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What Predicts Success in Intermediate Algebra?

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Abstract

Successfully completing college math courses is an issue both nationally and locally. The purpose of this study was to develop a better understanding of the students enrolled in intermediate algebra (Math 108) at Boise State University and to uncover variables which predicted success in that course. Predictor variables were divided into two categories: pre-enrollment variables and course variables. Pre-enrollment variables were further categorized into variables which measured academic preparation in math, attitudes and dispositions, and other commitments. Course variables were further categorized into course and instructor variables, study skills and attitudes, and time commitments. Success in the course was measured by status at midterm (knowing their grade, having a passing grade), passing with a "C" or better at the end of the course, and common final exam score. Mid-term status also became a course variable when predicting course success and final exam score.

Using students enrolled in Math 108 in the spring of 2001, we found that:

- Most (90%) of students enrolled in Math 108 were previously enrolled in Math 025. About 20% of this group enrolled in Math 108 with grades of "D" or "F" in Math 025.
- Off-campus jobs took a large chunk of time with over half reporting they worked more than 20 hours per week. Almost 60% reported expecting to spend 10 hours or less per week preparing for their classes, despite the fact that 12 credits was the average load.
- Time log data completed by students verified that they spent about 9 hours per week on the average studying for the class. About two-thirds of the time spent studying was fairly or quite productive.
- Students were particularly positive about the effects of the instructor and the homework with over 80% indicating that these variables were either somewhat helpful or very helpful. A large majority of students did not use the Student Solutions Manual, the videos in the library, or become a member of a study group.
- By the mid-term, about 75% knew what their current grade was in Math 108.

Obtaining a "C" or better in the course depended upon student motivation and anxiety levels and mid-term status, as measured by students knowing their grades at mid-term and having passing grades at that point. Predicting how students would perform on the 200-point common final exam again depended upon student study skills and motivation levels and mid-term status. Math background, specifically percentile scores on students' placement tests and grades in their last math course, also played a role in predicting performance on the final.

The inclusion of mid-term status indicated that students need to perform well early in the course (and know that they are doing so). While math placement scores helped somewhat, what the instructor and student did during the course made a bigger difference. The Concentration scale from the Learning and Study Skills Inventory (LASSI) was consistently important for students in knowing their midterm status and performing well at mid-term. This scale included items such as "I am distracted from my studies very easily" and "I don't understand some course material because I don't listen carefully." There also appeared to be a group of instructors who were more effective than others at letting their students know early on how they were performing.

It was also interesting to note what failed to be a significant predictor in this study. For example, very few of the course-related variables on how the class was structured or managed were significant. Who taught the course also failed to be included as a significant factor for either obtaining a "C" in the course or scoring high on the final exam.

Time on task was also expected to be a good predictor of course success but was not. None of the variables that asked about how students spent their time, or how much time they spent studying, or whether they felt the amount of time they could allot to the course was sufficient showed much value to predict final performance in the course.

These findings suggest that the early part of the course is critical to student success, so instructors may want to be more direct with their students about their chances of success if their early grades are poor. On the other hand, the issues of motivation and study skills fall squarely in the domain of student responsibility. While instructors can increase motivation somewhat by continually emphasizing the usefulness of what's being learned, ultimately nothing an instructor can say or do will make a difference if the student is unmotivated to implement it. A similar statement could be made about study skills. The instructor can make suggestions to improve how students approach their studies, but again it is up to the student to implement necessary study skills. Overall, student motivation and commitment were the most significant predictors of success for intermediate algebra.

What Predicts Success in Intermediate Algebra?

Mathematics is the subject area in college that causes more grief to students than any other. In a review of a national sample of student college transcripts, Adelman (1995) reported that math courses held the top seven spots in the percentage of grades that were withdrawals (W), incompletes (I), or no credit repeats (NCR). The first six of these courses were pre-college level math courses while the seventh was college algebra. Four developmental math courses also were in the top five courses for percentage of grades that were failures. Clearly, math is a difficult subject area for many students, especially those who begin college with less than college-level skills.

At Boise State University, about a third of new freshmen have test scores that indicate they need developmental help in math. These students begin their course work in elementary algebra (Math 025) and/or intermediate algebra (Math 108) before reaching the college-level algebra course that they can count as meeting general education and perhaps major requirements. For any given semester, about half of the students enrolled in Math 108 will receive a grade of less than "C" (including D, F, W, and the occasional I).

Why do so many students fail these courses? In trying to answer this question, most research has focused on the characteristics of students in relation to their math performance rather than on characteristics of the course or instructor. In particular, researchers have studied the effects of math aptitude and prior achievement, attitudes and beliefs (including math anxiety), and demographic characteristics such as gender and age on performance in math courses.

Goolsby et al. (1988) predicted course grade in developmental math using a variety of attitudinal variables, high school grade point average, and SAT Quantitative score and found that only confidence in ability to learn math, HSGPA, and SAT-Q contributed significantly. The authors noted that it has been difficult to find a consistent relationship between math anxiety and performance. Goolsby et al. (1988) reported that while some studies found a significant negative relationship between math anxiety and achievement (Austin-Martin, et al., 1980; Buckley & Ribordy, 1982; Alexander & Cobb, 1984; Wright & Miller, 1981), others have found factors such as SAT-Q (Llabre & Suarez, 1985) and incentive and self-efficacy (Siegel, Galassi & Ware, 1985) were better predictors than math anxiety scores.

Bassarear (1986) also found that general attitudes were not significant predictors of performance in a college-level math course. Since the author found some evidence that attitude interacted differently for different groups of students, specifically males and females and those of low and high ability, he speculated that these complex relationships may be at least in part the cause of the contradictory findings regarding attitudes. However, while Heher (1989) found that Mathematics Anxiety and Confidence Scales were not as significant an indicator of success as were scores on the SAT-Q and an institutionally-designed mathematics diagnostic instrument, age and sex did not appear to be related to the incidence or intensity of math anxiety. In addition, the subjects' hiatus from math courses produced only a marginal significance. Goldston (1983) concluded that a positive attitude toward math correlated with success in a basic mathematics course but a negative attitude didn't correlate strongly with failure.

Gender and age have also been inconsistent in helping identify who will be successful in passing math in college. Goolsby et al. (1988) found that a better prediction could be developed for females than for males, with high school GPA playing a more significant role for women. Bassarear (1986) also found some evidence that attitudes interacted differently for males and females. Goldston (1983) found that the pass rate in a basic math course was higher for women than men, especially women who were returning to college (i.e., older women), for students taking fewer credits, and for students working 31-40 hours per week. However, Frerichs and Eldersveld (1981) concluded that while older students were more successful, gender was not a significant factor, and Heher (1989) found that neither age nor gender was related to math anxiety.

Little research was located that related to course variables and math success. Frerichs and Eldlersveld (1981) found that students assigned to a traditional instructional method where the instructor provided the pacing and organization for testing and learning were more successful in developmental math compared to students who provided their own pacing and organization for testing and learning. Jones et al. (1996) concluded that allowing students to replace earlier test scores with higher scores from that portion of the final related to the topic produced no difference in attitudes or completion rate.

Whatever the variables employed, predicting math performance seems a difficult task. Goolsby et al. (1988) could only account for 17% of the variance, while Llabre and Suarez (1986) reported that prediction of achievement in beginning college algebra course was not improved significantly beyond the 10% explained by the SAT-Q. Frerichs and Eldersveld (1981) could only account for 9% of the variance despite using instructional method, cognitive style, numerical skills, age sex, student's assessment of their math knowledge, student attitudes toward math, student's assessment of their math ability, and students' reasons for taking developmental courses to predict passing a developmental math course. In a local study of Boise State students enrolled in Math 108, Ward (2000) found that ACT scores correlated only .31 with common final exam scores, while SAT-Q correlated .25 and COMPASS Algebra scores only correlated .12. He recommended that a placement test alternate needed to be found, that grading standards in Math 025 (the prerequisite for many students) should be raised, and that students needed to bring discipline and responsibility to their college math courses.

