Correlational Study of Factors Related to Student Achievement in Physics 303K: Fall 1996 and Spring 1997

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During the fall semester of 1996, faculty members in the Department of Physics expressed concern that an unacceptably large proportion of students was failing Physics 303K, Engineering Physics I. The class is the required first physics course for students in all engineering majors, and students must earn a grade of at least *C* in it before they may enroll in the next course in the required sequence, Physics 303L, Engineering Physics II. At the request of the department, representatives of the Measurement and Evaluation Center (MEC) and the Center for Teaching Effectiveness (CTE) agreed to conduct a study to answer the question, “Why do students fail Physics 303K?”

It was decided to choose a research design by which to determine the demographic, academic, and attitudinal traits that may be correlates of students’ achievement in Physics 303K. Four sources of data were identified:

- the university’s student records database that included background information about gender, ethnicity, university classification, and high school academic profile as reflected by standardized admission test score, grade point average, and rank in class for students enrolled in Physics 303K during fall 1996 and spring 1997;
- instructor-reported course participation and performance indicators that included attendance rates for lectures and recitation sessions as well as mid-semester quiz grades, test scores, homework grades, and final course grades for students enrolled in Physics 303K during fall 1996;
- interviews with students enrolled in Physics 303K during fall 1996;
- responses to the Five Common Items of the University Course Instructor Survey for Physics 303K for students enrolled during the period from spring 1994 through fall 1996.

MEC and CTE staff identified from each of these four data sources factors correlated with students’ performance—as indicated by final course grade—in Physics 303K.

The Relationship between Student Background Variables and Achievement in Physics 303K

Sample

Student background data were obtained from the university’s student records data base for 921 students enrolled in Physics 303K during the 1996-97 academic year: 430 students in four course sections during the fall 1996 semester and 517 students in five course sections during the spring 1997 semester. Twenty-six students enrolled in the class in both semesters. For each student, information was obtained concerning two demographic characteristics—gender and ethnicity—along with the student’s university classification and high school academic profile as indicated by standardized admissions test score, grade point average, and class rank.

Sample Demographic and Academic Characteristics

The groups of students enrolled in Physics 303K in the fall 1996 semester and spring 1997 semesters did not differ when identified in terms of students' distribution by gender and ethnicity, as indicated by the breakdowns shown in Tables 1 and 2. However, the groups did differ when identified in terms of students' university classification and SAT score (though not in terms of UT grade point average), as indicated by the breakdowns shown in Tables 3 and 4.

Sample's Performance Profile in Physics 303K

In the view of faculty in the Department of Physics, a student who receives a grade of *D* or *F* in Physics 303K has failed, because a grade of *D* does not allow a student to meet the prerequisite for enrolling in Physics 303L. With failure so defined, the failure rate in Physics 303K was 10.7% for fall 1996 students and was 9.8% for spring 1997 students. Another 10.7% of the fall 1996 students and 8.0% of the spring 1997 students did not complete the class for various reasons, as indicated by grades of *Q*, *X*, *O*, and *W*. The existence of this latter sizable group of students, virtually as large as the group who received a grade of *D* or *F*, may contribute significantly to the perception of faculty in the department that the proportion of students "failing" Physics 303K is large. Whether students failed to qualify for Physics 303L because of grades of *D* or *F* or because of discontinuing their work in Physics 303K, the result was that approximately one-fifth of the students who began the course in the 1996-97 academic year did not complete it satisfactorily.

The complete breakdown of the distribution of final grades in the class is shown in Table 5. Because the final grade data were obtained during the summer of 1997, the grade distribution for the fall 1996 semester was slightly different than it had been just after the end of the semester, because three grades of *X* (indicating a temporary delay in the reporting of a final grade) originally reported on the instructors' official grade sheets at the end of that semester had been resolved by the summer of 1997. It is possible that a similar slight difference would be reflected in the distribution of grades for the spring 1997 semester if the student records database had been obtained after the summer session of 1997.

Out of the 88 students who received grades of *D*, *F*, *Q*, or *W* in the fall 1996 semester, 26 (30%) enrolled in Physics 303K again in the spring 1997 semester. The pass rates for these students in their second try were variable: 86% (6 out of 7) of the students who received a *D* in the fall received a passing grade in the spring; 44% (4 out of 9) of the students who received an *F* in the fall received a passing grade in the spring; 75% (6 out of 8) of the students who received a *Q* (that is, who dropped the class) in the fall received a passing grade in the spring; and 50% (1 out of 2) of the students who received a *W* (that is, who withdrew from the university) in the fall received a passing grade in the spring.

Table 1
Distribution by Gender of Students Enrolled in Physics 303K
during the 1996-97 Academic Year

	Number of Students Enrolled		Percentage of Students Enrolled	
Gender	Fall 1996	Spring 1997	Fall 1996	Spring 1997
Male	353	421	82.1	81.4
Female	77	96	17.9	18.6
Total	430	517	100.0	100.0

Table 2
Distribution by Ethnicity of Students Enrolled in Physics 303K
during the 1996-97 Academic Year

	Number of Students Enrolled		Percentage of Students Enrolled	
Ethnicity	Fall 1996	Spring 1997	Fall 1996	Spring 1997
White	238	301	55.4	58.2
Asian American	90	100	20.9	19.3
Hispanic	69	81	16.0	15.7
International	17	24	4.0	4.6
Black	13	7	3.0	1.4
American Indian	3	4	0.7	0.8
Total	430	517	100.0	100.0

Table 3
Distribution by University Classification of Students Enrolled in
Physics 303K during the 1996-97 Academic Year

	Number of Students Enrolled		Percentage of Students Enrolled	
Classification	Fall 1996	Spring 1997	Fall 1996	Spring 1997
Freshman	179	323	41.6	62.5
Sophomore	166	133	38.6	25.7
Junior	54	34	12.6	6.6
Senior	30	27	7.0	5.2
Graduate	1	0	0.2	0
Total	430	517	100.0	100.0

Table 4
Academic Profile of Students Enrolled in Physics 303K during the 1996-97 Academic Year as Indicated by SAT Scores and UT Austin GPAs

	SAT Verbal Score		SAT Quantitative Score		UT Austin GPA	
	Fall 1996 (N=359)	Spring 1997 (N=473)	Fall 1996 (N=359)	Spring 1997 (N=473)	Fall 1996 (N=353)	Spring 1997 (N=502)
Mean	523.1	573.1	649.2	658.5	2.96	3.02
Stan. Dev.	101.8	93.7	77.7	64.2	0.77	0.70
Minimum	200	210	440	410	0.42	0.33
Maximum	800	800	800	800	4.00	4.00

Table 5
Distribution of Final Course Grades Received by Students Enrolled in Physics 303K during the 1996-97 Academic Year

		Number of Students Receiving the Grade		Percentage of Students Receiving the Grade	
Grade	Status	Fall 1996	Spring 1997	Fall 1996	Spring 1997
A	Pass	89	119	20.7	23.0
B	Pass	124	169	28.8	32.7
C	Pass	123	134	28.6	25.9
CR	Pass	2	3	0.5	0.6
	Pass Subtotal:	338	425	78.6	82.2
D	"Fail"	21	26	4.9	5.0
F	Fail	25	25	5.8	4.8
	Fail Subtotal:	46	51	10.7	9.8
Q	Drop	33	29	7.7	5.6
X	Incomplete	0	3	0.0	0.6
O	Removed	4	4	0.9	0.8
W	Withdraw	9	5	2.1	1.0
	Subtotal:	46	41	10.7	8.0
Totals		430	517	100.0	100.0

Based on these few data for students who retook Physics 303K after dropping the course or receiving an unsatisfactory grade, it could be hypothesized that students who drop with a grade of *Q* or who receive a *D* have a good chance of earning at least a *C* if they retake the course immediately.

