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ANALYSIS OF THE CHANGE IN MATH PLACEMENT TEST INSTRUMENTS

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Introduction

All students, before taking their first math course at Western, must take the Math Placement Test (MPT) prior to registering for the math course.[1] The score received on the MPT dictates the level of course that the student may register for. In May of 2000, a new MPT was put into use, and new point cut-offs were established for use with this new test. The purpose of this analysis is to explore any possible effects of the move to a new Math Placement Test with new point cut-offs for entry into specific courses.

The data used in this analysis are all new (first quarter) freshmen and transfer students who entered Western in fall of 2000, fall of 1999 and, for some illustrations, fall of 1998. In particular, we focus on those students who registered for a course in the Mathematics Department during their first quarter at Western. In fall of 1999, 64.6% (2262) of first-quarter students took the MPT, and 63.5% (2297) took the MPT in fall of 2000.

Information pertaining to the Math Placement Test is given as Appendix 1. Two math placement tests are available: intermediate (MPTI) and advanced (MPTA). Included in the appendix are the test scores required for entry into particular math courses (for both the old and new MPT). Because enrollment in the 200-level and above courses is small, this analysis will focus on the 100-level courses only. Also, because the same test scores are required for math 107, 114, and 156, they are combined for analysis.

Test Scores

We first examine the distribution of the students taking the Math Placement Test among the various course levels. Table 1a shows the cumulative percent of students who score at a level such that they are eligible to register for the given course. The table shows that in the fall of 1999, 18.3% of the students taking the MPT scored high enough to register for Math 118 or above. In fall of 2000, 27.3% scored at the same level. For every course level, a greater percentage of students were eligible to register in 2000 than in 1999. Indeed, in fall of 1999, 14.5% of first-quarter students taking the MPT did not score high enough to register for Math 102, the lowest level for-credit math course available. This is the case for only 5.3% of students in fall of 2000.

The new Math Placement Test (with its established point cut-offs) is placing students into more challenging math courses.

[1] There are exceptions —see Appendix 1.

Table 1a: All Students

	PERCENT OF ALL STUDENTS SCORING AT OR ABOVE EACH LEVEL	
Placement Level	**Fall 1999**	**Fall 2000**
124	5.6	9.3
157	7.1	10.7
118	18.3	27.3
107 114 156	51.5	64.2
102	85.5	94.7

Table1b: Freshmen & Transfers

	PERCENT OF FRESHMEN SCORING AT OR ABOVE EACH LEVEL	
Placement Level	**Fall 1999**	**Fall 2000**
124	5.1	9.8
157	6.6	11.2
118	16.8	27.7
107 114 156	49.4	64
102	84	94.7

	PERCENT OF TRANSFERS SCORING AT OR ABOVE EACH LEVEL	
Placement Level	**Fall 1999**	**Fall 2000**
124	7.6	6
157	9.3	6.7
118	25.3	24.3
107 114 156	60.9	65.5
102	91.6	95.1

Enrollment

The student uses their test score—and established placement level—to guide their selection of a math course. They may choose to register for a lower-level course, but are, in general, not permitted to register for a higher-level course. For the purpose of illustration, we say that a student is 'placed' into a particular course level if their MPT is high enough to allow them to register for a particular course, but not high enough to allow them to register into the next highest course. Often, students will register for a course that is not in their 'level'. For example, Math 157 requires an advanced MPT score of 18, and Math 124 requires a score of 19. Many students who achieve a score of 18 will not want to take Math 157—a math course designed for business/economics students. A dramatic shift 'up' to a course that is higher than the students' tested level occurs at the lowest level. Over half (66.5% in 1999) of students who score below the level required for Math 102 register for it anyway. Of these students, about three-fourths have a Math SAT score of 480 or greater, and are allowed an exception to enroll in Math 102. Presumably, the remaining low scoring students qualify for other exceptions.