Questions Addressed in this Study

This study builds on the work of Ward (2000) as well as other authors. In this study, however, focus was placed on *both* the impact of variables students brought with them to the course and on a number of course-related variables. Pre-course factors included prior math preparation, attitudes toward math, demographic characteristics, and other commitments such as work and home. In addition, a variety of course variables such as who taught the course and how the course was set up, including things such as textbooks, homework, study groups, and even time of day were also included in this study.

With such a broad variety of variables, the questions of the study were addressed in stages. Questions included:

- What do we know about students taking intermediate algebra, both prior to enrolling in the course and while they are taking it?
- How well do students' pre-enrollment variables predict success, both individually and as a group? Categories included demographic variables, attitudes and dispositions, and other commitments.
- How well do course-related variables predict success? Categories included course and instructor variables, study skills and attitudes employed during the course, and time commitments to math and other sources during the course.
- In the final analysis, which combination of variables provides the best prediction of success? Are most of these variables pre-enrollment variables or course-related variables?

"Success" as the outcome variable was measured in several ways: status at the mid-point of the course, score on the common final examination, and obtaining a "C" or better in the course. This variety of measures led to another question: Does the best set of predictors remain relatively stable, despite changing the measure of success?

Figure 1 provides an overview to both the outcomes and the predictors—whether pre-enrollment variables or course variables. Note that students' status at midterm serves a dual role as both an outcome and then as a predictor for final course success.

Methodology

Subjects

The study included 734 students enrolled in 19 sections of Math 108 during the spring of 2001. Students were evenly split by gender (49% female, 51% male). Age ranged from 16 to 53 with an average age of 22.4. Most (81%) described their ethnicity as white non-Hispanic. Almost everyone (90%) was an Idaho resident. About 60% were freshmen, 27% were sophomores, and the remaining 13% were upperclassmen. Their average credit load was 12.1 hours, with the number of credits ranging from 3 to 21. About two-thirds were full-time students.

Data Collection

The 15 instructors were asked to have their students complete four instruments throughout the semester. The first survey was returned by 396 students during the first week of class and covered prior math preparation, attitudes toward the course and achievement, and time spent on classes, work, dependents, and socialization. An additional 28 items covered students' confidence in their ability to perform a variety of mathematical calculations. A copy of the survey is available in Appendix A.

During the same week, 323 students completed the Learning and Study Skills Inventory (LASSI), a nationally-normed instrument designed to provide scores on 10 dimensions: anxiety about school performance (ANX), attitude toward and interest in school (ATT), concentration and attention to academic tasks (CON), information processing (including use of imaginal and verbal elaboration, comprehension monitoring, and reasoning) (INP), motivation and self-

discipline (MOT), self-testing when reviewing and preparing for classes and tests (SFT), selecting main ideas of importance for further study (SMI), use of study aids and support techniques to learn and remember new information (SMI), time management (TMT), and test strategies for preparing and taking tests (TST). Each scale has eight items, except the Selecting Main Ideas scale which has 5 items. The Administration Manual reports coefficient Alphas for the scales ranging between .68 (Study Aids) and .86 (Time Management). Test-retest correlations coefficients for the scales varied from .72 (Information Processing) to .85 (Concentration, Time Management), demonstrating high stability of scores.

Another survey was completed by 344 students about halfway through the course. This survey asked students their current grade in the course and whether 17 factors (e.g., time to devote to studying, math background, study skills, employer, instructor) were a help or a hindrance to their performance in the course. A copy of the survey is available in Appendix B.

Finally, students were asked to keep a study log for one week, marking down the time they were studying each day. For each study period, students were asked to rate their productivity on a 4-point scale where "1" was "learned nothing or extremely little" and "4" was "learned a great deal." From these logs, the number of study hours at each productivity level were calculated. The variables included in the study were total hours spent studying, number of productive hours (those rated "3" or "4"), and an efficiency variable based on the percent of hours spent studying that were productive (hours at level 4 divided by total hours). A total of 263 students completed this form. The study log form is included in Appendix C.

Outcome Variables: Success in the Course

At the end of the semester, all grades and student identifiers were gathered from the student information system for MATH 108. A frequency count of the 734 grades showed that 7.8% had an "A" in the course, 16.6% had a "B", 27.4% had a "C", 18.4% had a "D", 29.4% had an "F" or "W", and 0.4% received an "I". "Success" was defined as a "C" or better in the course, so 51.8% of the enrollees were deemed successful.

Common final examination scores were obtained from the Mathematics department, and zeros were assigned to anyone with a grade but without a final exam score. The mean for the 200-point final was 68.04 with a standard deviation of 53.08. A large group of students (29%) were assigned "0" on the final, probably because they were already failing and/or had withdrawn from the course. When these zeros were excluded, the mean was 95.98 with a standard deviation of 35.90.

At the mid-term, a total of 332 students provided information on their current grade in the course. Self-reports of grades were somewhat more optimistic than the assigned final grades. Over 60% thought they had a "C" or better in the course (12% As, 24% Bs, 26% Cs) and an additional 26% didn't know their grade. Only 9% thought they had a "D" and 4% thought they had an "F".

A listing of the outcome variables can be found in Table 1.

Pre-enrollment Variables Used to Predict Course Success

Table 2 lists the pre-enrollment variables used in the study. They are classified under four categories: demographics, academic preparation in math, attitudes and dispositions, and time commitments. Demographic information, credit load, test scores, and grade in elementary algebra (MATH 025) were obtained from the student information system. All other data were gathered through either the first-week survey or the LASSI (see above).

The 28 items from the first-week survey on self-confidence in performing various math calculations were analyzed using principal factor analysis with varimax rotation. The analysis resulted in five factors: word problems, polynomials, rational expressions, fractions and signed numbers, and linear inequalities and equations. See Table 3 for details on item loadings.

Course variables which were used to predict success

Again, a variety of variables were included under three organizational headings: course and instructor variables, study skills and attitudes, and time commitments. These are all listed in Table 4. In addition, mid-term status became a predictor variable for the outcomes of course success ("C" or better) and common final exam score.
Under "course and instructor variables," a key variable was instructor. To assess instructor effect, instructors above the mean on the outcome (e.g., common final) were assigned to group "1" while instructors below the mean were assigned to group "0."

The remaining variables in this category were taken from the mid-term survey where students were asked to rate how much a variety of factors had either helped or hindered their performance. Factors such as the textbook, homework, type of testing, instructor, time of day that class was held, study group membership, Student Solutions Manual, and library videos were included in this category.

"Skills and attitudes" variables also came entirely from the mid-term survey. Included were items on anxiety about the course, study environment, study skills, ability to take tests, and motivation level. Again, students rated the extent that each factor had helped or hindered their performance.

"Time commitment" variables were based on information from both the midterm survey and the time log that students kept. From the mid-term survey came student ratings on the extent that their time available to devote to studying, their family, and their employer either helped or hindered their performance. From the study logs, the total number of hours students said they spent studying in a week were included in the analysis. Number of *productive* study hours (defined as a "3" or "4" productivity rating on a 4-point scale) was also included. Finally, a variable to measure the *efficiency* of time spent studying was developed by taking the number of very productive hours ("4" on the 4-point scale) and dividing it by total number of study hours.

