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AUTHOR	House, J. Daniel
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ABSTRACT

A number of studies have examined the relationships between noncognitive variables, such as academic self-concept and achievement expectancies, and subsequent academic performance. Results from a recent study indicated that noncognitive variables were more effective predictors of college chemistry grades than were admissions test scores or high school coursework. The purpose of this study was to investigate the predictive relationship between initial student attitudes, admissions test scores, high school mathematics coursework, and subsequent achievement in college mathematics. Subjects (n=958) were students who began as new freshmen during the same fall semester and took a Finite Mathematics course during their freshman year. The results indicated that students' noncognitive characteristics were significant predictors of subsequent achievement in college math. Contains 55 references. (Author/MKR)

Student Attitudes and Academic Background as Predictors of Achievement in College Mathematics

J. Daniel House

Northern Illinois University

Paper presented at the Illinois Association for Institutional Research Annual Meeting, Oakbrook Terrace, IL, November 4-5, 1993.

Abstract

A number of studies have examined the relationships between non-cognitive variables, such as academic self-concept and achievement expectancies, and subsequent academic performance. Results from a recent study indicated that noncognitive variables were more effective predictors of college chemistry grades than were admissions test scores or high school coursework. The purpose of this study was to investigate the predictive relationship between initial student attitudes, admissions test scores, high school mathematics coursework, and subsequent achievement in college mathematics. Students included in this study were a sample of 958 students who began as new freshmen during the same fall semester and took a Finite Mathematics course during their freshmen year. The results of this study indicated that students' noncognitive characteristics were significant predictors of subsequent achievement in college math.

There is extensive interest in the identification of effective predictors of student achievement in college mathematics. Because a large number of career options such as business, science, and engineering require mathematical skills, lower achievement levels during the first year of college can restrict students' choices of majors and impact their subsequent career paths. However, there is relatively little knowledge of factors that are related to low math achievement (Oakes, 1990). Some research has indicated that students' attitudes and motivation may be related to their achievement in math and their achievement is then predictive of persistence in more advanced math courses (Meece et al., 1982). A model has recently been proposed to explain student achievement in math (Reyes & Stanic, 1988). In their model, Reyes and Stanic (1988) discussed the possible effects of several noncognitive variables on students' math achievement. Specific student attitudes that may be related to math achievement include students' comparisons of themselves with other students, their expectancies of success, and their confidence in their academic abilities. However, Reyes and Stanic (1988) have indicated that further research is needed to test their model and to investigate the relationship between students' attitudes and their subsequent math achievement.

The relationship between traditional measures such as admissions test scores and high school mathematics courses and subsequent grade performance in college math has been investigated. Considering admissions test scores, several studies have found the SAT and the ACT to be significant predictors of grade performance in college math. Bridgeman (1982) found a significant correlation between SAT-Math scores and grades earned in Elementary Algebra. Similarly, Troutman (1978) found a significant relationship between students'

SAT-Math scores and their grades in Finite Math while Gussett (1974) noted significant correlations between SAT-Total scores (SAT-Math and SAT-Verbal) and college math grades. Other research has found that ACT scores are significantly related to achievement in college math. Kohler (1973) found that ACT-Math scores and ACT-Composite scores were significant predictors of grades in college algebra. Edge and Friedberg (1984) found that ACT-Math, ACT-English, and ACT-Composite scores were each significantly correlated with calculus grades. Recent research has indicated that the combination of ACT-Composite scores and high school grades were most effective for predicting student grade performance in a number of college math courses (Noble & Sawyer, 1989). Finally, it has been reported that the relationship between admissions test scores and college math grades may be different for male and female students (Bridgeman & Wendler, 1991).

A number of studies have examined the relationships between noncognitive variables, such as students' academic self-concept and their achievement expectancies, and subsequent academic performance. Academic self-concept has been shown to be a significant predictor of achievement on several types of academic outcomes and for students of various ages. For example, academic self-concept has been found to predict the overall school performance and achievement test scores of elementary and secondary school students (Lyon, 1993; Lyon & MacDonald, 1990; Mboya, 1986; Mintz & Muller, 1977; Song & Hattie, 1985). Similar results have also been reported for college students. Wilhite (1990) found that academic self-concept accounted for a significant proportion of the variance in a multiple regression analysis of college course performance. Gerardi (1990) found a significant relationship between academic self-concept and the subsequent grade performance of minority engineering students. Recent research has also indicated that academic self-concept is a significant predictor of withdrawal from college for traditional students (House, 1992b, 1993c) and for academically underprepared students (House, 1992c). Finally, the results of a recent study suggested that students' self-ratings of their academic abilities were significant predictors of their grades in college chemistry (House, 1992a) In that study, it was also noted that noncognitive variables were more effective predictors of course grades than were admissions test scores or high school coursework. In addition, there were a number of differences between male and female students for the relationships between noncognitive variables and chemistry course grades (House, 1992a).

Students' expectancies of their academic performance have also been found to be significant predictors of college grade performance. Achievement expectancies have been shown to predict subsequent grades in general education courses (Gordon, 1989), exam grades in educational psychology courses (Holen & Newhouse, 1976), and college attrition (Trippi & Stewart, 1989). In addition, the significant relationship between achievement expectancies and grade performance has been found even after controlling for the effects of variables such as student goals, self-confidence, and prior achievement (Vollmer, 1984, 1986). Recent results indicated that the expectation of graduating from college was a significant predictor of earning a passing grade in college chemistry (House, 1992a).

