

Multiple Measures

MULTIPLE MEASURES: A PILOT STUDY

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INTRODUCTION

PURPOSE

The purpose of this report is to summarize and interpret results from a Multiple Measures Only pilot study conducted during the Fall 2016 test assessment and placement period (March 21st – September 4th, 2016). During four selected weeks (May 23rd – June 18th, 2016), students that underwent assessment took place in the MMPS. All students completed a questionnaire about their educational background and took the standard tests for class placement in the designated subjects: College Test for English Placement (CTEP) for placement in English and Reading classes, and/or the Mathematics Diagnostic Testing Project (MDTP) for placement in Math classes. Students were placed into the class corresponding to the highest placement as determined by either the test assessment or the multiple measures only guidelines. The goal of this pilot study was to use multiple measures only to place students in accelerated pathways towards degree completion and transfer, with the implication that students that would normally be placed in lower-level classes based on current test assessment procedures are now being placed in higher-level classes.

This report will focus on four primary questions:

- 1) Did the multiple measures only guidelines increase the number of students placed into college-level courses?
- 2) Did the multiple measures placement guidelines reduce the disproportionate impact of course placement observed using current test assessment procedures {see report released June, 2016; available upon request}?
- 3) Were students placed into college-level classes from multiple measures only as successful as students placed into college-level classes from current test assessment practice?
- 4) What student factors are related to academic success in college-level courses?

MULTIPLE MEASURES ONLY GUIDELINES

- i. English
 - a. HS GPA
 - i. If $HS\ GPA \geq 2.5$: ENGL 115
 - ii. If $2.0 \leq HS\ GPA < 2.5$: ENGL 114
- ii. Reading
 - a. HS GPA
 - i. If $HS\ GPA \geq 2.0$: Reading 158
- iii. Math (see Appendix)

- a. Last Math Class & Grade Received
- b. HS GPA

METHODOLOGY

DATA

Data was collected using Business Objects and the internal data source for the Test Assessment and Placement file.

ANALYSES

COLLEGE-LEVEL PLACEMENT

This analysis aims to answer the first primary research question: did the multiple measures only guidelines increase the number of students placed into college-level courses? The college-level placement proportions from the four-week MM pilot study will be compared in two separate analyses to appropriate control groups described below.

First, the placement rates of the MM pilot study will be compared to corresponding four-week periods drawn from Fall 2014 and Fall 2015 testing periods. For the Fall 2014 testing period, these four weeks are from May 18th – June 14th and for Fall 2015, these four weeks are from May 24th – June 20th. For each subject (English, Reading, and Math), the proportion of students placed at the college-level in 2014 and 2015 will be compared to the proportion of students placed at the college-level during the 2016 MM pilot study. The conclusions from this comparison will indicate whether college-level placement significantly increased during the 2016 MM pilot study compared to prior years.

Secondly, college-level placement rates from the Fall 2016 MM pilot study will be compared to the college-level placement rates from a randomly selected four-week period drawn from the remainder of the Fall 2016 testing period: March 21st, 2016 – September 4th, 2016, excluding the weeks included in the MM pilot study (May 23rd, 2016 – June 18th, 2016). Within each subject (English, Reading, Math), a four-week period was randomly selected. These weeks are listed below in **Table 1**.

	Control Groups						Experimental Group	
	2014		2015		2016 Randomly Selected		2016 MM Pilot	
	<i>Date Range</i>	<i>N</i>	<i>Date Range</i>	<i>N</i>	<i>Date Range</i>	<i>N</i>	<i>Date Range</i>	<i>N</i>
English	May 18 th – June 14 th	1002	May 24 th – June 20 th	838	July 24 th – August 20 th	833	May 23 rd – June 18 th	897
Reading	May 18 th – June 14 th	1047	May 24 th – June 20 th	908	April 3 rd – April 30 th	920	May 23 rd – June 18 th	935
Math	May 18 th – June 14 th	1129	May 24 th – June 20 th	1068	May 1 st – May 22 nd and June 19 th – June 25 th	1036	May 23 rd – June 18 th	1013

Table 1: Date ranges and student sizes for control samples to be compared to the MM Pilot Study.

The conclusions derived from the comparison between the college-level placement rates of the 2016 MM pilot and the randomly selected four-week period, in combination from the results of the first analysis, will indicate whether college-level placement significantly increased during the MM pilot study.

To conduct comparisons, a chi-square test of independent proportions will be used.

DISPROPORTIONATE IMPACT ANALYSIS (DIA)

To evaluate disproportionate impact of test assessment, we will use the 80 Percent Index. Using this method, we will be able to identify demographic or special population subgroups that may have been disproportionately impacted by the test assessment and placement process that took place during the MM pilot study. We will focus on four demographic variables: gender, ethnicity, age, and veteran/active-duty status.

In each analysis, the rate at which a sub-group is placed into college-level or pre-college level courses will be compared to a reference group. The selection of this reference group will correspond to the reference group previously selected in the Test Assessment Disproportionate Impact Report, released in June, 2016 [request for report can be made to the Research office].

For each reference group, we calculate a benchmark value that is 80% of the rate at which this reference group is being placed into college or pre-college level courses. For all other sub-groups, if their rate of college-level placement falls below this benchmark of college-level placement, we will conclude that disproportionate impact of test assessment and placement has occurred to this subgroup. If a sub-group's rate of pre-college level placement falls below the 80% Index for pre-college level placement, we will conclude that disproportionate impact has occurred to the reference group.

DISPROPORTIONATE IMPACT ANALYSIS, CHART INTERPRETATION

Within each DIA table, the reference group will be highlighted in light blue. Every subgroup rate that falls below the 80% Index for either college-level or pre-college-level placement will be highlighted in yellow. Cells with less than 10 students will be suppressed, and ** will be placed within the raw number cell (*n*) and the percentage (%) cell. A short conclusion will be detailed below each table.

Results from this DIA can be compared, with caution, to results from the June, 2016 Test Assessment Disproportionate Impact Report, which did find evidence of disproportionate impact of the test assessment and placement process for every subject: English, Reading, and Math.

COLLEGE-LEVEL COURSE OUTCOMES

This analysis aims to answer the third primary research question: were students placed into college-level classes from multiple measures as successful as students placed into college-level classes from standard test assessment practice? To answer this question we will compare the proportions of students that passed their college-level course (for English, Reading, or Math) between students placed using only multiple measures and students placed using current test assessment procedures. Using a chi-square test of independent proportions to make this comparison, we will be able to conclude if the rate of students passing the college-level courses in each subject is significantly different between the MM only group and the standard test assessment group.

Additionally, we will compare the overall proportion of students that passed the college-level courses in each designated subject, combining the outcomes of students who were placed using MM only guidelines and students who were placed using current test assessment procedures, to the pass rates from the 2014 and 2015 samples [**Table 1**]. So, while the pass rate between MM only placed students and test assessment placed students may significantly differ, if the overall pass rate is not significantly different than previous years, we will conclude that using multiple measures only guidelines will not decrease the number of students that will pass college-level courses in the designated subject (English, Reading, or Math). Of note, for Math, the numbers of course enrollments found in the 2014 and 2015 samples used for placement outcome comparisons (see above {College-level Placement} and **Table 1**) were too small for analyses on course outcomes. Therefore, alternative random samples of all students tested for math placement during the Fall 2014 and Fall 2015 testing period were used to achieve appropriate sample sizes.

COLLEGE-LEVEL COURSE OUTCOME PREDICTION

Finally, we will investigate the fourth primary research question: what student factors are related to success in college-level courses? To better understand the multitude of factors, this analysis will be divided into three sections: demographic factors, academic factors, and the interaction of academic factors. We will describe each factor and discuss how each factor relates to course outcomes. Finally, we will use the results from our academic factor predictions to suggest possible guidelines for placement into college-level courses.

