Attitudes vs. Performance in the Engineering Classroom

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Introduction

The paradigm subscribed to by most people is that if one believes that a goal can be achieved, success is more likely. This is especially true in the pursuit of educational goals[1]. A new trend in introductory texts focusing on orienting students to higher education, including those used in engineering courses, is to place a high degree of emphasis on this point. For example the widely used text by Landis[1] is filled with phrases such as "you can do it," "believe in yourself," and "an A in each course should be the goal." If one believes and subscribes to this paradigm, then a constant emphasis on a positive attitude will effect change in student learning outcomes as manifested by their overall Grade Point Averages (GPAs).
A few questions arise from this emphasis on motivating students toward positive attitudes. For example, one may ask the following questions:

1. Do introductory courses (e.g., Introduction to Engineering course taught at our university) that work within this positive-attitude paradigm truly support a positive outlook in students?
2. Is a positive attitude related to actual performance?
3. Does this positive attitude change during the duration of a course or the duration of a student's academic career?
4. Does previous performance in school affect students' attitudes and, in turn, their future grade?

The current study was undertaken to address the last three questions. A recent study by Petr[2] shows that a student's performance on an exam is related to his or her confidence when answering each question on the exam. Another study reported in Angelo and Cross[3] shows that by surveying the students' self-confidence in a class and making them aware of the results can help build self-confidence and competence in the classroom, although the competence was not tied specifically to performance. This work examines the correlation between the student's *overall attitudes* in a single class to his or her *overall performance*. A related study is looking at the effects of introductory courses on student outlook (question 1 above).

This study was performed to help elucidate the extent to which a student's initial positive attitude contributes to his or her successful performance in the engineering classroom. Moreover, the influence of students' overall GPA on their attitudes and course performance is also inferred. The overall goal here is to address the last three questions posed above using a sample of Civil

(Environmental) and Mechanical Engineering students at the California State University at Los Angeles (CSULA). Most of these students have previously taken a motivational Introduction to Engineering Course. To address these research questions, surveys were designed and administered to assess students' predictions of their own success. These predictions were compared both to actual individual course performance and to students' overall academic performance measured by cumulative GPAs.

Methodology

Students (N=122) were surveyed in six (6) engineering classes (8 different sections), in two engineering disciplines, over a three-year period. Specifically, Civil and Mechanical Engineering sophomores and juniors were surveyed in:

ENGR 300*: Engineering Economics (Fall 2001)
(*ENGR is a general Engineering course taken by all Engineering majors)
ME 326a: Thermodynamics I (Fall 2001)
CE 384: Introduction to Environmental Engineering (Spring 2000, Fall 2000)

CE 384 – Spring 2000 – Week 10 *Name:* _____

How much time have you been spending on preparing for each lecture in this class? ___ hours/week

How much time have you been spending on working on assigned work in this class? ___ hours/week

What grade do you expect to receive in this class now? ___

Is this grade higher or lower than what you had originally thought? ___

State three reasons why you will receive the grade you indicated above. If your anticipated grade has changed, state the reasons why.
1.
2.
3.

Why will your actual grade differ from those stated above?
1.
2.
3.

Figure 1. Sample survey conducted in Week 10 of CE 384.

Civil and Mechanical Engineering juniors and seniors were surveyed in:

ME 404: Turbomachinery (Fall 2001)
CE 454: Groundwater Contamination and Remediation (Spring 2000)
CE 484: Sewerage and Sewage Treatment (Fall 2000, Fall 2001)

For each course, students completed surveys four times during the quarter: the first day of class, after 3 weeks, after 7 weeks (usually following the first midterm), and right before finals (during

the 10th week of classes). This is true for all quarters except Fall 2001. In this quarter, surveys were conducted on the 2nd, 4th, 8th, and 10th week of the respective courses. The surveys asked the students to predict their grade in the course and explain their rationale for their predicted grade. They were also asked to give reasons why their assessment may not match their actual earned grade. Surveys varied slightly to match the time of administration; a sample survey (from the 10th week of CE 384) is shown in Figure 1.

