated that some homework activity occurred on days for which no CAPA activity was recorded. A survey was used to identify students who were likely to exhibit this sort of homework behavior. There were fifteen students who reported having worked most of their problems before logging onto CAPA, tended not to be near a computer when they did their work, and tended to submit most of their problems all at once. Exclusion of these fifteen students with suspect μ_p and σ_d values results in relationships with improved strengths and significance (shown in parentheses in Table 3).

(b) D-DaySpread vs. Final Grade



N*	98
Pearson Correlation	.41
Sig. (1-tailed)	.001

Figure 4. D-DaySpread data for Fall 98. (a) Distribution of D-DaySpread values for the Fall 98 class. (b) Results from an ANOVA indicate that students who did better spent more days on their assignments.

Table 3. Pearson Correlation data for Fall 98. Exclusion of 15 students with suspect μ_p and σ_d values resulted in more accurate relationships with improved strengths and significance (shown in parentheses).

	Final Grade	Homework	Exams
P-DayMean (μ_p)	-.50** (-.55**)	-.67** (-.69**)	-.14 (-.21*)
D-DaySpread (σ_d)	.41** (.42**)	.50** (.46**)	.20* (.25*)
Homework			.33**

** p<.01 * p<.05

∗ 3 outliers not included.

IV. The Changes In Behavior

The analyses conducted thus far have shown significant relationships between overall performance and when students did homework. These analyses have been conducted using the composite μ_p, σ_d values, which give general indications of when students did homework over the entire semester. Although the state of most homework behaviors could not be determined for any particular point within the semester, it was possible to evaluate changes in when students did homework by analyzing P-DayMean and D-DaySpread values for individual assignments. As an example, the general trend for the Fall 98 class was a decrease in P-DayMean values as students progressed through eleven assignments. As Figure 5 illustrates, performance on assignments tended to increase accordingly, and the correlation between the two variables was determined to be significantly high.

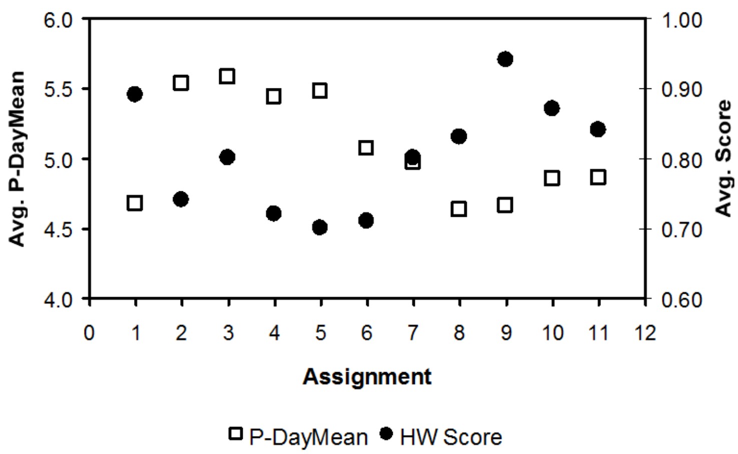


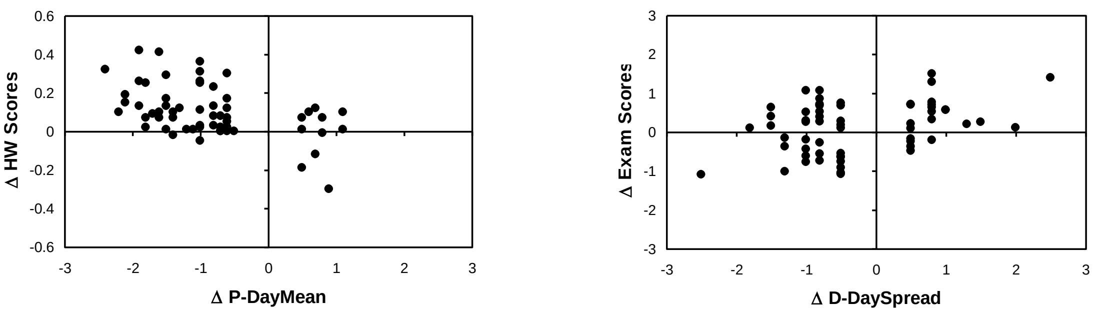
Figure 5. Average score on assignments vs. average P-DayMean values. The graph clearly indicates that, as the semester progressed, students did their work earlier in the week and homework scores increased accordingly. The Pearson correlation between the 2 variables was r=.77.

It is conceivable that a student's midterm grade could have had a significant impact on his/her outlook on course standing, and therefore homework behavior as well. An analysis was conducted to determine the extent to which both performance and when students did homework changed between the first and second halves of the semester. The results of the analysis are graphically summarized for all three sections in Figure 6. The left column in Figure 6 displays plots of changes in performance on assignments versus changes in P-DayMean; the column on the right displays changes in performance on exams versus changes in D-DaySpread.