The complete breakdown of the distribution of final grades for the 26 students who took Physics 303K during both the fall 1996 and the spring 1997 semesters is shown in Table 6.

Demographic Characteristics and Course Performance

A comparison of the pass rates by gender suggests that there was no difference in the performances of males and females in Physics 303K, as indicated by the similar rates (in the “percentage” columns) shown in Table 7. A comparison of the pass rates by ethnicity does reveal differences in students’ performances, as indicated by variable pass rates (in the “percentage” columns) shown in Table 8. The pass rate was similar for Asian American, American Indian, International, and white students, in the low to mid 80 percent range. The pass rate for Hispanic students was approximately 10 percentage points lower (72.9%) and for Black students approximately 20 points lower (63.2%). Among students who did not pass the course (that is, who received a grade of at least *C*), American Indian and International students were more likely to drop the course than receive a failing grade, while Black students were more likely to receive a failing grade than to drop the course.

Academic Characteristics and Course Performance

Approximately two-thirds of the students who enrolled in Physics 303K in the 1996-97 academic year had already completed Mathematics 408C, Differential and Integral Calculus. Because Physics 303K is a calculus-based course for engineering majors, it seemed reasonable to investigate whether there was a relationship between the grades students received in the two courses. It also seemed prudent to do so, because some students take the courses concurrently, raising the question whether such students’ prospects for success in Physics 303K might improve if they were to begin the physics course already equipped with the calculus skills provided by Mathematics 408C.

A relationship was found between grades in the two courses. As students’ grades in Mathematics 408C decreased, so too did the percentage of students who passed Physics 303K, as indicated in Table 9.

However, even among students who received a *D* in Mathematics 408C, the pass rate in Physics 303K was still approximately 71%, a drop of only about 3% from the pass rate for students who received a *C* in the calculus course. Moreover, students who received a failing grade in the calculus course still passed the physics course at a rate of 60%. The question raised by these data is whether taking Mathematics 408C is merely helpful or nearly essential for completing Physics 303K successfully.

Table 6
Grades Received in Physics 303K by Students Retaking the Course in Spring 1997 after Failing to Complete It Successfully in Fall 1996

	Spring 1997 Grade									
	A	*B*	*C*	*D*	*F*	*Q*	*X*	*W*		
Status	Pass			Fail					Pass Ratio	Pass Rate
Fall 1996 Grade										
D (N*=21)	0	3	3	0	0	0	0	1	6/7	86%
F (N=25)	0	1	3	2	2	1	0	0	4/9	44%
Q (N=33)	1	1	4	1	1	0	0	0	6/8	75%
W (N=9)	0	0	1	0	0	0	1	0	1/2	50%
Total	1	5	11	3	3	1	1	1	17/26	65%

* N indicates the total number of students who received the grade in fall 1996

Table 7
Comparison by Gender of the Pass Rates for Students Enrolled in Physics 303K during the 1996-97 Academic Year

	Course Performance						
	Pass (*A*, *B*, *C*, or *CR*)		Fail (*D* or *F*)		Other (*Q*, *X*, *O*, or *W*)		
Gender	Number	Percentage	Number	Percentage	Number	Percentage	N Total
Male	606	80.9	75	10.0	68	9.1	749
Female	139	81.8	16	9.4	15	8.8	170
N Total	745		91		83		919

Table 8
Comparison by Ethnicity of the Pass Rates and Grades Received for Students Enrolled in Physics 303K during the 1996-97 Academic Year

	Course Performance						
	Pass (*A*, *B*, *C*, or *CR*)		Fail (*D* or *F*)		Other (*Q*, *X*, *O*, or *W*)		
Ethnicity	Number	Percentage	Number	Percentage	Number	Percentage	N Total
Asian American	157	84.4	15	8.1	14	7.5	186
American Indian	5	83.3	0	0.0	1	16.7	6
International	34	82.9	2	4.9	5	12.2	41
White	435	82.5	47	8.9	45	8.5	527
Hispanic	102	72.9	21	15.0	17	12.1	140
Black	12	63.2	6	31.6	1	5.3	19
N Total	745		91		83		919

Table 9
Relationship between Grade Received in Mathematics 408C and Performance in Physics 303K during the 1996-97 Academic Year

	Performance in Physics 303K						
	Pass (*A*, *B*, *C*, or *CR*)		Fail (*D* or *F*)		Other (*Q*, *X*, *O*, or *W*)		
M 408C Grade	Number	Percentage	Number	Percentage	Number	Percentage	
A	234	91.4	12	4.7	10	3.9	256
B	156	82.1	22	11.6	12	6.3	190
C	122	73.9	22	13.3	21	12.7	165
D	17	70.8	3	12.5	4	16.7	24
F	3	60.0	1	20.0	1	20.0	5
CR	16	84.2	3	15.8	0	0.0	19
Not Completed	3	50.0	2	33.3	1	16.7	6
Total	551		65		49		665

A relationship was also found between students' performances in Physics 303K and their academic profiles as indicated by three available measures: their UT Austin grade point averages (GPA) and their scores on the verbal and quantitative subsections of the Scholastic Achievement Test (SAT). For the group of students who passed Physics 303K, the mean UT Austin grade point averages and mean SAT scores were markedly higher than for the groups of students who either failed the physics course or failed to complete it, as shown in Table 10. The difference in mean GPAs was three-quarters of a grade point—the equivalent of the difference between a *C+* and a *B*—and the differences in mean SAT scores was at least 25 points for the verbal section and 36 points for the quantitative section.

The Relationship between In-Course Student Performance Indicators and Achievement in Physics 303K

In-course performance information about the students enrolled in Physics 303K in the fall 1996 semester was obtained. The data consisted of each student's mid-course average for two quizzes (for all four class sections) and each student's attendance rates for lectures and recitation sessions (for three of the four class sections).

