California Community Colleges
Mathematics and Quantitative Reasoning Task Force
Report

Preamble from Recommendations – Part I

In fall 2017, the Academic Senate for California Community Colleges (ASCCC), the California Mathematics Council of Community Colleges (CMC^3) and the California Mathematics Council of Community Colleges-South (CMC^3-South) joined together and formed a task force to address mathematics and quantitative reasoning education in the California community colleges. Mathematics or quantitative reasoning is required for all majors, including both science, technology, engineering, and mathematics (STEM) majors and non-STEM majors, which may or may not have specific mathematics requirements. In particular, this task force examined quantitative reasoning as part of the general education pattern of curriculum design, especially in response to the requirements of AB 705 (Irwin, 2017) and the California State University Executive Orders 1100 and 1110. The ASCCC is recognized in statute as the voice of the faculty in the California Community College System in regard to academic and professional matters, which include curriculum, prerequisites, degree and certificate requirements, and student preparation. The ASCCC is working diligently to fulfill the direction of the legislature established in AB705 and to assist colleges with local implementation. CMC^3 and CMC^3-South are the California affiliates of the American Mathematical Association of Two-Year Colleges (AMATYC). AMATYC is the only organization exclusively devoted to providing a national forum for the improvement of mathematics instruction in the first two years of college. The California Community Colleges Mathematics and Quantitative Reasoning Task Force (MQRTF) was formed to address the following as feasible:

1. Research the various and diverse perspectives on appropriate content for mathematics and quantitative reasoning education for non-STEM majors;
2. Develop recommendations on mathematics and quantitative reasoning standards for non-STEM majors;
3. Develop a plan for how to provide opportunities for more students to consider STEM fields, since the United States is producing fewer and fewer STEM graduates, especially in groups that are disproportionately impacted;
4. Provide a report to the ASCCC, CMC^3, and others, such as the California Community Colleges Chancellor's Office and Board of Governors, that includes the research results and recommendations; and
5. Request a response from ASCCC, CMC^3, and other stakeholders.

The membership of the MQRTF is structured to include diverse perspectives in regard to mathematics and quantitative reasoning with representatives from disciplines such as mathematics, statistics, education, chemistry, and counseling. The MQRTF is guided by a commitment to equity in mathematics and quantitative reasoning, with the goal of providing a valuable education that meets the needs of all students, empowering them to be successful in a technologically evolving society.

Spring 2018

The MQRTF provided initial recommendations[1] to the field in response to the requirements of AB 705 and EOs 1100/1110, the first part of two sets of recommendations from the MQRTF. In particular, the MQRTF Recommendations Part I were shared with ASCCC, CMC^3, CMC^3-South, the California Community Colleges Chancellor's Office (CCCCO), and other stakeholder groups.

The ASCCC endorsed the MQRTF Recommendations – Part I[2] as one option that colleges may consider in implementing changes related to AB 705, recognizing that multiple pathways should exist for students to achieve transfer-level competency in mathematics and quantitative reasoning. Furthermore, the ASCCC recommended that the MQRTF create an additional C-ID descriptor for a pre-statistics course.

CMC^3 supported the work of the MQRTF while noting concern that there may be less focus on mathematics for career and technical education since much of the language from the CCCCO is geared towards transfer goals.

CMC^3-South is participating in this work but has not taken a position on it as an organization.

A representative from the California Acceleration Project expressed concern that the work of the MQRTF may not indicate an understanding about placement and opined that the idea of promulgating pre-transfer coursework may not be tenable. This concern was investigated and deemed unfounded.

Summer 2018

The president of the ASCCC and the executive vice-chancellor of education services co-authored a memo on July 10, 2018 that contained default placement guidelines for colleges to consider as they begin AB 705 implementation[3]. The default placement guidelines are required for colleges that engage in no other innovation to support student achievement. These guidelines, which usually would follow changes to Title 5 Regulations through a consultative process, were issued before the changes to Title 5 could take place due to the urgency of providing direction to the field for initial AB 705 implementation. In addition, an FAQ on AB 705[4], authored jointly by the ASCCC and the CCCCO, was sent to colleges in the system in August 2018.

The MQRTF, under consideration of the guidelines and under direction from the ASCCC, drafted and finalized four pre-transfer level C-ID Course Descriptors[5]. The MQRTF designed these descriptors to be flexible based on local placement practices and curricular pathways for

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[1] CCC MQRTF Recommendations – Part I: https://asccc.org/sites/default/files/MQRTF%20Recommendations%203-3-2018.pdf

[2] ASCCC Resolution 9.02 Spring 2018 Pathways to Meet General Education Requirements in Quantitative Reasoning: https://asccc.org/resolutions/pathways-meet-general-education-requirements-quantitative-reasoning

[3] Memo on AB 705 Implementation July 10, 2018: https://asccc.org/sites/default/files/AA%2018-40%20AB%20705%20Implementation%20Memorandum__0_0.pdf

[4] FAQ on AB 705, August 2018: https://asccc.org/sites/default/files/AB705_FAQ_030218_FINAL_2.pdf

[5] C-ID Descriptors – AB 705 Resources: https://www.c-id.net/resources

compliance with AB 705. The intent of each descriptor is to provide baseline preparatory or concurrent support courses that colleges may tailor to meet the needs of their student populations, and they are not intended for course submission to C-ID. In addition, these courses may be used to communicate to the public the essential topics needed for success in transfer-level mathematics and quantitative reasoning courses as well as to ease student movement within the community college system.