A limited number of studies have evaluated the predictive relationship between noncognitive variables and subsequent math achievement. Findings from research on middle school and high school students have indicated that students' noncognitive characteristics are related to their later math achievement. For example, student motivation has been shown to be related to the math achievement of middle school students (Reynolds, 1991; Reynolds & Walberg, 1992a) and high school students (Reynolds & Walberg, 1992b). Results from a recent study of high school students indicated that mathematics self-efficacy was a significant predictor of math performance (Randhawa, Beamer, & Lundberg, 1993); self-efficacy refers to a student's appraisal of his/her capability to perform a particular academic task (Schunk, 1991). Finally, Helmke (1990) found that self-concept exerted a causal influence on later math achievement. In each of these studies, math achievement was measured by students' performance on a test. Considering college students, Hackett and Betz (1989) reported that mathematics self-efficacy was significantly related to the choice of a science or mathematics major. Students' mathematics self-efficacy also appears to be related to how they respond to failure on a mathematics task in an experimental setting (Trice, Elliot, Pope, & Tryall, 1991). Dwinell and Higbee (1991) found that motivation and attitude toward mathematics did not account for significant proportions of the variance in a multiple regression analysis of the final algebra grades of academically underprepared students. Another recent study, however, found that students' self-concept in mathematics was significantly related to final grades in a college algebra course (Wheat, Tunnell, & Munday, 1991). Finally, House (1993a) found that academically underprepared students with higher academic self-concept earned higher grades in college algebra, even after the effects of prior academic achievement were accounted for. Consequently, it can be seen that relatively few studies have examined the relationship between noncognitive variables and achievement in college math courses, and those few studies have produced conflicting results.

The purpose of this study was to investigate the predictive relationship between initial student attitudes, admissions test scores, high school mathematics taken, and subsequent achievement in college mathematics. Relatively few studies have examined both cognitive and noncognitive measures as predictors of college math achievement. This study was designed to extend the findings of previous research that examined the relative contributions of student attitudes and academic background toward the prediction of achievement in college chemistry (House, 1992a).

Methods

Students

Students included in this study were a sample of 958 students (mean age = 18.1 years, SD = 0.31) who began as new freshmen at a large university during the same fall semester. In this sample, there were 488 male students and 470 female students).

Measures

During an orientation period held on campus prior to the start of the fall semester of their freshmen year, students were requested to complete a survey that assessed students' attitudes and high school experiences (American Council on Education, 1986). On this survey, there were several items that measured students' self-ratings of their academic abilities and their expectancies for academic achievement. Four academic self-concept items were selected for use in this study: self-ratings of overall academic ability, mathematical ability, drive to achieve, and students' self-confidence in their intellectual ability. On these items, students rated themselves as:

(a) lowest ten percent, (b) below average, (c) average, (d) above average, and (e) highest ten percent. Regarding students' achievement expectancies, two items were selected for use in this study: expectations of earning at least a B average in college and expectations of graduating with honors. On these items, students rated their probability of these academic outcomes as: (a) no chance, (b) little chance, (c) some chance, and (d) very good chance. In addition to these noncognitive measures, two additional predictor variables were selected for use in this study: ACT Composite scores and the number of years of math taken in high school. Finally, the dependent measure used in this study was the grade earned in a Finite Mathematics course taken during the first year of college. Topics covered in the course include functions and graphs, matrix algebra, solutions of linear equations, and probability. This particular course is not designed for mathematics majors or minors. Grades for this course were assigned using a four-point scale.

Procedure

Several procedures were used to analyze the data from this study. First, correlation coefficients were computed to examine the relationships between each of the predictor variables. Correlation coefficients were then computed to investigate the relationships between each of the predictor variables and subsequent achievement in college math. Because gender differences have been noted for the relationships between attitudes and achievement (Ethington, 1992; House, 1993b), correlation coefficients were computed for the entire sample and separately for male and female students. A Z-transformation procedure was used to test for any significant differences between the correlations obtained for male and female students (Kleinbaum & Kupper, 1978).

Ordinary least-squares multiple regression analyses were used to investigate the relative contribution of each student attitude for predicting achievement in college math. These multiple regression analyses were done for the entire sample and separately for male and female students. Multiple regression analyses were also conducted that included student attitudes, a measure of prior cognitive achievement (ACT Composite scores), and a measure of previous instructional experience (the number of years of high school math that were completed). These analyses investigated the relative ordering of student attitudes and cognitive variables for explaining achievement in college math.

In stepwise multiple regression procedures, the order of variable entry can be impacted by sampling error. When sample sizes are sufficiently large, cross-validation analyses can be performed that will provide insight into the effects of sampling error (House & Johnson, 1993). A cross-validation procedure that is commonly used is to divide the original sample into two cross-validation samples and then conduct stepwise multiple regression analyses on each cross-validation sample (Henderson & Denison, 1989; Pedhazur, 1982). This approach allows an examination of consistency in the ordering of the predictor variables for the two cross-validation samples. Consequently, a cross-validation analysis was performed for the entire sample using the complete set of predictor variables. The sample was divided into two random samples and stepwise multiple regression analyses were performed on each sample. An examination was made of the similarities and differences between the cross-validation samples for the ordering of the predictor variables.

In addition to the specific grade received in college math, a second outcome variable of interest is whether or not students passed the course. In many cases, a satisfactory grade is required to be allowed to enroll in more advanced courses. Consequently, analyses were done to investigate the efficacy of cognitive and noncognitive variables as predictors of whether or not students had earned satisfactory grades in college math. Stepwise logistic regression procedures were used to determine the relative ordering of each cognitive and noncognitive variable toward the explanation of satisfactorily passing college math. Logistic regression is particularly suited to the analysis of binary outcomes such as passed/failed. In logistic regression, the relationship between a binary outcome measure and a set of predictor variables (either categorical or continuous) is examined. Because it is a stepwise procedure, logistic regression provides an analysis of the relative ordering of each predictor variable toward the explanation of the outcome measure (Afifi, 1990).