RESULTS

ENGLISH

COLLEGE-LEVEL PLACEMENT

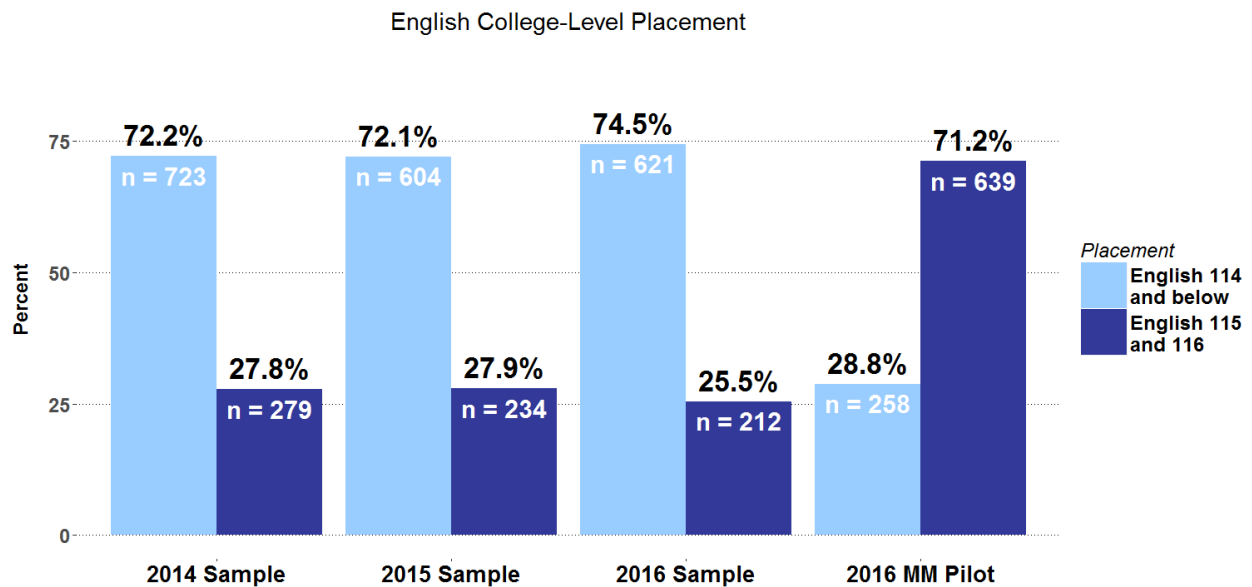


Figure 1: Graph displaying the distribution of students placed into college-level English (ENGL115 and 116) and below college-level English (ENGL 114 /99/71).

Students Placed at College-Level English

	2014 Sample	2015 Sample	2016 Sample	2016 MM Pilot
Below College-Level	723	604	621	258
College-Level	279	234	212	639

Table 2: Table displaying the number of students placed at college-level (ENGL 115/116) and below college-level (ENGL 114/99/71) English.

We find a significant increase in the number of students placed at college-level English between the matching weeks of 2014/2015 and the 2016 multiple measures pilot study ($\chi^2 = 463.3, p < .001$).

We also find that a significantly greater number of students were placed at college-level English during the 2016 multiple measures pilot study compared to a randomly selected four-weeks of the Fall 2016 testing period ($\chi^2 = 360.46, p < .001$).

Combined, these results indicate that college-level English placement significantly increased during the multiple measures pilot study.

DISPROPORTIONATE IMPACT ANALYSIS (PLACEMENT OUTCOMES)

GENDER

	Below College-Level (English 114 and below)		College-Level (English 115 and 116)		<i>Total</i>	
	<i>n</i>	%	<i>n</i>	%	<i>N</i>	%
Female	94	23.8%	301	76.2%	395	100.0%
Male	162	32.5%	337	67.5%	499	100.0%
No Response	**	**	**	**	**	100.0%
<i>Total</i>	258	28.8%	639	71.2%	897	100.0%
80% of Placement Rate for Reference Group (Males)		26.0%		54.0%		80.0%

Females were placed into pre-college-level English at a disproportionately lower rate than male students, indicating male students have been disproportionately impacted within the MM pilot study.

ETHNICITY

	Below College-Level (English 114 and below)		College-Level (English 115 and 116)		<i>Total</i>	
	<i>n</i>	%	<i>n</i>	%	<i>N</i>	%
African American, Non-Hispanic	19	34.5%	36	65.5%	55	100%
Am. Ind/Alskn.Nat	**	**	**	**	**	100%
Asian	**	**	16	80.0%	20	100%
Filipino	15	22.1%	53	77.9%	68	100%
Hispanic	193	31.4%	422	68.6%	615	100%
No Response	**	**	11	61.1%	**	100%
Other, Non-White	**	**	12	92.3%	13	100%
Pacific Islander	**	**	**	**	10	100%
Unknown	**	**	**	**	**	100%
White, Non-Hispanic	16	18.0%	73	82.0%	89	100%
<i>Total</i>	258	28.8%	639	71.2%	897	100%
80% of Placement Rate for Reference Group (White, Non-Hispanic)		14.4%		65.6%		80.0%

Those that did not respond to the question of ethnicity and race fell below the 80% benchmark for college-level placement. Without more information on the reasons these students did not indicate an ethnicity or race, we cannot draw conclusions on disproportionate impact at the ethnicity/race level.

AGE

	Below College-Level (English 114 and below)		College-Level (English 115 and 116)		<i>Total</i>	
	<i>n</i>	%	<i>n</i>	%	<i>N</i>	%
17 and younger	56	22.9%	189	77.1%	245	100%
18 and 19	90	24.5%	278	75.5%	368	100%
20 to 24	42	37.2%	71	62.8%	113	100%
25 to 29	17	35.4%	31	64.6%	48	100%
30 to 34	15	65.2%	**	**	23	100%
35 to 39	**	**	**	**	16	100%
40 to 49	11	45.8%	13	54.2%	24	100%
50 and older	**	**	**	**	**	100%
Unknown	16	29.1%	39	70.9%	55	100%
<i>Total</i>	258	28.8%	639	71.2%	897	100%
80% of Placement Rate for Reference Group (18 and 19 yr olds)		19.6%		60.4%		80.0%

We find the rate of college-level placement for individuals between the ages of 30 and 49 to be less than the 80% benchmark, indicating disproportionate impact on the basis of age.

VETERAN/ACTIVE-DUTY STATUS

	Below College-Level (English 114 and below)		College-Level (English 115 and 116)		<i>Total</i>	
	<i>n</i>	%	<i>n</i>	%	<i>N</i>	%
Non-Veteran Student	248	28.6%	618	71.4%	866	100%
Veteran/Active Duty Student	**	**	20	69.0%	**	100%
Unknown/No Response	**	**	**	**	**	100%
<i>Total</i>	258	28.8%	639	71.2%	897	100%
80% of Placement Rate for Reference Group (Non-Veteran Student)		22.9%		57.1%		80.0%

We do not find disproportionate impact based on Veteran/Active-Duty status for English placement during the MM pilot study.