Data Analysis

Since success in Math 108, knowing your grade at mid-term and having a passing grade at mid-term were all binary, logistic regression was used to analyze these data. However, traditional multiple regression analysis was also employed with very little difference found in the selection and weighting of the variables. Therefore, both approaches were used in selecting subsets of variables and in interpreting the data. Multiple regression alone was used to select predictors for the outcome, common final exam score.

As a first step, the groups of variables under each category (e.g., pre-enrollment demographics, course time commitments) were placed into the regression equation one group at a time. Individual variables within each group which had a significance level of .10 or smaller were then carried forward to a final equation to determine the best set of predictors. Once these were identified, the regressions were run again to determine the final equations. Only variables with a significance level of .05 or smaller were included in the final equation.

Results

Student Background – Pre-enrollment Variables

Academic Preparation in Math: Students were assigned to developmental math courses by scores on any of three measures: ACT, SAT, or COMPASS. As shown by Table 5, the greatest number of students had ACT scores, and the fewest students had COMPASS scores. These scores were close to the national average, though SAT Quantitative scores were somewhat further below that average. When students were asked how confident they were to perform a variety of mathematical operations, a majority of students were highly confident of their ability to perform simple tasks such as multiply and divide signed numbers, add and subtract signed numbers, and add and subtract fractions. However, students expressed the least confidence in handling anything that involved word problems. See Table 6 for further details.

Most students had taken their last math course quite recently, with a majority (54%) having taken their last math course in the last semester. Only about one-fourth took their last math course two years ago or longer. Almost three-fourths (71%) took their last course at Boise State, while 22% took it in high school. Most reported making a good grade in their last course (18% As, 28% Bs, 23% Cs, 12% Ds, 9% Fs, and 3% Ws). An additional 8% couldn't recall the grade they made in their last course.

A check of student records showed that almost 90% of Math 108 enrollees had grades in Math 025 (elementary algebra). Most had done well in Math 025—26% had As, 27% had Bs, and 28% had Cs. However, about 20% showed grades of "D" or "F" in Math 025 prior to enrolling in Math 108.

Attitudes and Dispositions: The Math 108 enrollees were close to the national average on most scales of the LASSI (see Table 7). Students appeared to excel most in Concentration and Attention to Tasks (CON) and least on Attitude and Interest in College (ATT) and use of study aids (STA).

When students were asked directly about their attitudes toward Math 108 and academic challenges in general, over 90% indicated that they preferred interesting and challenging courses and that Math 108 would be important and useful. Over 95% believed that their grades depended on the effort they exerted and that they expected to do well in the course. Almost 80% thought the course would be interesting. A similar percentage thought their grades depended on the instructor. See Table 8 for details.

Other Commitments: Off-campus jobs took a large chunk of time from Math 108 students with over half reporting they worked more than 20 hours per week (see Table 9). Almost 60% reported expecting to spend 10 hours or less per week preparing for their classes, despite the fact that 12 credits was the average load.

Less than one-fourth reported spending more than five hours per week on dependents' care—a lower figure than usually found for Boise State students. Students also reported spending little time on relaxing and socializing, with 80% reporting they expected to spend 15 hours or less each week on this activity.

Student Course Information

Most student course information was gathered through the mid-term survey. Details on student responses are contained in Table 10 and are discussed by area below.

Course and Instructor Variables: Students were particularly positive about the effects of the instructor and the homework with over 80% indicating that these variables were either somewhat helpful or very helpful. A majority (61.5%) also thought the textbook was helpful. Students were more evenly divided over the effects of the type of testing and the time of day that class was held, with the largest group remaining neutral. A majority of students did not use the Student Solutions Manual, the videos in the library, or become a member of a study group.

Study Skills and Attitudes: Of all the factors, the greatest percentage of students (51%) thought that their ability to take tests was a hindrance to their performance in the course; only 28% thought it was a help. Over 40% thought their anxiety about the course was a hindrance, while only 7% thought it was a help. Over half the students thought their study skills and motivation level both helped their performance. Over 40% thought their study environment was helpful, though about 20% thought it was a hindrance to their performance. Most students (61%) thought their math background was helpful in tackling intermediate algebra, though 28% thought it hindered.

Time commitments: Through the mid-semester survey, checks were again made on the impact of family and job requirements as well as the amount of time students were able to devote to studying and their perceived effects on performance. About 57% thought the amount of time they had available to devote to studying helped them, while 30% thought it hindered. About half thought their family and their employer neither helped nor hindered their performance in the class.

Time log data verified that students spent about nine hours per week on the average studying for Math 108. This average, however, hid a huge range of time, from 30 minutes to over 100 hours depending on the student. About two-thirds of the time spent studying was fairly or quite productive. However, less than 20% of the time spent studying was judged as very productive by students. See Table 11 for further details.

Predicting Mid-term Performance

By mid-term, students should have an idea of how they are doing in their course. The fact that about one-fourth did not know their status in intermediate algebra at mid-term was somewhat surprising. This lack of knowing could be due to students' lack of academic skills in managing their performance and/or due to the lack of instructor feedback. Indeed, as shown by Table 12, whether students knew their mid-term grade or not could be best predicted by students' attitudes and dispositions, particularly by their concentration and attention to tasks (CON). Several course variables were also significant, particularly the instructor variables.

In the final analysis, concentration, hours spent relaxing, who the instructor was, and perceiving the instructor as helpful formed the best prediction of students' knowing their grade at mid-term. The more hours students reported that they spent relaxing, the less likely they were to know their grade. Higher concentration scores were related to greater likelihood of knowing their grade. Instructor group was an especially powerful variable. Those with instructors in group 1 were almost 18 times more likely to know their grade. Those who perceived their instructor as helpful to their performance were 3.8 times more likely to know their grade. Details may be found in Table 13.

Most students who knew their grade at midterm thought that they were passing the course. Only 13% thought they had a "D" or "F" in the course. Again, attitudes and dispositions from the pre-enrollment variable group and course and instructor variables provided the strongest predictions (see Table 14).

Students who thought they had a passing grade at mid-term were more likely to have finished their freshman year and to have higher scores on the placement test and the Concentration scale of the LASSI. They also had lower scores on the Test Preparation scale of the LASSI, and were more likely to report that the textbook hindered and their motivation level helped them. Math placement scores and Concentration scores were particularly good predictors. For each one point increase in placement scores, the probability of knowing their grade increased by 3%; it increased by 17% for each one point increase in Concentration score. See Table 15 for further details.

The equations accounted for about 25% of the variability in knowing their mid-term grade and 22% of the variability in reporting they were passing the course at mid-term.

Predicting a "C" or better in Intermediate Algebra

As a first step, each group of pre-enrollment variables—demographics, academic preparation in math, attitudes and dispositions, and other commitments—were individually regressed against

the success criterion. As shown by Table 16, only the group of variables involving academic preparation in math was statistically significant using both logistic and multiple regression. This group of variables accounted for approximately 20% of the variance in the success criterion. Within that variable group, percentile score, recency of prior math course (Q1), whether the last course was taken at Boise State, and grade in Math 025 were each individually significant and were kept for later analysis.