Relationship between Students' Performances at the Middle and at the End of the Semester

Using the quiz score data, it was possible to investigate whether a relationship existed between students' performances at mid-semester and their final grades in the course. A measure of mid-semester performance was defined as the mean of the first two quiz grades, with a mean quiz grade of 69.5 or higher considered "passing" and lower mean quiz grades considered "failing." As indicated in Table 11, it was found that virtually all students who were passing at mid-semester received a passing final grade, while

Table 10
Relationship between Three Academic Profile Indicators and Performance in Physics 303K during the 1996-97 Academic Year

	Performance in Physics 303K					
	Pass (*A*, *B*, *C*, or *CR*)		Fail (*D* or *F*)		Other (*Q*, *X*, *O*, or *W*)	
Indicator	Mean	Stan. Dev.	Mean	Stan. Dev.	Mean	Stan. Dev.
UT Austin GPA	3.15	0.65	2.40	0.69	2.54	0.79
SAT Verbal	561.6	97.4	536.6	104.1	489.0	89.5
SAT Quantitative	661.9	68.4	625.5	69.9	629.2	69.1

Table 11
Relationship between Mid-Semester Performance and End-of-Course Performance in Physics 303K during the 1996-97 Academic Year

	End of Course Performance in Physics 303K						
	Pass (*A*, *B*, *C*, or *CR*)		Fail (*D* or *F*)		Other (*Q*, *X*, *O*, or *W*)		
Mid-Semester Performance in Physics 303K	Number	Percentage of Row Total	Number	Percentage of Row Total	Number	Percentage of Row Total	Row Total
Passing	181	98.9	1	0.6	1	0.6	183
Failing	157	65.7	46	19.3	36	15.1	239
Total	338		47		37		422

approximately two-thirds of the students who were failing at mid-semester nevertheless received a passing final grade. Only 15% of the students failing at mid-semester withdrew from the class.

Information about a student's mid-semester academic standing would appear to provide useful information about the probability of a student completing Physics 303K successfully, while also suggesting that a failing student's fate is not sealed at that point in the course.

Relationship between Students' Attendance at Lectures and Recitation Sessions and End-of-Course Performance

Using the lecture and recitation session attendance data, it was possible to investigate whether a relationship existed between attendance rates and students' final grades in the course.

It was found that nearly half of the students who passed Physics 303K attended at least three-fourths of the lectures, while less than one-fifth of the students who failed and less than one-third of the students who withdrew did so. Conversely, only 17% of the students who passed only attended at most one-fourth of the lectures, while half of the students who failed and more than one-third of the students who withdrew did so. Table 12 shows the full breakdown of students' attendance patterns for the lectures.

It was found that nearly one-third of the students who passed Physics 303K attended at least three-fourths of the recitation sessions, while slightly more than one-tenth each of the students who failed and of the students who withdrew did so. Conversely, only one-third of the students who passed only attended at most one-fourth of the recitation sessions, while more than two-thirds of the students who failed and nearly 60% of the students who withdrew did so. Table 13 shows the full breakdown of students' attendance patterns for the recitation sessions.

Student Responses to Survey Questions Concerning Possible Factors Affecting Achievement in Physics 303K

Summary of Student Survey Responses

Near the end of the fall 1996 semester, MEC staff interviewed three students enrolled in Physics 303K with majors in mechanical, electrical, and civil engineering. The students made observations concerning faculty assumptions, grading policy, class size and pace, lecture content, and prerequisites:

- They suggested that professors' assumptions about students' prior knowledge are too ambitious;
- They expressed frustration that partial credit is not awarded for examination problems;
- They said that classes were too large and fast-paced for them to ask questions;
- They said students would benefit from more examples being used during lectures in order to provide practice at problem-solving;
- They endorsed taking the general engineering course to be better prepared for Physics 303K

A summary of the students' responses to nine questions follows.

Question: What if anything made the class or lecture too difficult?

The students said that their professors assumed of them too much prior knowledge. One example offered was the case of a professor who used differential equations to solve problems in class, though many of the students hadn't yet studied them. Another example given was the case of a professor who used unit vector notation without explaining what it is. Students said professors were assuming that they knew or could recall more than they actually did or could, and that a brief review of concepts from previous classes would have been helpful.

Question: What was frustrating or confusing to you?

Students said they were frustrated that no partial credit was given on exams. They regretted that, even when they felt they could do the problems, "one little mistake" not

Table 12
Relationship between Attendance Patterns of Students at Course Lectures and End-of-Course Performance in Physics 303K in the Fall 1996 Semester

	Performance in Physics 303K*						
	Pass (*A*, *B*, *C*, or *CR*)		Fail (*D* or *F*)		Other (*Q*, *X*, *O*, or *W*)		
Percent of Lectures Attended	Number	Percentage	Number	Percentage	Number	Percentage	Total
76-100	117	49.4	5	19.2	9	29.0	131
51-75	26	11.0	2	7.7	3	9.7	31
26-50	53	22.4	6	23.1	7	22.6	66
0-25	41	17.3	13	50.0	12	38.7	66
Total	237	100.0	26	100.0	31	100.0	294

* Data for 3 out of 4 sections of students enrolled during the fall 1996 semester

Table 13
Relationship between Attendance Patterns of Students at Course Recitation Sessions and End-of-Course Performance in Physics 303K in the Fall 1996 Semester

	Performance in Physics 303K*						
	Pass (*A*, *B*, *C*, or *CR*)		Fail (*D* or *F*)		Other (*Q*, *X*, *O*, or *W*)		
Percent of Recitation Sessions Attended	Number	Percentage	Number	Percentage	Number	Percentage	Total
76-100	78	32.9	3	11.5	4	12.9	85
51-75	40	16.9	2	7.7	3	9.7	45
26-50	35	14.8	3	11.6	6	19.4	44
0-25	84	35.4	18	69.2	18	58.1	120
Total	237	100.0	26	100.0	31	100.0	294

* Data for 3 out of 4 sections of students enrolled during the fall 1996 semester

only rendered the problem incorrect, but brought upon them additional penalty because of the "correction for guessing."

One student expressed frustration over an exam that, in place of providing a figure, offered an unclear description of a figure. He said he knew of only one student who completed the item correctly.

Another student expressed frustration that lecture content was not represented in the test content; he characterized the problems solved in the lecture as much easier than those on the exam.

Question: Why didn't you ask more questions in class?

Students said that the class was too large and fast-paced for them to do so.

Question: What would help you do better in this class?

Students repeatedly expressed a need for more practice at problem solving. They said they would have liked the professors to have included more examples in their lectures. They said that a professor they felt had been effective was one who had made additional practice problems (with answers) available to them, and they also said they liked how this professor took care to stop and go over a concept if he thought the class didn't understand it. The students mentioned again that they found the problems given in class to be much easier than problems on tests.

Question: Did the recitation sessions help?

Students said that the recitation sessions did help somewhat in giving them more practice at solving problems.

Question: What other ways did you get help in the class?

Students said that forming study groups—done on their own—helped them prepare for the exam.

Question: What would better help you prepare for this class?

The students said that the general engineering course really helped better prepare them for Physics 303K (one student was currently enrolled in the course). They said that the course made them much better equipped to solve homework problems. One student thought "class talk" helped.