COLLEGE-LEVEL COURSE OUTCOMES

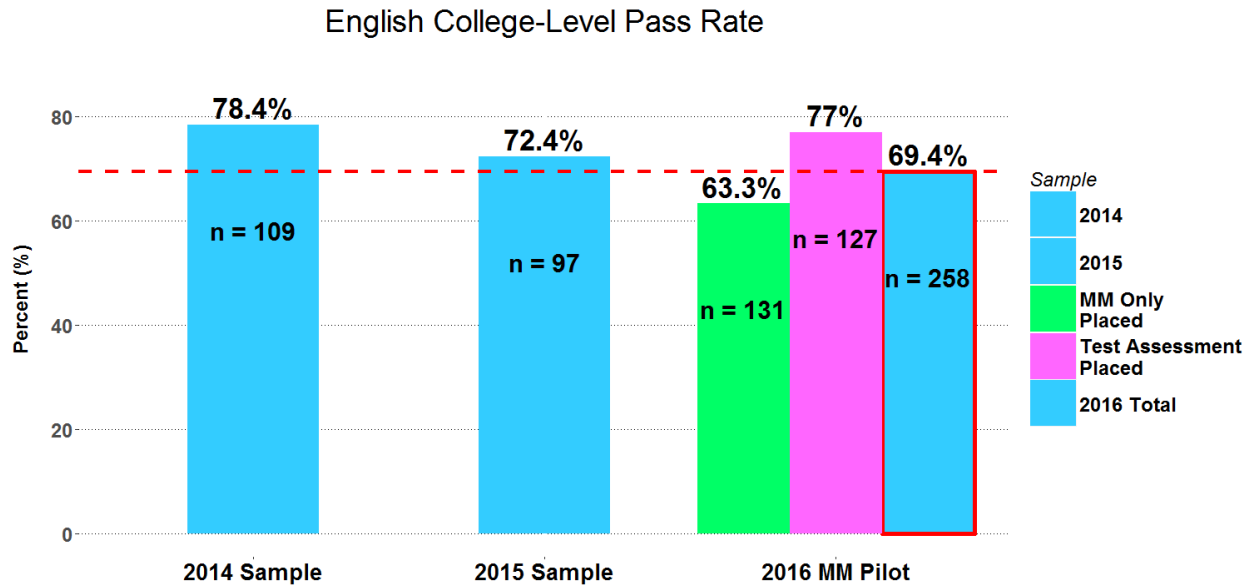


Figure 2: Graph displaying the pass rate for students placed into college-level English (ENGL 115/116) and enrolled in a college-level course. Red dotted line is the average pass rate for students placed during the 2016 MM pilot study.

College-Level English (115 & 116) Pass

	2014 Sample	2015 Sample	2016 MM Pilot Test Assessment Placed	2016 MM Pilot MM Only Placed	2016 MM Pilot Total
Failed	30	37	38	76	114
Passed	109	97	127	131	258

Table 3: Table summarizing the number of students that passed or failed their college-level English course (ENGL 115 & 116).

We find that those placed into college-level English based on multiple measures only guidelines are 48.4% less likely to pass their college-level English course compared to those that place into college-level English from current test assessment procedures ($p = .005$). However, the overall pass rate, combining the class outcomes of all students tested within the MM pilot study, is not significantly different from the pass rate of 2014 and 2015 ($\chi^2 = 4.1337, p = .127$). Therefore, we would not expect a significantly different proportion of students to fail college-level English if the MM pilot study was to be scaled to a larger sample of students.

DEMOGRAPHIC COURSE OUTCOMES DIFFERENCES

We sought to understand how demographic variables are related to a student's success in a college-level English class. These demographic variables include gender, age, ethnicity, and ESL status. For ethnicity, due to small numbers in some ethnic categories, groups were collapsed into larger categories: White (Non-Hispanic), Hispanic/Latino, Filipino/Asian, and Other (Non-White, includes Black/African-American).

We did find that male Filipino/Asian students were 7.22 times more likely to pass their college-level English class compared to female Filipino/Asian students ($p = .02$). Otherwise, there were no significant differences in student success based on age, gender, ethnicity, or reporting English as a secondary language. Of note, once we control for these demographic variables, the difference in pass rate previously found between those placed into college-level English from multiple measures and those placed from current test assessment procedures is no longer significant. This may indicate a more complex relationship between disproportionate impact of placement and the odds of success at course level.

COLLEGE-LEVEL COURSE OUTCOME PREDICTION

ACADEMIC FACOTRS

Next, we investigated differences in the independent predictive value of several academic factors in determining course success in college-level English. These variables included HS GPA, grade in last HS English class, years out of high school, CTEP Reading score, CTEP Syntax score, and CTEP Grammar score. We find that those with a HS GPA of 3.0 and above are 2.71 times more likely to pass their college-level English class than those with a HS GPA between 2.5 and 2.9 ($p < .001$), whereas there is no significant difference in the likelihood of passing college-level English between those with a GPA below 2.5 and those with a GPA between 2.5 and 2.9. In addition, we find a marginally significant increase in the likelihood of passing college-level English related to CTEP Grammar scores; for every one point increase on the CTEP Grammar score, the odds of passing college-level increase by approximately 7.9% ($p = .09$). In larger samples, we might expect this difference to become detectably significant.

ACADEMIC FACTOR INTERACTIONS

In our next model, we aimed to understand how the interaction between these academic factors relates to the likelihood of success in a college-level English class. We did not find any significant interactions between these academic factors, although we did find an interaction between CTEP Grammar scores and HS GPA that is trending toward significance. Those with a HS GPA of 3.0 and above have a 12.7% increased odds of passing college-level

English with each additional point scored on the CTEP Grammar test compared to those with a HS GPA of 2.5 and 2.9 ($p = .08$).

PREDICTIVE CONCLUSIONS

Based on the combination of these results, if multiple measures only is used to place students into college-level English, we would recommend only students with a HS GPA of 3.0 and above are placed into English 115 or 116. If this had been the guideline used in the MM pilot study, we would have placed 189 additional students at the college English level (students that would not have placed at the college level from current test assessment practice), and of the 113 from those additional students that enrolled in a college-level English class, 72.6% ($n = 82$) would have passed English 115 or 116.

However, using this method in place of the current test assessment procedures would have excluded some students that would have placed at the college-level using the current test assessment procedures. If only students with a HS GPA of 3.0 and above were placed at the college-level during the MM pilot study, only 336 students would have placed at the college-level, 210 of which would have enrolled in college-level English and 78.6% ($n = 165$) of which would pass the class; this excludes 118 students that would have been placed into college-level English from current test assessment procedures; from the 68 of those students that enrolled in an English course, 64.7% ($n = 44$) passed their college-level course.

Current placement practice for English involves utilizing CTEP scores, HS GPA, and grade in high school English to calculate a scaled score for students. Students that score above a 3.06 are placed into college-level English. Using this score to predict college-level English success in place of raw CTEP scores, HS GPAs, and HS English grades, we find that for every unit increase in these scores, students are 3.38 times more likely to succeed in the college-level course ($p < .001$). For example, a student that scored 3.0 is 3.38 times more likely to succeed in college-level English than a student that scored a 2.0. Additional graphical investigation reveals that the cutoff score used for college-level placement may be too high, excluding students that could otherwise succeed in college-level English courses. If students that received a score of 2.4 and above were placed into college-level English, we would have placed at total of 538 students in college-level English; 329 of these students would enroll in college-level English, and 73.3% ($n = 241$) of these students would pass college-level English.

Using a combination of the above findings, a recommendation would be to place students into college-level English if students meets either of these requirements:

1. A score ≥ 3.06 using the derived placement formula.
2. A score ≥ 2.4 using the derived placement formula and a HS GPA of 3.0 and above.

If these guidelines were used for placement, 419 students would be placed into college-level English; from the 264 of these students that enrolled in college-level English, 77.3% (n = 204) would pass their college-level English class. While less people would be placed at the college-level than if we used only a derived score ≥ 2.4 (a difference of 119 students), only 37 less students pass their college English class. To maximize likelihood of student success, this would be the recommendation for the next pilot study using multiple measures.

Outcomes following English Placement Proposed Guidelines

	Test Assessment Placed	Additional MM Placed	Total
Placement at English 115/116	265	154	419
Enrolled in English 115/116	165	99	264
Did not Pass English 115/116	38	22	60
Passed English 115/116	127	77	204
% Passed	77.0%	77.8%	77.3%

Table 4: Summary of outcomes that would have been observed under the revised placement recommendations for English 115.

