Software applications course as an early indicator of academic performance

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ABSTRACT

This study's objective is to determine if students who were unable to successfully complete a required sophomore level business software applications course encountered unique academic difficulties in that course, or if their difficulty signaled more general academic achievement problems in business. The study points to the importance of including a software applications course early in business schools' curriculum and examines factors associated with a success in the course, as well as in students' early college GPA. An examination of the characteristics of the students who do not successfully complete the business software applications course, and a comparison to the local predictive Major Field Test in Business (MFT-B) scoring model, suggests that over 84% of the unsuccessful students would be likely to receive an MFT-B score below the 50th percentile of an institutional normative distribution and 45% would be expected to score in the bottom 20% of that same distribution. Students who failed the course were predicted to score 23% lower on the MFT than comparable students.

Keywords: MFT-B, assessment, prediction, standardized tests

The ubiquity and significance of computers and computer skills makes the development of the skills necessary for utilization and deployment, rather self-evident for those pursuing undergraduate degrees in business. Although taking many forms, it is not surprising to learn that computer education, both in freestanding courses and integrated into disciplinary programs, permeates modern business education. Virtually all business academic programs require courses that focus on computer and data processing skill development (e.g., Brennan, Miller, & Moniotte, 2001). This study examines student performance in a required business software applications course at an Association to Advance Collegiate Schools of Business (AACSB) accredited college of business at a Land Grant institution classified as a Research University (very high research activity) by the Carnegie Foundation. The course while introducing students to best business practices associated with word-processing and presentation software emphasizes spreadsheet and database applications in finance, accounting, marketing, and management. The course is required for the undergraduate business degree at the study institution and is typically taken in the sophomore year. Historically, approximately 12% of enrolled students fail the course and another 14% withdraw before completion. This study's objective is to examine the characteristics of these failing or withdrawing students and to estimate how well they might be expected to perform in the overall undergraduate business program. Is failing or withdrawing from this required business software course an early signal of low achievement in subsequent business academic work, or are students who might otherwise succeed in the larger business curriculum encountering particular difficulty in this course? What factors predict that a student will pass the course? What factors affect early college GPA?

To answer these questions, use is made of the Major Field Test in Business (MFT-B) and methodologies for predicting MFT-B scores utilizing certain student characteristics. The MFT-B is a widely used learning assessment instrument, designed to be administered to graduating seniors in post-secondary undergraduate business programs. The primary motivations for administering the assessment is related to general assessment of learning and curriculum development efforts and to offer external accrediting bodies, such as the AACSB, evidence that a program is fulfilling or making progress toward its stated mission. Martell (2007) reported that in 2006, 46% of business schools used the MFT-B test in their students' learning assessment. The Educational Testing Service (ETS), the publisher of the instrument, reported that 132,647 individuals at 618 different institutions completed the MFT-B between 2005 and 2009 (Educational Testing Service, 2009). The ETS describes the instrument as being designed to measure students' knowledge and ability to apply significant facts, concepts, theories, and analytical methods related to business. The exam questions represent a wide range of difficulty, and the assessment attempts to cover both depth and breadth in assessing students' levels of achievement (Educational Testing Service, 2010). The assessment instrument contains 120 multiple-choice items covering a common body of knowledge typical of undergraduate business education: accounting (15%), management (15%), economics (13%), finance (13%), marketing (13%), quantitative business analysis (11%), information systems (10%), legal and social environment (10%), and international issues (about 12% drawn from other content areas) (Educational Testing Service, 2010). The scores range from 120 to 200 and the ETS reports the mean student score to be 153.5 with a standard deviation of 13.7 for 2010-11 (Educational Testing Service, 2011).

