

Multiple Measures Work Group
Summary of Discussion of Decision Rules for Mathematics and Recommendation to
CAISC - January 29, 2016
(Revised to add Tables 3 & 4 and executive summary, March 24, 2016)

Executive Summary

- At the request of the Common Assessment Initiative Steering Committee, the Multiple Measures Work Group (MMWG) reviewed the multiple measures placement rules developed for Statistics and other General Education transfer-level courses by the Multiple Measures Assessment Project (MMAP).
- Most California Community Colleges allow students to assess into foundational skills courses based either on their performance on an assessment test, other indicators, and/or a combination of the two with various weights. While some colleges may include a specific required course in high school for eligibility and/or recommend which placement test to take based on the last course taken, very few actually verify students high school course-taking before assessment or between assessment and placement and rely primarily if not entirely on the assessment process at the college for assessment and placement.
- Historical patterns of course-taking support this, demonstrating that 14% of students in Statistics and 18% in GE math courses have taken the course with no evidence of taking a course higher than Algebra in high school.
- The MMAP rules seek to provide evidence-based guidance to colleges assessment and placement systems as they currently exist, using historical performance of previous students in foundational skills courses to agnostically identify variables that are most strongly and reliably associated with success in those courses for possible use in assessment of whether students are likely to succeed in the course.
- Based on historical patterns, students who meet the rules identified by MMAP are much more likely to succeed in general. Most importantly, students who met the MMAP rules for Statistics and GE Math whose highest course in high school was Algebra 1 were more successful than students who did not meet the MMAP rules but had completed Intermediate Algebra or a higher course. Precluding the entry of students in the course who are likely to succeed while allowing access to the course for students less likely to substantially less likely to succeed would be highly problematic.
- As a result of this review, the MMWG recommended to continue to provide MMAP pilot colleges the current rules as is but also to continue to remind colleges that, as always, they retain full control over the placement process. As a result, they may choose how best to locally implement the MMAP rules with respect to how to set the additional minimum required course taken in high school as either Algebra or Intermediate Algebra as a necessary though not sufficient rule in addition to the MMAP rules.

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Recommendation of the Multiple Measures Work Group to the Common Assessment Initiative Steering Committee:

The Multiple Measures Work Group recommends that colleges be provided the decision rules as developed by the Multiple Measures Assessment Project but highlighting two options for the colleges for placement into statistics.

Colleges should be provided the current rules for statistics with an explanation that the evidence currently supports the use of those rules in combination with an additional requirement of successful completion of Algebra 1.

In addition, colleges should also be provided guidance that, given the evolving nature of the work in statistics pathways, a meaningful alternative approach would be to use the MMAP rules but instead substitute successful completion of Algebra 2 instead of Algebra 1.

The Multiple Measures Work Group further recommends that colleges be provided the various documentation reviewed by the work group as well as the evidence from student completion of Statistics within the MMAP research data set so that the colleges would be fully empowered to make an informed choice as to the most appropriate rule to use for their institution and students.

Summary of the MMWG Discussion of Decision Rules for Mathematics

At the request of the Common Assessment Initiative Steering Committee (CAISC), the Multiple Measures Work Group (MMWG) reviewed the evolving mathematics prerequisites for statistics as part of its role in guiding the development of potential placement decision rule recommendations based on the deployment of more comprehensive use of multiple measures, with particular attention to rules for entry into statistics courses. Members of the CAISC had expressed concern about the use of Algebra 1 as part of the rule sets of entry into statistics courses.

The initial MMWG discussion sought to clarify what might have been inartful wording in the previous rule sets identifying parts of the rule sets as prerequisites, perhaps implying that those courses were sufficient for entry into the course rather than as they were being deployed in the rules as necessary but not sufficient requirements. The MMWG reviewed how the MMAP decision rules had been initially constructed by allowing the categorization and regression tree (CART) analyses to identify combinations of student characteristics that were associated with students being likely to successfully complete the course, irrespective of other criteria. However, to be responsive to feedback from stakeholder groups around the state, additional "hard-coded" rules were added to the evidence-based rules in mathematics requiring students to complete previous courses in typical mathematics sequences but taking into account emerging evidence on alternative routes to statistics suggesting that Algebra 2 may not be necessary for such

entry level, non-STEM transferable courses in mathematics. These rules were **added** not as stand-alone prerequisites but as conjunctive rules – i.e., additional criteria that were added as requirements in addition to the decision rules developed through the CART analyses. In no case do the MMAP rules indicate or imply that completion of one of these rules is alone sufficient for preparation. Instead, these rules were added as an additional backstop to the rule sets developed from the analyses.