READING

COLLEGE-LEVEL PLACEMENT

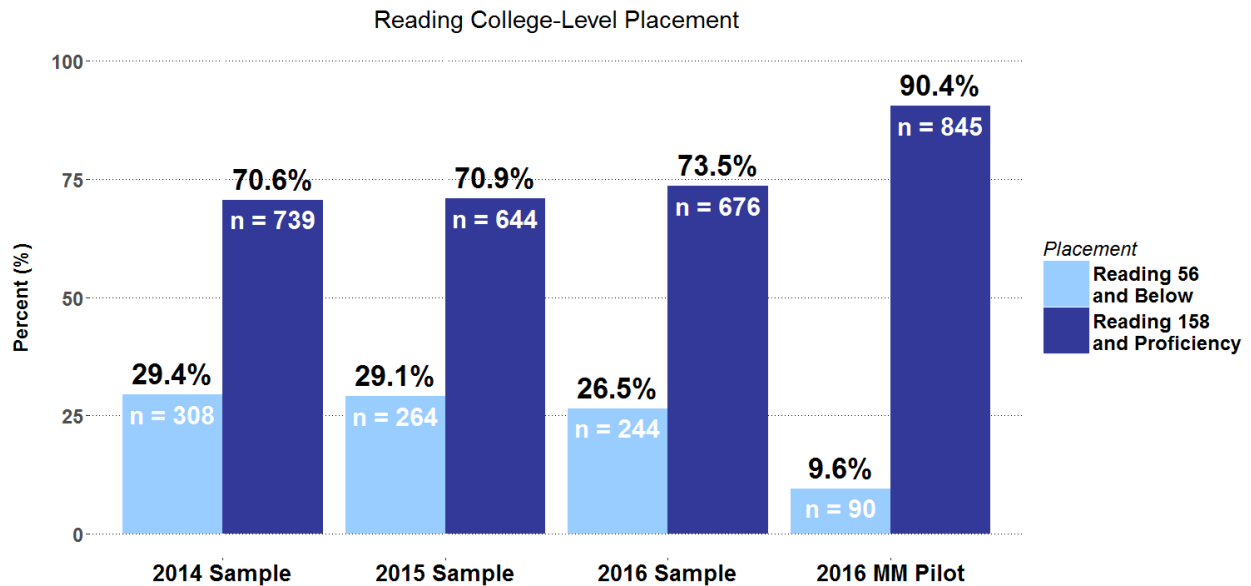


Figure 3: Graph displaying the distribution of students placed at college-level (RDG 158) or college-proficiency Reading and students placed below college-level Reading within each sample.

Students Placed at College-Level and College-Proficiency Reading

	2014 Sample	2015 Sample	2016 Sample	2016 MM Pilot
Below College-Level	308	264	244	90
College-Level	739	644	676	845

Table 5: Table summarizing the number of students placed at college-level (and college-proficiency) Reading and the number of students placed below college-level Reading within each sample.

We find a significant increase in the number of students placed at college-level or college-proficiency Reading between the matching weeks of 2014/2015 and the 2016 multiple measures pilot study ($\chi^2 = 136.94, p < .001$).

We also find that a significantly greater number of students were placed at college-level or college-proficiency Reading during the 2016 multiple measures pilot study compared to a randomly selected four-weeks of the Fall 2016 testing period ($\chi^2 = 88.528, p < .001$).

Combined, these results indicate that college-level and college proficiency Reading placement significantly increased during the multiple measures pilot study.

DISPROPORTIONATE IMPACT ANALYSIS (PLACEMENT OUTCOMES)

GENDER

	Below College-Level (Reading 56 and below)		College-Level (Reading 158 and Proficiency)		<i>Total</i>	
	<i>n</i>	%	<i>n</i>	%	<i>N</i>	%
Female	37	8.90%	377	91.1%	414	100%
Male	51	9.80%	467	90.2%	518	100%
No Response	**	**	**	**	**	100%
<i>Total</i>	90	9.60%	845	90.4%	935	100%
80% of Placement Rate for Reference Group (Males)		7.84%		72.2%		80.0%

We do not see evidence of disproportionate impact of Reading placement based on gender.

ETHNICITY

	Below College-Level (Reading 56 and below)		College-Level (Reading 158 and Proficiency)		<i>Total</i>	
	<i>n</i>	%	<i>n</i>	%	<i>N</i>	%
African American, Non-Hispanic	**	**	52	91.2%	57	100%
Am. Ind/Alsk.Nat	**	**	**	**	**	100%
Asian	**	**	18	85.7%	21	100%
Filipino	**	**	67	95.7%	70	100%
Hispanic	64	10.0%	574	90.0%	638	100%
No Response	**	**	13	68.4%	19	100%
Other, Non-White	**	**	13	92.9%	14	100%
Pacific Islander	**	**	11	91.7%	12	100%
Unknown	**	**	**	100%	**	100%
White, Non-Hispanic	**	**	85	93.4%	91	100%
<i>Total</i>	90	9.60%	845	90.4%	935	100%
80% of Placement Rate for Reference Group (White, Non-Hispanic)		5.28%		74.7%		80.0%

We find that those who did not respond to the question on ethnicity and race were placed into college-level and college-proficiency Reading at a rate lower the 80% benchmark.

However, without knowing why these students did not answer the question on ethnicity and race, we cannot draw conclusions on disproportionate impact based on ethnicity and race.

AGE

	Below College-Level (Reading 56 and below)		College-Level (Reading 158 and Proficiency)		<i>Total</i>	
	<i>n</i>	%	<i>n</i>	%	<i>N</i>	%
17 and younger	20	8.10%	226	91.9%	246	100%
18 and 19	22	5.80%	358	94.2%	380	100%
20 to 24	13	10.7%	109	89.3%	122	100%
25 to 29	**	**	47	88.7%	53	100%
30 to 34	**	**	19	73.1%	26	100%
35 to 39	**	**	12	70.6%	17	100%
40 to 49	**	**	20	76.9%	26	100%
50 and older	**	**	**	**	**	100%
Unknown	11	18.6%	48	81.4%	59	100%
<i>Total</i>	90	9.60%	845	90.4%	935	100%
80% of Placement Rate for Reference Group (18 to 19 yr olds)		4.64%		75.4%		80.0%

Students between the age of 30 and 39 were placed into college-level and college-proficiency Reading at a rate lower than the 80% benchmark, indicating disproportionate impact of Reading placement based on age.

VERTERAN/ACTIVE-DUTY STATUS

	Below College-Level (Reading 56 and below)		College-Level (Reading 158 and Proficiency)		<i>Total</i>	
	<i>n</i>	%	<i>n</i>	%	<i>N</i>	%
Non-Veteran Student	87	9.70%	813	90.3%	900	100%
Veteran/Active Duty Student	**	**	30	93.8%	32	100%
Unknown/No Response	**	**	**	**	**	100%
<i>Total</i>	90	9.60%	845	90.4%	935	100%
80% of Placement Rate for Reference Group (Non- Veteran Students)		7.76%		72.24%		80.0%

We do not find disproportionate impact of college-level/proficiency Reading placement based on veteran/active-duty status.

