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PERFORMANCE, PLACEMENT, AND PERSISTENCE:

AN EXPLORATORY STUDY OF THE FIRST-YEAR MATH EXPERIENCE

AT THE UNIVERSITY OF MONTANA

By

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Thesis

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This quantitative study investigates a number of parameters associated with the first-year student’s math experience at The University of Montana: performance in the course and mathematics placement in the fall of 2005. The study sample is comprised of 1,044 first-year students who enroll in one of six selected 100-level math courses offered by the Department of Mathematical Sciences, ranging from intermediate algebra to calculus. Average grade earned by first-year students varies from a low of 1.72 in intermediate algebra to a high of 3.37 in applied calculus.

The study finds that a first-year student’s ACT or SAT math score is only weakly associated with his performance in a first-year mathematics course. Twenty percent of students elect to take the optional university-administered placement test; the association is stronger between their score on this test and performance in a first semester math course. In general, students who comply with their recommendation earn a higher average grade than those who enroll in a course above their placement; students who enroll in a course below their recommended placement do even better. The exception to this pattern is the compliance findings for intermediate algebra.

The study identified a sub-sample of 348 first-year students who had also enrolled in one of two English composition courses during their first-year in attendance at The University. Using a triage analysis technique developed for this study, three distinct groups were identified: Category 1 students who succeed in both their first-year mathematics and composition courses, Category 2 students who are unsuccessful in both courses, and Category 3 students who successfully complete one course but not the other.

The study finds that 70% of first-year students in the sample are in Category 1, 9% in Category 2, and 21% in Category 3. Category 3 was further subdivided in order to identify the percentage of students who did not succeed in mathematics but did in English composition (Category 3M – 18% of the total first-year population) and the percentage of students who succeed in mathematics but not composition (Category 3E – 3%). The study concludes with recommendations for improving the performance of first-year students in mathematics, and an estimate of the resulting improvement in persistence and retention.

DEDICATION

To the students who dream of the better life a college degree will offer them.

ACKNOWLEDGEMENTS

To take an interesting question and build it into a viable research study requires a community of mentors, colleagues, and family. I am forever grateful for the encouragement and friendship of my advisor and committee chair Dr. Libby Knott, who believed in the worthiness of my study and my ability to do it justice. For the past four years, she has both supported and challenged me, inspiring in me a passion about my work.

I am indebted to the members of my committee, Drs. Arlene Walker-Andrews, David Patterson, and James Hirstein, for their continual encouragement. Their willingness to allow me to “think out loud” in their presence and their comments helped direct my inquiry. My heartfelt thanks to Tony Tomsu and Cathy Burleson in The University’s Office of Planning, Budgeting, and Analysis, for their cooperation in fulfilling my requests for data extracts in a matter of days

My family support spans three generations. Thank you to my mother Jody Cole, who always lets me know that she is proud of me. Thanks to my children, Kate and Colin Campbell, who navigated their teen and twenty-something years with a whiteboard in the dining room and a pre-occupied mom. Finally, I am deeply grateful to my husband Mike Panisko, whose abiding humor and grace helps me laugh through the hard stuff.

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INTRODUCTION

The phrase “math anxiety” was first coined by Sheila Tobias (1978) almost three decades ago to describe the condition she observed in math-anxious students and adults at a Connecticut university. In the ensuing years, the phrase has become commonplace in the American vernacular and psyche.

No wonder then that the study of mathematics is perceived by many entering college students as the most difficult of academic subjects (Parker, 2005). The study of mathematics has become a curricular gateway, and the college mathematics department is the gatekeeper. Not surprisingly, many colleges and universities are finding that a large percentage of incoming first-year students have sub-par mathematics skills that require remedial coursework before they are able to undertake a basic college mathematics course (Parker, 2005; Greene & Foster, 2003). Indeed, recent research concluded that, "next to the college GPA, a student's performance in a first-year math course is the strongest retention predictor for new freshmen in their first semester" (Herzog, 2005). The U.S. Department of Education found that the three most likely courses students fail in college are all in the area of mathematics (Adelman, 1999) and the four most likely courses students repeat or withdraw from are all math related (Adelman, 2004).

Several key questions motivated this study of the performance of first-year students enrolled in one of several 100-level math course at The University of

Montana. The initial area of inquiry addressed the performance of the first-year students in six selected 100-level mathematics courses at The University. How did first-year performance vary by course? Was first-year performance different from nonfreshmen performance?

Secondly, was the placement advice first-year students received from the Department of Mathematical Sciences credible? Did complying with Department placement guidelines increase the probability that the first-year student would successfully complete the course, compared with the students who enrolled in a course above their placement or who had no placement guidance at all?

Finally, the study examined the relationship between a student's first-year experience in a mathematics course and the student's persistence at The University through to the third semester. Is there a difference in the academic standing distributions for those students who successfully complete their first mathematics course versus those first-year students who fail to do so? Is there an association between academic standing at the end of the third semester and a student's first-year mathematics experience at The University?

NEED FOR STUDY

Globalization of the world economy is having a significant impact on America's workforce and its postsecondary institutions. Today, six out of every ten jobs require some postsecondary education and training (Lotkowski, Robbins & Noeth, 2004). In order to remain competitive in a twenty-first century world economy, the number of American students who enroll in postsecondary education and complete a degree in a timely manner must increase.

This study's focus on the first-year student's math experience is purposeful because student dropout behavior occurs most frequently during the first-year, both immediately after the first semester and in the transition from the first to second year of college. To be effective, student service interventions must be "front-loaded" – before the student drops out of college (Hoyt & Lundell, 2003). In order to determine which of those service interventions are most appropriate, it is necessary to gain a clearer picture of the first-year student's performance in mathematics at The University, and how well the mathematics placement process works for those first-year students. Prior to this study, there had not been a comprehensive examination of performance and placement of students for all 100-level math courses.

Among the staff members of academic support groups on campus – the University Advising Center, the Educational Opportunity Program (EOP), and the

Math Learning Center – a consensus exists that a significant challenge facing many students is the successful completion a 100-evel mathematics course. It is not uncommon for some students to attempt M100 (Intermediate Algebra) three times in their college career before successfully completing the course, or giving up.

Currently, The University is engaged in a vigorous retention improvement project. Discovering if there is a connection between a student's first-year math experience and his persistence to the second year could help direct limited resources toward improving both the mathematics placement guidance and performance outcomes for first-year students at The University of Montana.

LITERATURE REVIEW AND BACKGROUND

The National Picture

Throughout the United States, most students leave high school unprepared to succeed at the college level without some form of remediation. Using a college readiness screen that incorporated high school transcript analysis, Greene and Foster (2003) of the Manhattan Institute for Policy Research conducted a national study of the high school class of 2001 in which they estimated the percentage of students who leave high school ready to attend a four-year college. They reported a national percentage for college readiness (36%) as well as separate percentages for each state and racial/ethnic group within each state. For Montana, the researchers found only 35% of white students leave high school qualified for a four-year college; 13% of Native American students pass the Greene/Forster college readiness filter.

Two seminal studies in the field of high school preparation and postsecondary retention have been conducted by the Department of Education during the last two decades. The first*, Answers in the toolbox: academic intensity, attendance patterns and bachelor' degree attainment* (Adelman, 1999), investigated the student factors that most contributed to retention and graduation from 4-year colleges. The analysis was based on a national cohort of high school students scheduled to graduate in 1982, and followed their progress toward a college degree through 1993. The second study, *The toolbox revisited*, was a replication of the first, again using a national sample of high school students scheduled to graduate in 1992 and following their progress through 2000 (Adelman, 2004). One of Adelman's key findings was that “the combination of [a student’s] . . . composite high school performance (using a measure of academic curriculum intensity) and cumulative college level math credits” (p.73) established the curricular momentum toward graduation for college students. The two factors that most influence progress toward graduation from college were high school academic preparation and successful completion of college mathematics courses.

Other research studies have been carried out within the past decade that specifically investigate the association between a student’s first-year performance in a mathematics course and their persistence in college. Melanie Parker (2005) explored the relationship between student four-year graduation rates at Clarion University and student success in mathematics. She found that a student’s timely progress toward a four-year degree is reflected in his or her success in mathematics courses. Quantitative analysis of the course grades and retention records for all 1,215 students revealed that “students who were more successful in their mathematics courses were more likely to be retained at the university and to graduate in four years” (p.39).

The purpose of the study conducted by Herzog (2004) was to better understand why students left the University of Nevada after the first-year, and to identify those attributes that had a significant impact on second-year persistence of first-year students. He found that students who successfully completed a first-year math course were twice as likely to be retained by the university. His results suggested that the first semester math experience, regardless of whether it is developmental or at an advanced level, was central to a first-year student's progress in college. Students who required remedial mathematics were at an increased risk for early departure from the university, unlike those students who needed remedial English. Going beyond the student in developmental mathematics, his analysis found that students in math-intensive majors were also less likely to leave prior to graduation. He concluded by recommending to the University of Nevada that all first-year students be required to take a mathematics gateway course, focusing on skill mastery, during their first-year. For marginal students, identified by some form of math test score, he also proposed mandatory summer preparatory classes in mathematics that would be held prior to fall enrollment.

The University of Montana Institutional Setting

High school graduates are offered full admission to The University provided they successfully complete the College Preparatory Program set forth by the State of Montana Office of Public Instruction guidelines. For full admission, students are required to have taken three years of math, including Algebra I, Geometry, and Algebra II, or the sequential content equivalent of these courses. Students are encouraged, but not required, to take a math course in their senior year.

Provisional-status admission is offered to students who fail to meet the full-admissions requirement if The University Admissions Committee determines that the student could be successful by utilizing the available academic support services. Committing to using the support services is not a condition placed upon the student for admission.

Faculty at The University supports the value of mathematics as a critical component of a student's knowledge base. Like many general education curricula, *The University of Montana – Missoula 2005-2006 Course Catalog's* General Education standards require all students to complete a course in mathematical literacy that is numbered higher than M100 (Intermediate Algebra). This requirement is based on the faculty requirement that "all graduates of The University possess the ability to accomplish basic algebraic manipulations and achieve mathematical literacy at a level typically presented in college mathematics courses" (p 26). Alternatively, students can meet the mathematics literacy requirement by passing the Mathematical Literacy Examination offered by the Department or by scoring 50 or higher on the College-Level Examination Program (CLEP) College Algebra Test.

100-Level Mathematics at The University Of Montana

The Department of Mathematical Sciences offers eleven mathematics courses at the 100 level. The courses are taught primarily employing a traditional lecture delivery mode, with lecture sizes ranging from 20-30 students in M152 (Calculus) to around 300 students in M117 Probability and Linear Math, a course that primarily serves non-calculus track majors such as business, psychology, health and human performance, and pre-nursing. The number of days of lecture generally corresponds to the number of credits assigned for each course; only M117 has mandatory, additional discussion sections that meet once a week in a lecture setting with 20-30 students.

Mathematics Placement at The University Of Montana

The Department of Mathematical Sciences administers the Mathematics Placement Assessment (MPA), designed to help first-year students decide on their first math course. First-year students are not required to participate in the Department's Mathematics Placement Assessment (MPA).

A first-year student is encouraged to attend one of two MPA sessions conducted during a University orientation session. There are three University orientations held during the summer and one in the fall just before classes start.

During the two hour MPA, students are assembled in a large lecture hall and receive an informational handout on mathematics placement at The University. The Department's coordinator for the placement outlines the three placement methods the student may use to decide upon a mathematics course. Students may elect to use their math score from a recent ACT or SAT course to place themselves in a course numbered 130 or below, and leave without taking the

Department's placement exam. If they choose this option, they are instructed to note their ACT/SAT score on their placement handout, and take it with them to use when they meet with their advisor later during orientation.

Students who choose not to use their ACT or SAT math scores take one of the Department's two placement tests and receive a recommended course placement based on their performance. Taking one of the Department's placement tests is recommended for students without a recent (within the past fifteen months) ACT or SAT math score and for students whose ACT/SAT math score does not place them in their desired math course.