This paper analyzes the numerical data obtained from these surveys that pertain to grade prediction. Specifically, the expected grades are converted to grade points and compared to the actual grades. For this study, grades of "A", "B", "C", and "D" are worth 4, 3, 2, and 1 grade points, respectively. Some students listed mixed grades in which case the equivalent grade points were averaged. For example, a student listing an expected grade of "A/B+" received 3.65 grade points (i.e., (4+3.3)/2). A second paper is planned in which the written comments and the estimates of effort exerted (in hours) by students are compared to their final course grades.

To analyze survey results, scatter plots were created and correlational statistics were performed. First, students' predictions of their grades at various points during the academic term were plotted against their final grade. Second, changes in predictions over time were examined both during the duration of individual courses and in relation to the students' overall academic performance via their GPAs.

Results

Correlations with Course Grades

The data indicate that students begin each quarter with a very positive attitude toward each class. From these surveys, it can be seen that, in the first week, approximately 50% of students (i.e., 60 of 122 students) believed they would receive an "A" grade in their respective courses, while 25% believed they would receive a grade of "B" (Table 1). The percentage of expected "A" grades reduced to 24% immediately following midterms and increased slightly (i.e., to 25%) preceding finals week.

Table 1. Number of students expecting either an "A", "B", "C", or "D" as a function of the survey week. In-between grades (i.e, "+" and "–") are not considered in this table (N=122).

Grade	**Number of Students**			
	Week 1	***Week 3***	***Week 7***	***Week 10***
A	60	44	29	31
B	30	26	33	24
C	6	13	18	17
D	0	0	1	0
Mean GPA	**3.56**	**3.37**	**3.11**	**3.19**

These results indicate that during the course of the quarter, students became more realistic about their expected grades, especially after the midterm. From the students' perspective, the course midterm was a relatively strong indicator of their performance in the course. Toward the end of

the course, the percentage of students expecting "A" grades increased possibly because of an optimistic view of their performance on the final.

Scatter plots of students' predicted grades during the 1st, 3rd, 7th, and 10th weeks of the quarter versus their final earned course grades indicates a similar trend (Figure 2). A positive perfect