COLLEGE-LEVEL COURSE OUTCOMES

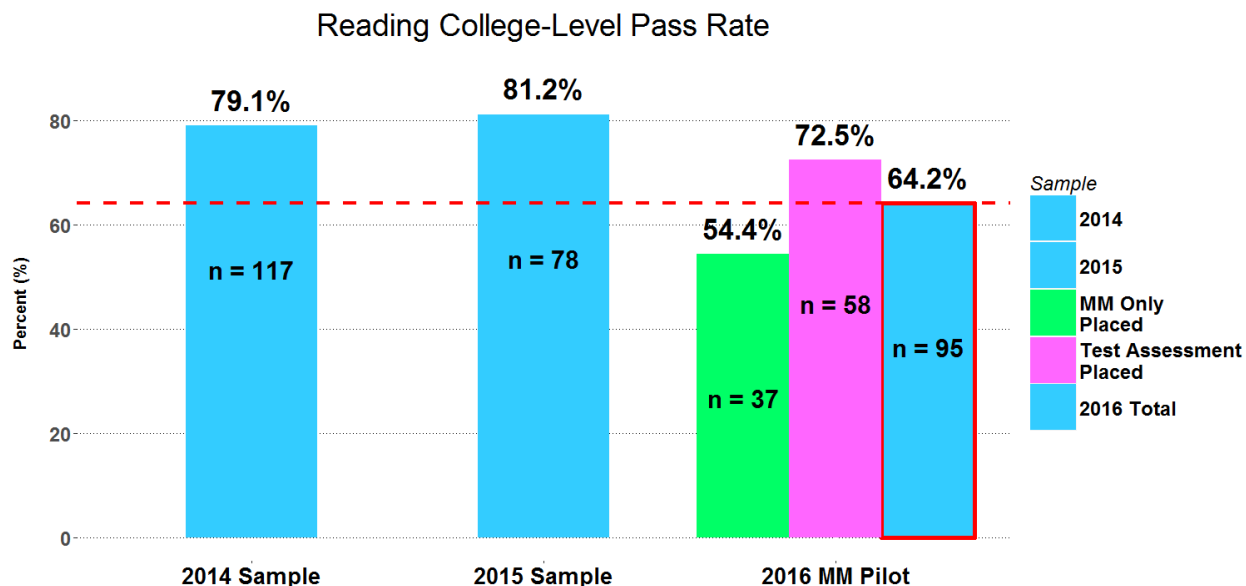


Figure 4: Graph displaying the pass rates for students placed into college-level (or college-proficiency) Reading and enrolled in RDG 158 within each sample.

Reading 158 Pass

	2016 MM Pilot Study				
	2014 Sample	2015 Sample	Test Assessment Placed	MM Only Placed	2016 MM Pilot Total
Failed	31	18	22	31	53
Passed	117	78	58	37	95

Table 6: Table summarizing the number of students that passed and failed RDG 158 within each sample.

We find that those placed into college-level Reading based on multiple measures only guidelines are 54.7% less likely to pass Reading 158 compared to those that place into college-level Reading from current test assessment procedures ($p = .023$). Additionally, we find the overall Reading 158 pass rate, found by combining the class outcomes of all students placed at college-level or college-proficient reading within the MM pilot study, to be significantly lower than the Reading 158 pass rate for 2014 and 2015, ($\chi^2 = 11.985$, $p = .002$). Therefore, it is not recommended to place students in Reading 158 from the multiple measures only guidelines used in this MM pilot study.

DEMOGRAPHIC COURSE OUTCOMES DIFFERENCES

We will determine if any basic demographic variables are related to student success in Reading 158: the college-level Reading class. We will include age, gender, and ethnicity. For ethnicity, due to small numbers in some ethnic categories, groups were collapsed into larger categories: White (Non-Hispanic), Hispanic/Latino, Filipino/Asian, and Other (Non-White, includes Black/African-American).

Based on this demographic model, we do not find any significant differences in student success based on age, gender, or ethnicity. The best predictor of student performance in this model remains whether the student was placed using the multiple measures only guidelines or if they student was placed using current test assessment procedures; students placed from multiple measures only are 59.6% less likely to pass Reading 158 compared to students placed from current test assessment procedures, controlling for age, gender, and ethnicity ($p = .019$).

COLLEGE-LEVEL COURSE OUTCOME PREDICTION

ACADEMIC FACTORS

In our next model, we investigated the independent predictive value of several academic factors in the likelihood of success in college-level Reading. After controlling for the basic demographic variables of age, gender, and ethnicity, these academic variables included: CTEP Reading scores, grade in last high school English class, high school GPA, and years out of high school. We find that CTEP Reading score is a significant predictor of successful course completion of Reading 158; for every additional point scored on the CTEP Reading test, the likelihood of successful course completion increases by 12.7% ($p = .03$), controlling for HS GPA, grade in last HS English class, and years out of high school. Additionally, those with a HS GPA below 2.5 are 58.13% less likely to pass Reading 158 than those with a HS GPA between 2.5 and 2.9 ($p = .05$).

ACADEMIC FACTOR INTERACTIONS

Next, we sought to understand how interactions between these academic factors may predict success in Reading 158. We found a marginally significant interaction between HS GPA and grade in high school English class: an interaction that may be significant in a larger sample. In this interaction, the likelihood of passing Reading 158 for those with a HS English grade of A or B versus a C or below is 5.3 times greater when the student has a HS GPA of 2.5 or below compared to a HS GPA of 2.5-2.9, or reversely, those with a HS English grade of C or below versus those with a HS English grade of A or B are 81.1% less likely to pass Reading 158 when their HS GPA is below 2.5 compared to when their HS GPA is between 2.5 and 2.9 ($p = .072$). This interaction is indicating a differential predictive value for English grades at various HS

GPA. For instance, if a student has an English grade of C and a GPA of 2.1 than they are significantly less likely to pass Reading 158 than if that same student had an English grade of C but also had a GPA of 2.7. We do not find this same interaction between students with a HS GPA from 2.5 to 2.9 and students with a HS GPA above 3.0; a student with a HS English grade of C and a HS GPA of 2.7 is not more or less likely pass Reading 158 than if that same student had a C grade and a 3.5 GPA ($p = .524$).

PREDICTIVE CONCLUSIONS

Based on these findings, we would recommend all students meet the following qualifications for Reading 158 placement; a HS GPA of 2.5 and above or a HS English grade of A or B. This would place 721 students at least at college-level Reading; 125 of these students enroll in Reading 158 and 69.6% ($n = 87$) pass. However, this is still a marginally significantly lower pass rate than found in previous years, ($\chi^2 = 5.039$, $p = .080$). Since we also found that CTEP Reading scores were predictive of success in Reading 158, we add in a minimum score for CTEP Reading score (based on graphical investigation) of 14. When we use the combination of these requirements, we place 683 students at least at college-level Reading; from these, 109 enroll in Reading 158 and 72.4% ($n = 79$) pass the class. This pass rate is not significantly lower than found in previous years ($\chi^2 = 2.563$, $p = .278$).

Similar to English placement, students are currently placed into Reading classes based on a score created from a combination of their CTEP Reading score, HS GPA, and grade in last high school English class. To test the predictive value of this score in determining success in Reading 158, we replaced CTEP Reading scores, HS GPA, and HS English grade with the scaled placements scores derived from these three variables, and found that for every one-unit increase in these placement scores (e.g. from 2.3 to 3.3), there is a 7.6 times increase in the odds of passing Reading 158 ($p < .001$).

Combining the results from above, we would recommend these requirements for college-level placement:

1. A derived score of ≥ 2.1 or CTEP Reading Score ≥ 14
2. HS GPA ≥ 2.5 **and/or** HS English Grade of A or B

Using these requirements, we would have placed 704 students at least at college-level Reading. From this group, 117 would enroll in Reading 158, and 71.8% ($n = 84$) would pass the course. This is not a significantly lower pass rate than found in previous years ($\chi^2 = 3.132$, $p = .2088$).

Outcomes following Reading Placement Proposed Guidelines

	Test Assessment Placed	Additional MM Placed	<i>Total</i>
Placement at RDG158/Proficiency	610	94	704
Enrolled in RDG 158	80	37	117
Did not Pass RDG 158	22	11	33
Passed RDG 158	58	26	84
% Passed	72.5%	70.3%	71.8%

Table 7: Summary of outcomes that would be have been observed under the revised placement recommendations for college-level Reading.