Students choose from two assessment exams. The Basic Algebra exam is recommended for students not intending to take a calculus course, with less than three years of college-prep math in high school, or whose most recent math class was more than two years ago. The Calculus Readiness exam is required for students considering enrolling in a calculus course. Students are informed that the Calculus Readiness exam results will either give them a go ahead to enroll in a calculus course, or place them in the precalculus course (M121). A student is permitted to switch exam types once the testing has begun.

The two exams are identical in structure, consisting of twenty-five multiple choice questions, five choices per question. They are not timed and most students finish within an hour. A calculator is permitted, but is not required. Loaner calculators are not available for students to use.

After students complete the exam, they leave the lecture hall to have it scored immediately by a waiting team of Department faculty and graduate students. Each student receives his result and then receives a recommended placement from his scorer based on his exam score and plans for study at The University.

First-year students are encouraged to enroll in the mathematics course that corresponds to their placement, but the placement is non-binding; students are free to enroll in the math course of their choosing without registration restrictions.

Results of the assessment exams are tabulated by the Department coordinator, to be used by the Chair of the Department as a guide for scheduling the number of sections likely to be needed for each 100-level course. Up until 2006, the exam results were recorded on the student's individual record in the student record database; as of this writing, that practice has been discontinued.

Retention at The University Of Montana

As of this writing, The University community is engaged in a comprehensive program with the goal of improving student retention. The University's Office of Planning, Budgeting and Analysis (OPBA) reports that, for full time first-year students in 1999, 68.3% persisted to the second year, 20.3% graduated within 4 years, and 44% graduated within six years (all percentages based on the entering class of 1,671 first-year, full-time students). The subsequent years' classes of first-year full time students post similar statistics.

OPBA has found that there is a significant difference in three year retention rates for those students earning at least 30 credits per year (PROGRESSORS) compared to students who earn credits at a lower rate (NONPROGRESSORS) (Table 1).

Table 1*: Student Retention Rates for Progressors and Non-Progressors*

N= 1788	Student Retention Rates By Year		
	Year 1	Year 2`	Year 3
PROGRESSORS	**88%**	**71%**	**60%**
NON-PROGRESSORS	**57%**	**33%**	**31%**

Source: Office of Planning, Budgeting, and Analysis, The University of Montana

One of the purposes of this study is to identify the degree to which the first-year student math experience contributes to this failure to thrive.

STUDY DESIGN

For the purpose of this study, the following courses were selected for performance analysis. The accompanying descriptions of the courses are taken directly from *The University of Montana – Missoula 2005-2006 Course Catalogue:*

> M100: **Intermediate Algebra 5 cr.** Offered autumn and spring. Prereq., MAT 005 or appropriate placement score. Topics include linear equations and systems of linear equations, inequalities, applications and graphing; polynomials; rational expressions and equations; radicals, rational exponents and complex numbers; quadratic equations; introduction to exponential and logarithmic functions. Credit no allowed for both MAT 100 and MATH 100.
>
> M107: **Contemporary Mathematics 3 cr.** Offered every term. Prereq., MATH 100 or appropriate placement score. An introduction to mathematical ideas and their impact on society. Intended for students wishing to satisfy the general education mathematics requirement.
>
> M117: **Probability and Linear Mathematics 3 cr.** Offered every term. Prereq., MATH 100 or appropriate placement score. Systems of linear equations and matrix algebra. Introduction to probability with emphasis on models and probabilistic reasoning. Examples of applications of the material in many fields. Credit not allowed for both MAT 117 and MATH 117.
>
> M121: **Precalculus 4 cr.** Offered autumn and spring. Prereq., MATH 100 or appropriate placement score or three years of college preparatory mathematics. Properties of algebraic functions of one variable and their graphs, conic sections, trigonometric functions and inverses, trigonometric identities, exponential and logarithmic functions, and polar coordinates. Credit not allowed for both MATH 121 and MAT 120.
>
> M150: **Applied Calculus 4 cr.** Offered autumn and spring. Prereq., MATH 121 or appropriate placement score. Introductory course surveying the principal ideas of differential and integral calculus with emphasis on applications and computer software. Mathematical modeling in discrete and continuous settings. Intended primarily for students who do not plan to take higher calculus.

M152: **Calculus I 4 cr.** Offered autumn and spring. Prereq., MATH 121 or equiv. or appropriate placement score. Differential calculus, including limits, continuous functions, Intermediate Value Theorem, tangents, linear approximation, inverse functions, implicit differentiation, extreme values and the Mean Value Theorem. Integral Calculus including antiderivatives, definite integrals, and the Fundamental Theorem of Calculus.

The following 100-level courses are not included, either because few freshmen enroll in the course, or the course was not offered during the fall of 2005: M109 (Numbers as News), M130 (Mathematics for Elementary Teachers I), Math 131 (Mathematics for Elementary Teachers II), M153 (Calculus II), M158 (Applied Differential Equations).

The study employs two measures of overall student performance in a math course. The first computes the **average grade earned** by a student in the course. The University of Montana uses the traditional A-B-C-D-F grading for mathematics courses, awarding 4,3,2,1,0 points for each grade respectively. Few students select the Credit/No Credit option, as the credits earned do not count toward meeting the general education mathematics requirement for graduation.

The second measure, termed the **student outcomes distribution**, separates aggregate student performance into three categories and determines the percentage distribution of students in each category. This measure recognizes that there are three possible outcomes for a student who enrolls in a math course at The University of Montana:

(1) Receiving a grade of A, B or C (successful completion);

(2) Receiving a grade of D or F (unsuccessful completion, in that the student is unable to use that course to meet his/her general education requirement); or

(3) Receiving a grade of W or WF as a result of withdrawing from the course (noncompleters).

The distribution of student performance outcomes is determined for each 100-level math course in the study.

It is advantageous to have two different measures of aggregate student performance by course, because it is hypothetically possible for two separate courses to post the same average grade earned, yet have substantially different student outcomes distributions, as is shown in Table 2.

Table 2: *Two Measures Of Aggregate Student Performance: Average Grade Earned and Student Outcomes Distribution*

	Student Outcomes Distribution			
Mythical University	A,B,C Grade (Successful Completer)	D,F Grade (Unsuccessful Completer)	*W Grade (Noncompleter)	**Average Grade Earned**
Course X: n=120	7 A, 59 B, 0C	16 D,20 F	18 W	**2.3**
	55%	**30%**	**15%**	
Course Y: n=120	20 A, 20 B,68 C	12 D,0 F	0 W	**2.3**
	90%	**10%**	**0%**	

* The W grade is not included in the calculation of the mean grade.

Despite the fact that students in both courses earn an average grade of 2.3, almost all (108) of the students initially enrolled in Course Y successfully complete the course. By contrast, 54 students who enrolled in Course X must try again to successfully complete the course, and are stalled in their progress toward graduation.

The design of the study was informed by the initial data collection and analysis of first-year student performance, and so is further elaborated upon in the sections on data collection and findings.

DATA COLLECTION

The original study design called for using the report-generating feature in Banner to examine the performance of freshmen students enrolled in the fall of 2005. Banner is the software used by the University to manage its financial, personnel, and student databases. However, this researcher discovered that course grade data were not available in Banner following the academic year in which they took place.

The Department of Mathematical Sciences does retain hard copy grade reports by year and course. Each course grade report includes the course number, section number, all enrolled students, their student identification number, standing (freshmen, sophomore, junior, senior or graduate) and the final grade they received in the course.

Microsoft Excel™, a spreadsheet/database software package with basic data analysis tools, was used to record and analyze the hard copy data. For the 1,044 freshmen who enrolled in one of the 100-level math courses in this study, each first-year student's identification number, the 100-level course in which he had enrolled, and the grade he received in the course were entered in the spreadsheet; the name of the student was not recorded. Only the grade received and the course were entered for nonfreshmen, since the scope of the study did not include investigating the relationships of performance, placement and persistence of nonfreshmen.

Once compiled as a spreadsheet file, reports were generated using the two indicators of student performance: average mean grade and student outcomes distribution.

In order to investigate math placement and persistence, the researcher enlisted the assistance of the University's Office of Planning, Budgeting, and Analysis to extract from The University's Data Warehouse database third semester information on the study's subjects. The extraction resulted in an augmented database that added the following fields to the original, hand-entered database of the 1,044 freshmen: Academic standing; ACT, SAT and math placement scores; GPA; most recent math course attempted; Composition or Basic Composition (ENEX 100/101) grade; high school and high school rank; and birth date, gender and ethnicity.

SPSS 14.0, a statistical analysis and graphics software program, was used to analyze the data and generate the graphic representations of the results. The findings immediately follow.

FINDINGS: FIRST YEAR STUDENT PERFORMANCE IN 100-LEVEL MATH COURSES

Average Grade Earned: All Students by Course

In the fall of 2005, the average grade earned by all students – first-year and nonfreshmen - in a 100-level course ranged from a low of 1.77 in M100 (Intermediate Algebra) to a high of 2.94 in M150 (Applied Calculus). The M100 average is almost half a grade point lower than the next lowest average of 2.25 (M121). Table 3 presents the results.

Table 3: *Average Grade Earned by 100-Level Mathematics Course*

		Average Grade	# Enrolled
M100 Intermediate Algebra	ALL STUDENTS	1.77	533
	FIRST-YEAR STUDENTS	**1.72**	**374**
	NONFRESHMEN	1.89	159
M107 Contemporary . Math	ALL STUDENTS	2.64	260
	FIRST-YEAR	**2.54**	**104**
	NONFRESHMEN	2.70	156
M117	ALL STUDENTS	2.66	709
Linear Math	**FIRST-YEAR**	**2.87**	**313**
& Probability	NONFRESHMEN	2.50	396
M121 Precalculus	ALL STUDENTS	2.25	238
	FIRST-YEAR	**2.31**	**130**
	NONFRESHMEN	2.18	108
M150 Applied Calculus	ALL STUDENTS	2.94	183
	FIRST-YEAR	**3.37**	**58**
	NONFRESHMEN	2.74	125
M152 Calculus I	ALL STUDENTS	2.33	147
	FIRST-YEAR	**2.37**	**71**
	NONFRESHMEN	2.29	76
ALL 100 LEVEL MATH COURSES	ALL STUDENTS	2.38	2070
	FIRST-YEAR	**2.35**	**1050**
	NON-FRESHMEN	2.41	1020

Average Grade Earned: First-year Students vs Nonfreshmen

In general, first-year students achieve about the same average grade per math course as their nonfreshmen counterparts (Table 4). Where differences do occur, they do not occur in the same direction. For M100 and M107, the first-year students' average grades are lower than the averages for nonfreshmen; first-year students outperform nonfreshmen in all other 100-level courses.

Table 4: *Average Grade Earned: First-year Students vs Nonfreshmen*

	M100	M107	M117	M121	M150	M152
First-year	**1.72**	**2.54**	**2.87**	**2.31**	**3.37**	**2.37**
Non-Freshmen	**1.89**	**2.70**	**2.50**	**2.18**	**2.74**	**2.29**

Distribution of Student Outcomes by 100-Level Math Course

The distribution of outcomes by course reports the percentage and number of students who successfully completed that particular course by attaining a grade of A, B or C.

As can be seen in Table 5, when viewed in the aggregate, 71% of all students who enrolled in a 100-level math course in the fall of 2005 successfully completed that course, 21% were unsuccessful, receiving a grade of D or F, and 7% withdrew from a 100-level mathematics course. A grade of W or WF is posted on a student's transcript when he withdraws prior to the end of the semester but after the first three weeks of instruction.

The distribution of student outcomes varies by course. The course with the lowest rate of successful completion (55%) is M100 (Intermediate Algebra); the course with the highest rate of successful completion (88%) is M150 (Applied Calculus).