PRIOR RESEARCH AND HYPOTHESES STATEMENT

A considerable body of research has shown that academic aptitude, as measured by ACT scores, prior academic performance, and effort, explain a significant portion of the variation in individual academic achievement and performance. Kruck and Lending (2003) demonstrated that grade point average (GPA), gender, and motivation (measured by early homework grades) predict performance in an introductory college-level information systems (IS) class and SAT/ACT scores predicted performance for male students but not for female students. Eskew and Faley (1988) produced an empirical study that demonstrated that aptitude (measured by ACT/SAT scores), effort (measured by number of quizzes taken), high school (HS) grades, and college GPA explain performance in a financial accounting course. In a study of academic performance in two college psychology courses Grabe and Latta (1981) found that ACT, GPA, gender, motivation, and effort could predict or explain academic performance. Marcal and Roberts (2000) analyzed course outcomes for students enrolled in a business communication course designed to increase students' writing, presentation, and information-gathering skills, which had a business computer literacy (word processing, spreadsheets, and databases) prerequisite. The authors sought to determine whether students who successfully satisfied the business computer literacy requirement obtained higher grades in the business communications class. They results indicated that completion of the business computer literacy requirement, while controlling for gender, time of class, and age, albeit not SAT/ACT scores, did not improve student performance in the business communications course. However, students with higher college GPAs had significantly higher grades in the communication course. In a related study, Marcal, Hennessey, Curren, and Roberts (2005) found students who completed the business communications course prior to taking an introductory marketing course performed significantly better than those who did not. Anderson, Benjamin, and Fuss (1994) analyzed factors that determine students' success in an introductory economics course and found that the most important explanatory factors were freshman GPA, completion of a HS calculus course, and on average, male students obtained 2.5 to 3.5 percentage points higher grades than their female classmates. Bosshardt and Manage (2011) found that calculus taken before a principles of economics course generally helps student performance. Manage and Li (2009) found business students who took and passed a computer proficiency exam generally scored higher in their follow-on, sophomore information technology course than those who passed the prerequisite, freshmen information technology (IT) course. However, curiously, the exam pass rate proved to be significantly lower than that of the course it replaced. Finally, D'Souza and Maheshwari (2010) reviewed the literature, identifying factors that could possibly influence performance in various introductory undergraduate courses. These included: student demographics (major, age, gender, and race), course structure (class size, duration, timing, and length), instructional methods (instructor status and presentation style), student motivation and effort (attendance, homework, and quizzes), student aptitude (SAT/ACT scores), effort (GPA), and student preparation (prerequisites, transfer, and course repetition). They concluded that the literature does not clearly identify a particular set of factors which influences student performance in all introductory college level courses. However, they examined factors that influence student performance in an introductory management science course and found current class GPA, average homework score, course utilization ratio (total hours earned by total hours attempted), and completion of a pre-calculus prerequisite to be significant performance determinants. Camara and Echternacht (2000) performed a meta-analysis of studies that sought to predict

overall college success and concluded that the best predictor was a student's first year GPA. They reported that the majority of studies they examined included SAT/ACT scores and HS records (i.e., GPA and class rank) as predictor variables.

This search for a stock of individual student characteristics predicting or explaining student performance has attracted the attention of researchers with an interest in the very widely used MFT-B. In this instance, there is considerably more agreement and replication across studies in different settings regarding the determinants of student performance. Standardized test scores (ACT/SAT), college GPA, major field of study, and gender have been consistently cited as determinative covariates (Allen & Bycio, 1997; Bean & Bernardi, 2002; Bielinska-Kwapisz & Brown, in press a, in press b; Bielinska-Kwapisz, Brown, & Semenik, 2012a, 2012b; Bycio & Allen, 2007; Mirchandani, Lynch, & Hamilton, 2001; Stoloff & Feeney, 2002; Zeis, Waronska, & Fuller, 2009).

In order to produce a deeper understanding of the overall academic achievement potential of students who failed or withdrew from the business software applications course, and informed by the previously cited research, this study examines the following three research hypotheses:

H1. Academic aptitude (ACT scores) and HS performance (GPA) will positively relate to students' early college GPA.

H2. College GPA, academic aptitude (ACT scores), and effort (the course engagement scores) will positively relate to performance in a business software applications course.

H3. Performance in the business software applications course is a predictor of performance on the MFT-B.