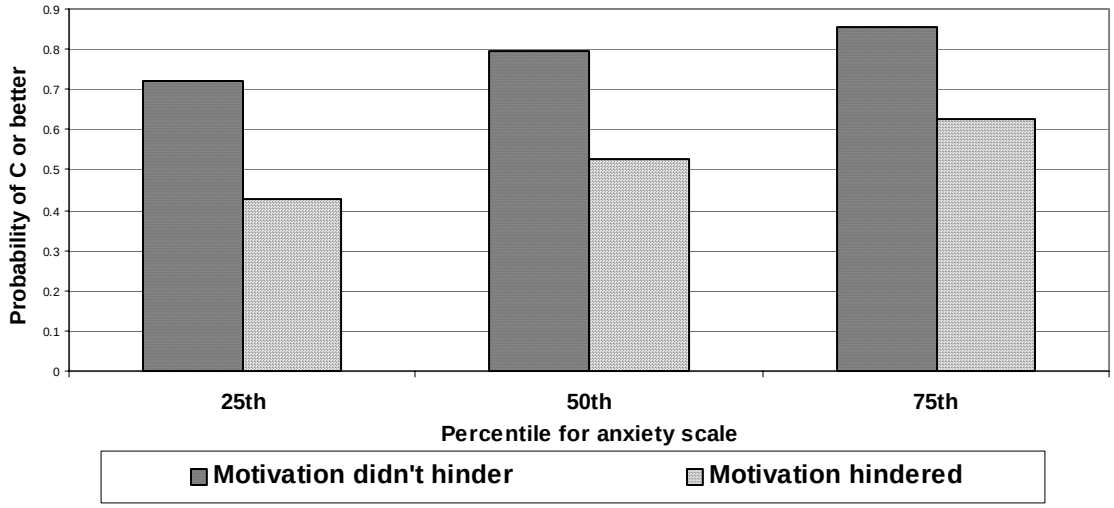
Several other variables also were statistically significant, even though the variable group as a whole was not. These variables were also kept for later analysis. Age was retained from the demographic variable group. Four scale scores from the LASSI—Motivation, Anxiety, Concentration and attention for tasks, and Testing strategic—also were kept. Student ratings of the importance of learning the course material (Q11) was barely significant in the logistic analysis and barely non-significant in the regression analysis so was also kept.

Table 16 also displays the regression results for the course variables. In this case, three variable groups—course and instructor, midi-term standing, and study skills and attitudes—were all significant, while time commitments was not significant. Study skills and attitudes accounted for the largest proportion of variance (20%) with mid-term standing accounting for almost as much variability. Course and instructor variables accounted for 12% of the variance in the success measure.

In the final analysis, a combination of pre-enrollment and course-related variables provided the best prediction of course success (see Table 17). The level of anxiety as measured by the LASSI was the most important pre-enrollment variable. In addition, it was important whether students knew their grade, whether they were currently passing the course, and if they felt their level of motivation was hindering their performance. Increases in anxiety were related to improved odds of passing as was having a passing grade at the mid-term. Not knowing their grade at mid-term and feeling their motivation was impeding their performance reduced the odds of a "C" or better at the end of the semester. Indeed, mid-term status was of the greatest significance. Having a passing grade at midterm made it 17 items more likely the student would pass the course and not knowing the grade at mid-term made it almost ten times *less* likely to pass.

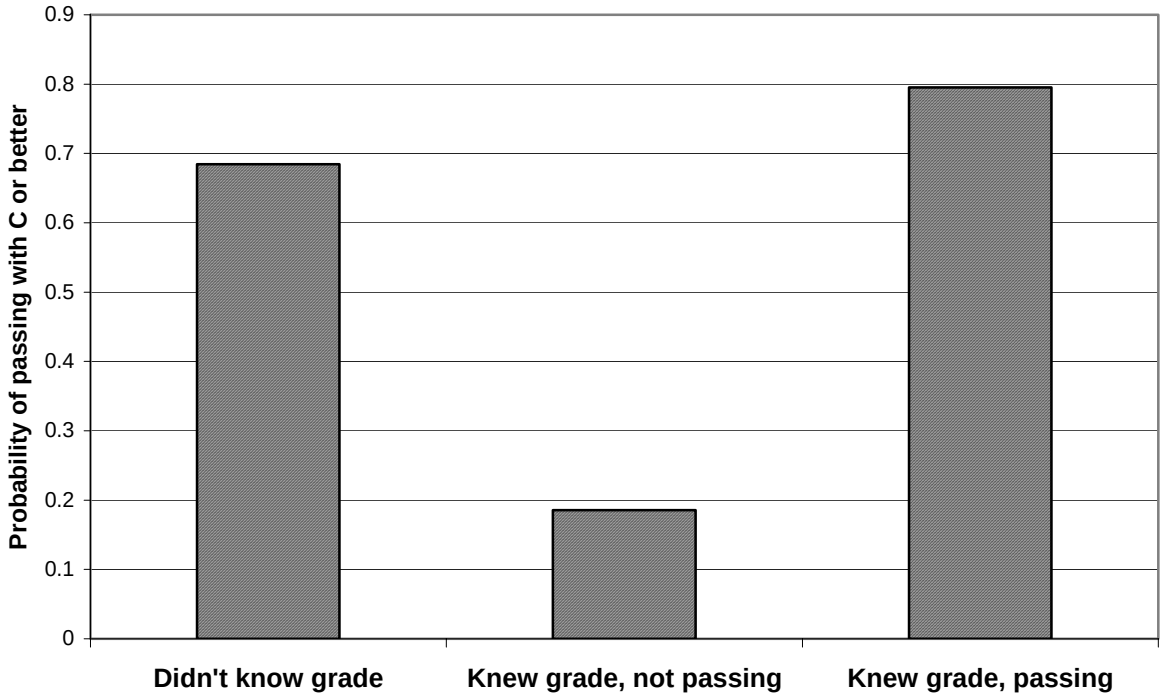
Figure 2 below shows the effects of anxiety level and motivation on the probability of passing intermediate algebra with a "C" or better. Though both affect the outcome, it appears that a motivation level that students saw as hindering their performance had the larger effect. This is particularly true when anxiety was low. When motivation didn't hinder performance, the probability of a "C" or better was .72, but the probability dropped to .43 when motivation was a factor.

Figure 2. Effect of anxiety and motivation on passing Math 108



The calculations for Figure 2 were based on students knowing their grade at midterm and having a passing grade. When anxiety was assumed to be at the 50th percentile and motivation was not an issue, Figure 3 illustrates the effects of knowing their grade at mid-term and having a passing grade. Notice that by far the worst case scenario was when students knew what their grade is at mid-term and that they were already failing.

Figure 3. Effects of knowing grade and having a passing grade at midterm



Predicting Scores on the Common Final Examination

One problem with the outcome of a "C" or better in the course is that different instructors grade differently. Thus, any instructor effects found may be due to grading practices as much as to teaching. All students, however, must take a common final exam at the end of the course which provides an outcome free of grading effects.

As shown by Table 18, results were much the same using final exam as when the criterion of "C" or better was employed, with several significant exceptions. For the pre-enrollment variables, compared to predicting a "C" or better, the proportion of variance accounted for (R^2) was very similar for the demographic and attitudes and dispositions variables, but increased for academic preparation in math (from .2047 to .3084) and increased for other commitments (to .0876 from .0424). The individual variables which were carried forward for later analysis were also quite similar. For the course variables, the proportion of variance accounted for increased for the study skills variables and remained similar for the other areas. A few more variables also were carried forward for inclusion in the final analysis.

The final regression equation consisted of only five variables (see Table 19). Two of the variables—passing the course at midterm and indicating that their motivation level was hindering their performance—had previously been included in the equation for predicting a "C" or better in the course. The remaining three variables—percentile score on the math placement exam, grade in last math course, and reporting that their study skills were helping their performance—were new predictors. In all, this combination of variables was able to account for about one-third of the variability in final exam scores. All variables had a positive effect on final exam scores with the exception of the motivation variable, where those whose motivation hindered their performance also had lower final exam scores.