Table 5: *Distribution of Student Outcomes by 100-Level Course*

		A-B-C Grade		D-F Grade		W Grade	
		Number	*(percent)*	Number	*(percent)*	Number	*(percent)*
M100- Int. Algebra	ALL STUDENTS **n=533**	**293**	*55.0%*	**198**	*37.1%*	**42**	*7.9%*
	FIRST-YEAR **n=374**	**206**	*55.1%*	**143**	*38.2%*	**25**	*6.7%*
	NON-FRESHMEN **n=159**	**87**	*54.7%*	**55**	*34.6%*	**17**	*10.7%*
M107 Contemp. Math	ALL STUDENTS **n=260**	**207**	*79.6%*	**40**	*15.4%*	**13**	*5.0%*
	FIRST-YEAR **n=104**	**80**	*76.9%*	**20**	*19.2%*	**4**	*3.8%*
	NON-FRESHMEN **n=156**	**127**	*81.4%*	**20**	*12.8%*	**9**	*5.8%*
M117 Linear Math & Probability	ALL STUDENTS **n=709**	**554**	*78.1%*	**109**	*15.4%*	**46**	*6.5%*
	FIRST-YEAR **n=313**	**256**	*81.8%*	**45**	*14.3%*	**12**	*3.9%*
	NON-FRESHMEN **n=396**	**298**	*75.3%*	**64**	*16.2%*	**34**	*8.5%*
M121 Pre-calculus	ALL STUDENTS **n=238**	**160**	*67.2%*	**50**	*21.0%*	**28**	*11.8%*
	FIRST-YEAR **n=130**	**90**	*69.2%*	**24**	*18.8%*	**16**	*12.0%*
	NON-FRESHMEN **n=108**	**70**	*64.8%*	**26**	*23.8%*	**12**	*11.4%*
M150 App. Calculus	ALL STUDENTS **n=183**	**161**	*88.0%*	**15**	*8.2%*	**7**	*3.8%*
	FIRST-YEAR **n=58**	**56**	*96.5%*	**2**	*3.5%*	**0**	*0.0%*
	NON-FRESHMEN **n=125**	**105**	*84.1%*	**13**	*10.3%*	**7**	*5.6%*
M152 Calculus I	ALL STUDENTS **n=147**	**102**	*69.4%*	**32**	*21.8%*	**13**	*8.8%*
	FIRST-YEAR **n=71**	**53**	*75.0%*	**15**	*20.6%*	**3**	*4.4%*
	NON-FRESHMEN **n=76**	**49**	*64.6%*	**17**	*22.8%*	**10**	*12.7%*
TOTALS	ALL STUDENTS **n=2070**	**1478**	*71.4%*	**443**	*21.4%*	**149**	*7.2%*
	FIRST-YEAR **n=1050**	**740**	*70.5%*	**250**	*23.8%*	**60**	*5.7%*
	NON-FRESHMEN **n=1020**	**736**	*72.2%*	**195**	*19.1%*	**89**	*8.7%*

Distribution of Student Outcomes: First-year Students vs Nonfreshmen

The percentage of successful completion (receiving a grade of A, B or C) is about the same for first-year students and nonfreshmen in M100. First-year students exhibit higher rates of successful completion in several courses (M117, M121, M150 and M152), and only lag behind their nonfreshmen counterparts in M107. However, when the data are subjected to a two-sample t-Test, none of the differences is significant at the 5% significance level. The test for significance is limited due to the small size of the subpopulations compared.

A number of factors may contribute to the disparity in student outcomes among the courses, but the results reveal little difference in first-year student and nonfreshmen successful completion rates by course.

Regarding course withdrawal rates, the data suggest that nonfreshmen exercise the option to withdraw at higher rates than first-year students, with the exception of M121 (Precalculus). What factors might contribute to this discrepancy? It may be helpful to think of first-year students as college students with training wheels, not yet capable of independently navigating their future at The University. Three weeks into the first semester, these first-year students may not realize that withdrawal from a course is an option, and indeed quite preferable to receiving a grade of D or F. Acknowledging that this is simply conjecture, perhaps first-year students, particularly in their first semester, do not take into account the full effect that a grade of D or F will have on their cumulative GPA, especially if it is a 5-

credit D or F. According to University Advising, twenty-five percent of first-year students enter The University without declaring a major. These students may not be looking ahead to the process of entering a program that requires a minimum GPA.

For many students, receiving a grade of D or F in their first math course is responsible for having their first-year grade point average blow up on the launching pad. The effects of that initial D or F in a math course may result in the student never recovering sufficiently, in either confidence or grade point average, to persist through to the second year, let alone to graduation.

Tables 6 & 7 illustrate how damaging the grade of D or F can be to the GPA of a first-year student. The scenario assumes that the student did moderately well in his other coursework and took a 12 credit load each semester.

Table 6: *Effect of Receiving an 'F' in M100 on First Year Student GPA*

1st Year - 1st Semester	**Grade**	**Credits**	**Quality Points**	**GPA**	**Cum. GPA**
M100	**F**	**5**	**0**		
Other course	**B**	**4**	**12**		
Other course	**C**	**3**	**6**	**1.5**	**1.5**
1st Year - 2nd Semester					
Other course	**B**	**3**	**9**		
Other course	**C**	**3**	**6**		
Other course	**C**	**3**	**6**		
Other course	**C**	**3**	**6**	**2.25**	**1.875**

For the student who receives a 5-credit F in the first semester, even moderately good performance in other coursework is not sufficient to prevent him from being placed on probation at the end of his first semester, and on academic suspension at the end of his second semester.

The student who receives a 5-credit D in the first semester (Table 7) is placed on probation after the first semester. With moderately good performance, he is able to restore himself to good academic standing at the end of the second semester, but with only a margin of .08 grade points to spare.

Table 7: *Effect of Receiving a 'D' in M100 on First Year Student GPA*

1st Year - 1st Semester	Grade	Credits	Quality Points	GPA	Cum. GPA
M100	**D**	**5**	**5**		
Other course	**B**	**4**	**12**		
Other course	**C**	**3**	**6**	**1.92**	**1.92**
1st Year - 2nd Semester					
Other course	**B**	**3**	**9**		
Other course	**C**	**3**	**6**		
Other course	**C**	**3**	**6**		
Other course	**C**	**3**	**6**	**2.25**	**2.08**

It is possible that nonfreshmen, who are farther along the learning curve of navigating college and declaring a major, better understand the consequences of an F or D grade to their GPA, and therefore choose to withdraw rather than experience those deleterious effects.

FINDINGS: FIRST-YEAR STUDENT PLACEMENT

This study's next area of inquiry examines how well any of the three mathematics placement methods the Department uses predicts a first-year student's success in a 100-level course. Of course, student success in a course is for the most part attributable to student effort and perseverance; there is no placement test that can predict a student's propensity to skip an 8:00 a.m. class, or rely upon last minute cramming before an exam.

The Department suggests three ways a student may place himself into his first math course at the University of Montana: use his ACT math score and the Department's recommendations based on that score; use his SAT math score and the Department's recommendations based on that score; or take the Basic Algebra Placement Test, administered by the Math Department at orientations during the summer and fall, and use the Department's recommended placement based on that score. A number of students enroll in their first math course without the benefit of scores in any of these tests.

However, we can expect that a placement test and its accompanying guidelines will do better than no guidance at all in accurately placing students of varying degrees of academic preparation in their first math course.

In order for the placement test to be valid, its content needs to be aligned with the content of the courses into which the students are placed. Additionally, developing a scale so that meaningful placement brackets result is just as crucial to validity as the design and content of the test itself.

If the placement test is valid, then its recommendations based on a student's test score, should be positively associated to aggregate student performance in the course. One would not expect the correlation to be perfect, for individual student performance ultimately rests with the student. But it is not unreasonable to expect that the placement test scores and recommendation guidelines would be, on aggregate, predictive of performance.

In order to explore the association between the placement method used and performance in the course, the 1,044 first-year students were grouped according to the 100-level course in which they had enrolled. Each course group was then sub-grouped by the three placement methods: those with ACT scores, those with SAT scores, and those who had taken the Basic Algebra test. In many cases, students belonged to more than one group, which explains why the total number of first-year students enrolled in the course is smaller than the sum of the three sub-groups. For each of the placement method sub-groups, the students were grouped by performance in the course (grades A-F & W). For each placement test method, the *y*-axis represents the range of scores possible under that method. ACT math scores range from 0-36, SAT scores from 200-800, and scores on the Department's Basic Algebra test range from 0-25.

For purposes of analysis, a boxplot is generated comparing the range of student placement scores with student performance in the course. The *x*-axis represents student performance by grade attained and the number of students in each category: how many received A's, B's, C's, D's, F's and W's. The *y*-axis represents the range of placement test scores. A boxplot graph reveals the 25th, 50th and 75th percentiles; the full range of scores is shown as the vertical lines emanating from the top and bottom of the boxplot.

What immediately follows are the placement method boxplot analyses for M100 (Intermediate Algebra) and M117 (Probability and Linear Math) (Figures 1-8). There are two reasons for directing attention to these two courses. First, of the 1,044 first-year students who took a math course in the fall of 2005, nearly 70% enrolled in one of these two courses. Secondly, the successful completion rate for M117 is significantly higher than that for M100 (77% and 55%, respectively), which prompts this researcher to ask whether it is possible that the current placement methods work reasonably well for M117, but not for M100?

Analysis of First Year Student Placement Methods for M100 (Intermediate Algebra)

Of the 374 freshmen in M100 in the fall of 2005, 242 have ACT Math scores, 143 have SAT math scores, and 114 have Basic Algebra test scores that they can use in conjunction with the Math Department placement guidelines to select their first math course.

Looking at Figure 1, we see that those students who receive an A in M100 have the highest median ACT score (22.5). If the ACT scores predict performance in a course, we would expect to see the boxplots stair-step down for each lower grade. We do see a drop from A to B; students receiving a B had an ACT median of 20. However, students receiving a C posted a median ACT score of 18, identical to the median ACT score for students receiving a D. For the 71 freshmen who received the grade of F, their median ACT score was 19, above the medians for students receiving C's or D's.