While the workgroup's intent was to fully explore the concern of the CAISC surrounding prerequisites for statistics, additional early discussion also sought to clarify that in no way would the MMAP alter the prerequisites for statistics or any course. Rather, the MMAP decision rules continue the long history of colleges assessing and placing students in courses as a function of student performance on assessment tests and/or a variety of other multiple measures, as required by Title 5. The primary distinction of the MMAP decision rules is that they have been specifically built to weigh or use variables in proportions better reflecting their actual relationship to student performance in foundational skills courses rather than a more typical small number of points allowing students perhaps one or two questions below a cut score on a standardized test to move up a single level. Otherwise, it reflects the same types of opportunities colleges have to allow students to test into a course based on an assessment test in lieu of having completed that course or to test below that course but be allowed entry based on the use of multiple measures (specific examples from around the California Community Colleges were discussed, including colleges that nominally have a requirement that students have taken a particular course in high school in order to have access to a particular test that would allow entry into certain courses but where the colleges' advice on which test to take is advisory not compulsory and students may thus still test in via an assessment). In fact, the MMWG later reviewed evidence that of students with complete high school data in the historical data set used for the MMAP analyses, fully 10% of students enrolled in statistics as their first community college mathematics courses did so without completed the Algebra 2 prerequisite or equivalent in high school.

Having laid that groundwork, given the concerns expressed about the potential danger of using the MMAP decision rules for articulation of statistics, the MMWG still reviewed aspects of Title 5 setting standards for prerequisites, assessment, and matriculation in assessment and placement for articulation of Statistics to CSU and UC, in particular §55003. (e) (3) & (4) which allow (though notably do not require) prerequisites to be established without scrutiny using content review if the prerequisite is required by four-year institutions or if baccalaureate institutions will not grant credit for a course unless it has a particular communication or computation skill prerequisite.

Continuing, the MMWG reviewed recent changes in the prerequisites for statistics at the University of California (<http://www.ucop.edu/transfer-articulation/transferable-course-agreements/tca-policy/regulations-by-subject-area.html#s>), contrasting those prerequisites with those for other transfer level courses in Mathematics (cf. <http://www.ucop.edu/transfer-articulation/transferable-course-agreements/tca-policy/regulations-by-subject-area.html#m>) in order to clearly identify the explicit removal of Algebra 2/Intermediate Algebra as a prerequisite for statistics, instead embracing a more holistic approach sampling across the CCCSM math standards.

The MMWG then reviewed the recent memo from the CSU Chancellor's Office General Education Advisory Committee (<http://cap.3csn.org/files/2015/10/Statistics-Pathways-in-CSU-Quantitative-Reasoning-Fall-2015.pdf>) as well as subsequent communications from the author of that memo to the MMWG on this particular question. The author of the memo clearly and strongly confirmed that the intent of the memo, included efforts like the research being done as part of MMAP to determine alternative pathways to achieving the necessary preparation to succeed in transfer-level statistics courses, even if those pathways were determined by other pre-collegiate coursework at either the college or in high school such as the use of a student's overall performance across their high school curriculum.

In addition, the MMWG reviewed the recent Adopted Resolution 9.13 F15 from the 2015 ASCCC Fall Plenary: Develop Descriptors for Alternative Prerequisites for Statistics (http://www.asccc.org/sites/default/files/Final_Adopted_Resolutions_Fall_2015%20v2.pdf) as well as the subsequent C-ID memo reviewing these changes. While noting that these documents do note concerns expressed by various stakeholders, particularly in mathematics (as does the CSU CO-GEAC memo) and that the understanding of the prerequisites here are evolving and so patience is requested as these changes are reviewed, all of these documents quite explicitly note the willingness of these institutions to grant credit for statistics courses with prerequisites other than intermediate algebra.