Summary and Conclusions

The purpose of this study was to develop a better understanding of the students enrolled in intermediate algebra (Math 108) and to uncover variables which predicted success in that course. Predictor variables were divided into two categories: pre-enrollment variables and course variables. Pre-enrollment variables were further categorized into variables which measured academic preparation in math, attitudes and dispositions, and other commitments. Course variables were further categorized into course and instructor variables, study skills and attitudes, and time commitments. Success in the course was measured by status at midterm (knowing their grade, having a passing grade), passing with a "C" or better at the end of the course, and common final exam score. Mid-term status also became a course variable when predicting course success and final exam score.

A combination of pre-enrollment and course-related variables were the best predictors of knowing grades at the mid-term and reporting they were passing the course at that point in time. Knowing mid-term grade seemed to rely mainly upon students' learning and study skills, particularly their motivation level, concentration and attention to academic tasks, and hours spent relaxing and socializing. The way the class was organized and managed by the instructor also seemed to make a difference. A similar set of learning and study skills were also important for

passing at mid-term, though placement test results also made a difference and the instructor did not.

Understanding the factors that predicted mid-term status was important since midterm status became a critical predictor of end-of-the-semester performance, whether obtaining a "C" or better in the course or scoring well on the final exam. Both knowing their grade at mid-term and passing at mid-term were key variables in the final regression equation for predicting the probability of a "C" in the course. The only additional variables employed were scores on the anxiety scale of the LASSI (where more anxiety was related to a greater probability of a "C") and reporting that motivation was hindering performance.

When predicting the finer distinctions of final exam score rather than a simple "C" or better in the course, math background played a stronger, but not exclusive, role. Both Math placement test scores and grade in their last math course were important predictors of final exam score, along with whether or not students were passing the course at the mid-term. Student perceptions about the value of their study skills and motivation level were also important predictors.

It appears, therefore, that while math background played a role in succeeding in Math 108, other factors weighed more heavily. In particular, students' learning and study skills and motivation levels were critical indictors. Students were easily able to identify when their level of motivation was affecting their performance—an effect that was a significant indicator for passing at midterm, passing the course, and final exam score.

The effects of anxiety were less clear, but still important. Anxiety as measured by the LASSI had a positive relationship with final exam score, indicating that anxiety (especially performance anxiety associated with tests) could help improve final exam scores. However, other measures of anxiety more directly related to math, including asking students about their self-confidence levels with a variety of math operations and whether anxiety was helping or hindering their performance in the course, were not significant predictors.

The consistent inclusion of mid-term status also indicated that students need to perform well early in the course (and know that they are doing so). While math placement scores helped somewhat, what the instructor and student did during the course made a bigger difference. The Concentration scale from the LASSI was consistently important for students in knowing their midterm status and performing well at mid-term. This scale included items such as "I am distracted from my studies very easily" and "I don't understand some course material because I don't listen carefully." There also appeared to be a group of instructors who were more effective than others at letting their students know early on how they were performing.

It was also interesting to note what failed to be a significant predictor in this study. For example, very few of the course-related variables on how the class was structured or managed were significant. Who taught the course also failed to be included as a significant factor, except for predicting who knew their grade at mid-term.

In addition, math faculty had felt that students simply weren't spending enough time on their math assignments to assure a good grade, perhaps due to job and family responsibilities. None

of these variables showed much value to predict final performance in the course, despite the variety of ways that this area was measured. The time log was expected to yield particularly good results but did not. Perhaps study time was mediated by other factors such as math background and so failed to reach significance on its own. Perhaps the time logs were an inaccurate reflection of student study time but would have reached significance if they had been more accurate. Perhaps too few students or a non-random subset of students completed the time logs in order to attain statistical significance. Perhaps how the available time was managed was more important than simply having enough time available for studying.

The problem with the time logs illuminates larger issues for the study. In particular, so few students completed some of the measures that the sample size dropped dramatically. Given the large number of variables in the study, some effects therefore may have been spurious. In addition, much of the data relied on student self-report. Since the surveys and time logs were completed and turned in through the instructor, this process may have affected the validity of student self-report.

These findings suggest that the early part of the course is critical to student success, so instructors may want to be more direct with their students about their chances of success if their early grades are poor. On the other hand, the issues of motivation and study skills fall squarely in the domain of student responsibility. While instructors can increase motivation somewhat by continually emphasizing the usefulness of what's being learned, ultimately nothing an instructor can say or do will make a difference if the student isn't motivated to implement it. A similar statement could be made about study skills. The instructor can make suggestions to improve how students study, but again it is up to the student to implement necessary study skills.

Compared to some previous studies, this study was more successful than most in predicting course success, however defined. Still, a great deal of work remains in developing an understanding of how students can be successful as they tackle their math requirements in college and in predicting who will succeed and who needs early intervention.

Table 1. Outcome Variables For Success In Math 108

Description	Short Name	Coding
Passing Grade at mid-term as reported by student	PASSGRAD	1=A, B, or C grade, else PASSGRAD=0
Know grade in course at midterm	KNOWGRAD	0 =don't know grade, else 1
Course success – passing with C or better	PASS	0=D,F, or W; 1=A,B, or C grades
Common final exam score	FINAL	Continuous

Table 2. Pre-Enrollment Variables Used In Prediction

Description	Short Name	Coding
Demographics:		
Age	Age	continuous
Gender	Female	0=female, 1=male
Ethnicity	minority	0=minority, 1=white non-Hispanic
Freshman	Freshman	0=freshman, 1=not a freshman
Resident of Idaho	Resident	0=resident, 1=out of state
Academic preparation in Mathematics		
Math percentile score on ACT, SAT, or CPT	Percentile	continuous
Whether percentile was from ACT/SAT or from CPT	ACTSAT	0=ACT or SAT score, 1=CPT score
How recently math was taken	Q1	1=last semester, 2=last year, 3=2 years or more
Last math course at BSU	BSULAST	0=took at BSU, 1=took high school or another college
Last math course in high school	HSLAST	0=took in high school, 1=took at BSU or other college
Grade in last math course	LASTGRADE	4=A, 3=B, 2=C, 1=D, 0=F,W, blank=can't recall
Self-assessed confidence with: …solving word problems	FACTOR1	continuous factor score
…polynomials	FACTOR2	continuous factor score
…rational expressions	FACTOR3	continuous factor score
…fractions and signed numbers	FACTOR4	continuous factor score
…linear inequalities and equations	FACTOR5	continuous factor score
Grade in Math 025	GRADE025	5=didn't need to take, 4=A, 3=B, 2=C, 1=D, 0=For W
Attitudes and Dispositions		
LASSI – Attitude and interest	ATT	continuous
LASSI – Motivation, diligence, self-discipline	MOT	continuous

Description	Short Name	Coding
LASSI – Time management	TMT	continuous
LASSI – Anxiety about school performance	ANX	continuous
LASSI – Concentration and attention for tasks	CON	continuous
LASSI – Information processing and reasoning	INP	continuous
LASSI – Selecting main ideas from reading	SMI	continuous
LASSI – Study aids, use of support techniques	STA	continuous
LASSI – Self-testing, reviewing, preparing	STF	continuous
LASSI – Testing strategies, preparing for tests	TST	continuous
Preference for interesting & challenging courses	Q9	1=strongly disagree, 2=disagree, 3=agree, 4=strongly agree
Think course will be interesting	Q10	1=strongly disagree, 2=disagree, 3=agree, 4=strongly agree
Think it's important to learn the material	Q11	1=strongly disagree, 2=disagree, 3=agree, 4=strongly agree
Think subject matter will be useful	Q12	1=strongly disagree, 2=disagree, 3=agree, 4=strongly agree
Believe grades depend on the effort exerted	Q13	1=strongly disagree, 2=disagree, 3=agree, 4=strongly agree
Believe grades depend on the instructor	Q14	1=strongly disagree, 2=disagree, 3=agree, 4=strongly agree
Expect to do well in course	Q15	1=strongly disagree, 2=disagree, 3=agree, 4=strongly agree
Commitments		
Hours per week spent preparing for classes	Q4	1=5 or less, 2=6-10, 3=11-15, 4=16-20, 5=21-25, 6=26=30, 7=30 or more
Hours per week spent working for pay on campus	Q5	1=5 or less, 2=6-10, 3=11-15, 4=16-20, 5=21-25, 6=26=30, 7=30 or more
Hours per week spent working for pay off campus	Q6	1=5 or less, 2=6-10, 3=11-15, 4=16-20, 5=21-25, 6=26=30,