SETTING AND SUBJECTS

The setting for the current study is an undergraduate college of business which has held continuous AACSB accreditation for over 25 years. The institution's students are predominantly Caucasian, with a small international and ethnic student population.

MFT-B Score Prediction Study

As part of an assessment of learning process, the MFT-B has been administered to every graduating senior at the institution offering the business software applications course, from the summer semester of 2005 through spring semester 2011. Background data identified in the study was obtained from student records. The total number of graduating seniors in the analysis of MFT-B scores was 885. Full data, most notably MFT-B and ACT scores, was available for 845 of these students, with sample mortality primarily attributable to the fact that transfer students were not required to submit ACT scores. In addition, for each of the 845 students in the prediction study, the data includes university GPA measured at graduation, gender, and major area of study (accounting, finance, management, or marketing). Starting in the spring semester of 2008, students received extra-credit points in their capstone business course to incent their best efforts on the MFT-B (5 points for a 50th percentile score, 7.5 points for 75th percentile, and so on).

For the 845 students who took the MFT-B, the mean score was 160.86 with a standard deviation of 12.2. Table 1 (Appendix) reports the full list of variables, their definitions, and descriptive statistics. There are no very high (above ± 0.5) correlations between any pair of independent variables providing reassurance regarding the possibility of multicollinearity.

Business Software Application Student Performance Study

The business software applications course is required for all business majors and is typically taken during the sophomore or, occasionally, the freshman year. Basic computer literacy is a prerequisite for this course. Data on 446 students in the course were collected from fall 2009 to spring 2010 semester. Background data identified in the study was obtained from class and official student records. The majority (67%) of the study subjects were identified on university records as freshman, although it is likely that most were in their second year of college attendance. Twenty-nine percent of study subjects were identified as transfer students. Sixty percent of students were male and 80% declared their major as business. Seventy-four percent of the study subjects passed the course with a grade of C- or higher (the minimum required for satisfaction of college of business academic requirements); 31% received an A; 27% a B; 16% a C; 4% a D; 8% an F; and 14% withdrew (W) from the course (including 10% who enrolled but did not attend any classes). For students enrolled in the course, the average GPA was 2.8/4.0, the average ACT was 23, and the average age was 22 years.

ANALYSIS AND RESULTS

Determinants of GPA

Numerous studies have examined the predictors of first year college GPA (Camara & Echternacht, 2000) and found SAT scores and HS records (i.e., GPA, rank) to be significant determinants. The following basic model was estimated to determine whether students' early college GPA is related to academic aptitude (ACT scores), HS performance, gender, and age;

$$GPA_i = \beta_0 + \beta_1 \, ACT_i + \beta_2 \, HS_i + \beta_3 \, Male_i + \beta_4 \, Age_i + \varepsilon_i \qquad (1)$$

where GPA_i is student *i* GPA; ACT_i is his/her either ACT score, ACT English or ACT Math score; HS_i is either HS GPA or student's rank in HS (place divided by the school size); $Male_i$ is a binary variable that takes a value of 1 if student is male and zero if female; and Age_i is his/her age; βs are coefficients to be estimated, and ε_i is a random error. Results are presented in Table 2 (Appendix).

Examining Models 1-3 in Table 2 (Appendix), it can be observed that total ACT is a better predictor of an early college GPA than ACT English or ACT Math alone. Comparing Models 4 and 5 in Table 2 (Appendix), it is observed that HS GPA is a better predictor than the rank in HS (scaled by the HS size). Overall, Model 5 is the best predictive model. The results suggest that ACT and HS GPA are the best predictors, explaining approximately 38% of the variation in early college GPA. It is interesting to note that when controlling for HS performance, the previously observed female advantage disappears: the Male variable was negative and significant in Models 1-3, but becomes insignificant in Models 4 and 5. On average, a 1% increase in ACT score increases early college GPA by 0.33% and a 1% increase in HS GPA increases early college GPA by 0.63% (all elasticities evaluated at sample means). H1 was fully supported.