A number of logistic regression analyses were performed. For the first set of analyses, course grades of A, B, and C were considered as satisfactory while grades of D or F were considered as unsatisfactory. Logistic regression analyses were first done using only noncognitive variables as predictors and were done for the entire sample as well as separately for male and female students. Analyses were then done using both cognitive and noncognitive variables as predictors and were also done for the entire sample as well as separately for male and female students. The same procedures were then followed using the criteria of passing grades defined as A, B, C, or D vs. the failing grade of F, thus providing an examination of the relationship between cognitive and noncognitive predictors and the subsequent earning of a failing grade in college math.

Because there is considerable interest in the identification of predictors of high achievement in math (Benbow & Arjmand, 1990; Swiatek & Benbow, 1991), the final set of logistic regression analyses examined the effectiveness of cognitive and noncognitive variables as predictors of students' achieving the highest possible grade in their college math course (A) vs. achieving lower grades (B through F). As before, logistic regression analyses were first done for the entire sample as well as separately for male and female students using only noncognitive predictors. Finally, analyses were also done using both cognitive and noncognitive variables as predictors and were done for the entire sample as well as by student gender.

Results

Descriptive statistics for each predictor variable and grades earned in college mathematics are presented in Table 1. Previous research has indicated that female students tend to enroll in fewer elective math courses in high school (Oakes, 1990). However, there have been conflicting results regarding gender differences in grade performance in math courses (Kimball, 1989). Consequently, preliminary analyses were performed to investigate the presence of significant differences between male and female students for two predictor variables (ACT Composite scores and the number of years of high school math taken) and for grades earned in introductory college math. For this sample, male students showed significantly higher ACT Composite scores ($t(956) = 5.40$, $p = .0001$) and had taken significantly more high school mathematics ($t(956) = 3.78$, $p = .0002$). However, despite these initial differences, there was not a significant difference between male and female students in the grades earned in introductory college mathematics ($t(956) = 0.61$, $p = .5392$).

Correlations between each of the predictor variables are shown in Table 2. Correlations were computed for the entire sample as well as separately for male and female students. As can be seen, several significant correlations between predictor variables were obtained. Considering the entire sample, self-ratings of mathemat-

Table 1

Descriptive Statistics (For All Students and By Student Gender)

	All Students		Male Students		Female Students	
Variable	M	SD	M	SD	M	SD
Self-Rating of Overall Academic Ability	3.94	0.54	3.97	0.53	3.91	0.55
Self-Rating of Drive to Achieve	3.87	0.72	3.85	0.76	3.90	0.68
Self-Rating of Mathematical Ability	3.67	0.80	3.73	0.79	3.62	0.81
Self-Confidence in Intellectual Ability	3.73	0.74	3.86	0.72	3.61	0.72
Expect to Graduate With Honors	2.69	0.69	2.68	0.67	2.70	0.71
Expect to Make at Least a B Average in College	3.43	0.58	3.43	0.58	3.43	0.58
ACT Composite Score	22.83	2.93	23.33	2.92	22.32	2.85
Years of High School Mathematics	3.68	0.53	3.74	0.50	3.61	0.56
Finite Mathematics GPA	2.61	0.85	2.62	0.89	2.59	0.79

ical ability were significantly correlated with students' self-confidence in their intellectual ability, expectations of earning at least a B average in college and of graduating with honors, ACT Composite scores, and the number of years of high school mathematics taken. Interestingly, the only noncognitive variable that was significantly correlated with the number of years of high school math taken was self-rating of mathematical ability. The number of years of high school math taken was not significantly correlated with ACT Composite scores. When analyzed by student gender, similar patterns were observed. However, the correlation between the number of years of high school math taken and self-ratings of mathematical ability

Table 2

Intercorrelations Between Predictor Variables

All Students	2	3	4	5	6	7	8
1. Self-Rating of Overall Academic Ability	.19**	.26**	.27**	.36**	.26**	.42**	.02
2. Self-Rating of Drive to Achieve		.15**	.32**	.24**	.21**	-.01	.05
3. Self-Rating of Mathematical Ability			.17**	.18**	.17**	.13**	.29*
4. Self-Confidence in Intellectual Ability				.19**	.19**	.16**	.02
5. Expect to Graduate With Honors					.42**	.20**	-.02
6. Expect to Make at Least a B Average						.13**	.01
7. ACT Composite Scores							-.03
8. Years of High School Mathematics							---

**p < .01, *p < .05.

Table 2 (Continued)

Male Students	2	3	4	5	6	7	8
1. Self-Rating of Overall Academic Ability	.18**	.23**	.26**	.37**	.27**	.40**	-.02
2. Self-Rating of Drive to Achieve		.15**	.34**	.25**	.26**	-.01	.05
3. Self-Rating of Mathematical Ability			.12**	.18**	.19**	.10*	.22*
4. Self-Confidence in Intellectual Ability				.19**	.14**	.10*	.02
5. Expect to Graduate With Honors					.44**	.11*	-.03
6. Expect to Make at Least a B Average						.05	-.02
7. ACT Composite Scores							-.08
8. Years of High School Mathematics							---

Female Students	2	3	4	5	6	7	8
1. Self-Rating of Overall Academic Ability	.20**	.28**	.26**	.35**	.24**	.43**	-.04
2. Self-Rating of Drive to Achieve		.15**	.34**	.22**	.16**	.01	.06
3. Self-Rating of Mathematical Ability			.19**	.18**	.15**	.13**	.34**
4. Self-Confidence in Intellectual Ability				.20**	.24**	.17**	-.01
5. Expect to Graduate With Honors					.40**	.29**	-.01
6. Expect to Make at Least a B Average						.21**	.03
7. ACT Composite Scores							-.02
8. Years of High School Mathematics							---

**p < .01, *p < .05.

was significantly stronger for female students than for male students ($Z = 2.24$, $p < .05$). Also, the correlation between ACT Composite scores and expectations of graduating with honors was significantly stronger for female students than for male students ($Z = 3.00$, $p < .01$). Similarly, the correlation between ACT Composite scores and expectations of earning at least a B average in college was significantly stronger for female students than for male students ($Z = 2.59$, $p < .01$).