Figure 1: *Boxplot of ACT Math Scores by M100 Grade Categories*

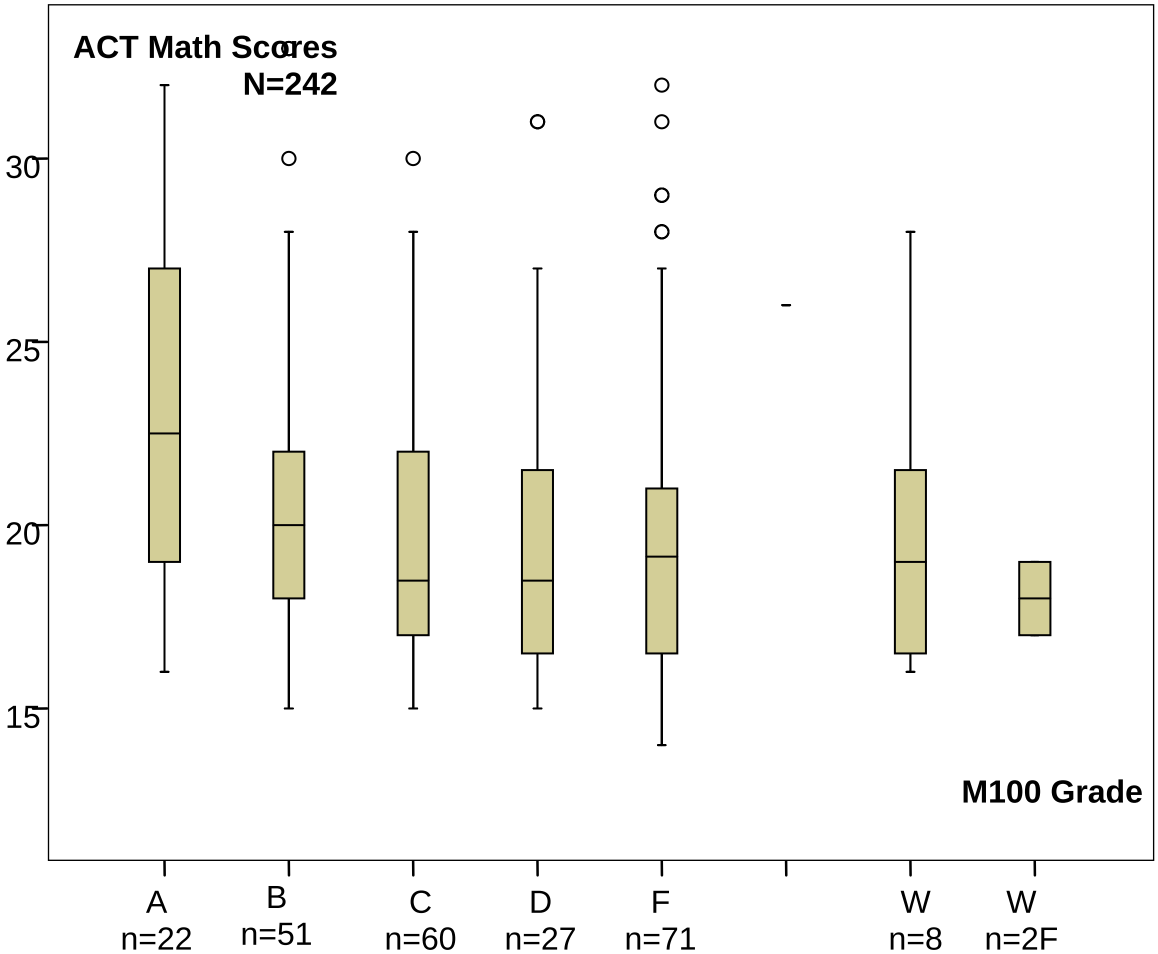
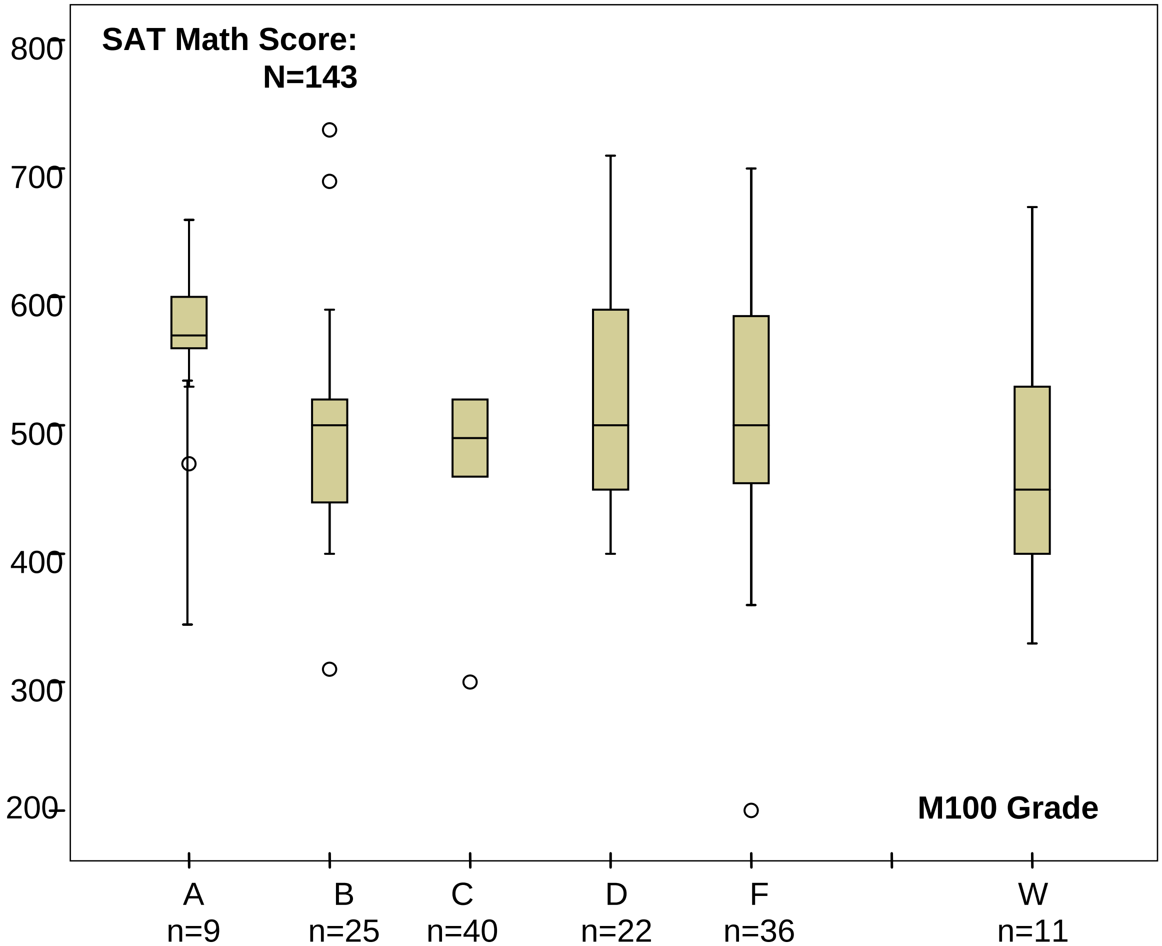


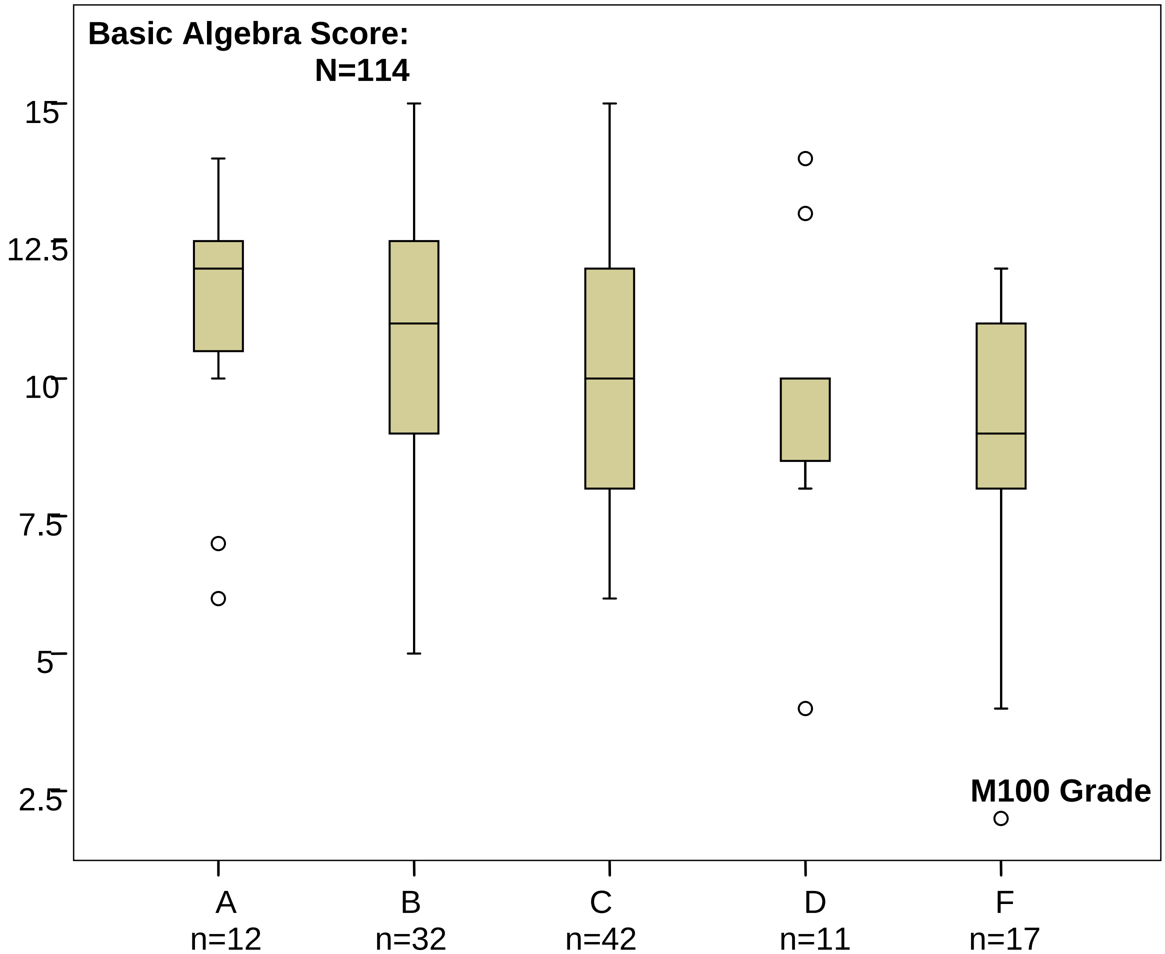
Figure 2 shows the results of the same analysis, using SAT Math scores. The highest SAT median score (570) occurs for those students receiving an A in M100. There is no apparent association between the boxplots of the SAT scores and the grade attained in the course for student receiving a grade of B, C, D, F or who withdrew from the course,

Figure 2: *Boxplot of SAT Math Scores by M100 Grade Categories*



Finally, we examine the boxplots of student scores on the Basic Algebra test, grouped by their M100 grade.

Figure 3*: Boxplot of Basic Algebra Test Scores by M100 Grade Categories*

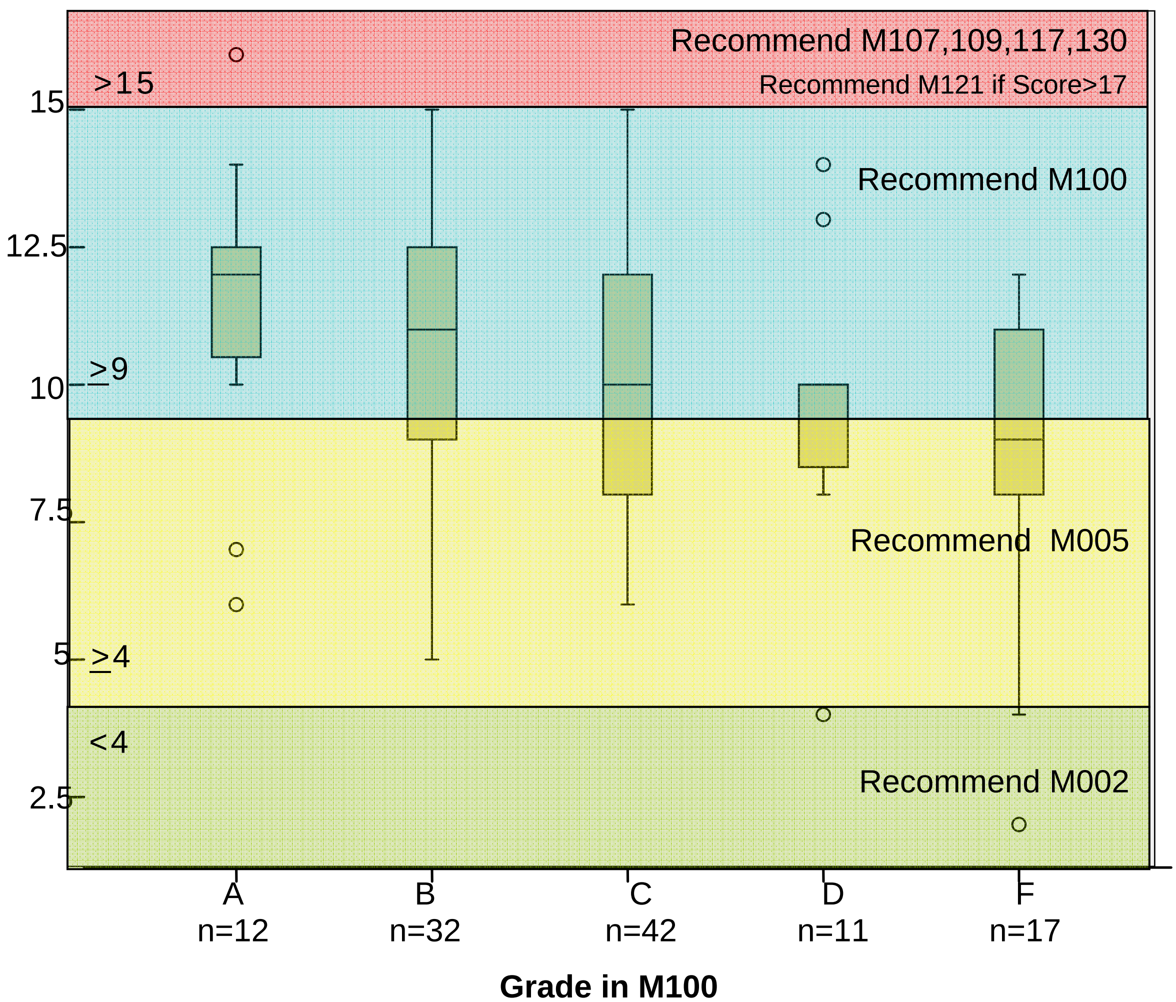


A slightly different picture emerges: this time, the median Basic Algebra placement test scores decrease as letter grade earned in M100 decreases. However, the differences in the median scores are relatively small: the highest median score is 12, for those attaining an A, and the lowest median score is 9, for those students receiving an F.