Question: Is there a critical point or time in the semester
when students may stop trying and give up?

The students said that some students may give up on the class and stop trying at about mid-semester; they guessed that such disillusionment may set in during the second or third test. This response, in part, was the impetus for the investigation described above and summarized in Table 11 of whether a relationship existed between students' mid-semester and end-of-semester performances. The finding that two-thirds of the students who were failing at mid-semester nevertheless passed Physics 303K, and that only 15% of those students withdrew from the course, may indicate that students are not so easily discouraged as this response might suggest.

Question: If you could change the class, what would you do?

The students said they would slow the class down and provide more relevant examples during lectures.

The Relationship between Prior Preparation and Performance in Physics 303K: The Role of the General Engineering Course and General Academic Readiness as Indicated by SAT Quantitative Scores and UT Austin GPA

It was possible to evaluate the usefulness of the implied suggestion by the students in their interview responses that students enroll concurrently in the general engineering course while they studied Physics 303K. General Engineering 208K, Supplemental Instruction for Physics 303K, is restricted to engineering students, yet may not be counted toward any engineering degree. Its prerequisite is concurrent enrollment in Physics 303K.

Out of the 430 students in four sections of Physics 303K in the fall 1996 semester, 52 were concurrently enrolled in two sections of General Engineering 208K. Out of the 517 students in five sections of Physics 303K in the spring 1997 semester, 84 were concurrently enrolled in General Engineering 208K.

Compared to fall 1996 Physics 303K students who were not enrolled in the general engineering (GE) class, the fall 1996 Physics 303K students who were enrolled in the GE class had a lower mean SAT quantitative score (654 vs. 620) and UT Austin GPA (3.00 vs. 2.67), a difference that is statistically significant. However, there are no statistically significant differences on these variables between the GE and non-GE students during the spring 1997 semester: the mean SAT quantitative score for the non-GE students was 660 compared to 648 for the GE students, and the mean UT Austin GPA for the non-GE students was 3.03 compared to 3.00 for the GE students.

Simple t-tests comparing the mean grade in Physics 303K for the GE and non-GE groups showed no statistically significant difference for either semester. The average grade in Physics 303K for the fall GE group was 2.51, and for the non-GE group it was 2.62. The average grade in Physics 303K for the spring GE group was 2.87, and for the non-GE group it was 2.66. Comparison of the mean grades in Physics 303K is confounded by the differences between the GE and non-GE groups in SAT quantitative scores and UT Austin GPA. The SAT quantitative scores and UT Austin GPAs correlate 0.33 and 0.53, respectively, with grades in Physics 303K. Because the students who were enrolled in the GE class had slightly lower SAT quantitative scores and UT Austin GPAs, one would not expect them to have higher grades in Physics 303K than the non-GE group, even if the GE class had improved their performance in Physics 303K.

In order to compare the grades in Physics 303K between the GE and non-GE groups controlling for the relationship between SAT quantitative score, UT Austin GPA, and Physics 303K grade, an analysis of covariance using SAT quantitative score and UT Austin GPA as covariates was performed on the data for the two semesters combined. This analysis yielded a statistically significant difference ($p = 0.0013$) between the Physics 303K grades of the GE and non-GE groups. Specifically, given two students with equal UT Austin GPAs and SAT quantitative scores, the student who takes the GE class is predicted to receive a Physics 303K grade that is three-tenths of a grade point higher (on a 0 to 4 grade scale) than the student who does not take the GE class. This is a difference of just under one-third of a letter grade.

For this analysis of covariance it was necessary to use the restriction that the difference in predicted grade in Physics 303K between the GE and non-GE groups be assumed to be the same at all levels of GPA and SAT quantitative scores. A less restrictive model suggests that there was an interaction between SAT score and the effect of the GE class on grade on Physics 303K ($t = 1.814$, $df = 1$, $p = 0.07$). That is, the difference in grades in Physics 303K between the GE and non-GE groups varied at different levels of SAT score. The table below shows the predicted grade in Physics 303K at levels of GPA ranging from 2.00 to 4.00 in increments of 0.25, and levels of SAT quantitative score ranging from 400 to 750 in increments of 50 for the GE and non-GE groups.

As shown in Table 14, when GPA is held constant, the difference in predicted grade in Physics 303K between the GE and non-GE groups varies according to the level of SAT score, becoming smaller as SAT score increases. For example, the predicted grade in Physics 303K for a GE student with a GPA of 3.00 and an SAT score of 400 is 2.87, whereas the predicted grade for a non-GE student is 2.01, a difference of 0.86. However, for the same GPA but with an SAT score of 750, the GE and non-GE predicted grades are 2.83 and 2.80 respectively, a difference of 0.03.

Also, at any fixed level of GPA, there is essentially no difference in predicted Physics 303K grade for a GE student as SAT score increases, while there are substantial increases in predicted grade for a non-GE student as SAT score increases. This pattern of predicted grades suggests that the GE course makes little or no difference for students with high SAT quantitative scores, but for students with low SAT scores the GE course enables them to “make up” for their low SAT scores with respect to their grade in Physics 303K.

Students’ Attitudes Toward Physics 303K as Indicated by Student Responses to the Course Instructor Survey, Spring 1994 through Fall 1996

Common Form Survey Results

Student responses to the five course-instructor survey Common Form items were aggregated over instructors for each of the long semesters since spring 1994, as shown in Table 15 and Figure 1. The trend over the six semesters has been ratings indicating increasing satisfaction, as reflected by general ratings growth in each of the five areas addressed by the Common Form items: course organization, instructors’ communication skills, instructors’ skill in prompting independent thinking, instructors’ effectiveness, and overall course satisfaction.

The mean ratings for each item for the most recent semester available, fall 1996, are by far the highest of any semester means during the six-semester period. In view of the six-semester trend, it could be asked whether these markedly higher mean ratings reflect a significantly improved experience for students in Physics 303K or simply an anomaly. Mean ratings for spring 1997 could provide evidence to answer the question.