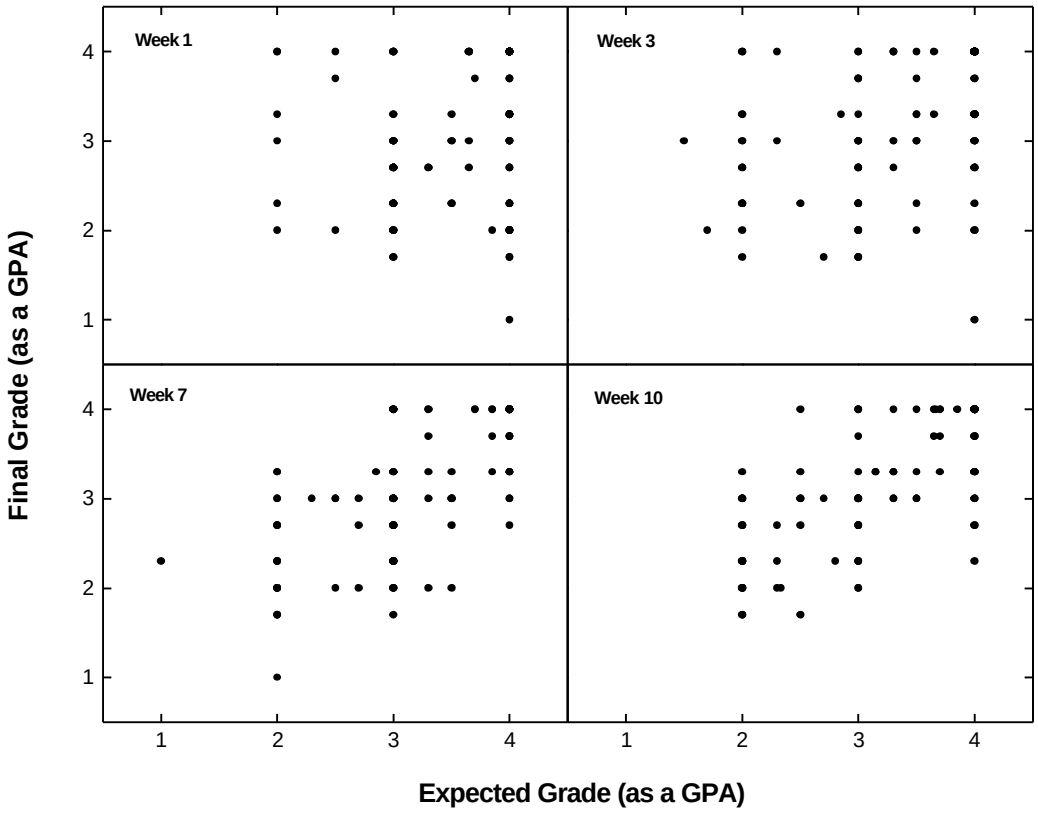

Figure 2. Scatter plots comparing the final class grade received by student (as a GPA) to the students' predicted grades collected during the first, third, seventh, and tenth weeks of the quarter.

correlation (r = 1.0) between predicted and final grade would be represented on these plots by a straight diagonal line (i.e., with a positive slope of 1).

A visual inspection of these plots reveals that student predictions at Week 1 showed no trend toward this correlation (i.e. they have random scatter). Order does start to appear as the quarter moves along. At Week 10, the predicted and earned grades cluster more tightly, conforming more to the line of best fit for a positive perfect correlation. In other words, as the quarter progresses, the students' expected grades are more closely correlated with their final course grades. Statistically this same observation can be shown with the correlation coefficients obtain with the Pearson method shown in Figure 2 (see Table 2). Specifically, a coefficient of 1 represents an exact positive correlation, of -1 represents an exact negative correlation, and a correlation of 0 represents no correlation. A two-tailed t-test is used to check the probability (p) that the correlation coefficient would just as easily be equal to zero as it is equal to the value

determined. This null hypothesis is traditionally rejected if the probability of r being equal to zero is less than 0.05.

In the first week of each course, the students did not predict their grades well (i.e., correlation between expected and final grades close to zero with $r = -0.032$ and $p = 0.720$); thus, the correlation is not statistically significant. In the 3rd week, a statistically significant yet weak correlation between expected and actual grades is observed (i.e., $r = 0.381$, $p<0.001$). By the 10th week, a relatively strong and significant correlation (i.e., $r = 0.654$, $p<0.001$) exists between student expectations and student performance. This analysis supports the discussion above in that, initially, most students believed they would earn an "A" in the course based on a positive attitude. However, this prediction of the grade decreased during the quarter, most notably right after midterms, until it more closely matched the actual grade awarded at the end of the term. This underscores the importance of timely and constant feedback to help students self-assess their status in each individual course to help them adjust to enhance their learning and performance in the course. It also suggests that if the student can monitor his or her attitudes and expectations, he or she may be able to positively affect change in his or her course grades.

Table 2. Correlation coefficients for linear fits to the data presented in Figure 2 as a function of survey week. A correlation coefficient of "1" indicates that most students successfully predicted their final grades. A coefficient value close to zero indicates that most students failed to predict their final grades accurately.

Week	Correlation Coefficient (r values)	Significance (p)
1	-0.032	0.720
3	0.381	<0.001
7	0.482	<0.001
10	0.654	<0.001

A corollary to this is that students with low cumulative GPAs started each quarter with the attitude that "this quarter, I will make time and work hard" as judged by students' comments. However, as the quarter progresses, work, school, family, and other obligations forced students into a more "realistic" view of their performance in the course. If an instructor knew this ahead of time, he or she could help the student cope with external influences which may, in turn, help the student keep a positive outlook toward the course and school. In the long run, this may positively affect the individual student's learning outcomes in future courses.

Another way of presenting these findings is by plotting the average normalized expected final grade in the classes (Figure 3). The normalized grade is obtained by dividing the average expected grades from all students by the overall average final grades in the course. If, throughout the quarter, students consistently predicted their final grades accurately, this normalized plot should be a straight horizontal line at 1 for all weeks of the quarter. The average student, however, initially predicted his/her grade at about 1.45 grades above the final grade earned for the course (Figure 3). This inflated prediction decreased over time, reaching a value of about 1.2 grades above the final earned grade in the 10th week of the course.