MATH

COLLEGE-LEVEL PLACEMENT

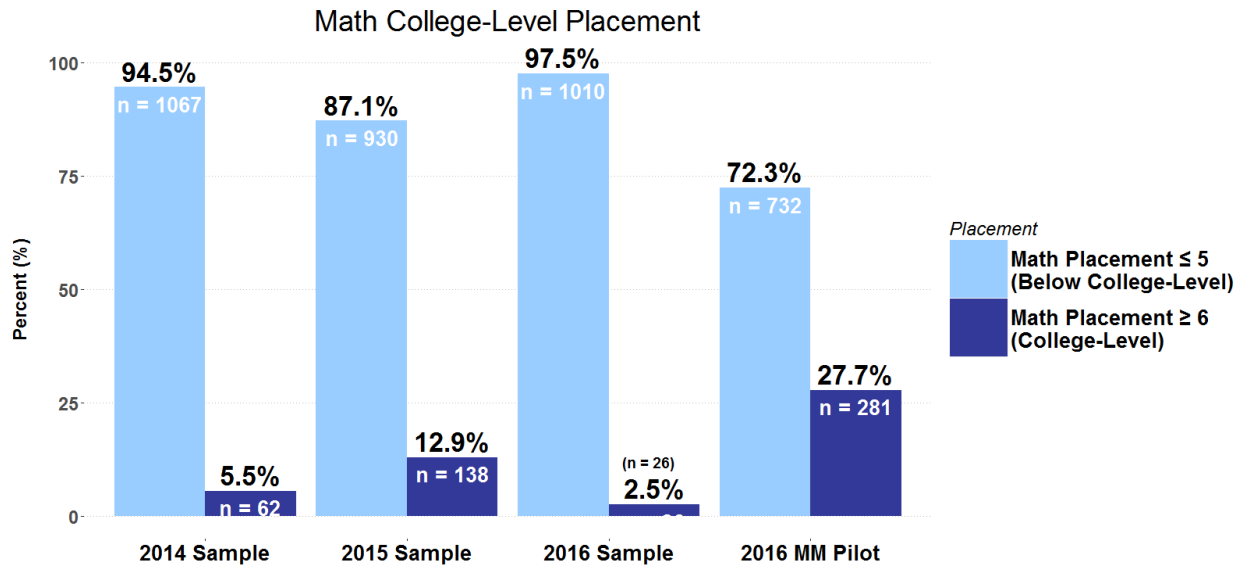


Figure 5: Graph displaying the distribution of students placed at college-level Math (Placement 6+) and below college-level (Placement 5 and below) within each sample.

Students Placed at College-Level Math

	2014 Sample	2015 Sample	2016 Sample	2016 MM pilot
Below College-Level	1067	930	1010	732
College-Level	62	138	26	281

Table 8: Table summarizing the number of students placed at college-level Math and the number of students placed below college-level Reading within each sample.

We find a significant increase in the number of students placed at college-level Math between the matching weeks of 2014/2015 and the 2016 multiple measures pilot study ($\chi^2 = 187.56, p < .001$).

We also find that a significantly greater number of students were placed at college-level Math during the 2016 multiple measures pilot study compared to a randomly selected four-weeks of the Fall 2016 testing period ($\chi^2 = 253.97, p < .001$).

Combined, these results indicate that college-level Math placement significantly increased during the multiple measures pilot study.

DISPROPORTIONATE IMPACT ANALYSIS (PLACEMENT OUTCOMES)

GENDER

	Below College-Level (Placement Level 5 and below)		College-Level (Placement 6 and above)		<i>Total</i>	
	<i>n</i>	%	<i>n</i>	%	<i>N</i>	%
Female	316	69.1%	141	30.9%	457	100%
Male	412	74.8%	139	25.2%	551	100%
No Response	**	**	**	**	5	100%
<i>Total</i>	732	72.3%	281	27.7%	1013	100%
80% of Placement Rate for Reference Group (Males)		59.8%		20.2%		80.0%

We do not find evidence of disproportionate impact of Math Placement on gender during the MM pilot study.

ETHNICITY

	Below College-Level (Placement Level 5 and below)		College-Level (Placement 6 and above)		<i>Total</i>	
	<i>n</i>	%	<i>n</i>	%	<i>N</i>	%
African American, Non-Hispanic	52	83.9%	10	16.1%	62	100%
Am.Ind./Alskn.Nat.	**	**	**	**	**	100%
Asian	14	50.0%	14	50.0%	28	100%
Filipino	49	66.2%	25	33.8%	74	100%
Hispanic	508	73.0%	188	27.0%	696	100%
No Response	24	85.7%	**	**	28	100%
Other, Non-White	**	**	**	**	11	100%
Pacific Islander	**	**	**	**	15	100%
Unknown	**	**	**	**	**	100%
White, Non-Hispanic	61	67.8%	29	32.2%	90	100%
<i>Total</i>	732	72.3%	281	27.7%	1013	100%
80% of Placement Rate for Reference Group (White, Non-Hispanic)		54.2%		25.8%		80.0%

We find that African-American students were placed at college-level Math at a rate lower than the 80% benchmark, indicating disproportionate impact of Math placement on ethnicity/race. In addition, Asian students had a lower rate of placement into pre-college-level Math courses compared to the 80% benchmark set by White, Non-Hispanic students, again indicating disproportionate impact of Math placement during the MM pilot study.

AGE

	Below College-Level (Placement Level 5 and below)		College-Level (Placement 6 and above)		<i>Total</i>	
	<i>n</i>	%	<i>n</i>	%	<i>N</i>	%
17 and younger	191	66.6%	96	33.4%	287	100%
18 and 19	262	66.8%	130	33.2%	392	100%
20 to 24	108	80.6%	26	19.4%	134	100%
25 to 29	48	88.9%	**	**	54	100%
30 to 34	27	96.4%	**	**	28	100%
35 to 39	15	100%	**	**	15	100%
40 to 49	18	81.8%	**	**	22	100%
50 and older	**	**	**	**	**	100%
Unknown	59	76.6%	18	23.4%	77	100%
<i>Total</i>	732	72.3%	281	27.7%	1013	100%
80% of Placement Rate for Reference Group (18 and 19 yr olds)		53.4%		26.6%		80.0%

Those between the ages of 25 and 29 and those that did not report an age were placed at college-level Math at a rate lower than the 80% benchmark, indicating disproportionate impact of the Math placement process on the basis of age.

VETERAN/ACTIVE-DUTY STATUS

	Below College-Level (Placement Level 5 and below)		College-Level (Placement 6 and above)		<i>Total</i>	
	<i>n</i>	%	<i>n</i>	%	<i>N</i>	%
Non-Veteran Student	696	71.5%	278	28.5%	974	100%
Veteran/Active Duty Student	34	94.4%	**	**	36	100%
Unknown/No Response	**	**	**	**	**	100%
<i>Total</i>	732	72.3%	281	27.7%	1013	100%
80% of Placement Rate for Reference Group (Non-Veteran Students)		57.2%		22.8%		80.0%

We do not find disproportionate impact of Math placement on the basis of veteran/active-duty status.