With the placement method analysis complete for M100, we next examine the Department's placement guidelines developed to help students place themselves accurately in their first math course.

Because the Basic Algebra test appears to be the placement test that is the most positively associated with student course performance, we compare the Basic Algebra test scoring guidelines to its Placement Analysis. Figure 4 overlays the Department's M100 placement guidelines on top of Figure 3.

Figure 4: *Department M100 Placement Guidelines for Basic Algebra Test Scores N=114*



Students who score between 4 and 8 on the 25-question placement test are advised to enroll in M005, Beginning Algebra, a remedial, non-credit course; those who score between 9 and 14 are advised into M100; and students who score 15 or more are advised to enroll in either Precalculus (M121), a mathematical ideas survey course (M107), or a course in probability and linear math (M117). Students who place into the three higher-numbered courses base their enrollment decision on the requirements of their major.

Interpreting how well the Basic Algebra Test predicts student performance in M100 depends on whether you choose to look at the glass as half empty or half full. On one hand, for students whose Basic Algebra scores placed them in M100, 60 out of 72 (83%) successfully completed the course. On the other hand, for students whose Basic Algebra score placed them into M005, 26 out of 42 (62%) were able to successfully complete M100 (Table 8).

Table 8: *M100: Basic Algebra Placement Advice and Student Performance*

M100 Student Performance N=114		**Advised to take M005**	**Advised to take M100**	**Total**
Grade Received	A,B,C	26	60	**86**
	D, F, W	16	12	**28**
		42	72	**114**

Cross Tabulation: M100 Grade X Basic Algebra Test Scores

The expectation is that if the Basic Algebra test performs well when placing students in M100, we will find that the percentage of students receiving grades of A, B, and C – the successful completers – is higher among placement-compliant students than among students who ignored their placement into M005 and enrolled in M100 anyway.

Table 9 displays the distribution of M100 grades for each Basic Algebra Test score, subtotaling within each placement recommendation. Recall that a score between 4 and 8 places the student into M005; a score between 9 and 14 places him into M100; and a score above 14 places him into his choice of a higher-numbered course.

Placement-compliant students have only slightly higher rates of successful completion than non-compliant students. Seventy-six percent (76%) of placement-compliant students were successful in M100, receiving a grade of A, B or C. For students who enrolled above their recommended placement, the percentage drops to 71%. Similarly, 29% of the students who over-enroll in M100 receive a D or an F, just slightly higher than the 25% of students who comply with their recommendation yet are not successful in the course.

Table 9: *Cross Tabulation: M100 Grade X Basic Algebra Test Scores*

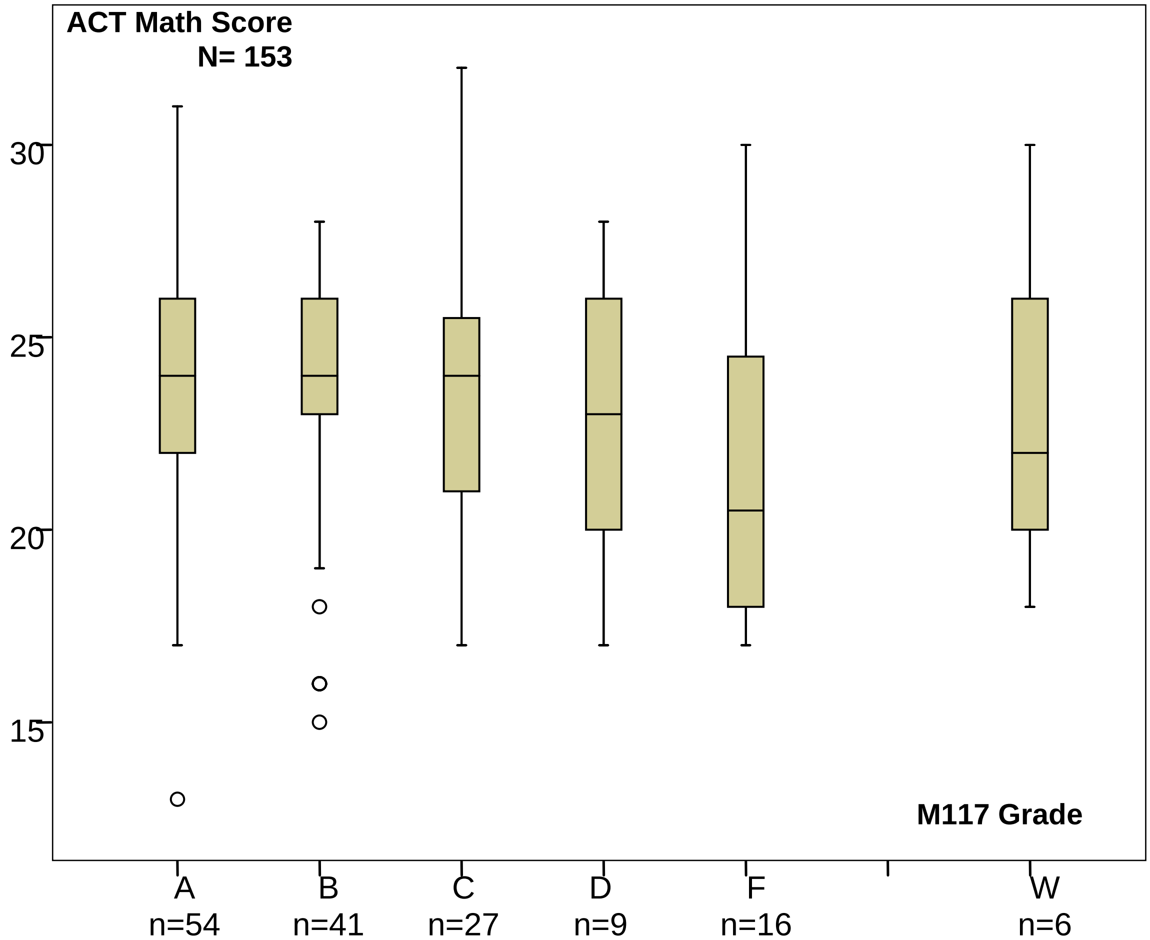
		M100 Student Grade Distribution					
		# of A's	# of B's	# of C's	# of D's	# of F's	Total
Student Score on Basic Algebra Placement Test	2	0	0	0	0	1	1
	4	0	0	0	1	1	2
	5	0	1	0	0	0	1
	6	1	2	2	0	0	5
	7	1	1	6	0	2	10
	8	0	3	3	2	1	9
	Subtotal	**2**	**7**	**11**	**3**	**5**	**28**
	%	**7%**	**25%**	**39%**	**11%**	**18%**	**100%**
	9	0	3	4	2	5	14
	10	1	2	7	4	2	16
	11	2	8	4	0	4	18
	12	3	4	5	0	1	13
	13	1	4	8	1	0	14
	14	1	3	1	1	0	6
	Subtotal	**8**	**24**	**29**	**8**	**12**	**81**
	%	**10%**	**30%**	**36%**	**10%**	**15%**	**100%**
	15	0	1	1	0	0	2
	16	1	0	0	0	0	1
Calculus Readiness Test	109	0	0	1	0	0	1
	110	1	0	0	0	0	1
	Subtotal	**2**	**1**	**2**	**0**	**0**	**5**
		n/a	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**
Grand Totals		**12**	**32**	**42**	**11**	**17**	**114**

Analysis of First Year Student Placement Methods for M117 (Probability and Linear Math)

The study now addresses the relationship between placement testing and course performance for the 313 freshmen who enrolled in M117 in the fall of 2005. Of the 313 first-year students in M117, 153 have ACT Math scores, 120 have SAT math scores and 54 have Basic Algebra test scores that they can use in conjunction with the Math Department placement guidelines to select their first math course.

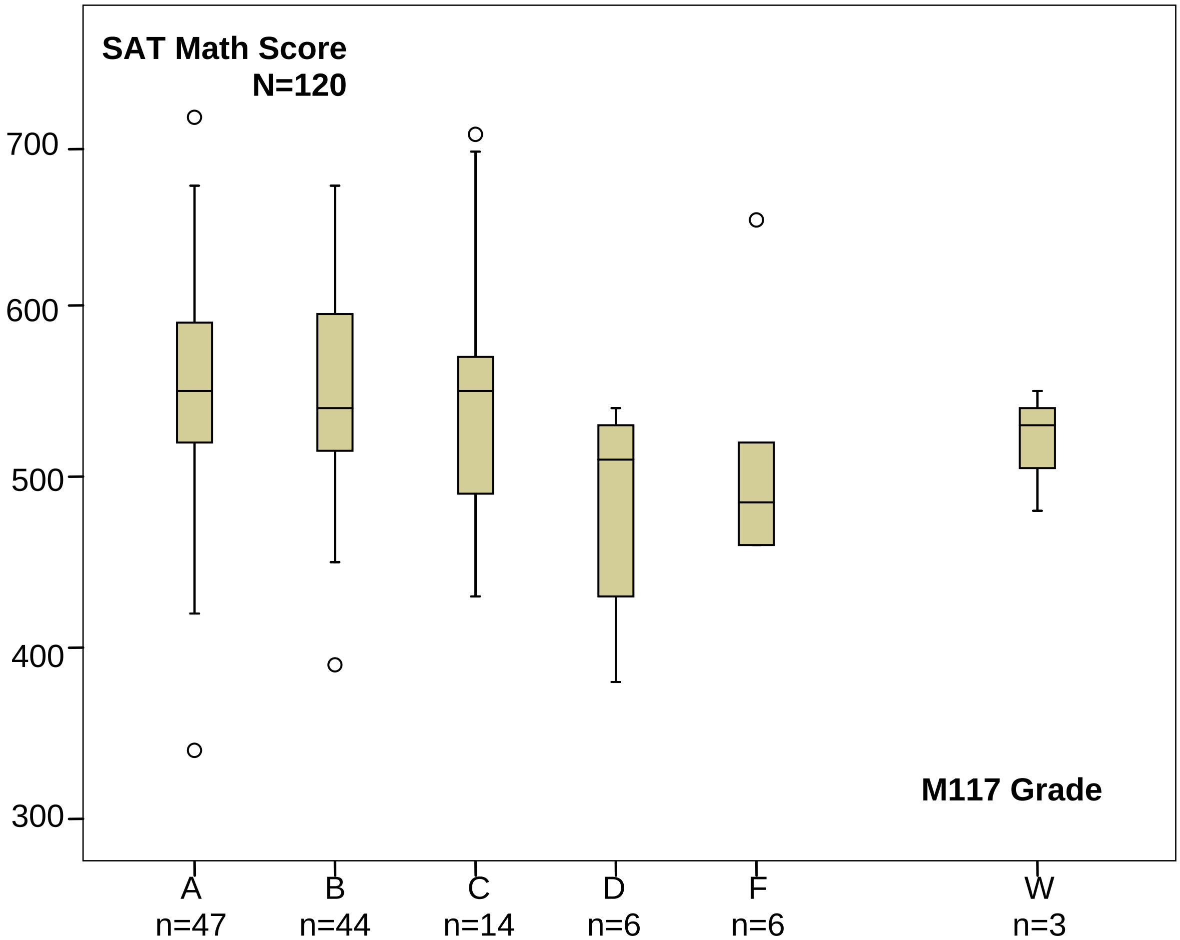
For M117, there seems to be little association between a student's ACT score and his performance in the course. For the ACT scores, those students receiving a C in the course have nearly the same distribution of scores as those students who receive an A (see Figure 5).