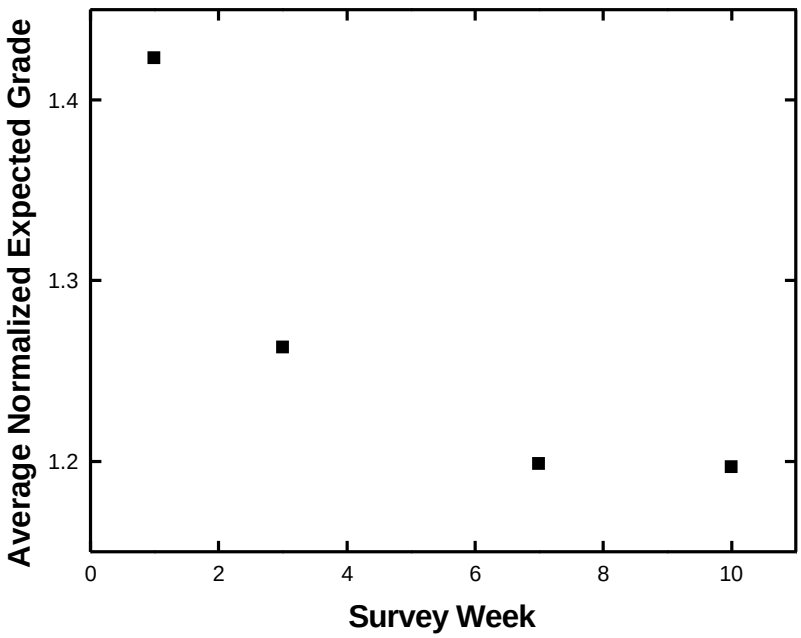

Figure 3. Average expected final grade in the classes normalized by the final grade obtained for each reporting period.

Correlations with GPAs

To assess whether a student's performance in surveyed courses was representative of his or her past performance (i.e., their overall GPA to date), their overall GPA was compared to their grade in the course in which they were surveyed (Figure 4). Most students surveyed in this study have enough units so that their performance in the single class they were surveyed in should not affect their overall GPA's significantly. In other words, the overall GPA is a good measure of a student's academic standing regardless of his or her performance in the classes in which he or she was surveyed. Because of a strong positive correlation ($r = 0.634$, $p = <0.001$), the grades assigned for these classes can be seen as representative of the grades that the students typically earn. This supports the old adage: "success breeds success." The question to be asked is "does a student's overall GPA lock him or her into an attitude which hampers efforts to enhance his or her performance?" Future studies will attempt to answer this question.

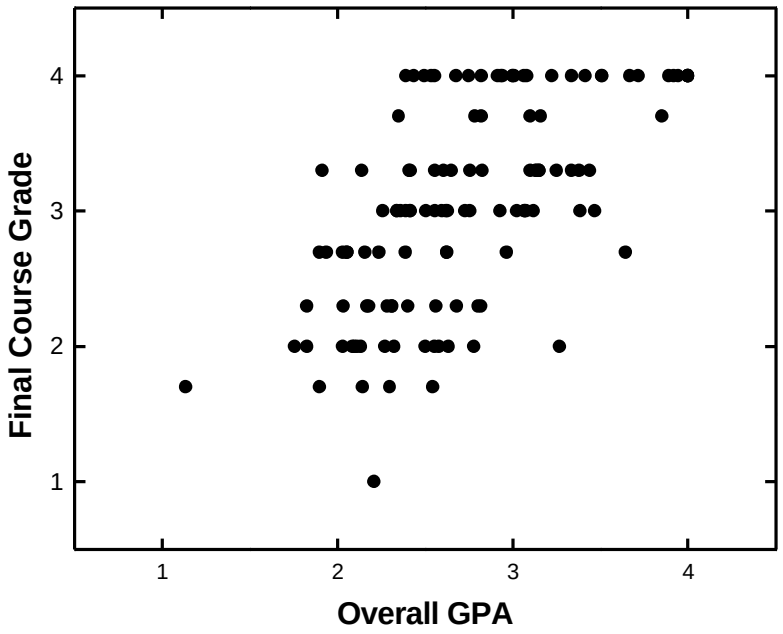

Figure 4. Scatter plots of Overall GPA versus earned grade in the course.

Another interesting aspect of the data is how students' predictions (or expected grades) varied over time as a function of their overall GPAs. Expected grades from students with lower cumulative GPAs tended to vary more than those from students with higher GPAs (Figure 5). In Figure 5, the difference between the final earned grade and the initial prediction versus the overall GPA of each student is shown. As an example, one student's information is plotted using the symbol "?" in Figure 5. This student has an overall GPA of 2.39. The student's expected grade was 2 grades higher than his or her actual final grade in the course. In other words, if this student expected an "A" in the first week of the course, he or she earned a final grade of "C" in the course.

