

2010 Math 110 Diagnostic Test Results

Background

The Basic Skills Test (BST) has been used to predict students' performance in Calculus I since 2007. As the university's admission requirement changed in 2009, the prerequisite of regular Calculus I courses (Math 100/102/104/180/184) also changed. Students who did not meet the prerequisite of these courses must register in Math 110, a two-term remedial Calculus I course. Since then, BST have become a qualifying exam only for students registered in Math 110 who would like to switch to regular Calculus I courses. As a result, the majority of Math 110 students did not take the BST.

In order to assess students' basic skills, a diagnostic test (DT, also called the Skills Test by the instructors) based on the questions from the 2010 BSTs (BST2: Sept 2; BST3: Sept 9) was given to all Math 110 students at the end of the third week of classes (Sept 24) after some review on algebra, functions and geometry. The DT was 50 minutes long, consisting of 16 multiple-choice questions that were either chosen or modified from BST. The questions can be divided into four categories: algebra, functions, geometry, word problems. The following table shows the types of DT questions and their corresponding BST questions.

Table 1: Types of DT questions and their correspondence to BST questions. (Boldface: same; Non-boldface: similar)

DT questions	BST2 questions	BST3 questions	Category
1			Geometry, Functions
2	23	23	Geometry
3	21	21	Geometry
4	18	18	Word problem
5	11		Word problem
6	2	2	Algebra
7		20	Geometry, Word problem
8		25	Functions
9	30	30	Algebra
10	27	27	Algebra, Functions
11	13	13	Algebra
12	15	15	Algebra
13	7	7	Algebra, Functions
14	17	17	Algebra
15	4	4	Algebra
16	5		Word problem

Overall results with comparison to the first midterm

In total, 77 students wrote both BST and DT. The comparison between students who wrote the BST and those who did not based on 13 corresponding questions is given below.

Table 2: Comparison between students who wrote the BST and those who did not write. (error = standard error of mean)

	Overall	Did not write BST	Wrote BST
# students	262	185	77
Average (/16)	6.79 ± 0.22	6.48 ± 0.26	7.55 ± 0.40
Median (/16)	6.5	6	8

Table 3: Comparison in different categories of questions between students who wrote the BST and those who did not write.

	Overall	Did not write BST	Wrote BST
# students	262	185	77
Algebra (/8)	3.36 ± 0.13	3.16 ± 0.15	3.83 ± 0.22
Geometry (/4)	2.01 ± 0.07	1.89 ± 0.09	2.30 ± 0.14
Functions (/4)	2.25 ± 0.07	2.14 ± 0.09	2.53 ± 0.14
Word problems (/4)	1.35 ± 0.07	1.32 ± 0.09	1.43 ± 0.14

We see from the above table that students performed the best on functions, followed by geometry, algebra, and word problems. The following table shows how much students have improved from BST to DT based on 13 similar questions. Question by question analysis will be discussed in the next section.

Table 4: Comparison between students who wrote BST2 and those who wrote BST3 based on 13 similar questions in DT.

	Wrote BST2	Wrote BST3
# students	44	33
Avg in BST (/13)	4.43 ± 0.36	5.00 ± 0.33
Avg in DT (/13)	6.07 ± 0.47	6.06 ± 0.48
p-value	< 0.01	0.04

We were interested to see how much students' basics skills can affect their performance in the course. The following figure shows the correlation between the scores in DT (Sept 24) and the scores in Midterm 1 (Oct 20). The correlation coefficient is $r = 0.545$. The red circles represent the Midterm 1 averages versus the DT averages for different sections.