Figure 5: *Boxplot of ACT Math Scores by M117 Grade Categories*



For students with SAT math scores, there is a similar lack of association (Figure 6).

Figure 6: *Boxplot of SAT Math Scores by M117 Grade Categories*

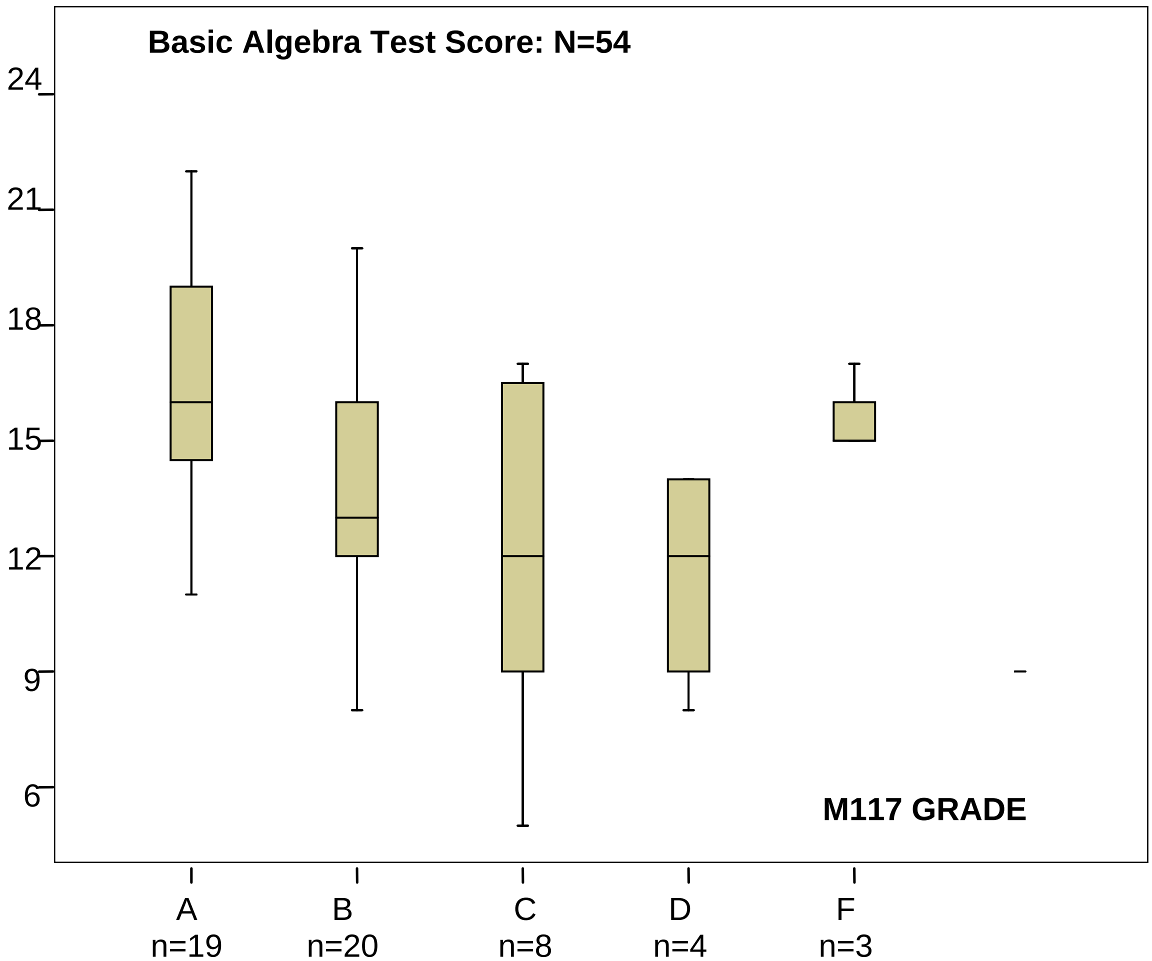


In the case of the SAT scores, students who earn a C in the course post a higher median SAT Math score than those who receive an A or a B.

Just as was observed in the case of M100, there appears to some association between the score a student receives on the Basic Algebra test and the grade he earns in M117 (Figure 7). As the grade earned drops, the median score on the

Basic Algebra Test drops as well. Again the differences in the median scores are relatively small: the highest median score is 16 for those attaining an A, and the lowest median score is 12, for those students receiving a D.

Figure 7*: Boxplot of Basic Algebra Test Scores by M100 Grade Categories*



With the placement method analysis complete for M117, we next examine how well the Department's placement guidelines predict student performance in M117. Once again, since the ACT and SAT math scores appear limited in their ability to predict student performance in M117, we omit analyses of the Department's placement guidelines for those scores, and focus solely on the Department's Basic Algebra Test scores. Figure 8 overlays the Department's M117 placement guidelines on top of Figure 7.

Figure 8: *Department M117 Placement Guidelines for Basic Algebra Test Scores (N=54)*

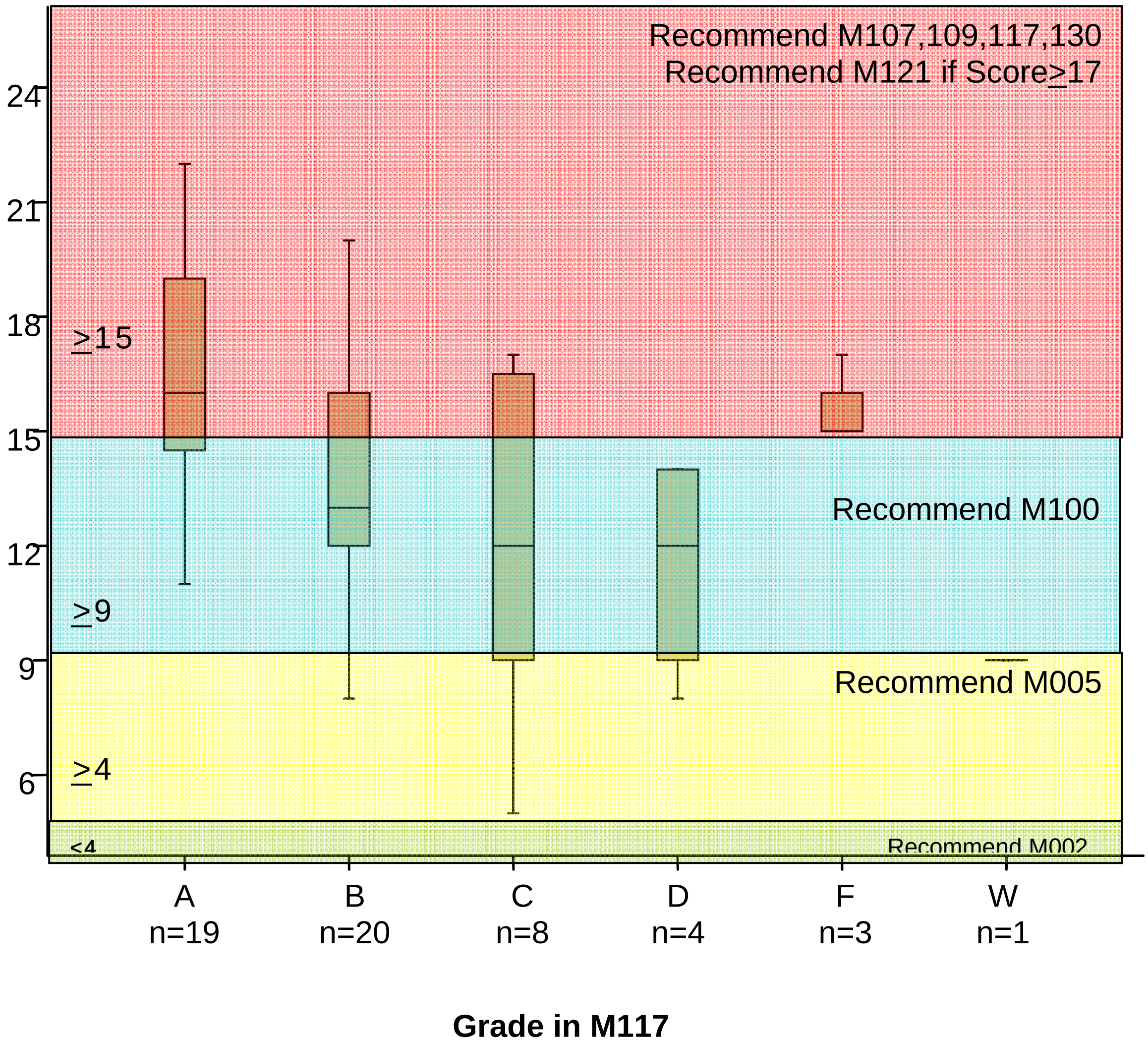


TABLE 10: *M117: Basic Algebra Test Placement Advice and Student Performance*

M117 Student Performance N=54		**Advised to take M100**	**Advised to take M117**	**Total**
Grade Received	A,B,C	20	27	**47**
	D, F, W	4	3	**7**
		24	30	**54**

Again the analysis shows the Basic Algebra test score is an inconsistent predictor of student success in M117. Ninety percent of the students who placed in M117 based on their Basic Algebra test score received a grade of A, B or C. Yet it is also true that 83% of the students who **ignored** their lower placement were nevertheless successful in M117. In other words, had the placement results of the Basic Algebra test been mandatory, 20 out of 47 students, or 43% of those who successfully completed the course, would have been unable to enroll in the course.

Cross Tabulation: Student Basic Algebra Test Score X M117 Grade Earned

The expectation is that if the Basic Algebra Test performs well when placing students in M117, we will find that the percentage of students receiving grades of A, B, and C – the successful completers – is higher among placement-compliant students than among students who ignored their placement into a lower-numbered course and enrolled in M117 anyway.

Table 11 displays the distribution of M117 grades for each Basic Algebra Test score, subtotaling within each placement recommendation. Recall that a score below 9 places the student into M005; a score between 9-14 places him into M100; a score 15 or higher places him into M117.

For M117, the percentage of students who received a grade of A is much higher among placement-compliant students (those whose Basic Algebra Test scores are above 14) than among students who ignored their lower placement and enrolled in M117 (47% vs. 24%). This suggests that students who score within the M117 placement range are twice as likely to obtain an A in the course than those who score below. When comparing rates of successful completion, we find that 90% of placement-compliant students successfully complete the course. However, the percentage drops only slightly to 86% for those students who ignored their lower placement and enrolled in M117 anyway.

Given the small number of students in this sample (54), the researcher stresses the need for additional analysis with a much larger data set before any definitive conclusions can be made regarding the efficacy of the Basic Algebra placement test.

Table 11: *Cross Tabulation: M117 Grade X Basic Algebra Test Scores*

		M117 Student Grade Distribution					
		# of A's	# of B's	# of C's	# of D's	# of F's	Total
Student Score On Basic Algebra Placement Test	5	0	0	1	0	0	1
	8	0	1	0	1	0	2
	Subtotal	**0**	**1**	**1**	**1**	**0**	**3**
	%	n/a	n/a	n/a	n/a	n/a	
	9	0	1	3	0	0	5
	10	0	0	0	1	0	1
	11	1	2	0	0	0	3
	12	0	4	0	0	0	4
	13	1	3	0	0	0	4
	14	3	0	0	2	0	5
	Subtotal	**5**	**10**	**3**	**3**	**0**	**21**
	%	**24%**	**48%**	**14%**	**14%**	**0%**	**100%**
	15	2	4	1	0	2	9
	16	3	0	1	0	0	4
	17	2	1	2	0	1	6
	18	1	2	0	0	0	3
	19	2	1	0	0	0	3
	20	0	1	0	0	0	1
	21	3	0	0	0	0	3
	22	1	0	0	0	0	1
	Subtotal	**14**	**9**	**4**	**0**	**3**	**30**
	%	**47%**	**30%**	**13%**	**0%**	**10%**	**100%**
Grand Total		**19**	**20**	**8**	**4**	**3**	**54**

Student Compliance with Math Course Placement

First year students who followed the Department's placement advice were expected to attain a higher average grade in a 100-level course than students who enrolled in a course above their placement. Similarly, this researcher predicted that students who enroll in a course below their placement will perform better on average than all other students, since one would presume that the course will be easier for them. This researcher had no preconceived notions about how the 149 first-year students lacking ACT, SAT and Basic Algebra test scores to guide them in their enrollment decision would perform relative to the others.