What the ratings could be expected to be for spring 1997—which would complete a single academic year pair of long semester ratings—could be considered in light of the six-semester trend. Item by item, little variation is evident in the ratings for semester pairs

Table 14
Comparison of Predicted Grades in Physics 303K by UT Austin Grade Point Average and by SAT Quantitative Score for Students Who Took General Engineering versus Students Who Did Not Take General Engineering, Fall Semester 1996

	GE	SAT Quantitative Score							
UT GPA	Status*	400	450	500	550	600	650	700	750
2.00	No	1.26	1.38	1.49	1.60	1.72	1.83	1.94	2.06
2.00	Yes	2.13	2.12	2.12	2.11	2.11	2.10	2.10	2.09
2.25	No	1.45	1.56	1.68	1.79	1.90	2.01	2.13	2.24
2.25	Yes	2.31	2.31	2.30	2.30	2.29	2.29	2.28	2.28
2.50	No	1.64	1.75	1.86	1.97	2.09	2.20	2.31	2.43
2.50	Yes	2.50	2.49	2.49	2.48	2.48	2.47	2.47	2.46
2.75	No	1.82	1.93	2.05	2.16	2.27	2.39	2.50	2.61
2.75	Yes	2.69	2.68	2.68	2.67	2.66	2.66	2.65	2.65
3.00	No	2.01	2.12	2.23	2.34	2.46	2.57	2.68	2.80
3.00	Yes	2.87	2.87	2.86	2.86	2.85	2.85	2.84	2.83
3.25	No	2.19	2.30	2.42	2.53	2.64	2.76	2.87	2.98
3.25	Yes	3.06	3.05	3.05	3.04	3.04	3.03	3.03	3.02
3.50	No	2.38	2.49	2.60	2.72	2.83	2.94	3.05	3.17
3.50	Yes	3.24	3.24	3.23	3.23	3.22	3.22	3.21	3.21
3.75	No	2.56	2.68	2.79	2.90	3.01	3.13	3.24	3.35
3.75	Yes	3.43	3.42	3.42	3.41	3.41	3.40	3.40	3.39
4.00	No	2.75	2.86	2.97	3.09	3.20	3.31	3.43	3.54
4.00	Yes	3.61	3.61	3.60	3.60	3.59	3.59	3.58	3.58

* “No” indicates that students did not take General Engineering (GE) 208K; “Yes” indicates that students did take General Engineering 208K.

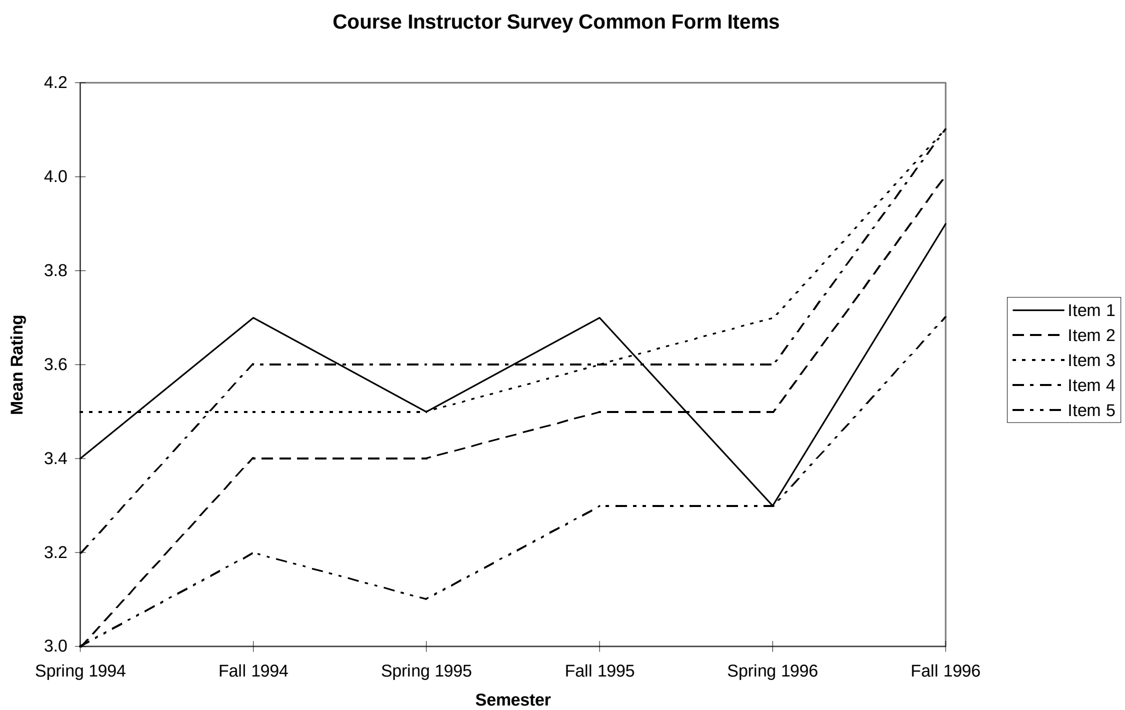
that correspond to a single academic year (fall 1994 and spring 1995; fall 1995 and spring 1996). Ratings are the same or within 0.1 point of each other in 8 of 10 possible cases, the only exceptions being a drop in mean rating in both academic years for the course organization item: the decrease was 0.2 from fall 1994 to spring 1995 and 0.4 from fall 1995 to spring 1996. In view of this, it could be asked whether the uncharacteristically large increases in mean ratings from spring 1996 to fall 1996 would be sustained into spring 1997.

Table 15
Course Instructor Survey (CIS) Results for Physics 303K:
Five-Item Common Form Mean Ratings for the Most Recent Six Long Semesters,
Spring 1994 through Fall 1996

	Semester					
CIS Common Form Item*	Spring 1994	Fall 1994	Spring 1995	Fall 1995	Spring 1996	Fall 1996
The organization of the course was . . .	3.4	3.7	3.5	3.7	3.3	3.9
The instructor's skill in communicating information effectively was . . .	3.0	3.4	3.4	3.5	3.5	4.0
The instructor's skill in helping me think for myself in this course was . . .	3.5	3.5	3.5	3.6	3.7	4.1
Overall, this instructor was . . .	3.2	3.6	3.6	3.6	3.6	4.1
Overall, this course was . . .	3.0	3.2	3.1	3.3	3.3	3.7

*The available rating options (and the scale value for each) for completing each item were "very unsatisfactory" (1 point), "unsatisfactory" (2 points), "satisfactory" (3 points), "very good" (4 points), and "excellent" (5 points).

Figure 1
Six-Semester Trends for Mean Ratings from the Five-Item Course Instructor Survey Common Form, Spring 1994 through Fall 1996



Summary and Recommendations

The purpose of this study was to investigate why an unacceptably large proportion of students “fail” Physics 303K, that is, fail to receive a grade of at least *C* and satisfy the prerequisite for enrolling in Physics 303L. In order to identify possible correlates of student performance in Physics 303K, demographic, academic, and attitudinal data were obtained for students enrolled in Physics 303K during the 1996-97 academic year.

Pass Rates

For the 1996-97 academic year, the proportion of students who failed Physics 303K—that is, who did not receive a final course grade of *A, B, or C*—was approximately one-fifth of those who initially enrolled in the class. Among those students who failed, approximately half received grades of *D* or *F*, while the rest simply did not complete the class, as indicated by grades of *Q, X, O, or W*. Among those students who failed during the fall semester, approximately one-third enrolled in the course again in the spring semester, with the majority of those who had received a grade of *D* or *Q* (drop)–but less than half of those who had received a grade of *F*–successfully completing the course in the spring semester.

By gender virtually no difference was found in the pass rates, but by ethnicity differences were found: the pass rates for Hispanic students and African American students were, respectively, approximately 10 and 20 percentage points lower than those for Asian American, American Indian, International, and white students.