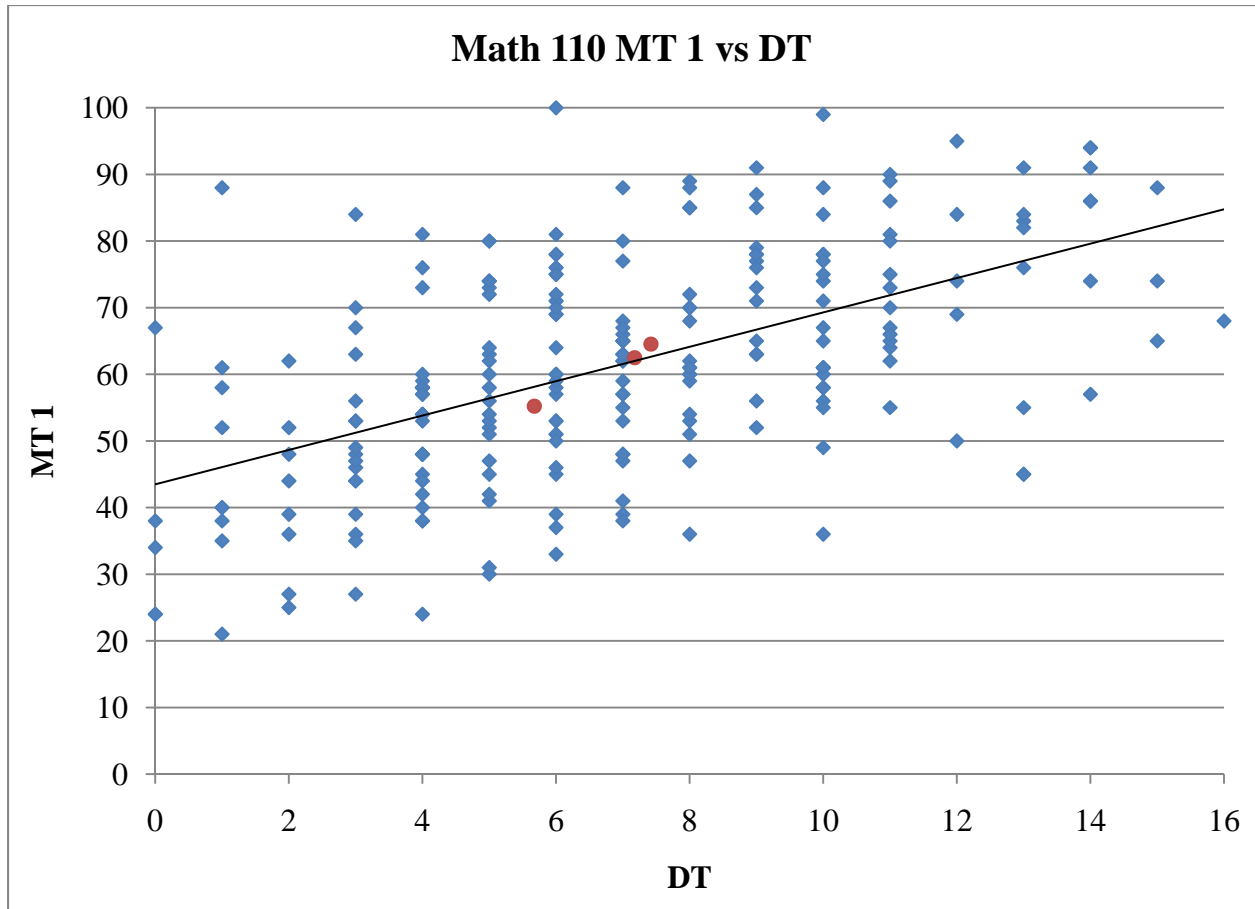


Figure 1: Scores in Math 110 Midterm 1 vs scores in DT ($r = 0.545$) (blue diamonds: individual students' scores; red circle: section averages)

Results based on individual questions

The following table shows discrimination index (DI) and the averages for each question. The DI is a value ranged from -1 to 1 that describes the difference between how well students who did well in DT answered the questions and how those who did poorly in DT answered the same question. It is defined as

$$DI = \text{average}(\text{top } 1/3 \text{ of the distribution}) - \text{average}(\text{bottom } 1/3 \text{ of the distribution})$$

The comparison between the averages of the DT questions and the corresponding BST questions are also shown in the following table. The improvement is considered significant if the associated p-value is less than 0.05.