Although MPT placed students in more challenging courses in 2000 than in 1999, students partially compensated for this by self-adjust their placement levels. Table 2

shows that for each tested level of placement, students in 2000 less often enrolled in courses above their tested level. For example, in fall of 1999, 14.4% of students testing at the 107/114/156 level enrolled in the lower-level math 102 course. In fall of 2000, more than twice as many students (30.2%) did so. Similarly, for all but the highest tested levels, students in 2000 more often chose to enroll in a course that was below their tested level than students in 1999.

Table 2: Percent Enrolled

Math Placement Level	Year	At Course Level	Above Course Level	Below Course Level
124	1999	64.9	8.5	26.5
	2000	79.2	1.3	19.4
157	1999	13.6	4.5	81.8
	2000	25.9		74.0
118	1999	48.2	3.0	48.8
	2000	37.4	2.7	59.9
107 114 156	1999	82.8	2.8	14.4
	2000	68.5	1.7	30.2
102	1999	98.9	1.1	
	2000	98.7	0.6	0.7
Below 102	1999	33.5	66.5	
	2000	46.2	53.8	

Course Outcomes

Tables 3a and 3b compare fall quarter outcomes for three years. Table 3a gives the course level, number enrolled, number completed for grade, mean grade, number dropped, and dropped as a percent of enrolled. Table 3b shows the difference in mean grade and percent dropped.

Outcomes for the two lowest level courses are important because of the number of new students affected. The mean grade given to first-quarter students enrolled in math 102 was 2.25 in 1998, 2.11 in 1999, and 1.98 in 2000. Average grade in the 107/114/156 level has also fallen. In fact, the average math grade given to new students in fall 2000 compared to fall 1999 is lower for every course level with the exception of math 157—a course that enrolls very few new students. Although such a drop in average grade may suggest a connection with the change in the MPT, table 3b shows that average grades also fell for most courses between the years 1998 and 1999—a period with no change in MPT. Along with declining grades, there has been a substantial increase in the number of first-quarter students who withdraw from math courses. Although the drop rate increased between the years 1998 and 1999, there was a much larger increase between 1999 and 2000.

Table 3a:

Fall 1998	Course	#Enrl	#Grade	Mean	#Drop	%Drop
	102	673	640	2.25	29	4.3
	107 114 156	549	506	2.48	43	7.8
	118					
	157	12	11	3.18	1	8.3
	124	90	87	3.06	2	2.2
	200+	86	73	2.45	13	15.1

Fall 1999	Course	#Enrl	#Grade	Mean	#Drop	%Drop
	102	689	639	2.11	50	7.3
	104 114 156	496	411	2.30	53	10.7
	118	104	92	2.48	12	11.5
	157	13	13	2.44	0	0.0
	124	94	86	3.15	7	7.4
	200+	90	85	2.88	5	5.6

Fall 2000	Course	#Enrl	#Grade	Mean	#Drop	%Drop
	102	766	652	1.98	113	14.8
	107 114 156	512	431	2.10	77	15.0
	118	119	100	2.26	17	14.3
	157	18	17	2.94	1	5.6
	124	126	120	2.76	3	2.4
	200+	45	34	2.62	10	22.2

Table 3b:

Difference in Mean Grade			
Course	99 - 98	00 - 99	00 - 98
102	-0.14	-0.13	-0.27
107 114 156	-0.17	-0.21	-0.38
118		-0.22	
157	-0.74	0.50	-0.24
124	0.08	-0.39	-0.30
200+	0.43	-0.26	0.17

Difference in % Drop			
Course	99 - 98	00 - 99	00 - 98
102	2.9	7.5	10.4
107 114 156	2.9	4.4	7.2
118		2.7	
157	-8.3	5.6	-2.8
124	5.2	-5.1	0.2
200+	-9.6	16.7	7.1