Determinants of Course Performance

Following D'Souza and Maheshwari (2010), student aptitude (ACT and GPA), student demographics (major, age, and gender), and student engagement measured by participation in in-class exercises were examined to determine the extent to which they influenced performance in the business software applications course. Utilizing percentage points earned on a common final exam as the dependent variable, the specification of the model was as follows;

$$FNL_{ik} = \beta_0 + \beta_1\,ACT_{ik} + \beta_3\,GPA_{ik} + \beta_4\,Male_{ik} + \beta_5\,Age_{ik} + \beta_6\,Engagement_{ik} + \mu_k + \varepsilon_{ik} \qquad (2)$$

where FNL_{ik} is student i in major k grade on the final exam; ACT, GPA, and Male are defined as above; $Engagement_{ik}$ is student engagement points; μ_k are majors' fixed effect (Accounting, Finance, Management, Marketing, and Other); βs are coefficients to be estimated, and ε_i is a random error. The engagement points are points students earn for actively working in class with their peers and are used here as a proxy for student effort and motivation. An ordinary least squares regression was used to estimate Equation (2). Table 3 (Appendix) reports the results of the basic regression analysis. The Other variable was omitted to avoid perfect multicollinearity.

The full model (Model 1, Table 3, Appendix) explains about 44% of the variation in the course final examination grades. Similar to previous studies, college GPA was the most significant determinant of the success in the course. On average, a 1% increase in GPA increases the final exam percentage by 0.75%. The ACT score was not a significant predictor of good performance on the final exam—a result similar to that reported by Kruck and Lending (2003). The relationship of performance on the final exam, and effort or motivation (as measured by engagement), was highly significant, similar to previous studies. Additionally, males scored about 4% higher on the final exam than females, and students who declared their major as marketing scored significantly lower compared to other majors. As mentioned before, Kruck and Lending (2003) also reported male advantage in the IS course, attributing this result to the fact that the course was required and females had to take it even though they were not interested in the subject. Kruck and Lending suggested further research on the subject. They also found that SAT scores did not predict academic performance for female students, but did for males. After performing separate analyses for male and female students, the estimated coefficients were similar to the ones reported in Table 3 (Appendix) (for all genders) with an exception that engagement was more important for male students. Note that these results are for students who took the final exam and did not withdraw from the course before the exam.

In addition, a logit regression was performed, with a binary dependent variable that takes a value of 1 if a student finished the course with a passing grade, and 0 if a student received D, F, or W in the course. These results are presented in Table 4 (Appendix). It can be observed that approximately 57% of the deviance in the model has been explained and GPA and engagement were both positive and significant—increasing the probability that student will receive a passing grade. Therefore, H2 was partially supported: college GPA and engagement (but not ACT) were positively related to performance in a business software application course.

Determinants of MFT-B Scores

Students in this MFT-B Score Prediction study took the MFT-B in their senior year, as a course requirement in their senior seminar. A predictive model for MFT-B scores based on ACT, college GPA, gender, and a binary indicator of extra credit being offered is shown in Table 5

(Appendix). Students must take the MFT-B to pass the course, but it was not until the spring semester of 2008 that students received extra credit points to incent their best efforts on the MFT-B (many business programs administering the MFT-B do offer some form of credit for taking the exam, as reported by Bycio & Allen, 2007).

Based on the results from 845 graduating seniors, MFT-B scores were predicted using the following formula;

MFT-B = 91.76 + (1.61 ACT) + (8.86 GPA) + (5.08 Male) + (2.11 ExCredit) (3)

Expected MFT-B scores were calculated for all software applications students with available ACT and GPA data (n = 322). There was a significant difference in the mean expected MFT-B percentile of students who passed the course and those who did not (28.2 vs. 50.8; t = 7.96). Table 6 (Appendix) presents the predicted MFT-B distributions for students who passed the course with students who did not pass. Inspection of the two distributions reveals that students who did not pass the software applications course are predicted to score in lower percentiles.

Eighty four percent of students who were unable to successfully complete the course had predicted MFT-B scores below the 50th percentile on the MFT-B and 45% were predicted to score below the 20th percentile. Only 11% of students who passed the course were predicted to score below the 20th percentile.