Description	Short Name	Coding
		7=30 or more
Hours per week spent relaxing and socializing	Q7	1=5 or less, 2=6-10, 3=11-15, 4=16-20, 5=21-25, 6=26=30, 7=30 or more
Hours per week spent providing care for dependents	Q8	1=5 or less, 2=6-10, 3=11-15, 4=16-20, 5=21-25, 6=26=30, 7=30 or more
Credit load	UNT_TAKEN_PRGSS	continuous
Ratio of credit load to time spent preparing for classes	RATIOTIME	continuous, UNT_TAKEN_PRGSS / Q4

Table 3. Factors Related To Self-Assessed Confidence In Handling Various Types Of Problems, Numbers, And Equations

Item (item number)	Factor 1 Word problems	Factor 2 Poly-nomials	Factor 3 Rational expressions	Factor 4 Fractions & signed numbers	Factor 5 Linear inequalities & equations
Solving word problems involving mixtures (Q41)	.815				
Solving word problems involving numbers (Q39)	.777				
Solving word problems involving distance, rate, and time (Q42)	.775				
Solving word problems involving ratio and proportion (Q43)	.741				
Solving word problems involving geometry (Q40)	.726				
Translating verbal expressions to algebraic expressions (Q38)	.508				
Multiplying and dividing polynomials (Q30)		.855			
Factoring polynomials (Q31)		.855			
Adding & subtracting polynomials (Q29)		.829			
Solving polynomial equations by factoring (Q32)		.698			
Simplifying expressions with positive integer exponents (Q28)		.428			
Adding & subtracting rational expressions (Q34)			.765		
Multiplying & dividing rational expressions (Q33)			.747		
Solving absolute value inequalities (Q25)			.556		
Solving rational equations (those involving fractional expressions) (Q36)			.530		
Solving absolute value equations (Q24)			.517		
Solving systems of linear equations (Q37)			.517		
Simplifying complex fractions (Q35)			.486		
Adding & subtracting fractions (Q19)				.757	
Multiplying & dividing fractions (Q18)				.704	
Multiplying & dividing signed				.674	

numbers (Q16)					
Adding & subtracting signed numbers (Q17)				.586	
Simplifying expressions with nested parentheses (Q20)				.544	
Solving linear inequalities (Q23)					.699
Solving linear equations (Q21)					.691
Solving literal equations (Q22)					.639
Finding equations of lines (Q26)					
Finding slopes and intercepts of lines (Q27)					
Variance explained by each factor	3.862	3.666	3.349	2.893	2.347

Table 4. Predictor Variables Which Were Part of the Course

Description	Short Name	Coding
Course and instructor variables		
Instructor (based on course records)	Instructor	0=sections below mean, 1=sections above mean
Textbook helped or hindered performance	Help10, Hinder10	If helped some or helped great deal, Help10=1, else Help10=0. If hindered some or hindered great deal, Hinder10=1, else Hinder10=0
Homework helped or hindered performance	Help11, Hinder11	If helped some or helped great deal, Help11=1, else Help11=0. If hindered some or hindered great deal, Hinder11=1, else Hinder11=0
Instructor helped or hindered performance	Help12, Hinder12	If helped some or helped great deal, Help12=1, else Help12=0. If hindered some or hindered great deal, Hinder12=1, else Hinder12=0
Type of testing used helped or hindered performance	Help13, Hinder13	If helped some or helped great deal, Help13=1, else Help13=0. If hindered some or hindered great deal, Hinder13=1, else Hinder13=0
Time of day that class is held helped or hindered performance	Help14, Hinder14	If helped some or helped great deal, Help14=1, else Help14=0. If hindered some or hindered great deal, Hinder14=1, else Hinder14=0
Membership in a study group helped or hindered performance (Hinder15 deleted from further analysis because less than 5% of responses)	Help15, Hinder15	If helped some or helped great deal, Help15=1, else Help15=0. Hinder15 deleted from analysis due to low N
The Student Solutions Manual helped or hindered performance (Hinder16 deleted from further analysis because less than 5% of responses)	Help16, Hinder16	If helped some or helped great deal, Help16=1, else Help16=0. Hinder16 deleted from analysis due to low N
The videos in the library helped or hindered performance (Both Help17 and Hinder17 deleted from further analysis because less than 5% of responses)	Help17, Hinder17	If helped some or helped great deal, Help17=1, else Help17=0. Hinder17 deleted from analysis due to low N
Midterm Standing		
Knew grade in course at midterm	Knewgrad	0=didn't know grade, 1=knew grade

Description	Short Name	Coding
Had “C” or better in course at midterm	Passgrad	1=A,B, or C, 0=else
Study Skills and Attitudes		
My math background helped or hindered performance	Help2, Hinder2	If helped some or helped great deal, Help2=1, else Help2=0. If hindered some or hindered great deal, Hinder2=1, else Hinder2=0
My anxiety about this course helped or hindered my performance	Help3, Hinder3	If helped some or helped great deal, Help3=1, else Help3=0. If hindered some or hindered great deal, Hinder3=1, else Hinder3=0
My study environment helped or hindered my performance	Help4, Hinder4	If helped some or helped great deal, Help4=1, else Help4=0. If hindered some or hindered great deal, Hinder4=1, else Hinder4=0
My study skills helped or hindered my performance	Help5, Hinder5	If helped some or helped great deal, Help5=1, else Help5=0. If hindered some or hindered great deal, Hinder5=1, else Hinder5=0
My ability to take tests helped or hindered my performance	Help6, Hinder6	If helped some or helped great deal, Help6=1, else Help6=0. If hindered some or hindered great deal, Hinder6=1, else Hinder6=0
My motivation level helped or hindered my performance	Help9, Hinder9	If helped some or helped great deal, Help9=1, else Help9=0. If hindered some or hindered great deal, Hinder9=1, else Hinder9=0
Time Commitments		
The time I had available to devote to studying helped or hindered my performance	Help1, Hinder1	If helped some or helped great deal, Help1=1, else Help1=0. If hindered some or hindered great deal, Hinder1=1, else Hinder1=0
My family helped or hindered my performance	Help7, Hinder7	If helped some or helped great deal, Help7=1, else Help7=0. If hindered some or hindered great deal, Hinder7=1, else Hinder7=0
My employer helped or hindered my performance	Help8, Hinder8	If helped some or helped great deal, Help8=1, else Help8=0.