The correlations between each predictor variable and subsequent college math grades are summarized in Table 3. When the entire sample was considered, only two predictor variables, the number of years of high school math taken and self-confidence in intellectual ability, were not significantly correlated with later achievement in college math. The strongest single predictor of achievement in college math was students' self-rating of their mathematical ability. Correlations between each predictor variable and college math grades were also computed separately for male and female students and those correlations were compared for any significant differences. There were a number of instances where the correlation coefficent obtained was significant for students of one gender but not the other. For example, the relationship between students' self-ratings of their drive to achieve and college math achievement was significant for male students but not for female students. Also, the correlation between expectations of making at least a B average in college and subsequent grade performance in college math was significant for male students but not for female students. Finally, the correlation between the number of years of high school math and later college math achievement was significant for female students but not for male students. However, in none of these instances were the correlations obtained for male and female students significantly different from each other.

The results of the multiple regression analysis of noncognitive variables as predictors of introductory college mathematics grades are presented in Table 4. When the data from the entire sample were analyzed, three variables (self-ratings of mathematical ability, overall academic ability, and self-confidence in intellectual ability) entered the regression equation significantly. For the entire sample, the overall regression equation was significant ($F(6, 951) = 19.23$, $p = .0001$) and explained 10.8% of the variance in college

Table 3

Correlations Between Predictor Variables and Grade Performance in College Math (All Students and By Student Gender)

Predictor Variables	All Students	Male Students	Female Students	Z
Self-Rating of Overall Academic Ability	.219**	.212**	.226**	0.07
Self-Rating of Drive to Achieve	.085**	.094*	.075	0.29
Self-Rating of Mathematical Ability	.278**	.269**	.289**	0.34
Self-Confidence in Intellectual Ability	.010	.005	.008	0.05
Expect to Graduate With Honors	.101**	.096*	.108*	0.18
Expect to Make at Least a B Average in College	.066*	.094*	.034	0.92
ACT Composite Score	.193**	.229*	.149**	1.28
Years of High School Mathematics	.060	.016	.102*	1.32

**p < .01, *p < .05.

math grades. When analyzed by student gender, two variables (self-ratings of mathematical ability and overall academic ability) entered the regression equations as the first and second variables for both male and female students and, in each case, were the only two predictor variables that were significant. For male students, the overall regression equation was significant ($F(6, 481) = 9.30$, $p = .0001$ and explained 10.4% of the variance in college math grades. For female students, the overall regression equation was also significant ($F(6, 463) = 10.10$, $p = .0001$) and explained 11.6% of the variance in college math grades.

Table 4

Summary of Stepwise Multiple Regression Analysis of Math Grades Using Noncognitive Predictors (All Students and By Student Gender)

Step	Variable Entered	Model R-Square	F	p
All Students				
1	Self-Rating of Mathematical Ability	.077	80.28	.0001
2	Self-Rating of Overall Academic Ability	.100	24.38	.0001
3	Self-Confidence in Intellectual Ability	.106	6.00	.0145
4	Self-Rating of Drive to Achieve	.108	2.10	.1479
5	Expect to Make at Least a B Average	.108	0.15	.6940
6	Expect to Graduate With Honors	.108	0.06	.8091
Male Students				
1	Self-Rating of Mathematical Ability	.072	37.94	.0001
2	Self-Rating of Overall Academic Ability	.096	12.78	.0004
3	Self-Confidence in Intellectual Ability	.101	2.49	.1153
4	Self-Rating of Drive to Achieve	.104	1.62	.2044
5	Expect to Graduate With Honors	.104	0.04	.8330
6	Expect to Make at Least a B Average	.104	0.02	.8989
Female Students				
1	Self-Rating of Mathematical Ability	.084	42.64	.0001
2	Self-Rating of Overall Academic Ability	.106	11.80	.0006
3	Self-Confidence in Intellectual Ability	.113	3.67	.0561
4	Self-Rating of Drive to Achieve	.114	0.55	.4607
5	Expect to Make at Least a B Average	.115	0.46	.4970
6	Expect to Graduate With Honors	.116	0.39	.5326

Results from the multiple regression analysis using noncognitive variables, the number of years of high school math taken, and ACT Composite scores as predictors are summarized in Table 5. For the entire sample, four variables entered the regression equation

Table 5

Summary of Stepwise Multiple Regression Analysis of Math Grades Using Cognitive and Noncognitive Predictors (All Students and By Student Gender)

Step	Variable Entered	Model R-Square	F	p
All Students				
1	Self-Rating of Mathematical Ability	.077	80.28	.0001
2	ACT Composite Score	.103	27.05	.0001
3	Self-Rating of Overall Academic Ability	.112	9.80	.0018
4	Self-Confidence in Intellectual Ability	.119	7.05	.0080
5	Self-Rating of Drive to Achieve	.122	3.62	.0573
6	Expect to Make at Least a B Average	.122	0.26	.6104
7	Years of High School Mathematics	.122	0.02	.8883
8	Expect to Graduate With Honors	.122	0.00	.9997
Male Students				
1	Self-Rating of Mathematical Ability	.072	37.94	.0001
2	ACT Composite Score	.113	22.38	.0001
3	Self-Rating of Overall Academic Ability	.120	3.74	.0538
4	Self-Confidence in Intellectual Ability	.125	2.53	.1126
5	Self-Rating of Drive to Achieve	.129	2.68	.1023
6	Years of High School Mathematics	.130	0.25	.6190
7	Expect to Make at Least a B Average	.130	0.04	.8393
8	Expect to Graduate With Honors	.130	0.05	.8238
Female Students				
1	Self-Rating of Mathematical Ability	.084	42.64	.0001
2	Self-Rating of Overall Academic Ability	.106	11.80	.0006
3	Self-Confidence in Intellectual Ability	.113	3.67	.0561
4	ACT Composite Score	.117	1.95	.1637
5	Self-Rating of Drive to Achieve	.118	0.81	.3677
6	Expect to Make at Least a B Average	.120	0.74	.3902
7	Years of High School Mathematics	.120	0.24	.6261
8	Expect to Graduate With Honors	.121	0.17	.6791