Relationship Between Test Scores & Performance

Bi-variate correlations are given in Table 4 for all courses combined, and some individual courses. The correlations show a general modest relationship between test scores and grades. Table 4 shows some patterns and some inconsistencies. Correlations for math SAT and High School GPA are included for reference. Because the great majority of students have a High School GPA and take the SAT, we may expect relatively consistent relationships to grades across the three years. In fact, the table shows that SAT score is related to new student math grades essentially equally across all three years, with one exception. The correlation between math SAT score and math 102 grades jumps from the upper .20s to .41 in 2000. High School GPA seems to be a fairly strong predictor of math grades, but the relationship shows a pattern of slow decline across the three years. Correlations with the MPTA scores vary somewhat—probably due to lower numbers of students taking this test. MPTA has a fairly weak relationship to grades in 1998, with the exception of math 124. The relationship improves in 1999, and remains about the same in 2000. The relationship between MPTI and grades, however, clearly coincides with the change in MPT. The relationship between MPTI and grades is relatively weak in 1998, stays about the same in 1999, and improves in 2000.

Table 4:

Correlation with Grade Given

Fall 1998		MPTI	MPTA	HS GPA	Math SAT
	All Courses	.21**	.26**	.45**	.38**
	102	.26**		.41**	.27**
	107 114 156	.20**	.21**	.41**	.30**
	118				
	124		.46**	.17	.22**

Fall 1999		MPTI	MPTA	HS GPA	Math SAT
	All Courses	.23**	.36**	.40**	.35**
	102	.27**		.36**	.28**
	107 114 156	.21**	.32**	.38**	.23**
	118	0.24	.38**	.39**	0.16
	124		0.10	.32**	0.19

Fall 2000		MPTI	MPTA	HS GPA	Math SAT
	All Courses	.31**	.34**	.37**	.38**
	102	.36**		.31**	.41**
	107 114 156	.33**	.30**	.34**	.23**
	118	.34*	.41**	.25*	0.13
	124		.26**	.47**	.19*

Multivariate Models

What predicts math grades for new students, and has that changed since the adoption of the new Math Placement Test? Table 5 summarizes a series of linear multiple regression models explaining course grades in each year for a series of math courses. This analysis provides some information regarding the efficacy of various tools for predicting course performance, but it addresses a question slightly different from the question of what tools best place students in one of these courses. The question here is whether the range of individual differences, for example, in MPT, among those particular students placed in a particular level of math helps us explain why they received the course grade they received. These results will certainly be similar to the question of how efficiently each factor would place students into each level, but the question is distinct and findings are suggestive only.

Table 5 lists only the standardized Beta coefficients, indicating in standardized, comparable terms, the partial effects attributed uniquely to each variable at the left. A dash is used to indicate cases where a factor tested had no effect. Courses at or above the 118 level had low enough enrollments that relatively few factors load.

Scanning all course levels for both years, we see high school GPA as the strongest predictor of success/failure in math courses. This is true despite the fact that high school GPA has a weak correlation to MPT scores, and even to math SATs. Math SATs correlate about .4 with the MPT, so that these two factors tend somewhat to divide predictive power, but even where only one or the other loads, its power is in most cases lower than high school GPA to predict success. This finding suggests that general study habits, engagement in school, etc.—factors influencing GPA but not scores on standardized tests—have a great deal to do with success in courses at Western, and that the power of high school GPA to have that influence is less truncated by placement into levels of math classes than are the math-related test scores.

MPT and math SAT tend to have similar power to predict course grades, but here we notice what seems to be a difference between the two years. For 1999, SAT score is perhaps a slightly more consistent predictor of course grade, although that differs by course. In 2000, MPT appears the stronger and more consistent predictor, especially at higher course levels where MPT did not load at all in 1999. It appears that the revised MPT does a somewhat better job of predicting performance than the old one.

One course, Math 118, seems especially well attuned to the predictive direction of the MPT. In both years, MPT was a better predictor of grades in that course than in any other, and MPT loaded while SAT did not.

Following up on findings for fall 1998 freshmen in a separate study, course time and status of instructor were also examined in these analyses. As Table 5 shows, however, these factors seldom had impact. The same is true of gender.