Correlates of Final Course Grade in Physics 303K

An examination of the relationship between performance in Physics 303K and prior measures of academic achievement indicated that five measures were positively related to final course grade in Physics 303K: UT Austin grade point average (GPA), mean SAT score, final course grade in Mathematics 408C (Differential and Integral Calculus), mid-semester performance, and attendance at lecture and recitation sessions.

Students who passed Physics 303K had substantially higher mean UT Austin grade point averages (GPAs) and higher mean SAT scores than those students who did not pass the course, and better-performing students in Physics 303K tended to have performed better in Mathematics 408C. Students who received grades of *A* or *B* in Mathematics 408C passed Physics 303K at a high rate, but students who received a *C* in Mathematics 408C passed Physics 303K at a rate more nearly similar to the pass rate of students who received a *D* in M 408C than to that of students who received a *B*.

A relationship was also found between mid-semester performance and final grade in the course. Virtually all students who were passing the course at mid-semester received a passing final grade in the course, while approximately two-thirds of the students who were failing at mid-semester passed the course. While the majority of the students who were failing the course at mid-semester received a passing grade in the course, information about a student’s standing at mid-semester could be used to identify those students who are at risk of failing the course and who might benefit from some type of remediation.

Students who passed Physics 303K also tended to be present at more lecture and recitation sessions than those students who failed the course. While a relationship between session attendance and performance in the class was found in this study, the direction of the relationship between attendance and performance in the course could not be determined. Further investigation of the effect of class attendance on performance in physics could be undertaken if more accurate attendance records were maintained.

Student Interview Data

Interviews with students revealed that they held six general impressions about their experiences in the course:

- professors assumed of them too much prior knowledge;
- classes were too large and fast-paced for them to ask questions;
- not receiving partial credit on exams items was frustrating;
- problems on tests were more difficult than those on the homework;
- additional practice at problem-solving would have been desirable;
- the general engineering course was especially helpful to their performance in Physics 303K.

The students' claim about the usefulness of the general engineering course for performance in Physics 303K was investigated. It was found that, when UT Austin GPA was held constant, students with lower SAT scores who were concurrently enrolled in the general engineering (GE) course received substantially higher predicted grades in Physics 303K than students with identical SAT scores who did not take the general engineering course. Additionally, when UT GPA was held constant, students with lower SAT scores who were concurrently enrolled in the GE course had predicted grades in Physics 303K that were virtually identical to those students with high SAT scores. This suggests that the GE course may, for the lower SAT group, compensate for missing skills indicated by those lower scores, by providing those skills important to performing well in Physics 303K. Because the GE course may be helpful in improving student performance, it may be desirable to identify the skills provided by the course that appear to be most helpful to students, and incorporate instruction in those skills into the Physics 303K course and/or recitation sessions if possible.

Fall 1996 Common Form mean instructor ratings from the Course-Instructor Survey were substantially higher than those in previous semesters. Considered in light of the higher than expected pass rate for the 1996-97 academic year, these ratings may indicate both a generally increased level of student satisfaction as well as better student course performance as compared with previous semesters. To investigate whether these higher ratings could indicate a trend or an aberration, mean instructor ratings could be obtained for the spring 1997 semester to examine whether the level of satisfaction with the course was maintained.

Recommendations for Future Research

The results of this study provide no clear-cut answer to the question, "Why do students fail Physics 303K?" However, several course performance correlates were identified that may be helpful for indicating how to improve students' performances in Physics 303K.

Three correlates suggest useful strategies for improving student performance in the short term: the effects of attendance at lecture and recitation sessions, of taking the GE course concurrently with Physics 303K, and of students' self-reported need for additional problem-solving practice. It would seem advisable to strongly encourage that students attend both the lecture and recitation sessions. It would also be desirable to identify those aspects of the general engineering course that are most helpful to students, and try to incorporate them into the Physics 303K curriculum. And providing more practice at problem solving for students may be helpful, such as by providing additional problems (with their solutions) on the Web.

Three correlates suggest useful strategies for identifying students at risk for poor or failing performance in Physics 303K: mid-semester evaluations, UT Austin GPA, and SAT score. While the mid-semester measure would be useful for identifying students having difficulty in the course, it would be most beneficial to use the two academic measures—SAT score and UT Austin GPA—to identify even earlier students who may have difficulty with Physics 303K, prior to the beginning of the course. In addition, students could be assessed during orientation using other measures that are related to performance in physics, measures of such constructs as general math skill, reasoning ability, and graphical interpretation. Together with SAT scores, these measures could be used to better identify those students who would most likely benefit from some type of remediation.

Appendix

Annotated Bibliography

Wollman, W. & Lawrenz, F. (1984). Identifying potential "dropouts" from college physics classes. *Journal of Research in Science Teaching*, 21(4), 385-390.

The study examined whether students who have difficulty with physics (including those who dropped out) could be identified using a mathematics pretest and records of past performance (total GPA, ACT scores, and high school rank). Four-hundred eighty-three students enrolled in an introductory non-calculus physics course participated in the study. A 13-item mathematics test containing eight mechanical skill items and five reasoning items was administered as a pretest.

The correlation between the mathematics pretest and physics achievement for students who completed the course was .461. A step-wise multiple regression on GPA, ACT scores, and the mathematics pretest score for students who completed the course yielded an R^2 of .569, with GPA being the most significant predictor (R^2 = .486). For the dropouts, the math pretest and GPA yielded a low, nonsignifcant correlation (R^2= .042). The reasoning portion of the mathematics pretest for the dropouts had a correlation of -.13 with achievement.

The authors reported the results of the following discriminant function analyses: 1) classifying *A*s, *B*s, and *C*s (72.7% correctly identified) vs. *D*s, *F*s, and dropouts (55.6% correctly identified), 2) classifying *A*s and *B*s (74.5% correctly identified) vs. dropouts (87.9% correctly identified), and 3) classifying *As* and *Bs* (56.1% correctly identified) vs. *C*s, *D*s, *F*s, and dropouts (97.5% correctly identified). The authors concluded that mathematical reasoning items, despite the emphasis on reasoning in the course, were not useful in predicting dropouts but that these items were useful in a discriminant analysis to predict students who would earn a *C* or lower in the course.

Hudson, H. T. (1986). A comparison of cognitive skills between completes and dropouts in a college physics course. *Journal of Research in Science Teaching*, 23(1), 41-50.

The purpose of the study was to examine whether performance on reasoning and problem-solving skills tests could be used to distinguish between students who successfully completed a physics course and those who dropped out. One-hundred and fifty-two students in a first-semester physics course completed three instruments during the first week of class: a 31-item mathematics skills test (KR = .87), an "eight-question test of proportions involving both direct and indirect ratios" (KR = .59), and an 11-item test with general word problems and problems that required the "translation of symbols to words and words to symbols" (KR = .48). Student performance was defined as first course examination score. For students who exercised the option of retaking the first examination, the first course examination score recorded was the second score if it was higher, or the average of both tests if the second score was lower.