For the purposes of this exploration, the first-year students were divided into four categories:

COMPLIANT: Students who follow the Department's placement guidelines and enroll in the recommended course;

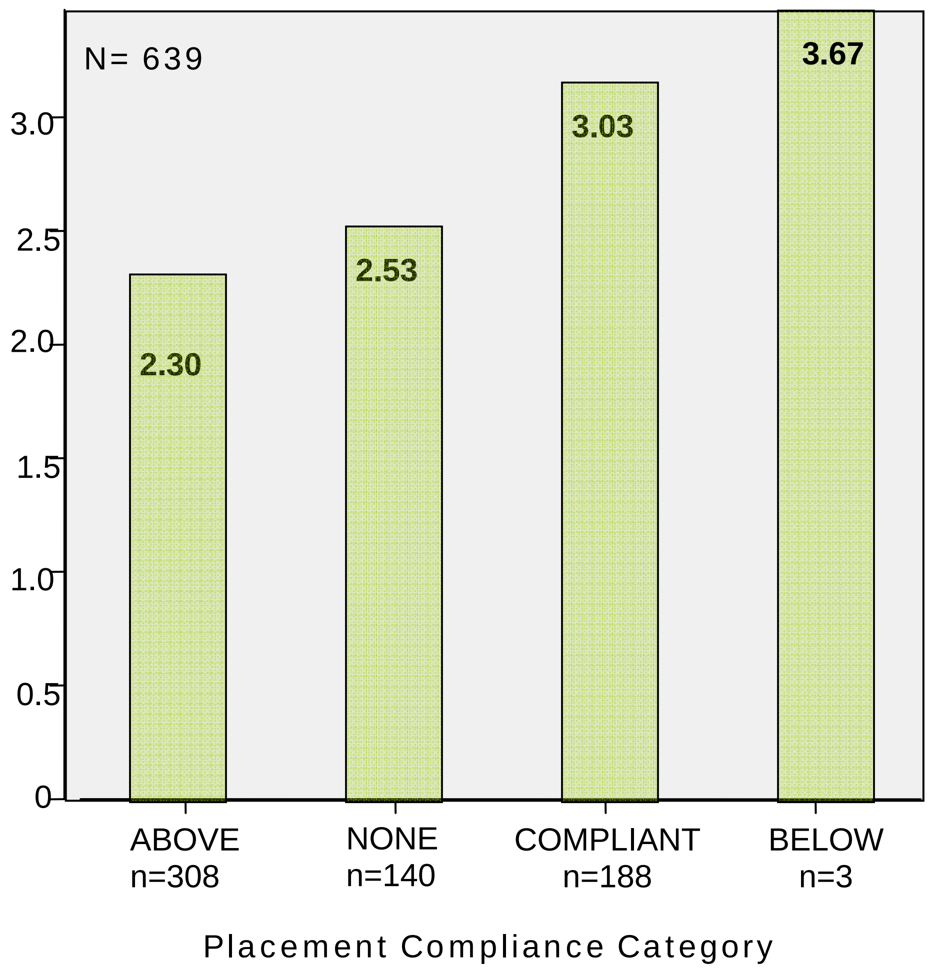
BELOW: Students who enroll in a course below their recommended placement;

ABOVE: Students who enroll in a course above their recommended placement; and

NONE: Students who did not have an ACT, SAT or a Basic Algebra test score on which to base their decision.

The average grade in 100-level mathematics course was then calculated for each of the four sub-groups of students. In order to isolate the placement compliance effect for M100 grade performance, a separate analysis was conducted for that course alone. Figure 9 shows the average grade earned for all 100-level mathematics courses excluding M100 by compliance category.

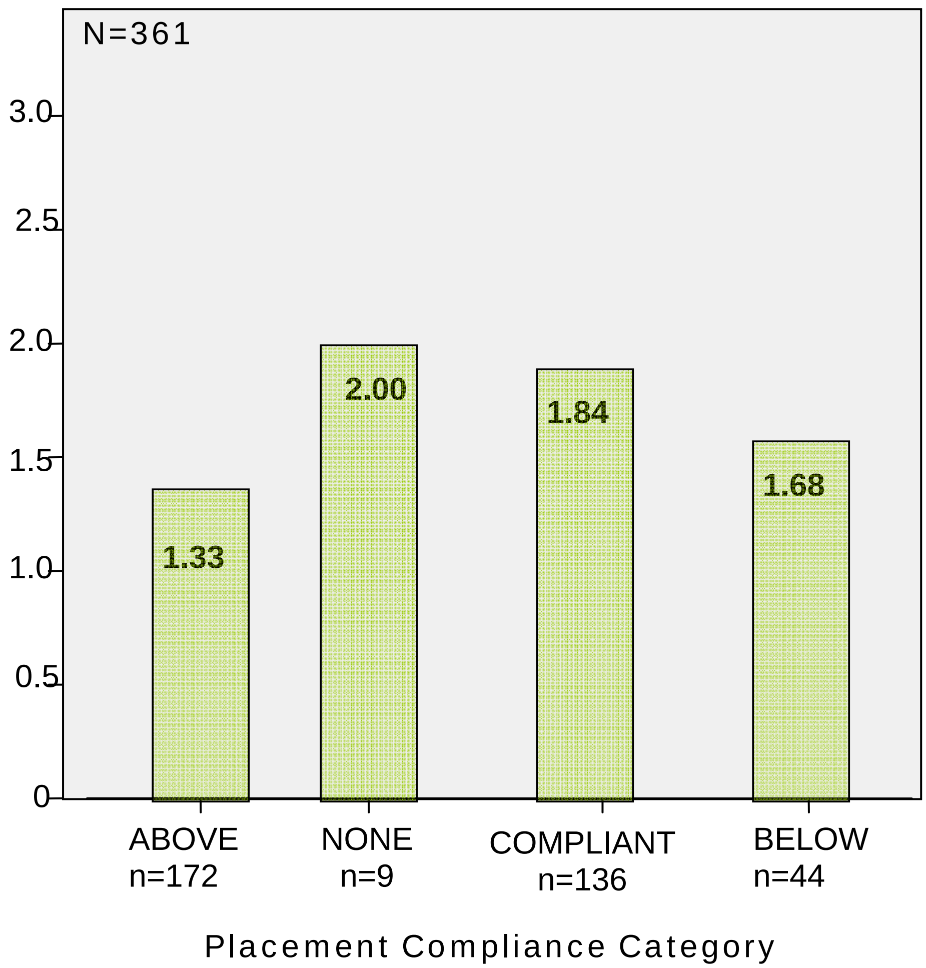
Figure 9: *Average Grade Earned by Compliance Category (Excludes M100)*



The findings confirm the expectations: first-year students who enrolled in a course above their placement (ABOVE) attained a lower average grade than students who complied (COMPLIANT) with their placement. The students who had no test scores of any type (NONE) on which to base their enrollment decision posted a higher average grade than the above-placement students (ABOVE), but not as high as the compliant students (COMPLIANT). Those who enrolled in a course below their placement (BELOW) had the highest average grade.

For M100, first-year students who comply with their placement (COMPLIANT) earn a higher average grade than those who enroll above their placement (ABOVE) (Figure 10).

Figure 10: *Average Grade Earned by Compliance Category - M100 Only*



The analysis reveals two curious anomalies. First, students without an ACT, SAT or Basic Algebra placement score (NONE) post the highest average grade in M100 - better than those who take the Basic Algebra test. Secondly, students who enroll in M100 below their placement (BELOW) earn a **lower** average grade than those who comply with their placement (COMPLIANT) into M100. This is at odds with the notion that students who enroll in what should be an easier course will outperform students in all other compliance categories.

The analysis reveals that, regardless of compliance category, the average grade earned in M100 is substantially below its counterpart category for all other 100-level courses, confirming the average grade earned findings reported earlier in the section on performance. Since the average grade earned in M100 compared to other 100-level courses is lower for every category of compliance, we can rule out the possibility that the performance difference noted earlier is due to a difference in compliance patterns for M100 and other 100-level courses. Apparently, the difference in average grade earned cannot be explained by differences in course placement compliance.

FINDINGS: FIRST YEAR PERFORMANCE IN MATHEMATICS AND PERSISTENCE THROUGH TO THE SECOND YEAR

A Triage Analysis of First Year Student Persistence and Mathematics Performance

The empirical findings for performance and placement confirm the anecdotal reports from mathematics faculty and advisors that a significant percentage of all students struggle in 100-level mathematics courses, especially in M100. First-year students perform on par with their non-freshmen counterparts, except for first-year students' lower rates of course withdrawal. We now turn to the final phase of the study that investigates the first-year student's persistence to the second year.

Because The University has a mission to reach out to Montana high school students seeking a college education, it is inevitable that a number of first-year students will arrive at the University inadequately prepared academically, socially and/or emotionally to succeed at that time. In attempting to identify the effect that first-year math performance has on student persistence through to the second year, it is necessary to separate these not-yet-ready students from the students who demonstrate that they are capable of college-level work in other academic disciplines, but whose Achilles' heel is the first-year math course. In order to identify these two distinct groups, the researcher conducted a triage analysis of the 1,044 first-year students in the fall of 2005.

Triage is an intervention and assessment strategy that originated on the battlefields of World War I, where emergency medical teams would evaluate the wounded and allocate limited medical treatment resources according to three categories:

(1) slightly injured soldiers needing little treatment or whose treatment could wait,

(2) soldiers with injuries so severe that no level of treatment would prevent the inevitable, and

(3) soldiers who could survive if they received immediate and aggressive treatment.

For the triage analysis of first-year math performance, the study compares two measures of a first-year student's academic performance: his grade in a 100-level math course and his grade in one of the two English composition courses (ENEX 100 or 101). Using this filter, the original study's sample size of 1,044 is reduced to 348 first-year students. These are the students who enrolled in both a 100-level math course in the fall of 2005 and in one of the two ENEX courses during the 2005-2006 academic year.

Using the triage paradigm to define the three groups, the first group is comprised of students who successfully completed both a 100-level math and an ENEX course. There are 244 students in this category, which the study labels

Category 1. The supposition is that this group is generally doing well at The University, although the 14 students who receive a C in both courses may be considered to be at-risk for persistence.

The second group is comprised of 35 first-year students who receive a D, F or W in both a 100-level math and an ENEX course. The inability of these students to successfully complete either one of the two courses suggests that they are not yet ready to succeed at the University, for a myriad of reasons. The study defines this group as Category 2.

In the final group, Category 3, 77 first-year students exhibit a disparity in their performance in the two courses. Disparity exists when a student successfully completes one of the courses but not the other, e.g. the student earns a grade of A in ENEX 100 and a D in M117, or a W in ENEX 101 and B in M100. Within Category 3, the groups are further split into 3M and 3E. Category 3M students fail to successfully complete their first 100-level math course, yet are successful in ENEX 100 or 101. In contrast, Category 3E students are successful in their first 100-level math course, but fail to succeed in ENEX 100 or 101. The triage analysis reveals that there are six times as many students in Category 3M as in Category 3E (67 vs. 10).

Tables 12 & 13 display the triage category frequencies, in detail and summary formats, respectively.