To see if performance in the course explains variation in MFT-B scores beyond what is predicted from students' characteristics (ACT, GPA, and gender), the following model was estimated:

$$\%MFT_i = \beta_0 + \beta_1\ Grade_i + \varepsilon_i \tag{4}$$

where $\%MFT_i$ is student's i predicted percentile on the MFT-B distribution; Grade is student's i grade status after finishing the course: A , B, C, or Failed (D, F, or W); βs are coefficients to be estimated, and ε_i is a random error. Model (4) was estimated four times, once for each Grade. For example, in the first model (4), Grade takes a value of 1 if student i received an A in the course grade and zero otherwise. The estimated coefficients are presented in Table 7 (Appendix) (only β_1 coefficients are reported). Note that if the Grade coefficient for students who failed the class is not significant, then a required business software applications course has no long-term impact on students' acquisition of business education knowledge and, therefore, students who were unable to successfully complete the course encountered unique academic difficulties in that course.

Table 7 (Appendix) indicates that students who received an A in the course could be expected to score 29 percentiles higher on the MFT-B; no significant effect was found for students who received a B; and students who received a C could be expected to score lower on the MFT-B by 14 percentiles. Most importantly, students who did not pass the class could be expected to score 23 percentiles lower on the MFT-B. Therefore, the grade in the course is actually a good predictor of MFT-B performance beyond that which is explained by the variations in ACT, GPA, and gender. This study's results provide reassurance that the course does not seem to be creating any sort of unique or inconsistent academic challenges in the context of the overall curriculum. Students who were unable to successfully complete this required sophomore level business software applications course are likely to have more general achievement problems with acquisition and thus H3 was supported.

SUMMARY AND CONCLUSIONS

This study's objective was to determine whether students unable to successfully complete a required sophomore level business software applications course were encountering unique academic difficulties in that course, or whether their difficulty was a signal they would likely have more general academic achievement problems. With considerable long-term experience with the MFT-B and having administered the MFT-B to its graduating business students for over five years, the institution was able to identify the dispositional characteristics (e.g., ACT/SAT scores and GPA) of their students most strongly associated with performance on the MFT-B. An examination of the student characteristics for those unable to successfully complete the business software applications course and a comparison to the local predictive MFT-B scoring model, suggested that over 84% of the failing/withdrawing students would likely receive an MFT-B score below the 50th percentile of a normative distribution. Almost half (45%) would be expected to score in the bottom 20% of that same distribution. Even though MFT has no separate category for software applications, students who received an A grade in the course were predicted to score, on average, 29% higher on the MFT, those who received a grade B to be on average, grade C to score 14% lower, and those who did not successfully complete the course are expected to score 23% lower on the MFT. The relationship between performance in the course and performance on the MFT-B is beyond what can be explained by students' characteristics (ACT, GPA, and gender).The study results provide reassurance that the course does not seem to be creating any sort of unique or inconsistent academic challenges but is an early career indicator of a student's success in the business curriculum.

While the MFT-B tends to be primarily used in an ex-post-facto assessment of learning context, it also permits forward looking predictions, for matters like admission and curricular evaluation. Its utility in any context is, of course, a function of its validity as a measure of business knowledge and capability. The high correlations between MFT-B scores, GPAs, and ACT/SAT scores, along with descriptions as to how the MFT-B was developed (expert panels), provides some reassurance of the MT-B's validity. Although the study methodology would seem to be easily replicated in other settings the generalizability of results are, as always is the case, limited by the fact that the study was done at one university. Despite these caveats, for the specific instance of this study, performance in a sophomore level business software applications course proves to be a good predictor, beyond student characteristics of ACT, GPA, or Gender, of a student's success pursuing a business curriculum.

