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AUTHOR Goldstein, Jeffrey; High, Robert V.  
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ABSTRACT

This study examined the student characteristics, affective or cognitive, which predict academic success in undergraduate and graduate business statistics courses. The issue was found to be important because most business curricula require courses in business statistics and because both undergraduate and graduate students come to business programs with limited mathematics preparation. A survey instrument was developed containing a number of different affective and cognitive variables and allowing for a simple check-off indicating the range of response for the category. The survey was distributed to a total of six undergraduate introductory statistics sections, and six introductory graduate statistics sections. The final sample contained a total of 325 completed surveys from 174 undergraduates (50 percent male, 50 percent female) and 151 graduate students (60 percent male, 40 percent female). Analysis found that the cognitive variables of grade point average, mathematics Scholastic Aptitude Test score, and high school grade point average were significant determinants of success in statistics. The affective variables of whether or not the student postponed taking statistics and the predicted grade for the course were not found to be determinants of success in statistics. However, postponement was a more important factor for graduate students than for undergraduates. Included are two tables and four references. (JB)

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Identifying Cognitive and Affective Variables as they Relate to  
the Successful Completion of Business Statistics.

Robert V. High, Ph.D. & Jeffrey Goldstein, Ph.D.

Department of Administrative Sciences  
Schools of Business  
Adelphi University  
Garden City, New York 11530  
516-877-4674

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### Abstract

The purpose of the present study was to determine those variables which could be used to predict success in business statistics. A survey instrument was developed containing a number of different cognitive and affective variables and distributed to both undergraduate and graduate business students. The final sample consisted of  $N = 325$  completed surveys. It was found that GPA, Math SAT score, high school average, the respondent's self-predicted grade for the course, and whether or not the respondent had postponed taking statistics were all significant variables in predicting success in statistics.

Identifying Cognitive and Affective Variables as they Relate to the Successful Completion of Business Statistics.

Because of its widespread applicability, in the area of business, the study of basic statistical techniques is a required course for undergraduate business students, as well as for MBA students. Because both many undergraduate students have had little mathematical training in high school and many MBA students have limited exposure to mathematics courses in college, a large proportion of these students have a great deal of apprehension towards the subject matter, indeed, they tend to postpone taking statistics until the end of their program of studies.

To remedy the situation, many schools attempt to provide back-up support for students in statistics. However, the first step in any support program is to identify those students most in need of the help. The lack of a background in mathematics may indicate a possible need for extra help. In addition, the postponement by the student in taking statistics may indicate a belief on the student's part that he/she will need help. However, it has been found that other cognitive and affective variables can also be used to help identify those students most in need of support.

In an early study by Webb (1971), using a sample of 87 doctoral students in education, the relationship between several variables and course performance in a graduate education statistics course was examined. Feinberg and Halperin (1978) used a sample of 278 students from four sections of introductory statistics to determine which of a set of cognitive and affective variables correlates with course performance. The sample consisted of liberal arts majors along with some education and nursing majors. They found associations between a number of cognitive and affective variables and course performance. Additionally, they discovered gender differences; females not only reported poorer attitudes and lower expected grades, they actually received lower grades than their male counterparts in the statistics class.

More recently, in a paper presented at the annual meeting of the American Educational Research Association, Harvey, Plake and Wise (1985) found that mathematics background and ability, logical reasoning ability, attitude towards statistics, and anxiety all had a relationship to statistics achievement. They also found no differences related to gender or year (i.e. undergraduate vs. graduate). This study was conducted using 51 students in an introductory educational statistics course.

None of these studies was done with business students and two of them were done with low sample sizes. The purpose of the present study is to identify those cognitive and affective

variables that correlate with course performance in Business Statistics. Hopefully this will aid the business mathematics faculty to offer the students who need extra support when they take statistics. The study will examine both undergraduate students in sections of an introductory business statistics course, and will also examine attributes of graduate students in sections of an MBA introductory statistics course. Both undergraduate and graduate courses cover introductory material (probability concepts, interval estimation, hypothesis testing, chi-square distribution, ANOVA, simple and multiple correlation and regression). The undergraduate and graduate courses are taught separately, and usually by different faculty members.

It is hypothesized that several cognitive and affective variables will correlate with the final grade. Specifically it is hypothesized that:

(a) The GPA of the student will correlate positively with course performance, as measured by the final grade in the class.

(b) The Math SAT score of the student will correlate positively with course grade.

(c) The Average of high school mathematics courses will correlate positively with the final course grade.

(d) Joy of mathematics, as measured by the response to four questions concerning enjoyment of mathematics, will correlate positively with the final grade.

(e) The grade predicted by the student at the beginning of the course will also correlate positively with the final course grade.

It is further hypothesized that the pattern of correlations will be similar for both the undergraduate students and the graduate students. Further, based on many years of teaching experience, it is felt that there will be no gender differences in the analysis.

#### Method:

A survey instrument was developed (available upon request from the authors) containing a number of different affective and cognitive variables. The instrument allowed for a simple check-off indicating the range or category for the response. In addition, after being assured their responses had nothing to do with their grade in the class, the respondents were asked to supply the last four digits of their social security number so the responses could be compared to the final grade in the class (grades are posted by social security number).