Table 12: *Detailed Result of Triage Analysis:(Grades in 100-Level Math X Grades in English Composition Courses)*

N=356			ENEX (100 or 101) Grade					
			A	B	C	D	F	W,I
100-level Math Grade	*n=71*	A	**45**	**25**	**1**	**0**	**0**	**0**
	n=107	B	**37**	**56**	**10**	**1**	**1**	**2**
	n=76	C	**23**	**33**	**14**	**1**	**4**	**1**
	n=24	D	**4**	**15**	**3**	**1**	**1**	**0**
	n=59	F	**4**	**21**	**12**	**3**	**13**	**6**
	n=19	W,I	**2**	**5**	**1**	**1**	**1**	**9**
Subtotals: ENEX Grade			*n=115*	*n=155*	*n=41*	*n=7*	*n=20*	*n=18*

Table 13: *Summary Result of Triage Analysis (Grades in 100-Level Math X Grades in English Composition Courses)*

N=356		ENEX (100 or 101) Grade	
		A B C	D F W,I
100-level Math Grade	A B C	**Category 1 68.6%**	**Category 3E 2.8%**
	D F W,I	**Category 3M 18.8%**	**Category 2 9.8%**

Cross Tabulation: Triage Category and Academic Standing

We now compare a first-year student's triage category with his academic standing at the end of the third semester (Table 14).

Table 14: *Number of Students in Each Triage Category by Academic Standing (Triage Study N=348)*

Triage Category X Academic Standings *N=348		# Good	# Probation	# Suspended	**TOTALS** by Triage Category
TRIAGE CATEGORY	Category 1	230	7	5	242
	Category 2	2	19	11	32
	Category 3M **(% of Category)**	**23** ***(36%)***	**14** ***(22%)***	**27** ***(42%)***	**64** ***(100%)***
	Category 3E	4	4	2	10
TOTALS by Academic Standing		259	44	45	348

* The original sample size of 356 has been reduced to 348; academic standings of A (Admitted on Probation) and R (Reinstated) are excluded due to small sample size.

The results appeal to common sense: if a student is successful in both his first-year math and composition courses (Category 1), there is a 95% probability that he is in good standing at the end of the third semester. Similarly, if a student fails to succeed in both courses (Category 2), there is a 94% probability that he is either on academic probation or suspension at the end of the third semester. The true rate of attrition for Category 2 students is probably underestimated here, since the triage study data do not include students who leave during their first semester before being assigned an academic standing.

Students who succeed in one course but not the other (Categories 3M and 3E) have a distribution of academic standings that generally falls between the extremes of Category 1 and Category 2. For the 64 students in Category 3M, 36% are in good standing, 22% are on probation, and 42% have been suspended from The University.

Estimating the Number and Academic Standing of Category 3M Students in the Fall 2005 First Year Student Population

Projecting the results from the triage study to the entire population of 1788 first-year students, this researcher estimates that there are as many as 336 Category 3M students at the end of the third semester following their initial enrollment (Table 15).

Table 15: *Projected Number of Students in Each Triage Category for 2005 First Year Student Population (N=1788)*

		ENEX vs MATH Triage Study Category Distributions N=348		2005 First-Year Student Population: N=1,788
Triage Category	Category 1	242	68.6%	1,227
	Category 2	32	9.8%	175
	Category 3M	64	18.8%	336
	Category 3E	10	2.8%	50
		348	100.00%	1,788

Assuming the academic standing distribution for the 336 Category 3M students is follows the same distribution found for the 64 Category 3M students in the triage study, we can estimate the number of first-year 3M students in each of the three academic standing categories: Good, Probationary, and Suspended (Table 16).

Table 16
Academic Standing Projections for Category 3M Students (Category 3M Projected N=336)

	# Good (36%)	**# Probation (22%)**	**# Suspended (42%)**	**TOTALS (100%)**
Category 3M	121	74	141	336

The researcher estimates that, at the end of their third semester at The University, 215 of the Category 3M students either are on probation or have left The University under suspension. The projected number of probationary and suspended students represents 12% of the total enrollment of first-year students from the fall of 2005, and does not include the 9.2% of students who fail both their first-year math and ENEX courses.

Completion of Mathematics General Education Requirement and Persistence

This researcher was curious about the GPA and academic standing distributions for two subsets of the population of 1,044 first-year students. The first subset is comprised of 251 students from the large study who successfully completed their general education mathematics requirement in the fall 2005 semester (GEN ED COMPLETERS). In order to belong to this group, the student successfully completed M107, M117, M121, M150, or M152 in their first semester at The University. Students who successfully completed M100 in the fall of 2005 are not included in this group, since they still needed to succeed in one additional math course beyond M100 to fulfill the general education mathematics requirement.

The second group is comprised of 103 students from the large study who enrolled in a 100-level mathematics course but did not complete their general education mathematics requirement in the fall of 2005 and had not enrolled in another math course by the end of their third semester at The University (MATH COURSE ABSTAINERS). This group includes all of the first-year students who enrolled in M100 and students who enrolled in but were unsuccessful in M107, M117, M121, M150, or M152 in the fall of 2005. In either case this second group had not taken another math course, stalling their progress toward completion of the general education mathematics requirement.

The average GPA and academic standing distribution for these two groups is reported in Table 17. Not surprisingly, the data suggest that completion of The University mathematics requirement during the first semester is associated with good academic standing and a higher grade point average. They also reveal a category of students who, while reported to be in good academic standing, have yet to meet The University’s mathematical literacy general education requirement.

Table 17: *GPA and Academic Standing Distributions for Math Gen Ed Completers and Math Course Abstainers*

	Academic Standing	N=	3^{rd} Semester GPA
GEN ED COMPLETERS	Good Probation or Suspended	234 17	**3.00**
MATH COURSE ABSTAINERS	**Good** **Probation or Suspended**	**63** **40**	**1.94**

Just within the study sample alone, 63 students were listed in good academic standing at the end of their third semester, but had not yet completed their mathematics general education requirement.

It is likely that some of the 63 students delayed enrolling in their next math course until deciding upon a major. However, other reasons could account for a significant number of the 63 students to abstain from math courses. Some students may be concerned that poor performance in a math course would lower their GPA as they attempt to qualify for entrance to a professional degree program, such as business or nursing. Others may be abstaining due to an unsuccessful (and confidence-destroying) first math experience at The University. In either case, this researcher is concerned that the mathematical capabilities of all of the 63 students continue to erode with each passing semester of abstinence. By postponing (or avoiding) the necessary math course(s), the students are jeopardizing their ability to fulfill their mathematical literacy requirement and progress toward graduation at The University in a timely manner. In fact, depending on their choice of majors, many of them will need to successfully complete two mathematics courses in order to meet those goals.

STUDY LIMITATIONS

The findings in this study are in a sense merely a snapshot of the 1,044 first-year students who chose to enroll in a 100-level mathematics course at The University in the fall of 2005. Missing from the picture are the 959 first-year students who did not take a math course that fall. Similarly absent from the analysis are first-year mathematics students from preceding and subsequent years.

Data from multiple years would make it possible to compare performances and persistence distributions longitudinally. With a more extensive data set, analysis could reveal the existence of trends and patterns of performance and persistence. With a multi-year sample, sub-group sizes would be large enough to be able to test for statistical significance, allowing stronger statements of inference. With just one year of data to analyze, the findings can only suggest the true nature of the existing conditions; a more comprehensive study is required in order to speak with a stronger voice.

IMPLICATIONS FOR PRACTICE AND RECOMMENDATIONS

Perhaps the most compelling finding is the sheer amount of knowledge we gain about the first-year student's math experience just by conducting a relatively straightforward study of their performance, placement, and persistence. A case in point: among many students (and some faculty advisors), M117 is decried for its large lecture format and its reputation as a "killer course". However, the analysis of performance for all courses does not support this perception. The M117 average grade earned and percentage of successful completion is the second highest among the six 100-level mathematics courses investigated. Popular wisdom is a poor substitute for quantitative data; empirical evidence is a far better platform on which to base opinions about curriculum and delivery modalities.

Over 25% of first-year students take M100 as their first mathematics course at The University. Of all the 100-level courses studied, M100 has the lowest average grade earned and the lowest percentage of successful completion for all students enrolled in 100-level mathematics courses. With regard to improving retention of first-year students, it makes sense to direct attention and limited resources to further study of the M100 course. As of this writing, the Office of the Provost has announced plans to move instructional responsibility for M100 from the Department of Mathematical Sciences to The University of Montana – College of Technology within two years. The transition period could serve as an opportunity to re-examine the goals, curriculum and delivery modality of the course. Perhaps it is time to think out of the box and recast M100 into two separate courses: one for students on a calculus-track, the second for students headed for discrete mathematics and statistics. Creating two new courses that respond to the specific needs of the consumer – namely, the student – need not increase instructional costs, yet could prove effective in raising the successful completion rate for both types of students.

The issue of enforcing course prerequisites and placement compliance is inexorably tied to the validity of the placement testing process. This very preliminary study of placement testing suggests that further study is needed. Further analysis with a larger data set is required in order to determine if ACT/SAT math scores are valid for placing first-year students into 100-level courses. The Department's Basic Algebra placement test should be studied as well, perhaps adding questions that test for arithmetic skills and concepts. Leveling the playing field for students by banning the use of calculators on the Basic Algebra test would identify the students most in need of immediate remediation of computational skills.

One of the ways to support the under-prepared student would be to hold two-week, fee-based, non-credit mathematics refresher courses before classes start in the fall and during the intersession period between first and second semesters. This “mathematics boot camp” environment allows students to focus exclusively on mathematics preparedness prior to the start of the semester and their other coursework. Students could work intensively on basic computational skills as well as fundamental algebra and data literacy concepts. Perhaps attendance at The University's mathematics boot camp could become a requirement for provisionally admitted first-year students and non-traditional students desiring to re-activate their mathematical knowledge.

The research literature on retention stresses the importance of early warning and intervention systems for students in academic trouble. The most effective intervention programs are those that are front-loaded – before a student is on probation or suspension – rather than last-chance. The coordinator of an early warning and intervention program would be responsible for counseling struggling students and directing them to existing tutoring and placement resources. For every math student who finds himself in trouble, time is of the essence. The intervention must happen early enough – within the first two or three weeks of the semester – to preserve the option of having the student transfer into in a lower-level math course.

A different type of retention warning system is worth considering as well. The study estimates a significant number of students fail to complete their mathematical literacy requirement within four semesters at the University. Some of these students, who the study identified as abstainers, maintain good academic standing, and so are not showing up on anyone's radar screen for intervention. However, they are failing to make progress on the fulfillment of the mathematical literacy requirements for graduation. In fact, it is likely that their math skills erode with each passing semester. Reaching out to these students and helping them get back on track mathematically might prevent some of them from leaving The University in their third and fourth years.

Every call for institutional change must be accompanied by a strategy for how to pay for it. It is unrealistic to expect academic transformation be carried out solely through the efforts of the usual group of good-hearted volunteers from the faculty and administration. Making meaningful and long-lasting improvement in retention requires paying for professionals whose primary responsibility is the coordination and implementation of the necessary academic transformation.

Dr. Tom Angelo is an international expert in postsecondary assessment and retention. In April 2007, he conducted several retention-focused workshops for faculty and graduate students at Washington State University. At one of those sessions, he said:

> When looking at retention issues, research shows that universities have about three weeks to engage a student, and that holds true for whether the student is struggling or whether the student is highly capable. So, those first-year courses are hugely important and must be very carefully considered and constructed, and they must work in concert.

At universities that are doing the first-year well, he said, those first-year classes are often the responsibility of a university-wide unit. “No department can fix that by itself,” he said.

Funding programs directed at retaining students, if done with targeted and strategic interventions that work, is a far lest expensive endeavor than continually needing to recruit replacements for the students who leave.   Increasing retention does not cost a university money; rather, it enhances its economic well-being. No one is clearer on that point than Dr. Angelo: “Every 1% increase in student retention that is achieved at a 4-year public university results in a net revenue increase of $500,000 to $1,000,000 to that university each year.”

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