Students who dropped the course had similar scores on the pretest measures as students who completed the course. Results indicated that students who completed the course had slightly negative correlations between their math and reasoning scores, while students who dropped the course had significant positive correlations between math scores and reasoning scores. The authors suggest that students who complete the course "appear to have skills for solving the reasoning questions that are independent of the skills used in purely mechanical mathematical operations," while "the dropouts appear to have highly overlapping cognitive processes as applied to the same types of problems."

Hudson, H. T. & Rottman, R. M. (1981). Correlation between performance in physics and prior mathematics knowledge. *Journal of Research in Science Teaching*, 18(4), 291-294.

The purpose of this study was to examine the relationship between prior mathematics knowledge and grade in an introductory physics course. On the first day of class, a 28-item test covering 14 topics from algebra and geometry was administered to 1,403 students in a pre-professional physics course. At the end of the semester, the math pretest was correlated with overall performance in the class. For students who dropped the course, the math pretest was correlated with their performance at the time they dropped the course. The correlation between math pretest score and grade for the students who dropped the course was .232, while for those who completed the course the correlation between math pretest and final course grade was .418. The authors concluded that a measure of students' level of mathematics skill is a reasonable predictor of final grade for students who complete the course, but is not a good predictor of students who will drop the course.

McCammon, S., Golden, J. & Wuensch, K. L. (1988). Predicting course performance in freshman and sophomore physics courses: women are more predictable than men. *Journal of Research in Science Teaching*, 25(6), 501-510.

The purpose of this study was to assess the role of critical thinking skills and mathematics skills in the performance of freshman and sophomore science majors in physics courses. Two-hundred and six science majors enrolled in either an introductory physics and engineering course, a general physics course, or an advanced general physics course were included in the study.

Cognitive skills were measured by means of the Watson-Glasser Critical Thinking Appraisal (CT) and the Primary Mental Abilities Test (PMA). The CT instrument is designed to measure five critical thinking skills: inference, recognition of assumptions, deduction, interpretation, and evaluation of arguments (test-retest reliability = .73, alternate forms reliability = .75). The PMA instrument is designed to measure five basic factors of intelligence: verbal meaning, number facility, reasoning, perceptual speed, and spatial relations (test retest reliability = .84 at a one-week interval, .87 at a four-week interval).

Mathematical competence was measured by means of an anxiety scale and two mathematical skills tests. The Mathematics Anxiety Rating Scale (MARS) was used "as a screening diagnostic scale to measure the anxiety associated with the manipulation of numbers and the use of mathematical concepts" (test-retest reliability = .78-.85). The

Arithmetic Skills Test (ARI) was designed to measure students' competence in operations with whole numbers, operations with fractions, operations with decimals and percentages, and applications involving computation (reliability = .87). The Elementary Algebra Skills Test (ALG) was used to measure three basic skills in algebra: operations with real numbers, operations with algebraic expressions, and solutions of equations, inequalities and word problems (reliability = .91).

All tests were administered in the first four weeks of the semester, and scores were correlated with final course grade. The multiple correlation between all five predictor variables and final course grade was .40. Semipartial correlations yielded only two significant variables, ALG and CT. When the results were analyzed by gender, it was found that the predictor variables were successful in predicting the performance of women but not of men.

Griffith, W. T. (1984). Factors affecting performance in introductory physics courses. *American Journal of Physics,* 53(9), 839-842.

The purpose of this study was to determine the effect of formal reasoning and mathematics knowledge on student performance in an introductory physics course. Three predictor variables were used in the study: scores from the Science Logic Test (SLT), scores from a mathematics pre-test (MPT), and total points earned on homework (HW). The SLT is a 12-item instrument intended to measure a variety of reasoning abilities identified by Piaget as components of formal thinking. The MPT is a 12-item test on algebra skills, including the manipulation of exponents, inequalities, logarithms, and trigonometric functions. Also included in the study was a total test variable (TT) that was the sum of the exam scores over the semester.

Students from a two-semester introductory physics (non-calculus) course and a two-semester general physics (calculus-based) course were included in the study. The TT variable was separated into two scores: total points from qualitative items (QT) and total points from traditional physics problem items (PT). Qualitative items required explaining physical concepts, interpreting graphical information, and predicting physical effects in qualitative terms.

Results indicated that the SLT accounted for 11% to 23% of total variance for the four courses after math pretest and homework scores were accounted for. With QT as the criterion variable, SLT accounted for 13% to 39% of variance. For the first semester Physics course (Physics 1), SLT accounted for the most variance in the dependent variables TT and QT, 23% and 39 % respectively. The Mathematics pretest was a better predictor for PT than for QT, but only accounted for 6% of unique variance. The authors concluded that the SLT is an important predictor of overall performance in introductory physics, but because it is negatively correlated with study effort (as measured by homework score), the importance of the SLT in predicting performance may be obscured unless study effort is controlled for.

Deboer, G. E. (1985). Characteristics of male and female students who experienced success or failure in their first college science course. *Journal of Research in Science Teaching*, 22(2), 153-162.

The purpose of this study was to identify correlates of success for male and female students in their first college science course, using a sample of 91 freshman students. Students completed the Omnibus Personality Inventory and the Personal Values Inventory prior to taking the course. The Omnibus Personality Inventory contains 2 subscales: Thinking Introversion, which measures preference for reflective thought, and Theoretical Orientation, which measures a preference for scientific activities, such as problem solving, analysis, and conducting original research. The Personal Values Inventory contains 3 subscales: Hardworking/Persistent, which measures students' belief that they are perceived as hard workers by parents, teachers, and friends; Reckless/Rash, which measures students' involvement in risk-taking and thrill-seeking activities; and Future Orientation, which measures students' ability to plan and the value they place in planning. Results from a factorial ANOVA indicated there was a significant difference for gender and theoretical orientation: women who were enrolled in science showed less preference for problem solving, analyzing, and conducting original research. Measures of persistence, rashness, and future orientation were strong predictors of performance for women but not for men.

Hackett, G., Casas, J. M., Betx, N. E., & Rocha-Singh, I. A. (1992). Gender, ethnicity, and social cognitive factors predicting the academic achievement of students in engineering. *Journal of Counseling Psychology*, 39(4), 527-538.

The purpose of the study was to examine "the relationship of measures of occupational and academic self-efficacy, vocational interests, outcome expectations, academic ability, and perceived stress, support, and coping to the academic achievement of men and women enrolled in university-level engineering/science programs." Subjects consisted of 197 first-and second-year engineering students. Occupational self-efficacy is defined as students' belief that they can successfully complete the educational requirements for various science and engineering occupations, while academic self-efficacy is defined as students' confidence in their ability to complete the requirements in the engineering program.