The MMWG thereafter discussed the importance of reviewing the status of existing articulation agreements with various other baccalaureate institutions as being necessary to review in light of the evolution of the prerequisites of the primary transfer destinations of California Community College students.

However, keeping in mind that the proposed rules did not actually seek to change the prerequisites for Statistics but merely alter the ways in which multiple measures based on student performance were incorporated into student placement in the course, the MMWG discussed the likelihood that §55003. (e) (3) & (4) were no longer fully sufficient to support the requirement of intermediate algebra as a prerequisite. As a result, the MMWG reviewed the evidence for the remaining standard that could most strongly be deployed in supporting intermediate algebra as a required prerequisite for Statistics, §55003 (d)(2), that the prerequisite will assure that a student has the preparation necessary to succeed in the course, such that a student who has not met the prerequisite is **highly unlikely to receive a satisfactory grade in the course** for which the prerequisite is being established. To examine that question, the MMWG reviewed the success rates of students with complete high school records who took statistics as their first mathematics course in the California Community Colleges in the MMAP statewide dataset (n= 22,403) as a function of the highest math course completed and whether or not the students met the criteria established in the MMAP decision rules predicting success in statistics:

- Direct matriculants
 - HS 11 GPA \geq 3.0 or
 - HS 11 GPA \geq 2.3 AND Pre-Calculus C (or better)
- Non-Direct matriculants
 - HS 12 GPA \geq 3.0 or
 - HS 12 GPA \geq 2.6 AND Pre-Calculus C (or better)

The distribution of the students can be seen in Table 1, below. As alluded to above, 13.7% (3,087) of these students took their first math course in the CCCs in Statistics despite not having completed Intermediate Algebra or higher in high school.

Table 1. Students in sample who enrolled in Statistics as their first math course as a function of highest math course taken in HS and whether or not students met the criteria in the MMAP decision

| Highest Math taken in HS | Any | Higher than Algebra 2 | Algebra 2 | Algebra 1 | Neither prereq met |
|---|--------|-----------------------|-----------|-----------|--------------------|
| All students | 22,403 | 10840 | 8476 | 2,435 | 652 |
| MMAP statistics placement (or higher) rules met | 16,419 | 10482 | 5072 | 703 | 167 |
| MMAP statistics placement rules not met | 5,984 | 358 | 3404 | 1,732 | 485 |

The MMWG further reviewed the actual success rates of these different combinations of students finding that meeting the criteria of the MMAP decision rules were strongly associated with success in statistics, with students meeting those criteria having a success rate nearly 30 percentage points higher than those who did not (see Table 2).

Table 2. Success rates of students in sample who enrolled in Statistics as their first math course as a function of highest math course taken in HS and whether or not students met the criteria in the MMAP decision

| Highest Math taken in HS | Any | Higher than Algebra 2 | Algebra 2 | Algebra 1 | Neither prereq met |
|---|-----|-----------------------|-----------|-----------|--------------------|
| All students | 69% | 79% | 63% | 49% | 49% |
| MMAP statistics placement (or higher) rules met | 77% | 80% | 72% | 60% | 74% |
| MMAP statistics placement rules not met | 48% | 47% | 50% | 44% | 41% |

More importantly, students who met the MMAP criteria but only completed Algebra 1 (60%) or lower (74%) in high school were actually more successful than all students who did not meet the MMAP criteria (48%), including those who had successfully completed Algebra 2 (50%) or higher (47%) in high school but who did not meet the MMAP criteria. At the very least, there is little evidence to support that students who met the MMAP criteria without having completed Algebra 2 were highly unlikely to succeed in Statistics. If anything, this evidence demonstrates that these students are more likely to succeed than a large number of students who have historically been placed into

statistics as a matter of course. The pattern of data for liberal arts or general education mathematics courses were also reviewed, revealing a remarkably identical pattern, though with a smaller overall sample size (n=6005).

The distribution of the students can be seen in Table 3, below. As alluded to above, 18.4% (1106) of these students took their first math course in the CCCs in GE Math despite not having completed Intermediate Algebra or higher in high school.