COLLEGE-LEVEL COURSE OUTCOMES

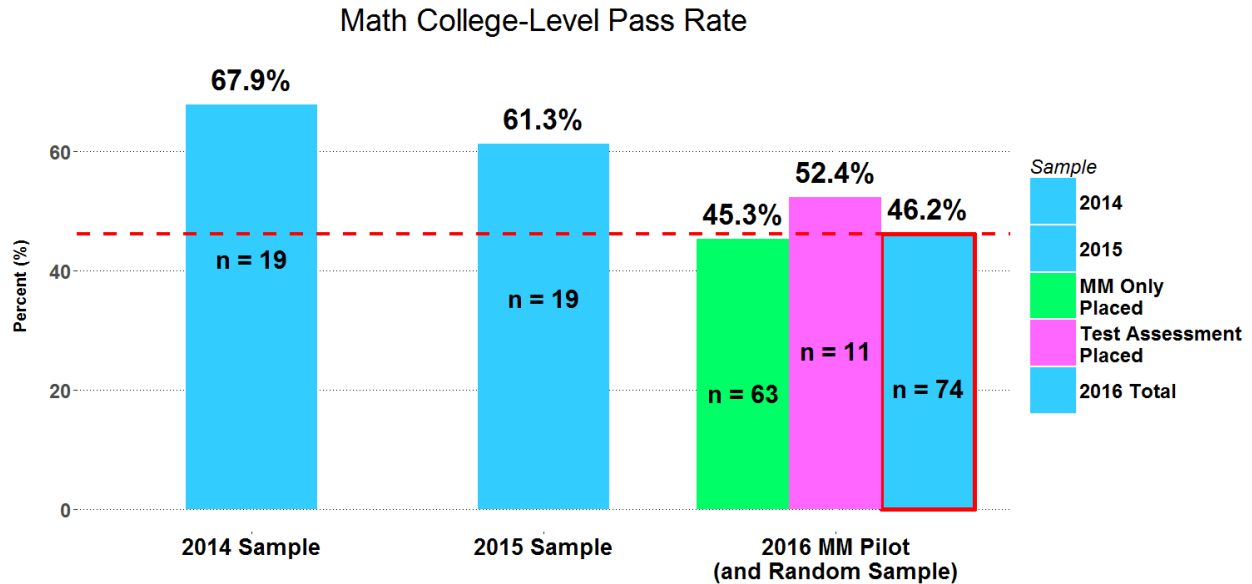


Figure 6: Graph displaying the pass rates for students placed at college-level Math and enrolled in a college-level Math course within each sample.

	College-Level Math Pass				2016 MM Pilot & Random Sample Total
	2014 Random Sample	2015 Random Sample	2016 MM Pilot & Random Sample Test Assessment Placed	2016 MM Pilot & Random Sample MM Only Placed	
No Pass	9	12	10	76	86
Pass	19	19	11	63	74

Table 9: Table summarizing the number of students that passed and failed their college-level Math course within each sample.

We find that those placed into college-level Math from the multiple measures only guidelines did not pass or fail their college-level Math course at a significantly different rate than those that placed into college-level Math from current test assessment procedures ($p = .546$). Similarly, we found the overall college-level Math pass rate, using all students that underwent Math assessment during the MM pilot study, not to be significantly different from the college-level Math pass rate found in random samples from 2014 and 2015 ($\chi^2 = 5.941, p = .051$). However, these results are based on a small number of students, resulting in larger error estimates; in larger samples, our estimates would be more precise and we would better be able to determine if differences existed. Therefore, we caution the interpretation of these results.

DEMOGRAPHIC COURSE OUTCOMES DIFFERENCES

In this first test, we will determine if any basic demographic variables are related to student success in college-level Math (101, 104, 119, 120, 121, 130, 244, 122, 250, 251, and 252). We will include age, gender, and ethnicity. For ethnicity, due to small numbers in some ethnic categories, groups were collapsed into larger categories: White (Non-Hispanic), Hispanic/Latino, Filipino/Asian, and Other (Non-White, includes Black/African-American).

We find that Filipino/Asian students are 3.24 times more likely to pass college-level Math compared to Hispanic students ($p = .02$). No other demographic variables were significant predictors of student success in college-level Math.

COLLEGE-LEVEL COURSE OUTCOME PREDICTION

[CONSIDERS ONLY STUDENTS IN MM PILOT STUDY]

(ENROLLMENT = 144 STUDENTS; PASSED = 64, FAILED = 80, PASS RATE = 44.4%)

ACADEMIC FACTORS

In our next model, we investigated the independent predictive value of various academic factors in determining student success in college-level Math. We exclude ($n = 9$) students that did not receive a score on the Elementary Algebra Score; these students completed only the Algebra Readiness test. After controlling for the basic demographic variables of age, gender, and ethnicity, these academic variables included: HS GPA, grade in last high school Math class, level of last high school Math class, years out of high school, and Elementary Algebra test scores.

We find that no academic factors independently significantly predict college-level course success. However, we do find marginally significant effects of Elementary Algebra test scores and HS GPA on course success, effects that may be detectable at significant levels if the sample size was larger. For every additional point scored on the Elementary Algebra test, the odds of course success increase by approximately 4.5% ($p = .068$), controlling for all other academic factors included in the model. Also, those with a HS GPA of 3.0 and above are approximately 2.38 times more likely to pass a college-level Math course than those with a GPA between 2.5 and 2.9 ($p = .09$), whereas those with a GPA between 2.5 and 2.9 and those with a GPA below 2.5 did not differ in their odds of success. Success was also not significantly different between students that reported a HS Math grade of A or B and those that reported a math grade of C or below ($p = .32$), not significantly different between students that reported different levels of high school math ($p = .23$), and not significantly different based on the numbers of years since high school ($p = .401$). Filipino/Asian students remain approximately 3

times as likely to pass their college-level math courses after controlling for these academic factors ($p = .04$).

ACADEMIC FACTOR INTERACTIONS

Next, we sought to understand how interactions between these academic factors may predict success in college-level math courses. We find a significant interaction between Elementary Algebra test scores and high school math level; for those that completed a calculus level course in high school compared to those that did not, their odds of success in a college-level math course increases by 13.1% for each additional point scored on the Elementary Algebra test ($p = .043$). Additionally, we find an interaction between HS GPA and HS Math grade that is trending toward significance, and may indeed be a significantly detectable interaction within a larger sample. Those with an A or B in their last high school math course, compared to those with a C or below, are 5.96 times more likely to pass their college Math courses if they also have a HS GPA above 3.0 compared to those with a GPA between 2.5 and 2.9 ($p = .079$). Even controlling for these interactions of academic factors, Filipino/Asian students remained over 3 times more likely to pass their college-level Math course than Hispanic students ($p = .03$).

PREDICTIVE CONCLUSIONS [CONSIDERS ONLY STUDENTS IN MM PILOT STUDY]

Based on our results, several possible guidelines could be suggested. For instance, if we only placed students into college-level courses if HS GPA ≥ 3.0 and the grade in the last HS math class was an A or B, we would have placed 130 students at college-level Math; of these, 67 students enrolled in a college-level course and 56.7% ($n = 38$) passed the course. In our entire sample, 64 students passed their college-level math course (44.44% pass rate), which means that using the guidelines of a HS GPA ≥ 3.0 and HS math grade of A or B, we would have excluded 26 students that could pass a college-level course, but overall, increased the rate at which students were passing. Alternatively, if we only allow students that scored a 33 or above on the Elementary Algebra Test (based on graphical evidence suggesting this score as a cutoff), 111 students would have been placed at college-level. From the 53 that attempted a college-level course, 64.2% passed the class ($n = 34$).

Using a combination of Elementary Algebra test scores (≥ 33) and HS GPA ≥ 3.0 , we would place 191 students at the college-level; out of 101 students that enrolled in a college-level course, 50.5% ($n = 51$) passed. From a combination of Elementary Algebra Test scores (≥ 33), HS GPA ≥ 3.0 , and HS Math Grade of an A or B, we would have placed 58 students at college-level; 33 of whom enrolled in a college-level course and 69.7% ($n = 23$) of whom passed the class.

To determine the best guidelines of placement, we must consider both the pass rate and the raw number of students that will pass the class. Due to the variations in both of these elements by the several purposed guidelines, we recommend subsequent discussion that considers these guideline variations with as much sensitivity to student success as possible.