One final observation from Table 5 is that total ability to explain or predict grades in these courses is modest at best. Since Western uses MPT exclusively to place students in math courses, one might expect it to be a stronger predictor of success in math. Even the combination of the three strongest predictors—MPT, math SAT and high school GPA—typically explains around one-fourth of variation in grades, and MPT uniquely explains only about ten percent. These analyses do not include the factors that might would be the strongest single predictor—grades in previous math course and highest level of previous math passed—because Western does not have these factors in its student information system. We cannot, therefore, provide evidence on that option. What is suggested by these analyses, however, is that MPT is a relatively weak predictor of success in math courses at Western and that it might be valuable to explore options.

Table 5: Multivariate Models Explaining Grades in 100-Level Math Courses

	Standardized Beta				
Course:	**102**	**114**	**118**	**124**	**156**
Factors in Fall 1999					
MPT	.20	.12	.28	-	-
Math SAT	.23	.30	-	.24	-
H.S. GPA	.35	.34	.37	.34	.44
Frosh (vs. Transfer)	-.07	-.10	-	-	-
Start at 8 am	-	-	-	-	-
Start 4 pm or later	18	-	.17	-	-
Lecturer*	-	-	-	-	-.17
Gender (female)	-	-	-	-	-
Variance Explained	.26	.25	.25	.16	.24
Number of Students	538	278	83	64	90

* For Math 102, lecturer is contrasted to TA; for other courses, lecturer is contrasted to regular faculty.

	Standardized Beta				
Course:	**102**	**114**	**118**	**124**	**156**
Factors in Fall 2000					
MPT	.25	.17	.38	.22	.35
Math SAT	.27	.17	-	.19	-
H.S. GPA	.29	.27	-	.51	.45
Frosh (vs. Transfer)	-	-	-	-	-
Start at 8 am	-.12	-	-	-	-
Start 4 pm or later	-	-	-	-	-
Lecturer*	-.08	-	-	-	-
Gender (female)	-	-	.24	-	-
Variance Explained	.31	.17	.18	.33	.36
Number of Students	535	292	99	109	107

* For Math 102, lecturer is contrasted to TA; for other courses, lecturer is contrasted to regular faculty.

Possible Effects of a Change in MPT Cut-Off Levels

The new Math Placement Test, along with its cut-off levels required for each course, placed students into higher level courses in 2000 than in 1999 (see Table 1). If we formulate cut-off figures such that fall 2000 students are placed in course levels with approximately the same proportion as fall 1999 students, we can show the outcomes of the remaining students. Using the test scores of new students in fall 2000, we compare the actual outcomes (also shown in table 3a) with outcomes that may have occurred, had the cut-off levels of the new MPT produced placements proportional to 1999. Table 6 shows that the outcomes would have improved across all course levels. The improvements are consistent, but small, as expected from the finding that MPT has a modest ability to predict course grades, but a comparison with Table 3b shows that most of the decline in course grade average between 1999 and 2000 would be eliminated by the revised cut-offs shown in Table 6.

The drop between 1998 and 1999 is something on which this analysis cannot shed light.

Table 6:

	Course	#Enrl	#Grade	Mean	#Drop	%Drop
Actual	102	766	652	1.98	113	14.8
Formulated Cut-Off (MPTI=14 MPTA=5)		424	388	2.10	36	8.5
Actual	107 114 156	512	431	2.10	77	15.0
Formulated Cut-Off (MPTI=19 MPTA=11)		390	342	2.20	48	12.1
Actual	118	119	100	2.26	17	14.3
Formulated Cut-Off (MPTI=25 MPTA=19)		47	43	2.38	4	8.5
Actual	157	18	17	2.94	1	5.6
Formulated Cut-Off (MPTA=21)		8	8	3.00	0	0
Actual	124	126	120	2.76	3	2.4
Formulated Cut-Off (MPTA=23)		45	44	3.10	1	2.2