Description	Short Name	Coding
		If hindered some or hindered great deal, Hinder8=1, else Hinder8=0
Hours in a week devoted to studying	TOTTIME	continuous
Hours in a week devoted to productive studying	PRODTIME	continuous
Percent of time spent studying that was productive	PRODPCT	PRODTIME/TOTTIME

Table 5. Scores Used to Place Students in Math Courses

Test Score	Mean	Std Deviation	Valid N
ACT Mathematics Score	19.50	3.35	470
ACT Mathematics Percentile	50.26	20.92	470
COMPASS Algebra Score	52.55	18.03	98
COMPASS Algebra Percentage (same as score)	52.55	18.03	98
SAT Quantitative Score	481.32	70.96	152
SAT Quantitative Percentile	38.37	22.00	152

Table 6. Self-Assessed Confidence In Performing A Variety Of Math Operations[1]

Operation:	None %	Low %	Medium %	High %	unable to judge %
Q16: Multiplying & dividing signed numbers	1.0	4.5	36.9	56.3	1.3
Q17: Adding & subtracting signed numbers	1.3	1.9	24.2	71.6	1.0
Q18: Multiplying & dividing fractions	1.0	14.1	44.7	40.2	
Q19: Adding & subtracting fractions	1.3	7.7	38.4	52.3	.3
Q20: Simplifying expressions with nested parentheses	1.0	6.5	47.7	43.5	1.3
Q21: Solving linear equations	1.3	14.5	53.5	24.8	5.8
Q22: Solving literal equations	2.3	21.8	45.6	11.7	18.6
Q23: Solving linear inequalities	2.3	21.3	50.3	17.7	8.4
Q24: Solving absolute value equations	1.3	11.0	46.8	38.4	2.6
Q25: Solving absolute value inequalities	1.9	15.6	46.8	28.6	7.1
Q26: Finding equations of lines	1.6	28.0	47.3	19.3	3.9
Q27: Finding slopes & intercepts of lines	3.6	21.5	46.3	28.3	.3
Q28: Simplifying expressions with + exponents	1.3	17.2	47.2	27.5	6.8
Q29: Adding & subtracting polynomials	1.6	15.5	47.1	30.6	5.2
Q30: Multiplying & dividing polynomials	1.0	20.3	46.5	26.5	5.8
Q31: Factoring polynomials	1.9	23.6	41.4	28.5	4.5
Q32: Solving polynomial equations by factoring	1.9	26.9	43.0	22.7	5.5
Q33: Multiplying & dividing rational expressions	2.0	23.5	51.6	13.7	9.2
Q34: Adding & subtracting rational expression	1.6	21.5	52.4	16.3	8.1
Q35: Simplifying complex fractions	2.0	27.7	46.3	19.5	4.6
Q36: Solving rational equations (w fractions)	2.0	31.0	49.8	7.9	9.2

[1] The factor analysis of these items can be found in Table 3.

Q37: solving systems of linear equations	2.6	28.9	48.4	9.5	10.5
Q38: Translating verbal expressions to algebra	3.9	28.9	46.1	17.4	3.6
Q39: Solving word problems involving numbers	4.5	33.0	43.7	18.8	
Q40: Solving word problems involving geometry	6.1	38.8	37.2	15.2	2.6
Q41: Solving word problems involving mixtures	6.8	43.5	34.1	10.7	4.9
Q42: Solving word problems involving distance	5.5	35.3	40.1	17.8	1.3
Q43: Solving word problems involving ratios	6.8	40.0	39.7	10.6	2.9

Table 7. Learning And Study Skills Inventory (LASSI) Scale Score Results (N=323)

	Mean	Std Deviation	Percentile Equivalent
Attitude and interest	31.42	5.69	41
Motivation, diligence, self-discipline	31.10	5.02	52
Time management	24.60	5.86	62
Anxiety about school performance	25.97	6.31	50
Concentration and attention for tasks	26.63	5.67	62
Information processing, reasoning	26.73	5.29	53
Selecting main ideas	18.21	3.38	53
Study aids- use of support techniques	23.18	5.13	40
Self-testing, reviewing, preparing	25.08	5.04	50
Test strategies and preparing for tests	28.54	5.25	44

Table 8. First Week Attitudes Toward Math, This Course, And Personal Role In Success (N=396)

	strongly disagree	disagree	agree	strongly agree
Prefer interesting & challenging courses	.6%	1.3%	63.3%	34.7%
This class will be interesting	2.6%	21.0%	68.4%	8.1%
Important to learn this material	.6%	3.9%	38.4%	57.1%
Subject matter will be useful	1.0%	9.1%	52.1%	37.9%
Grades depend on effort exerted	1.0%	2.9%	39.5%	56.6%
Grades depend on instructor	2.3%	20.8%	60.3%	16.6%
Expect to do well in this class	.3%	4.2%	65.0%	30.5%

Table 9. Hours Per Week Spent On Activities (N=386)

	5 or less	6-10	11-15	16-20	21-25	26-30	31 or more
Time preparing for classes	21.6%	37.1%	20.0%	13.5%	3.9%	1.9%	1.9%
Time working for pay on campus	84.9%	3.8%	3.8%	2.6%	3.4%		1.5%
Time working for pay off campus	19.9%	3.7%	6.6%	15.9%	13.3%	10.6%	29.9%
Time relaxing and socializing	24.2%	31.8%	24.2%	9.3%	4.0%	2.6%	4.0%
Time providing care for dependents	75.7%	9.4%	2.1%	2.1%	1.0%	1.7%	8.0%

Table 10. Helps and Hindrances to Student Success in Math 108 (N=344)

Factors which Might Affect Success	hindered a great deal %	hindered some %	neither helped nor hindered %	helped some %	helped a great deal %	not applicable %
Time available to devote to studying	9.4	20.8	12.2	35.1	22.2	.3
My math background	9.1	18.5	10.8	38.3	22.6	.7
My anxiety about this course	12.9	31.0	41.8	4.5	2.8	7.0
My study environment	2.4	18.8	36.1	31.9	10.8	
My study skills	3.5	21.1	22.5	45.3	7.6	
My ability to take tests	16.3	34.4	20.8	20.1	8.0	.3
My family	2.8	10.0	54.0	15.6	9.3	8.3
My employer	3.8	18.0	48.8	6.9	5.5	17.0
My motivation level	2.8	24.1	19.6	37.4	15.4	.7
My textbook	3.1	12.2	22.6	48.3	13.2	.7
The homework	3.1	5.9	8.4	47.7	34.8	
The instructor	5.2	4.8	6.6	30.8	51.6	1.0
The type of testing used	7.0	20.0	34.4	27.7	9.1	1.8
Time of day class is held	1.4	17.0	47.2	21.9	10.8	1.7
Membership in a study group	.3	2.1	22.1	10.7	3.1	61.6
The Student Solutions Manual	2.1	2.1	19.4	14.6	9.7	52.1
Videos in the library	.7	.7	19.7	1.0	.3	77.5

Table 11. Time Spent In One Week Studying In Math 108 (N=263)

Time Spent:	Mean	Std Deviation	Minimum	Maximum
Hours spent learning nothing or little (LV_1)	.99	5.85	.00	84.50
Hours spent learning something but not much (LV_2)	2.23	2.54	.00	11.50
Hours spent learning a fair amount (LV_3)	4.24	3.43	.00	24.00
Hours spent learning a great deal (LV_4)	1.95	3.23	.00	26.00
Total hours (LV_1 + LV_2 + LV_3 + LV_4)	9.40	8.37	.50	104.50
Productive hours (LV_3 +LV_4)	6.18	4.92	.00	39.00
Efficiency ((LV_4 / Total hours) X 100)	18.14	24.33	.00	100.00

Table 12. Summary Of Regression Results For Knowing Midterm Grade

Area:	Probability Likelihood Ratio	Probability F – regression	R^2	Variables carried forward (p<.10 on either analysis)[2]
Pre-enrollment Variables				
Demographics (N=289)	.0325	.0311	.0423	Freshman
Academic Preparation in math (n=126)	.9468	.9603	.0409	none
Attitudes & dispositions (N=134)	.0621	.1141	.1870	MOT, CON, *Q9 (preference for interesting & challenging courses)*
Other commitments (N=152)	.0352	.0446	.0936	Q7 (hours spent relaxing and socializing)
Course Variables				
Course & instructor (N=264)	<.0001	.0001	.1505	Instructor group, *Help12 (instructor)*, Help13 (type of testing)
Study skills & attitudes (N=289)	.3237	.3413	.0428	Help9 (motivation)
Time commitments (N=176)	.6602	.6874	.0377	Help8 (employer)