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APPENDIX

Table 1
Data Definitions and Description

Name	Description	Mean	St.Dev.	Min	Max	N
ACT	ACT score on a scale to 40	23.13	3.73	13	35	322
ACT Eng	ACT English	22.24	4.35	7	35	323
ACT M	ACT Math	23.57	4.23	14	36	323
GPA	Cumulative GPA	2.82	0.67	0	4	446
HSGPA	High School GPA	3.27	0.51	1.64	4	272
HSRANK	Student's rank in High School	105.48	107.29	1	502	222
HSSIZE	Size of the High School	261.91	174.46	3	804	222
Male	1 = male; 0 = female	0.59		0	1	446
Age	Age in years	21.98	4.10	18	53	446
Pass	1 = course grade A to C- 0 = D, F, W	0.74		0	1	447
FNL	Final exam score, as percent of possible	70.23	29.85	0	100	407
ACCT	1 = Accounting major	0.19		0	1	447
FIN	1 = Finance major	0.15		0	1	447
MGMT	1 = Management major	0.30		0	1	447
MKTG	1 = Marketing major	0.16		0	1	447
Other	1 = if not ACCT, FIN, MGMT, MKTG	0.20		0	1	447
MFT-B	MFT-B score for college of business students	160.86	12.155	129	194	845

Table 2
GPA Estimation

	Model 1: ACT		Model 2: ACT English		Model 3: ACT Math		Model 4: rank in HS		Model 5: HS GPA	
	Coeff	t	Coeff	t	Coeff	t	Coeff	t	Coeff	t
(Intercept)	1.92	4.04	2.41	5.01	2.17	4.46	2.49	4.49	0.05	0.06
ACT	0.07	7.57					0.04	4.11	0.04	4.36
ACT Eng			0.05	5.78						
ACT Math					0.06	6.33				
Male	-0.19	-4.20	-0.12	-3.02	-0.32	-4.70	-0.05	-0.78	-0.08	-1.29
Age	-0.02	-1.24	-0.03	-1.27	-0.06	-0.96	-0.01	-0.33	0.01	0.28
HS rank							-1.12	-6.63		
HS GPA									0.54	7.33
R-squared	0.1205		0.1534		0.1715		0.3814		0.3531	
Adj R-squared	0.1155		0.1475		0.1656		0.3697		0.3476	
N	322		322		322		217		265	

Table 3
Regression for Final Exam (n = 268)

Variable	Model 1 (Full Model)			Model 2		
	Coefficient	t-stat	p-value	Coefficient	t-stat	p-value
(Intercept)	6.83	0.50	0.6212	2.78	0.21	0.835
ACT	-0.01	-0.03	0.9757	0.02	0.10	0.919
GPA	18.78	11.16	0.0000	19.18	11.37	0.000
Male	3.85	2.29	0.0229	4.17	2.47	0.014
Age	0.03	0.06	0.9546	0.06	0.11	0.911
Engagement	0.18	3.62	0.0004	0.18	3.50	0.001
Acct	-0.81	-0.30	0.7649			
Fin	-0.32	-0.12	0.9041			
Mgmt	-1.68	-0.70	0.4860			
Mktg	-6.85	-2.45	0.0148			
R-squared	0.4635			0.4472		
Adjusted R-squared	0.4447			0.4366		
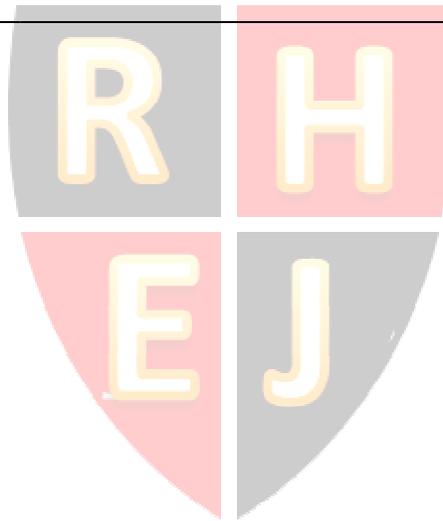
Table 4
Logit for Pass