significantly; self-ratings of mathematical ability entered the regression equation first as the most significant predictor, followed by ACT Composite scores, self-ratings of overall academic ability, and self-confidence in intellectual ability. The number of years of high school math taken entered the regression equation as the seventh of eight predictor variables and was not significant. For the entire sample, the overall regression equation was significant ($F(8, 949) = 18.88$, $p = .0001$) and explained 12.2% of the variance in college math grades. For male students, only two variables (self-ratings of mathematical ability and ACT Composite scores) entered the regression equation significantly. For female students, only two of the non-cognitive variables (self-ratings of mathematical ability and of overall academic ability) significantly entered the regression equation. When the overall regression equations were examined, the regression equation for male students was significant ($F(7, 479) = 8.96$, $p = .0001$) and explained 13.0% of the variance in math grades while, for female students, the overall regression equation was also significant ($F(8, 461) = 7.90$, $p = .0001$) and explained 12.1% of the variance in college math grades.

The results of the cross-validation analysis using the entire set of predictors variables are presented in Table 6. As was the case for the entire sample, self-ratings of mathematical ability were the first variables to significantly enter the regression equations for both cross-validation samples. For the first cross-validation sample, two additional variables (self-ratings of overall academic ability and self-confidence in intellectual ability) also significantly entered the regression equation. For the second cross-validation sample, one additional variable (ACT Composite scores) also significantly entered the regression equation. Finally, both cross-validation samples produced significant overall regression equations. For the first sample, the overall regression equation was significant ($F(8, 470) = 6.76$, $p = .0001$) and explained 10.3% of the variance in college math grades. The overall regression equation for the second cross-validation sample was also significant ($F(8, 470) = 10.50$, $p = .0001$) and explained 15.2% of the variance in college math grades.

Table 6

Cross-Validation Analysis Using Cognitive and Noncognitive Predictors (All Students)

Step	Variable Entered	Model R-Square	F	p
Cross-Validation Sample No. 1				
1	Self-Rating of Mathematical Ability	.053	26.67	.0001
2	Self-Rating of Overall Academic Ability	.083	15.44	.0001
3	Self-Confidence in Intellectual Ability	.094	6.11	.0138
4	ACT Composite Score	.100	2.77	.0968
5	Self-Rating of Drive to Achieve	.103	1.59	.2085
6	Expect to Make at Least a B Average	.103	0.19	.6619
7	Expect to Graduate With Honors	.103	0.08	.7828
8	Years of High School Mathematics	.103	0.07	.7985
Cross-Validation Sample No. 2				
1	Self-Rating of Mathematical Ability	.108	57.57	.0001
2	ACT Composite Score	.141	18.53	.0001
3	Self-Rating of Overall Academic Ability	.145	2.25	.1344
4	Self-Confidence in Intellectual Ability	.148	1.29	.2567
5	Self-Rating of Drive to Achieve	.151	2.16	.1425
6	Expect to Make at Least a B Average	.151	0.05	.8151
7	Expect to Graduate With Honors	.152	0.06	.7940
8	Years of High School Mathematics	.152	0.00	.9750

Findings from the logistic regression analysis of noncognitive variables as predictors of earning a satisfactory grade (A, B, or C) vs. an unsatisfactory grade (D or F) in college math are presented in Table 7. When the entire sample was considered, two variables (self-ratings of mathematical ability and of overall academic ability) significantly entered the regression equation. Similarly, self-ratings of mathematical ability entered the regression equations first for both male and female students. For male students, self-ratings of overall academic ability also entered the regression

Table 7

Summary of Stepwise Logistic Regression Analysis of Earning a Satisfactory Grade (A,B,C) vs. an Unsatisfactory Grade (D,F) in Math Using Noncognitive Predictors (All Students and By Student Gender)

Step	Variable Entered	Chi-Square	p
All Students			
1	Self-Rating of Mathematical Ability	21.93	.0001
2	Self-Rating of Overall Academic Ability	5.67	.0172
3	Self-Confidence in Intellectual Ability	1.82	.1773
4	Self-Rating of Drive to Achieve	1.23	.2674
5	Expect to Graduate With Honors	0.10	.7576
6	Expect to Make at Least a B Average	0.00	.9710
Male Students			
1	Self-Rating of Mathematical Ability	13.34	.0003
2	Self-Rating of Overall Academic Ability	4.59	.0322
3	Self-Rating of Drive to Achieve	0.90	.3431
4	Self-Confidence in Intellectual Ability	0.83	.3613
5	Expect to Make at Least a B Average	0.58	.4480
6	Expect to Graduate With Honors	0.30	.5859
Female Students			
1	Self-Rating of Mathematical Ability	10.60	.0011
2	Self-Rating of Overall Academic ABility	1.92	.1654
3	Expect to Make at Least a B Average	2.15	.1426
4	Self-Confidence in Intellectual Ability	0.37	.5436
5	Self-Rating of Drive to Achieve	0.05	.8152
6	Expect to Graduate With Honors	0.01	.9426

equation significantly. For female students, however, self-rating of overall mathematical ability was the only variable to enter the logistic regression equation significantly. In addition to providing an analysis of the relative contribution of each predictor variable, the logistic regression equation procedure also provides an analysis of the joint significance of the explanatory variables. When the entire sample was included in the analysis, the overall logistic regression equation that included six noncognitive variables was significant (χ^2 (6, N = 958) = 29.76, p = .0001) for explaining whether students earned satisfactory or unsatisfactory grades in college math. When analyzed by student gender, the overall logistic regression equation for male students was significant (χ^2 (6, N=488) = 20.24, p = .0025) as was the overall regression equation for female students (χ^2 (6, N = 470) = 14.30, p = .0265).