Students' response options on a self-efficacy measure ranged from no confidence at all (0) to complete confidence (9). Cronbach's alpha for the two scales was .95. Additionally, students were assessed in their interest in specific engineering occupations, outcome expectations for successfully completing an undergraduate degree in engineering, stress, strain, coping, support measures, and the perceptions of faculty support. A forward selection regression analysis on cumulative college GPA with four predictor measures (academic self-efficacy, SAT-math, faculty encouragement, and high school GPA) yielded an R^2 of .51. The researchers concluded that academic milestones self-efficacy and the presence (or absence) of faculty encouragement are important predictors of scholastic performance.

Lent, R. W., Brown, S. D., & Larkin, K. C. (1984). Relation of self-efficacy expectations to academic achievement and persistence. *Journal of Counseling Psychology*, 31(3), 356-362.

The purpose of this study was to investigate the relationship between self-efficacy (one's belief in his or her ability to successfully perform a task) and academic performance and persistence in scientific and engineering fields. Subjects consisted of 42 undergraduate students (28 male and 14 female). A self-efficacy questionnaire was administered on which students indicated the degree to which they believed they could successfully complete the educational requirements and job duties of 15 engineering and science fields. The questionnaire contained four scales of self efficacy: level (ER-L) and strength (ER-S) of self-efficacy for educational requirements, and level (JD-L) and strength (JD-S) of self-efficacy for actual job duties. Preliminary Scholastic Aptitude Test (PSAT) scores, high school rank, college grades, and declared major were obtained to examine the relationships among self-efficacy, academic aptitude, and scholastic performance. The researchers found that the correlation of ER-L and ER-S scores with PSAT scores were $r = .41$ and $r = .53$ respectively, and with high school ranks were $r = .38$ and $r = .37$ respectively.

Lent, R. W., Brown, S. B., & Larkin, K. C. (1986). Self-efficacy in the prediction of academic performance and perceived career options. *Journal of Counseling Psychology*, 33(3), 265-269.

This study was designed to explore whether the construct of self-efficacy could be used to predict academic success, persistence, and range of perceived career options in technical/scientific fields. Also used to predict academic success were high school rank (HSR), Preliminary Scholastic Aptitude Test (PSAT) scores, declared major, and college grades. Participants in the study were 105 students enrolled in a 10-week planning course for undergraduate students who were considering a major in engineering or science.

The results indicated that subjects who scored higher on self-efficacy measures achieved higher grades and remained enrolled longer in the college of technology than did the low self-efficacy groups. Hierarchical regression analyses were conducted with grade point average in technical and science courses (TGPA) and the number of college quarters as completed in the college of technology (QTRS). Self-efficacy measures accounted for additional variance ($R^2 = .03\text{-}.08$) in predicting both TGPA and QTRS beyond math PSAT scores, high school rank, and interests.

Lent, R. W., Brown, S. D., & Larkin, K. C. (1987). Comparison of three theoretically derived variables in predicting career and academic behavior: self-efficacy, interest congruence, and consequence thanking. *Journal of counseling psychology*, 34(3), 293-298.

This study was similar to the study by Lent et al. (1986) designed to explore whether the construct of self-efficacy could be used to predict academic success, persistence, and range of perceived career options in technical/scientific fields, except that the relative prediction of interest congruence and consequence thinking on technical grades and persistence was also explored. The authors used the same sample of students as in their 1986 study. Results of the hierarchical regression showed that only self-efficacy accounted for unique variance in the prediction of technical grades (R^2 = .08) and persistence (R^2 = .11).

Brooks, J. H. & DuBois, D. L. (1995). Individual and environmental predictors of adjustment during the first year of college. *Journal of College Student Development*, 36(4), 347-360.

The purpose of this study was to examine predictors of academic and psychological adjustment during the first year of college study. Stepwise hierarchical multiple regression analyses were performed to assess the relative influence of a variety of variables (ACT scores, social support, occurrence and impact of stressful life events, problem-solving behaviors, self-esteem, psychological symptoms, and adjustment to college) on academic and psychological adjustment. Students' anticipated GPA for the semester was related to their ACT score (R^2 = .21) and satisfaction with social support received (R^2 = .10). Students' academic adjustment was related to both their ACT score and problem-solving behavior (R^2 = .30). Students' social adjustment was related to their age and family income (R^2 = .18), support satisfaction and distance from home (R^2 = .15), and personality characteristics of surgency/intellect (R^2 = .12). Students' personal/emotional adjustment was related to family income (R^2 = .26) and ACT score (R^2 = .24).

Betz, N. E. & Hackett, G. (1983). The relationship of mathematics self-efficacy expectations to the selection of science-based college majors. *Journal of Vocational Behavior*, 23, 329-345.

The purpose of this study was to examine whether mathematics self-efficacy was related to choosing a science-based major in college. Subjects consisted of 262 (109 male 159 female) undergraduate college students. The researchers examined the students' degree of mathematics self-efficacy, attitudes toward mathematics, and sex role orientation.

The self-efficacy variable was measured using the Mathematics Self-Efficacy Scale, a 52-item scale consisting of 18 items on math tasks, 16 items on math-related college courses, and 18 items on math problems.

The attitude variable was measured by asking students to rate their degree of confidence in performing the math task, in obtaining at least a grade of *B* in each class, or in solving the math problem. A revised version of The Fennema-Sherman scales was used, which contains five 10-item scales consisting of "math anxiety, confidence in learning mathematics, perceptions of the usefulness of math, perceptions of math as a male domain, and effectance motivation in math."

The sex-role orientation variable was measured using the Bem Sex Role Inventory to examine the relationship of sex roles to mathematics self-efficacy. Results indicated that mathematics self-efficacy was significantly related to choosing a science-based major in college. A multiple regression with the predictors of mathematics self-efficacy expectations, years of high school math, math anxiety, and sex yielded an R^2 of .62 (all predictors were significant). Males scored higher on mathematics self-efficacy measures than females.

Cohen, H. D., Hillman, D. F. & Agne, R. M. (1978) Cognitive level and college physics achievement. *American Journal of Physics*, 46(10), 1026-1029.

The purpose of this study was to examine the relationship of SAT scores and Piagetian tasks to achievement (as measured by final course grade) in physics. Subjects consisted of 195 students from introductory physics courses. The SAT mathematics score significantly correlated ($r = .389$) with final course grade. The relationship between Piagetian tasks and final course grade was nonsignificant ($F = .84$).

Cooper, S. E. & Robinson, D. A. G. (1988) Psychometric properties of the student adaption to college questionnaire with engineering and science students. *Measurement and Evaluation in Counseling and Development*, 21, 124-129.

The purpose of this study was to examine the role of the "freshman myth," which is defined by the authors as "the tendency of students entering college to have overly optimistic expectations about their upcoming experience." Subjects were 362 (161 male 38 female) students consisting primarily of engineering and science majors. The discrepancy between expected and actual adjustment for a group of engineering and science majors was examined. Results indicated that the students' expected adjustment was much higher than their actual adjustment. The discrepancy in perceived and actual adjustment was larger for the sample of engineering and science students in this study than for samples of students of different majors in other studies. The authors hypothesized that this may be due to the high demands of a technical program such as engineering and science.