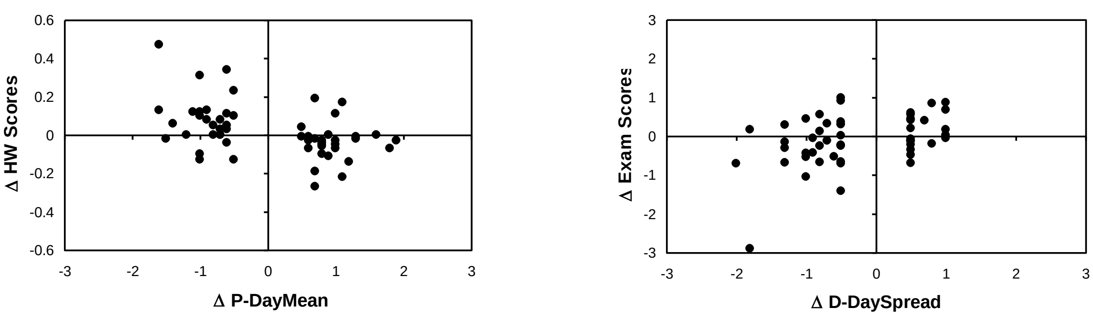
Although regression analysis indicates that each of the six sets of data constitutes a significant relationship, more useful information can be extracted from a visual interpretation of the plots. It is clear that a majority of the students in the Fall 98 class (Fig. 6(a)) exhibited better homework behavior after the midterm, as indicated by the changes in P-DayMean and D-DaySpread values. The plots for the Fall 98 section illustrate a significant improvement in

Homework scores for those students who did homework earlier in the week than they had before the midterm, and also indicate an improvement in exam scores for students who spent more days per week after the midterm.

(a) Fall 98



(b) Spring 98



(c) Spring 99

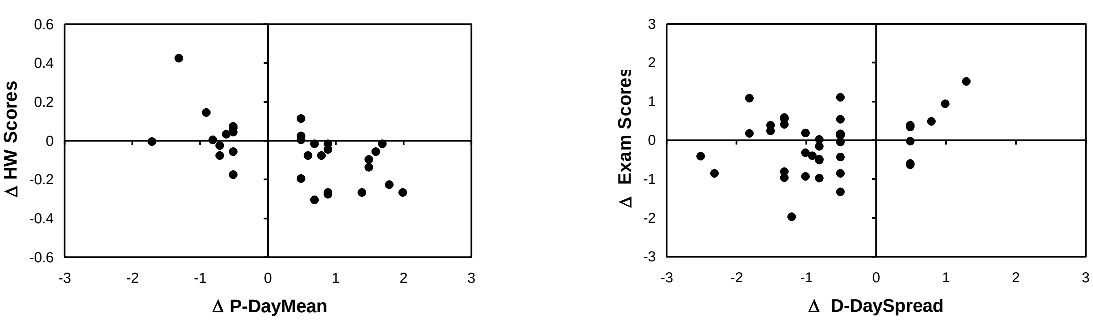


Figure 6. Changes in performance vs. changes behavior. The left column displays changes in normalized homework scores vs. changes in P-DayMean values. The changes are the differences between the first and second halves of the semester. Data containing little or no change in behavior is excluded from the plots. The column on the right displays plots of changes in studentized exam scores vs. changes in D-DaySpread values. All six sets of data constitute significant relationships ($p<.05$).

The data for the spring sections show similar relationships between change in performance and change in when students did homework. However, the plots for these classes also show that the change in behavior tended to be opposite of that for the fall semester students. Many of the Spring 98 students achieved lower D-DaySpread values after the midterm and did not do as well on exams, as was the case for many students in the Spring 99 class. In addition, the homework plots for the spring sections indicate that after the midterm a majority of the students tended to submit their homework later in the week, and tended to achieve lower scores on their assignments.

V. Conclusions

Significant relationships ($p < .001$) were found when homework behavior and achievement in physics were analyzed with students' GPA data. Not only were Day-Mean and Day-Spread values correlated to final grades in physics, they were also correlated ($r = .5$) to cumulative GPA prior to entering the course. More interestingly, homework behavior and physics grades were significantly correlated ($r = .4$) to an adjusted semester GPA that had physics grades factored out. This immediately suggests a possible relationship between homework behavior in physics and homework behavior in other courses.

Isolation of the "P-DayMean" and "D-Day Spread" parameters before and after the midterm period also yielded interesting results. Generally, students who had exhibited better homework behavior after the midterm achieved better scores in relation to their performance before the midterm period. While this type of relationship was consistent among all of the sections, differences were observed with respect to which direction students actually changed. For example, during the fall semester many students had worked on the homework earlier in the week after the midterm, and achieved higher scores on assignments. During the spring semesters, on the other hand, a majority of the students spent fewer days per week on assignments after the midterm; this change in behavior was accompanied by a drop in exam scores.

One is tempted to blame this pattern on "spring fever." (This is an issue we leave to the social science researchers.) A more important interpretation of the data involving changes in behavior, however, is that it substantiates the results mentioned in this and previous studies,[4,5,6] which are based on the students' composite μ_p and σ_d values. In other words, the relationship between performance and homework behavior may actually be stronger than what has been presented because the composite values tend to "average out" the observed relationships associated with changes in behavior.

References

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