The variables on the instrument that were thought to provide an insight into indentifying and predicting performance in statistics were:

1. Current Grade Point Average (GPA)
2. Mathematics SAT score (MATHSAT)
3. English SAT score (ENGSAT)
4. High school average for all Mathematics courses (AVERHS)

5. The most Advanced Math course taken in high school (ADVMATH)
6. Whether or not the taking of statistics has been postponed (recorded on a 5-point Likert-type scale ranging from strongly agree to strongly disagree) (POSTPONE)
7. How much the respondent has enjoyed mathematics. This item is the aggregate score of the responses to four individual statements answered on a 5-point scale ranging from strongly disagree to strongly agree. The statements were:
  - I enjoyed math in high school
  - I enjoyed math in college
  - I find math to be enjoyable
  - Math is something I enjoy very much(JOY)
8. The predicted grade for the class. (PREDICTED)

#### The Sample:

During the first two weeks of the Spring, 1991 and the Fall, 1991 semesters, the survey instrument was distributed to a total of six sections (three per semester) of introductory undergraduate business statistics. Additionally, another six sections (also three per semester) of introductory graduate (MBA) business statistics classes were surveyed. Both courses, while taught separately and by different faculty, are introductory courses covering essentially the same material. After excluding those surveys that contained missing items, lacked the last four digits of the social security number, or those that were completed by a student withdrawing within the

first three weeks of the semester, the final sample contained  $n = 325$  surveys with 174 on the undergraduate level and 151 on the graduate level. The sample was divided 50% / 50% between male and female undergraduate students and 60% / 40% between male and female graduate students.

#### Analysis:

Pearson Correlation Coefficients were calculated for the eight independent variables of interest in the study and the final grade achieved. The coefficients for the entire sample, for the undergraduate students, and for the graduate students, are contained in Table 1.

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INSERT TABLE 1

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The pattern of correlations for the undergraduate students and the graduate students was very similar. One difference was in the correlation between the predicted grade and the final grade. The undergraduates were better able to predict their grade (correlation of .23) than were the graduate students (correlation of .06). Additionally, the undergraduate students who did not postpone taking statistics did not necessarily do

any better than those who did postpone the taking of statistics (correlation of .09). However, those graduate students who did not postpone taking statistics did tend to do better than those graduate students who postponed taking statistics (correlation of .21).

In the full sample, of the five independent variables that were found to be significantly correlated with the final course grade, four of them ( GPA, MATHSAT, AVERHS, and PREDICTED) had been hypothesized to be positively correlated with the final grade. The hypothesized variable, JOY, was not found to be significantly correlated with the course grade. Additionally, while not hypothesized, the variable POSTPONED, was also positively correlated with the final grade. Table 2 lists the intercorrelational coefficients between the five independent variables and the final grade.

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Insert Table 2

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The only non-significant intercorrelation coefficient was between the high school average (math course average) and whether or not the person postponed taking statistics. As mentioned previously, since undergraduate students don't have much opportunity to postpone taking statistics, this would tend

to explain the non-correlation for undergraduate students. Because of the number of significant intercorrelations, prediction using regression analysis was not done.

Analyses were done for the males and females in the sample separately. It was found that there were no gender differences. The attitude toward statistics, the expected grade, and the final grade were equal, within sampling error, for the two groups of males and females. The only significant difference found between the two groups separated by gender was in the correlation coefficient between GPA and the final grade. The females had a correlation between GPA and their final grade of  $r = .54$ , while the males had a correlation of  $r = .34$  ( $P < .01$ )

#### Discussion:

We have seen that the cognitive variables of GPA, MATHSAT, and AVERHS are significant determinants of success in statistics. Interestingly, the level of mathematics studied in high school (ADVMATH) was not correlated with success in statistics as was the high school average (AVERHS) for the mathematics courses that were taken.

The affective variables of whether or not the student postponed taking statistics (POSTPONED) and the predicted grade

(PREDICTED) were also found to be determinants of success in statistics. The postponement of taking statistics was not as important a factor for the undergraduate students as it was for the graduate students. A possible explanation is that for the most part the schedule of prerequisites for undergraduate students does not allow the student to postpone taking statistics for much more than one semester. For graduate students on the other hand, since statistics is not a prerequisite for their other classes, they can postpone taking statistics for as much as a year or longer, especially since most of them are part-time students and their program of study typically lasts two years. Interestingly, whether the student expressed enjoyment of mathematics (JOY) did not correlate with the statistics grade.

So measures of past academic performance (AVERHS, GPA), mathematics aptitude (MATHSAT), and how a student feels about taking statistics, as measured by whether or not they have postponed taking statistics (POSTPONED), at least as far as graduate students are concerned, and their predicted grade for the class (PREDICTED), are all variables that should be looked at by the statistics teacher when trying to predict what students may profit from extra help in the course material.

Table 1  
Correlation Coefficients Between Eight Independent  
Variables and the Final Grade

| Variable  | n=325          | n=174              | n=151    |
|-----------|----------------|--------------------|----------|
|           | Full<br>Sample | Under-<br>Graduate | Graduate |
| GPA       | .43**          | .49**              | .35**    |
| MATHSAT   | .22**          | .22**              | .21*     |
| ENGSAT    | .01            | -.20*              | .14      |
| AVERHS    | .15**          | .18*               | .16      |
| ADVMATH   | .06            | .00                | .15      |
| POSTPONE  | .15**          | .09                | .21**    |
| JOY       | .09            | .16*               | .01      |
| PREDICTED | .15**          | .23**              | .06      |

\* P < .05      \*\* P < .01

Table 2  
Intercorrelational Coefficients Between Five Independent  
Variables and the Course Final Grade

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| Variable     | 1 | 2     | 3     | 4     | 5     | 6     |
|--------------|---|-------|-------|-------|-------|-------|
| 1. GPA       |   | .33** | .19** | .17** | .27** | .43** |
| 2. MATHSAT   |   |       | .38** | .30** | .22** | .22** |
| 3. AVERHS    |   |       |       | .10   | .26** | .15** |
| 4. POSTPONE  |   |       |       |       | .27** | .15** |
| 5. PREDICTED |   |       |       |       |       | .27** |
| 6. FINAL     |   |       |       |       |       |       |

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\*\* P < .01

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