The maximum prediction error (i.e., greatest variance between initial expected grade and final earned grade) for any student was 2 grades (Figure 5). Students with this maximum prediction error were in an overall GPA range between 2.3 and 3. Students with GPAs less than 2.3 had a maximum prediction error of 1.25 grades while students who have GPAs that approach 4 tend to have a maximum prediction error of 0.5 grades.

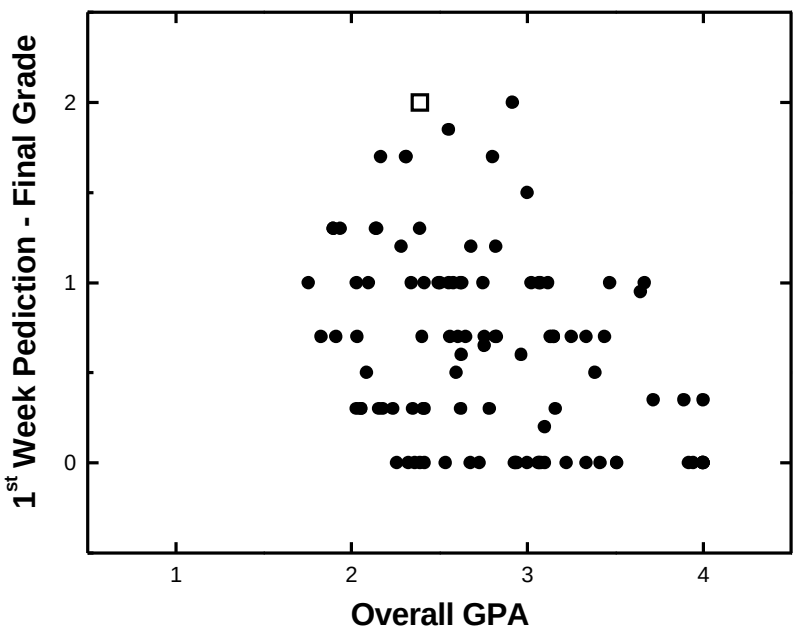

Figure 5. Difference between the final earned grade and the initial prediction versus the overall

GPA of each student. The data point marked by "?" is used as an example in the text.
One way to interpret the results shown in Figures 4 and 5 is that "C" students who predicted that they will earn a "B" actually earned either a "B" or a "C", and "A" students who believed that they would earn an "A" actually earned an "A" or an "A-". Students in the middle (i.e., "C+" to "B" students) tended to believe that they would perform significantly better than their records show.

Summary and Instructional Implications

It appears that engineering students at the California State University, Los Angeles, hold success-based attitudes that are stressed in their Introduction to Engineering courses. Over 73% of all students beginning a course, regardless of their past academic records, believed that they would earn an "A" or a "B". Students' predictions of their grades decreased during the term, most notably right after midterms, until predictions were more closely align with the grades actually awarded. Although students' positive predictions changed as the course progresses, they apparently remain strong throughout the student's academic career regardless of past failure.

One implication of this study is that students tend to deceive themselves about their abilities, commitment to the course, and present performance. As feedback is obtained, the student acquires a more realistic view of his or her ability to perform in a given class. If frequent and early feedback is provided, the student's performance misconception should be corrected in time for the student to make behavior adjustments (e.g., increased time on task, more interaction with the instructor). Thus, when the instructor is able to help students understand the root of their positive attitudes and the reasons for the discrepancy between their expectations and outcomes, the instructor and student can work as a team to increase the student's performance.

1. Landis, R. B. (2000). Studying Engineering: A Road Map to a Rewarding Career. Los Angeles, CA, Discovery Press.

2. Petr, D. W. (2001). "Confidence Scores Measure (and Enhance?) Student Perceptions of Their Work." Journal of Engineering Education 90(4): 469-475.

3. Angelo, T. A. and K. P. Cross (1993). Classroom Assessment Techniques: A Handbook for College Teachers. San Francisco, CA, Jossey-Bass Publishers.