Variable	Coefficient	z-stat	p-value
(Intercept)	-7.81	-1.96	0.050
ACT	-0.08	-1.13	0.257
GPA	3.99	5.73	0.000
Gender	0.60	1.15	0.252
AGE	-0.18	-1.12	0.265
Engagement	0.06	5.39	0.000
Deviance Goodness of Fit (D^2)	0.57		
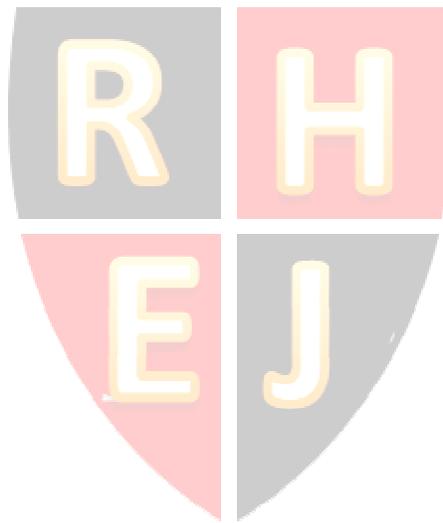
Table 5
Regression for MFT-B (n = 845).

| Variable	Coefficient	t-stat	p-value
(Intercept)	91.76	30.70	2.00E-16
ACT	1.61	15.20	2.00E-16
GPA	8.86	9.21	2.00E-16
Male	5.08	7.72	3.30E-14
ExCredit	2.11	3.26	0.00116
R-squared	0.4194		
Adjusted R-squared	0.4167		
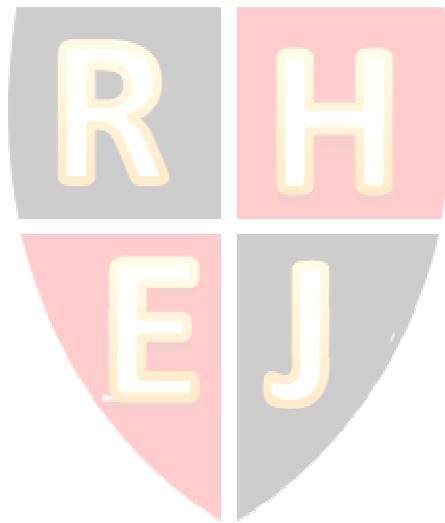
Table 6
Distributions for Students Who Passed or Not Passed Bus 211

| Current MFT-B Percentile	Students Who Did Not Pass (D, F, or W)			Students Who Passed		
	Number	Percentage	Cumulative %	Number	Percentage	Cumulative %
0-10	17	21.3	21.3	12	5.0	5.0
11-20	19	23.8	45.0	16	6.6	11.6
21-30	13	16.3	61.3	24	9.9	21.5
31-40	15	18.8	80.0	31	12.8	34.3
41-50	3	3.8	83.8	42	17.4	51.7
51-60	5	6.3	90.0	31	12.8	64.5
61-70	2	2.5	92.5	26	10.7	75.2
71-80	3	3.8	96.3	25	10.3	85.6
81-90	3	3.8	100	26	10.7	96.3
91-100	0	0.0		9	3.7	100
Total	80			242		
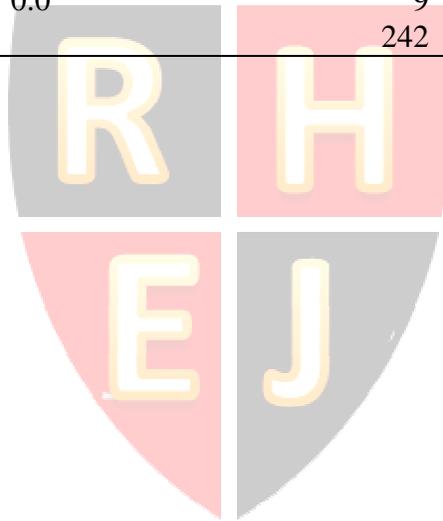
Table 7

Regression, Dependent Variable: Predicted Percentile on MFT-B Distribution (n = 322)

Grade	Coefficient	t-stat	Model Adjusted R-squared
A	0.29	10.96	0.271
B	0.01	0.45	0.002
C	-0.14	3.93	0.043
Failed class (D, F, W)	-0.23	7.54	0.148