In Table 8, findings from the logistic regression analyses of earning a satisfactory grade (A, B, or C) vs. an unsatisfactory grade (D or F) using noncognitive variables, ACT Composite scores, and the number of years of high school math taken are presented. For each analysis in Table 8 (the entire sample and by student gender), the variables that significantly entered the regression equations were the same noncognitive variables that were identified as significant in Table 7. Neither ACT Composite scores nor years of high school math taken significantly entered any of the three logistic regression analyses presented in Table 8. However, the overall regression equation using the entire set of predictors was significant for all students (χ^2 (8, N = 958) = 33.67, p = .0001). Similarly, the overall regression equation for male students for explaining whether students earned satisfactory or unsatisfactory grades in college math was significant (χ^2(8, N = 488) = 24.15, p = .0022) as was the overall regression equation for female students (χ^2(8, N = 470) = 17.57, p = .0247).

Table 8

Summary of Stepwise Logistic Regression Analysis of Earning a Satisfactory Grade (A,B,C) vs. an Unsatisfactory Grade (D,F) in Math Using Cognitive and Noncognitive Predictors (All Students and By Student Gender)

Step	Variable Entered	Chi-Square	p
All Students			
1	Self-Rating of Mathematical Ability	21.93	.0001
2	Self-Rating of Overall Academic Ability	5.67	.0172
3	Years of High School Mathematics	2.26	.1326
4	Self-Confidence in Intellectual Ability	1.86	.1725
5	Self-Rating of Drive to Achieve	1.23	.2666
6	ACT Composite Score	1.07	.3017
7	Expect to Graduate With Honors	0.09	.7656
8	Expect to Make at Least a B Average	0.00	.9651
Male Students			
1	Self-Rating of Mathematical Ability	13.34	.0003
2	Self-Rating of Overall Academic Ability	4.59	.0322
3	ACT Composite Score	1.74	.1876
4	Years of High School Mathematics	2.03	.1541
5	Expect to Make at Least a B Average	1.27	.2595
6	Self-Rating of Drive to Achieve	0.80	.3698
7	Self-Confidence in Intellectual Ability	0.90	.3431
8	Expect to Graduate With Honors	0.22	.6393
Female Students			
1	Self-Rating of Mathematical Ability	10.60	.0011
2	Self-Rating of Overall Academic Ability	1.92	.1654
3	Expect to Make at Least a B Average	2.15	.1426
4	Years of High School Mathematics	2.41	.1203
5	ACT Composite Score	0.34	.5570
6	Self-Confidence in Intellectual Ability	0.25	.6172
7	Self-Rating of Drive to Achieve	0.06	.7996
8	Expect to Graduate With Honors	0.01	.9262

Logistic regression analyses were also conducted to examine the relative ordering of noncognitive variables as predictors of earning a passing grade (A, B, C, or D) vs. a failing grade (F) in college math. The results of these analyses are summarized in Table 9. For the entire sample, only two variables (self-ratings of mathematical ability and of drive to achieve) significantly entered the regression equation. The same variable (self-rating of mathematical ability)

Table 9

Summary of Stepwise Logistic Regression Analysis of Earning a Passing Grade (A,B,C,D) vs. a Failing Grade (F) in Math Using Noncognitive Predictors (All Students and By Student Gender)

Step	Variable Entered	Chi-Square	p
All Students			
1	Self-Rating of Mathematical Ability	18.25	.0001
2	Self-Rating of Drive to Achieve	5.31	.0212
3	Self-Rating of Overall Academic Ability	0.16	.6893
4	Expect to Graduate With Honors	0.03	.8555
5	Expect to Make at Least a B Average	0.00	.9573
6	Self-Confidence in Intellectual Ability	0.00	.9768
Male Students			
1	Self-Rating of Mathematical Ability	7.88	.0050
2	Self-Rating of Drive to Achieve	2.92	.0877
3	Self-Confidence in Intellectual Ability	0.62	.4326
4	Expect to Make at Least a B Average	0.19	.6670
5	Self-Rating of Overall Academic Ability	0.09	.7614
6	Expect to Graduate With Honors	0.02	.8901
Female Students			
1	Self-Rating of Mathematical Ability	11.54	.0007
2	Self-Confidence in Intellectual Ability	3.71	.0540
3	Self-Rating of Drive to Achieve	0.78	.3786
4	Self-Rating of Overall Academic Ability	0.10	.7468
5	Expect to Make at Least a B Average	0.09	.7673
6	Expect to Graduate With Honors	0.12	.7319

also entered the regression equations as the first variable for both male and female students. In addition, self-rating of drive to achieve was nearly significant in the equation for male students. Similarly, self-confidence in intellectual ability was nearly significant in the logistic regression equation for female students. The overall regression equation for the entire sample was significant (χ^2(6, N = 958) = 23.90, p = .0005). The overall regression equation for female students was also significant (χ^2(6, N = 470) = 15.81, p =.0148) while the overall regression equation for male students was not significant (χ^2(6, N = 488) = 12.30, p = .0557).

Findings from the logistic regression analyses using noncognitive variables, ACT Composite scores, and the number of years of high school math taken as predictors of earning a passing grade (A, B, C, or D) vs. a failing grade (F) are presented in Table 10. For the entire sample, three variables (self-ratings of mathematical ability and drive to achieve and ACT Composite scores) significantly entered the logistic regression equation. When analyzed by student gender, only one variable (self-ratings of mathematical ability) significantly entered the regression equations for male and female students. In addition, two variables (self-ratings of drive to achieve and ACT Composite scores) were nearly significant in the regression equation for male students. Similarly, one additional variable (self-confidence in intellectual ability) was nearly significant in the regression equation for female students. Finally, the overall logistic regression equation with eight predictor variables was significant for the entire sample (χ^2(8, N = 958) = 29.83, p = .0002). When analyzed by student gender, the overall regression equation for male students was significant (χ^2(8, N =

488) = 16.82, p = .0320). The overall regression equation using eight predictor variables to explain passing vs. failing college math was also significant for female students (χ^2 (N = 470) = 19.97, p = .0104).