Table 5: Results from DT by questions with comparisons to BST scored. (A = algebra, G = geometry, F = functions, W = word problems)

DT questions	Overall		Wrote BST		
	DI	DT average	BST average	DT average	p-value
1 (G,F)	0.490	0.611 ± 0.030			
2 (G)	0.506	0.489 ± 0.031	0.312 ± 0.053	0.532 ± 0.057	< 0.01
3 (G)	0.454	0.523 ± 0.031	0.312 ± 0.053	0.584 ± 0.057	< 0.01
4 (W)	0.452	0.317 ± 0.029	0.182 ± 0.044	0.299 ± 0.053	0.04
5 (W)	0.555	0.340 ± 0.029	0.205 ± 0.062	0.386 ± 0.074	0.03
6 (A)	0.406	0.321 ± 0.029	0.299 ± 0.053	0.364 ± 0.055	
7 (G,W)	0.488	0.385 ± 0.030	0.182 ± 0.068	0.485 ± 0.088	< 0.01
8 (F)	0.474	0.454 ± 0.031	0.394 ± 0.086	0.515 ± 0.088	
9 (A)	0.509	0.458 ± 0.031	0.286 ± 0.052	0.532 ± 0.057	< 0.01
10 (A,F)	0.537	0.565 ± 0.031	0.636 ± 0.055	0.636 ± 0.055	
11 (A)	0.527	0.401 ± 0.030	0.312 ± 0.053	0.468 ± 0.057	0.02
12 (A)	0.528	0.370 ± 0.030	0.364 ± 0.055	0.325 ± 0.054	
13 (A,F)	0.600	0.622 ± 0.030	0.688 ± 0.053	0.727 ± 0.051	
14 (A)	0.416	0.344 ± 0.029	0.338 ± 0.054	0.390 ± 0.056	
15 (A)	0.487	0.279 ± 0.028	0.442 ± 0.057	0.390 ± 0.056	
16 (W)	0.412	0.313 ± 0.029	0.250 ± 0.066	0.295 ± 0.070	

Among the students who write BST, we noticed that they have noticeably improved in geometry. However, improvement in algebra skills is not as significant.

Table 6: Distributions of answers in per cents. (The correct answers are shaded.)

	A	B	C	D	E	F	G	H	I	J	Did not answer
1	2.3	3.8	4.2	1.1	61.1	14.9	8.8	3.1			0.8
2	1.9	6.5	9.9	3.1	7.3	2.7	10.3	3.4	48.9	3.4	2.7
3	14.1	0.4	52.3	21.0	9.9						2.3
4	12.6	28.2	4.6	5.7	9.9	2.3	0.8	31.7	0.4	1.5	2.3
5	6.5	6.1	10.7	9.2	34.0	7.3	8.8	6.5	1.9	5.7	3.4
6	5.0	2.3	3.8	5.7	8.4	32.1	4.6	11.8	5.7	16.8	3.8
7	3.8	1.9	29.4	1.5	6.9	7.3	8.8	38.5			1.9
8	2.7	7.6	4.2	5.7	2.7	6.1	5.3	3.1	45.4	16.0	1.1
9	3.1	3.1	5.3	2.7	45.8	6.1	6.5	8.0	3.8	9.9	5.7
10	3.4	56.5	2.7	4.6	3.4	7.6	5.3	1.9	1.9	9.9	2.7
11	6.5	9.9	1.5	7.3	1.9	10.3	40.1	12.6	5.0	0.8	4.2
12	9.5	11.5	14.1	16.8	37.0						11.1
13	0.4	17.9	2.7	3.1	5.3	2.7	62.2	0.0	2.3	1.9	1.5
14	3.8	7.3	34.4	9.9	7.6	6.1	3.4	2.3	0.8	16.4	8.0
15	9.9	12.6	7.6	6.9	5.3	2.3	27.9	2.3	21.4		3.8
16	10.7	34.0	1.5	0.8	3.1	5.7	5.7	31.3	1.5	1.9	3.8