Table 3. Students in sample who enrolled in a GE math course as their first math course as a function of highest math course taken in HS and whether or not students met the criteria in the MMAP decision

| Highest Math taken in HS | Any | Higher than Algebra 2 | Algebra 2 | Algebra 1 | Neither prereq met |
|---|------|-----------------------|-----------|-----------|--------------------|
| All students | 6005 | 2421 | 2478 | 886 | 220 |
| MMAP GE placement (or higher) rules met | 3010 | 1752 | 1087 | 143 | 29 |
| MMAP GE placement rules not met | 2995 | 669 | 1391 | 743 | 191 |

Table 4. Success rates of students in sample who enrolled in a GE math course as a function of highest math course taken in HS and whether or not students met the criteria in the MMAP decision

| Highest Math taken in HS | Any | Higher than Algebra 2 | Algebra 2 | Algebra 1 | Neither prereq met |
|---|-----|-----------------------|-----------|-----------|--------------------|
| All students | 69% | 77% | 67% | 54% | 52% |
| MMAP GE placement (or higher) rules met | 80% | 82% | 79% | 70% | 86% |
| MMAP GE placement rules not met | 58% | 62% | 59% | 51% | 47% |

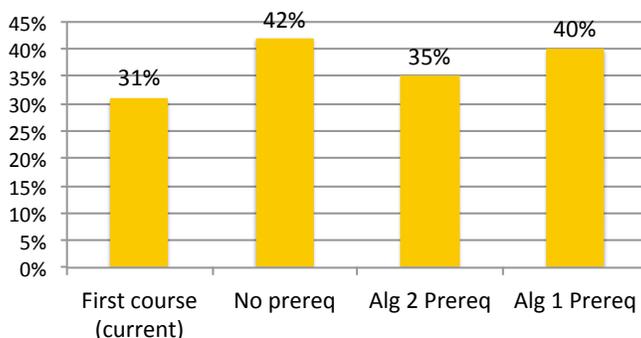
Again, students who met the MMAP criteria but only completed Algebra 1 (70%) or lower (86%) in high school were actually more successful than all students who did not meet the MMAP criteria (58%), including those who had successfully completed Algebra 2 (59%) or higher (62%) in high school but who did not meet the MMAP criteria. Again, there is little evidence to support that students who met the MMAP criteria without having completed Algebra 2 were highly unlikely to succeed in Statistics and that, if anything, these students are more likely to succeed than a large number of students who have historically been placed into statistics.

The efforts of the Multiple Measures Work Group remain focused on placing students more accurately into the courses for which they have demonstrated evidence of their preparation and the likelihood of success in that course. The students identified by the rule sets developed by the Multiple Measures Assessment Project for statistics continue to be well-aligned for that purpose. Although, again, no attempts are being made to adjust or change colleges' course prerequisites and efforts remain focused on examining holistically whether students have the preparation necessary to succeed in the course work as clearly and explicitly required by Title 5, the work group has carefully

reviewed evidence in order to assuage the concerns of the CAISC with respect to questions raised regarding prerequisites for entry-level, non-STEM transferable courses in mathematics and find that, given the evidence, those concerns should be substantially mitigated.

In addition, the MMWG reviewed the projected differences in placement into transfer level math as a function of the different possible rules and their representation in the overall data set, which revealed that using Algebra 2 as a hard-coded rule instead of Algebra 1 would reduce the potential increase in transfer-level placement by slightly more than half (or about 5% of the overall sample). See Figure 1.

Figure 1: Projected Math Placement Differences



Using students with complete HS records in research sample: N = 254321

Based on this review, the discussion of the evolving nature of the standards, the potential impact to student placement, and the desire to be meaningfully cognizant of the concerns of stakeholders in mathematics and in other disciplines, the MMWG considered four possible recommendations to make to the CAISC with respect to the MMAP decision rules for statistics. Some members of the workgroup supported leaving the rules as they currently are based on the evidence and the pilot/exploratory nature of the project while others supported changing the hard-coded rule to require Algebra 2/Intermediate Algebra given some of the expressed concerns and the facts that some of the particulars remain in flux. After discussion in person, on the phone and via Basecamp over several weeks, members of the MMWG unanimously agreed to the set of compromise recommendations at the beginning of this document.