Table 10

Summary of Stepwise Logistic Regression Analysis of Earning a Passing Grade (A,B,C,D) vs. a Failing Grade (F) in Math Using Cognitive and Noncognitive Predictors (All Students and By Student Gender)

Step	Variable Entered	Chi-Square	p
All Students			
1	Self-Rating of Mathematical Ability	18.25	.0001
2	Self-Rating of Drive to Achieve	5.31	.0212
3	ACT Composite Score	5.76	.0164
4	Self-Rating of Overall Academic Ability	0.74	.3906
5	Expect to Graduate With Honors	0.02	.8825
6	Years of High School Mathematics	0.02	.8931
7	Self-Confidence in Intellectual Ability	0.00	.9667
8	Expect to Make at Least a B Average	0.00	.9682
Male Students			
1	Self-Rating of Mathematical Ability	7.88	.0050
2	Self-Rating of Drive to Achieve	2.92	.0877
3	ACT Composite Score	3.73	.0536
4	Self-Rating of Overall Academic Ability	0.53	.4664
5	Years of High School Mathematics	0.45	.5006
6	Self-Confidence in Intellectual Ability	0.23	.6300
7	Expect to Make at Least a B Average	0.11	.7381
8	Expect to Graduate With Honors	0.01	.9407
Female Students			
1	Self-Rating of Mathematical Ability	11.54	.0007
2	Self-Confidence in Intellectual Ability	3.71	.0540
3	ACT Composite Score	1.96	.1617
4	Years of High School Mathematics	1.36	.2429
5	Self-Rating of Drive to Achieve	0.94	.3319
6	Self-Rating of Overall Academic Ability	0.14	.7065
7	Expect to Graduate With Honors	0.00	.9785
8	Expect to Make at Least a B Average	0.00	.9879

The next set of logistic regression analyses examined the relative ordering of noncognitive variables as predictors of students' earning the highest possible grade (A) in their college math course vs. a lower grade (B, C, D, or F). The results of these analyses are summarized in Table 11. Considering the entire sample, two noncognitive variables (self-ratings of mathematical ability and of overall academic ability) significantly entered the

Table 11

Summary of Stepwise Logistic Regression Analysis of Earning the Highest Grade (A) vs. Lower Grades (B,C,D,F) in Math Using Noncognitive Predictors (All Students and By Student Gender)

Step	Variable Entered	Chi-Square	p
All Students			
1	Self-Rating of Mathematical Ability	29.98	.0001
2	Self-Rating of Overall Academic Ability	11.36	.0008
3	Self-Confidence in Intellectual Ability	3.51	.0610
4	Expect to Graduate With Honors	1.15	.2835
5	Self-Rating of Drive to Achieve	0.54	.4614
6	Expect to Make at Least a B Average	0.61	.4361
Male Students			
1	Self-Rating of Mathematical Ability	19.62	.0001
2	Self-Rating of Overall Academic Ability	8.10	.0044
3	Self-Confidence in Intellectual Ability	2.71	.0998
4	Expect to Graduate With Honors	0.39	.5308
5	Expect to Make at Least a B Average	0.52	.4721
6	Self-Rating of Drive to Achieve	0.19	.6613
Female Students			
1	Self-Rating of Mathematical Ability	9.71	.0018
2	Self-Rating of Overall Academic Ability	3.65	.0559
3	Self-Confidence in Intellectual Ability	1.91	.1670
4	Self-Rating of Drive to Achieve	1.41	.2354
5	Expect to Graduate With Honors	0.71	.4008
6	Expect to Make at Least a B Average	0.08	.7740

logistic regression equation. In addition, a third variable (self-confidence in intellectual ability) was nearly significant. For male students, the same two noncognitive variables significantly entered the regression equation while self-confidence in intellectual ability was nearly significant. For female students, only one variable (self-ratings of mathematical ability) significantly entered the regression equation while a second noncognitive variable (self-ratings of overall academic ability) was nearly significant. The overall logistic regression equation using noncognitive variables for the entire sample was found to be significant (χ^2(6, N = 958) = 47.65, p = .0001). The overall regression equation for male students was also significant (χ^2(6, N = 488) = 31.09, p = .0001) as was the regression equation for female students (χ^2(6, N = 470) = 17.97, p = .0063).

The final set of logistic regression analyses examined the relative ordering of noncognitive variables, ACT Composite scores, and the number of years of high school math taken toward predicting students' earning the highest possible grade vs. a lower grade in college math. The results of these analyses are presented in Table 12. For the entire sample, the first two variables (self-ratings of mathematical ability and ACT Composite scores) entered the regression equation significantly. The third variable to enter the equation (self-confidence in intellectual ability) was nearly significant while the fourth variable to enter the regression equation (self-ratings of overall academic ability) accounted for a significant proportion of the remaining variance. When analyzed by student gender, three variables (self-ratings of mathematical ability, ACT Composite scores, and the number of years of high school math taken) significantly entered the regression equation for male students. In addition, a fourth variable (self-ratings of overall academic ability) was nearly significant. For female students, only two variables (self-ratings of mathematical ability and ACT Composite scores) significantly entered the regression

Table 12

Summary of Stepwise Logistic Regression Analysis of Earning the Highest Grade (A) vs. Lower Grades (B,C,D,F) in Math Using Cognitive and Noncognitive Predictors (All Students and By Student Gender)