SUB-ANALYSIS: MATH PRE-COLLEGE COURSE OUTCOMES

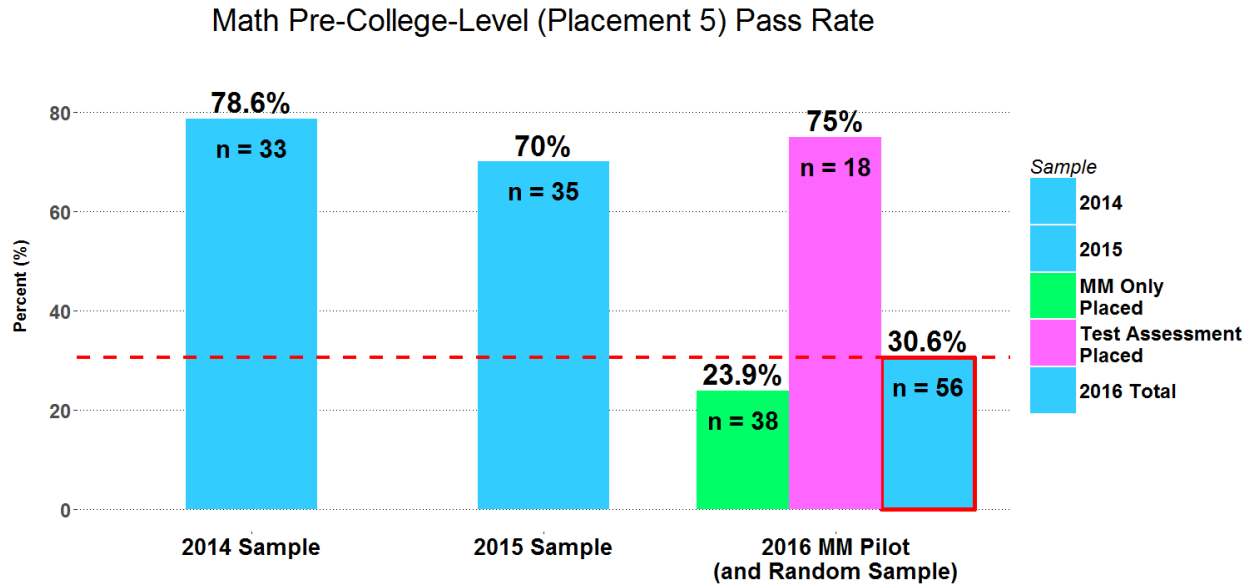


Figure 7: Graph display the pass rate for students placed at the pre-college-level Math placement level (Level 5) and enrolled in a Level 5 course within each sample.

Pre-College-Level (Placement 5) Math Pass

	2014 Sample	2015 Sample	2016 MM Pilot & Random Sample	2016 MM Pilot & Random Sample	2016 MM Pilot & Random Sample
			Test Assessment Placed	MM Only Placed	Sample Total
No Pass	9	15	6	121	127
Pass	33	35	18	38	56

Table 10: Table summarizing the number of students that passed or failed their Level 5 math course.

We find that those placed one level below college-level Math (Placement 5, [Math 70, 100, 110, 112]) from the multiple measures only guidelines are 85.4% less likely to pass a pre-college level math course than those placed at the pre-college level from current test assessment procedures ($p = .007$). Additionally, the overall pass rate for pre-college level math courses, combining the course outcomes from all students placed at pre-college level during the MM pilot study, was significantly lower than the pass rate from 2014 and 2015 ($\chi^2 = 44.653$, $p < .001$).

APPENDIX

MULTIPLE MEASURES ONLY GUIDELINES FOR MATH PLACEMENT

MULTIPLE MEASURES PLACEMENT: BASED ON CAPP SELF REPORTED DATA			
If the last Math class taken was:	And received grade of:	And High School GPA is:	* Then student is eligible for any of the following:
None	N/A	N/A	Math 35
Basic Math (Arithmetic)	N/A	N/A	Math 35
Geometry	N/A	N/A	Math 35
Integrated Math I	A, B or C	N/A	Math 45
	≤ C	N/A	Math 55
or Geometry Algebra I (Integrated Math II) SWC equivalent: Math 45	A or B	N/A	Math 60 (Level 1)
	C	N/A	Math 45 (Level 1)
	< C	N/A	Math 35 (Level 1) *
Algebra II (Integrated Math III) SWC equivalent: Math 70	A	N/A	Math 100, 101, 104, 110, 119, 120, 121, 130, 244 (Level 1)
	B or C	≥ 3.0 (B or better)	Math 100, 101, 104, 110, 119, 120, 121, 130, 244 (Level 1)
		< 3.0 (Below B)	Math 70, 100 (Level 1)
	< C	N/A	Math 60 (Level 1)
Trigonometry SWC equivalent: Math 104	A or B	N/A	Math 100, 101, 104, 110, 119, 120, 121, 130, 244 (Level 1)
	C	≥ 3.0 (B or better)	Math 100, 101, 104, 110, 119, 120, 121, 130, 244 (Level 1)
		< 3.0 (Below B)	Math 70, 100 (Level 1)
	< C	N/A	Math 60 (Level 1)
College Algebra/ Pre-Calculus (Math Analysis) SWC equivalent: Math 244	A, B	N/A	Math 250 (Level 1)
	C	N/A	Math 100, 101, 104, 110, 119, 120, 121, 130, 244 (Level 1)
	< C	N/A	Math 70, 100 (Level 1)
Calculus SWC equivalent: Math 250 ** Without an AP Score **	A, B	N/A	Math 250 (Level 1)
	≤ C	N/A	Math 100, 101, 104, 110, 119, 120, 121, 130, 244 (Level -1)

* Any student that places into Math 45 or higher may choose to take the Math 57 and Math 115 (Statway I and II)

** Student may be referred to Math 48

*** Student may be referred to Fast-track Math 60 and 70

PLACEMENT LEVELS AND CLASSES {UPDATED JUNE, 2016}

PLACEMENT CODE		COURSE/LEVEL	
Mathematics – MDTP			
1 or 2	MATH 35	Pre-Algebra	
2A	MATH 48	Developmental Mathematics	
3	MATH 45	Elementary Algebra	
	MATH 57	Statway I	
4	MATH 60	Intermediate Algebra I	
	MATH 70	Intermediate Algebra II	
	MATH 100	Mathematics for General Education	
5	MATH 110	Mathematics for Elementary School Teachers I	
	MATH 112	Children's Mathematical Thinking	
	<i>Math Proficiency</i>		
	MATH 101	College Algebra	
	MATH 104	Trigonometry	
	MATH 119	Elementary Statistics	
6	MATH 120	Calculus for Business Analysis	
	MATH 121	Applied Calculus I	
	MATH 130	Introduction to Computer Programming	
	MATH 244	Pre-Calculus with Trigonometry	
7	MATH 122	Applied Calculus II	
8	MATH 250	Analytic Geometry & Calculus I	
9	MATH 251	Analytic Geometry & Calculus II	
10	MATH 252	Analytic Geometry & Calculus III	
English – CTEPE or APSW			
1	ENGL 71	Basic Writing and Editing	
	ENGL 99	Accelerated Intro to Reading & Writing Analytically	
3	ENGL 114	Introduction to College Composition	
4	ENGL 115	College Composition: Reading & Writing Analytically	
5	ENGL 116	Critical Thinking and Composition	
Reading – CTEPR or APSR			
1	RDG 52	Basic Reading	
2	RDG 54	Developmental Reading	
3	RDG 56	Introduction to College Reading	
4	RDG 158	College Reading	
5	<i>Reading Proficiency</i>		

TABLE OF ENROLLMENT FOLLOWING COLLEGE PLACEMENT

Enrollment following College Placement

	English		Reading (158)		Math	
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
Total Tested during MM Pilot	897	100%	935	100%	1013	100%
Placed at College Level {for Reading: RDG 158 only considered}	639	71.2%	423	45.2%	281	27.7%
{Of those placed at College Level} Enrolled at College Level	372	58.2%	147	34.8%	144	51.2%