Table 13. Final Logistic and Multiple Regression Equations for Knowing Grade at Midterm

Statistic:	Intercept	Concentration score (LASSI)	Q7 (hours relaxing)	Instructor group	Help12 (Instructor helped)
Logistic Regression Results[3]					
Parameter estimate	-2.1801	0.0837	-0.3164	2.8799	1.3317
Chi square	2.4077	3.7479	4.2914	12.4683	6.0946
Prob > Chi square	0.1207	0.0529	0.0383	0.0004	0.0136
Odds ratio	N/A	1.087	0.729	17.812	3.787
Multiple Regression Results[4]					
Parameter estimate	0.18617	0.01395	-0.06513	0.36709	0.22844
t value	0.82	2.04	-2.53	4.62	2.57
Probability > |t|	0.4120	0.0433	0.0127	<.0001	0.0112

[2] Variables which were selected by only one of the two approaches are italicized.
[3] Likelihood Ratio Chi square=40.7573, DF=4, p=<.0001
[4] F ratio=11.19, DF=4&134, P=<.0001, R^2=.2504, Adjusted R^2=.2280

Table 14. Regression Results for Passing Course at Midterm

Area:	Probability Likelihood Ratio	Probability F – regression	R^2	Variables carried forward (p<.10 on either analysis)[5]
Pre-enrollment Variables				
Demographics (N=289)	.0284	.0301	.0423	Minority, Freshman
Academic Preparation in math (n=126)	.4366	.4883	.0928	Percentile
Attitudes & dispositions (N=134)	.0663	.1052	.1893	ANX, CON, TST, Q13 (grades depend on effort)
Other commitments (N=152)	.2600	.2843	.0110	none
Course Variables				
Course & instructor (N=264)	<.0001	<.0001	.1547	Instructor group, *help10 (text)*, help13 (type of testing), help14 (time of day), hinder10 (textbook)
Study skills & attitudes (N=289)	.0061	.0076	.0867	Hinder3 (anxiety), Help9 (motivation)
Time commitments (N=176)	.7789	.8025	.0311	Hinder1 (time for studying)

Table 15. Final Logistic and Multiple Regression Equations for Having a Passing Grade at Midterm

Statistic:	Intercept	Freshman	Percentile	CON	TST	Hinder 10 (textbook)	Help 9 (motivation)
Logistic Regression Results[6]							
Parameter est	-3.2964	0.8067	0.0337	0.1565	-0.1142	1.5296	0.9010
Chi square	7.8229	3.8349	11.4246	9.7938	4.6650	6.3607	5.1207
Prob > Chi sq	0.0052	0.0502	0.0007	0.0018	0.0308	0.0117	0.02236
Odds ratio	NA	2.241	1.034	1.169	0.892	4.616	2.462
Multiple Regression Results[7]							
Parameter est	-0.13368	0.16462	0.00653	0.03159	-0.02368	0.29634	0.18079
t value	-0.61	2.05	3.67	3.45	-2.34	2.66	2.31
Probability > |t|	0.5451	0.0419	0.0003	0.0007	0.0209	0.0087	0.0226

[5] Variables which were selected by only one of the two approaches are italicized.
[6] Chi square=35.6950, DF=6, Prob =<.0001
[7] F=6.55, DF=6&137, Prob=<.0001, R^2=.2228, Adjusted R^2=.1888

Table 16. Summary of Regression Results by Area for Passing Course with C or better

Area:	Probability Likelihood Ratio	Probability F – regression	R^2	Variables carried forward (p<.10 on either analysis)[8]
Pre-enrollment Variables				
Demographics (N=728)	.0727	.0756	.0137	Age
Academic Preparation in math (n=164)	.0002	.0004	.2047	Percentile, Q1 (recency of math), bsulast, Grade025
Attitudes & dispositions (N=203)	.0826	.1107	.1241	Mot, Anx, Con, Tst, *Q11(importance of material)*
Other commitments (N=249)	.1462	.1577	.0424	none
Course Variables				
Course & instructor (N=288)	.0007	.0008	.1178	Instructor_grp, Help13 (test type), Help15 (study group)
Midterm standing (N=289)	.0001	.0001	.1661	knowgrad, passgrad
Study skills & attitudes (N=289)	<.0001	<.0001	.1984	Help2 (math background), Hinder3 (anxiety), Hinder9 (motivation)
Time commitments (N=176)	.3948	.4196	.0528	Hinder1 (time available for studying)

Table 17. Final Logistic and Multiple Regression Equations for Passing Course with C or better

Statistic:	Intercept	ANX (anxiety score)	knowgrad	passgrad	Motivation (hinder9)
Logistic Regression Results[9]					
Parameter estimate	-1.3545	0.0819	-2.2545	2.8353	-1.2431
Chi square	2.8561	6.8507	10.5351	17.8173	9.9385
Probability > Chi square	0.0910	0.0089	0.0012	<.0001	0.0016
Odds ratio	N/A	1.085	0.105	17.035	0.288
Multiple Regression Results[10]					
Parameter estimate	0.26582	0.01509	-0.41172	0.53275	-0.24815
t value	1.86	2.84	-4.00	5.50	-3.41
Probability > |t|	0.0644	0.0050	<.0001	<.0001	0.0008

[8] Variables which were selected by only one of the two approaches are italicized.
[9] Likelihood ratio Chi square=53.4853, DF=4, Probability <.0001
[10] F-value=16.28, DF=4 & 176, Probability= <.0001, R^2=.2701, Adjusted R^2=.2535

Table 18. Regression Results Using Common Final Exam Score as the Outcome

Area:	Probability > F	R^2	Variables carried forward
Pre-enrollment Variables			
Demographics (N=634)	.0336	.0190	Age
Academic Preparation in Math (N=203)	<.0001	.3084	Percentile, Q1, Bsulast, Lastgrade, Factor4 (fractions & signed numbers), Grade025
Attitudes & Dispositions (N=203)	.1107	.1241	Mot, Anx, Con, Tst
Other commitments (N=248)	.0022	.0876	Q6 (hours working off campus)
Course Variables			
Course & instructor (N=288)	.0090	.0954	Help13 (tests), Help16 (Solutions Manual)
Midterm standing (N=288)	<.0001	.1633	knowgrad, passgrad
Study skills & attitudes (N=288)	<.0001	.2493	Help2 (math background), Help3 & Hinder3 (anxiety), Help5 (study skills), Hinder9 (motivation)
Time commitments (N=176)	.1851	.0713	Hinder8 (employer), Hinder1 (time available for studying)

Table 19. Final Regression Equation Using Common Final Exam Score as the Outcome[11]

Variable	Parameter Estimate	Standard Error	t value	Prob |t|
Intercept	22.36572	11.84732	1.89	0.0612
Percentile on Math placement	0.61486	0.16798	3.66	0.0004
Grade in last math course (lastgrade)	7.50046	2.67516	2.80	0.0058
Passing grade at midterm (passgrad)	20.86667	7.03161	2.97	0.0036
Help5 – Study Skills	21.01812	7.41534	2.83	0.0053
Hinder9 - Motivation	-16.71514	8.41438	-1.99	0.0490

[11] F=14.90, DF= 5 & 134, Probability=<.0001, R^2=.3573, Adj R^2=.3333