Step	Variable Entered	Chi-Square	p
All Students			
1	Self-Rating of Mathematical Ability	29.98	.0001
2	ACT Composite Score	19.78	.0001
3	Self-Confidence in Intellectual Ability	3.23	.0722
4	Self-Rating of Overall Academic Ability	4.66	.0308
5	Self-Rating of Drive to Achieve	1.79	.1807
6	Years of High School Mathematics	1.61	.2047
7	Expect to Make at Least a B Average	0.39	.5316
8	Expect to Graduate With Honors	0.76	.3836
Male Students			
1	Self-Rating of Mathematical Ability	19.62	.0001
2	ACT Composite Score	10.85	.0010
3	Years of High School Mathematics	3.85	.0499
4	Self-Rating of Overall Academic Ability	2.92	.0875
5	Self-Confidence in Intellectual Ability	2.69	.1012
6	Self-Rating of Drive to Achieve	0.68	.4098
7	Expect to Make at Least a B Average	0.35	.5552
8	Expect to Graduate With Honors	0.51	.4733
Female Students			
1	Self-Rating of Mathematical Ability	9.71	.0018
2	ACT Composite Score	7.40	.0065
3	Self-Confidence in Intellectual Ability	2.14	.1439
4	Self-Rating of Drive to Achieve	2.70	.1005
5	Self-Rating of Overall Academic Ability	0.74	.3893
6	Expect to Graduate With Honors	0.17	.6834
7	Expect to Make at Least a B Average	0.20	.6513
8	Years of High School Mathematics	0.00	.9939

equation while the number of years of high school math taken entered the regression equation last and was not significant. Finally, the overall logistic regression equation using the complete set of eight predictor variables was found to be significant for the entire sample (χ^2 (8, N = 958) = 61.16, p = .0001). Similarly, the overall regression equation for male students was significant (χ^2(8, N = 488) = 39.77, p = .0001), as was the overall regression equation for female students (χ^2(8, N = 470) = 22.88, p = .0035).

Discussion

The results of this study indicated that student attitudes were significant predictors of subsequent achievement in college math. Results from the multiple regression analysis of grade performance using the entire set of predictor variables indicated that students' self-ratings of their mathematical ability entered the regression equation first as the most significant predictor, followed by ACT Composite scores. In addition, two other student attitudes also entered the regression equation significantly. Also considering grade performance, it was found that only noncognitive variables significantly entered the regression equation for female students while, for male students, ACT Composite scores also significantly entered the regression equation. When the outcome measure was whether or not students earned a passing grade in college math, three variables entered the logistic regression equation significantantly; the first two variables to enter the equation were students' self-ratings of their mathematical ability and of their drive to achieve while ACT Composite scores entered the equation third. Finally, when the criterion measure was whether students earned the highest grade possible in the course vs. lower grades, three variables significantly entered the logistic regression equation. Students' self-ratings of their mathematical ability entered the equation first while ACT Composite scores and self-ratings of overall academic ability were also significant. These findings indicate that students' noncognitive characteristics were predictive of several criterion measures of math achievement, including overall grade performance, passing vs. failing the course, and earning the highest grade possible in the course. It was interesting to note that the actual number of years of high school math taken did not significantly enter any of the regression equations. For these students, their self-appraisals of their mathematical ability were more predictive of their subsequent achievement in college math than were the number of years of high school math they had taken.

These findings extend the results of previous research on the relationship between noncognitive variables and achievement in college mathematics. Two recent studies found that either students' academic self-concept or their self-concept in mathematics were significant predictors of later achievement in college math (House, 1993a; Wheat, Tunnell, & Munday, 1991). The results of this study are consistent with those previous findings. These results are also consistent with the findings of previous research on the relationship between noncognitive variables and performance in other college courses. In a recent study, it was found that students' attitudes were more significant predictors of grade performance in introductory college chemistry than were ACT Composite scores or the number of years of high school math taken (House, 1992a). Consequently, the results of this study provide further support for the efficacy of noncognitive variables as predictors of achievement in college math and science.

There are a number of limitations to the present study. First, students at only one institution were included in this study. Further research is needed that would include students from several types of institutions to enhance the generalizability of these findings. Such multi-institutional studies have been conducted to assess the predictive validity of admissions tests (Rubin, 1980; Zwick, 1993). A second limitation of this study was that only traditional-aged students were included. There is considerable research which indicates that adult learners often have different educational objectives and employ different learning strategies than traditional-aged students (Ansello, 1982; Heimstra, 1980). Further study is needed to determine if the relationships found in this study would also be evident for adult learners. A final limitation of this study was that there were insufficient numbers of minority students in this sample to allow meaningful analyses to be made by student ethnic group. Previous studies have noted that African-American and Hispanic students tend to show mathematics test scores below the national average (Matthews, Carpenter, Lindquist, & Silver, 1984; Moore & Smith, 1987) and tend to take fewer advanced elective mathematics courses (Asnick, Carpenter, & Smith, 1981; Matthews, 1984). However, relatively little research has examined the relationship between the initial attitudes and later math achievement of minority students. Consequently, further study is needed to determine if noncognitive variables would prove to be effective predictors of the subsequent math achievement of minority students.

The results of this study provide a number of directions for further research. For example, additional research is needed to examine other types of mathematics outcomes such as enrollment in advanced elective math courses or the choice of a major field that requires extensive math skills. Another direction for further study is to investigate the causal relationships between student attitudes and college math achievement. Because of the exploratory nature of this study, no attempt was made to develop a causal model for math achievement. However, the findings from this study indicate that student attitudes are significant predictors of achievement in college math and are consistent with the results of a number of previous studies.

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Signature: J. Daniel House	Position: Research Associate
Printed Name: J. Daniel House	Organization: Northern Illinois University
Address: Office of Institutional Research Northern Illinois University	Telephone Number: (815) 753-6006
	Date: 11-9-93

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DeKalb, IL 60115

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