The draft descriptors were published for comment. The MQRTF, serving as the Faculty Discipline Review Group, considered those comments, made appropriate adjustments, and finalized the descriptors in September 2018. These descriptors fall outside of transfer level and are not subject to the mandates associated with the legislation of SB 1440 (Padilla, 2010)[6] and SB 440 (Padilla, 2013)[7].

The New C-ID Descriptors – Pre-Transfer Level

- Based on local placement processes and student populations
- Concurrent or preparatory support
- Flexibility in course content and unit load
- Lecture, lab, or combination format
- Credit or noncredit
- Options – not a requirement

Math 50x – Elementary Mathematics

- Review of basic mathematics, pre-algebra, and an optional algebra introduction – baseline topics for success in 60x and 70x
- Lecture and/or lab format, possibly noncredit
- Units are commensurate with the depth and breadth of topics, modules
- Corequisite/concurrent or prerequisite/preparatory based on local placement practices

Math 60x – Fundamentals of Algebra for Statistics or Liberal Arts

- Elements of beginning and intermediate algebra needed for statistics, liberal arts mathematics, or other non-mathematics-intensive fields.
- Lecture and/or lab format, possibly noncredit
- Units are commensurate with the depth and breadth of topics, modules
- Advisories/Recommended Preparation: Algebra I or the equivalent through the Common Core State Standards in Mathematics (CCSSM). Options for students who have not attained these skills may include the following:
  - Corequisite/concurrent model of C-ID Math 50X Elementary Mathematics
  - Prerequisite/preparatory model of C-ID Math 50X Elementary Mathematics

Math 70x – Foundations of Algebra for Mathematics-Intensive Fields

- Elements of beginning and intermediate algebra needed for mathematics-intensive fields. Includes baseline exit skills of an intermediate algebra course for students pursuing majors in mathematics-intensive fields.

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[6] SB 1440 (Padilla, 2010): https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=200920100SB1440
[7] SB 440 (Padilla, 2013): https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140SB440

- Lecture and/or lab format, possibly noncredit
- Units are commensurate with the depth and breadth of topics, modules
- Advisories/recommended preparation: Algebra I or the equivalent through the Common Core State Standards in Mathematics (CCSSM). Options for students who have not attained these skills may include the following:
    - Corequisite/concurrent model of C-ID Math 50X Elementary Mathematics
    - Prerequisite/preparatory model of C-ID Math 50X Elementary Mathematics

Math 80x – Algebra for Transition into Mathematics-Intensive Fields

- A bridge course for students who have been placed into or have completed a transfer-level quantitative reasoning course from a non-mathematics intensive pathway.
- Lecture and/or lab format, possibly noncredit,
- Units are commensurate with the depth and breadth of topics, modules
- Course requested by college and system leaders to provide pathway to B-STEM

Presentations and Publications

Since the formation of the MQRTF, a number of presentations have taken place at conferences throughout California to share with stakeholders the work being done. In addition, the work of the MQRTF has been highlighted in publications.

Presentations:

- ASCCC Fall Plenary Session, November 3, 2017: Quantitative Reasoning: Here and Now
- ASCCC Fall Plenary Session, November 3, 2017: Panel Presentation Follow-up: Quantitative Reasoning
- ASCCC Spring Plenary Session, April 12, 2018: Math and Quantitative Reasoning Task Force Recommendations
- ASCCC Spring Curriculum Regional Meetings, May 18, 2018
- ASCCC Spring Curriculum Regional Meetings, May 19, 2018
- ASCCC Curriculum Institute, July 12, 2018: Reimagined Pathways in Mathematics and Quantitative Reasoning
- ASCCC Curriculum Institute, July 12, 2018: New Options for Math and Quantitative Reasoning
- RP Group Strengthening Student Success Conference, October 4, 2018: Pathways to Transfer-Level Mathematics and Quantitative Reasoning Courses
- CMC^3 Fall Conference, December 8, 2017: AB 705 Discussion
- CMC^3 Recreational Math Conference, April 28, 2018: AB 705 – A Discussion
- ASCCC Fall Plenary Session, November 2, 2018: AB 705 and Considerations for General Education Pathways

Publications:

- Davison, Dolores, Virginia “Ginni” May, and Craig Rutan. “Local Implementation of AB 705—What We Know and What Remains to be Answered.”[8] *ASCCC Rostrum* February 2018.
- Banta, Leslie. “Math and Quantitative Reasoning Task Force.”[9] *CMC³ Newsletter* Summer 2018
- Banta, Leslie. “Math and Quantitative Reasoning Task Force.”[10] *CMC³ Newsletter* Spring 2018

CONSIDERATIONS

Who are our students?

On the CCCCO MIS Datamart website[11], reports show that 2,392,276 students were enrolled in the California Community College System during the academic year 2017-18. The following graphics offer more statistics on the students in the California Community College system. Of particular note, the graphics show that less than 29% of students are full-time, a trend that existed even before the years shown in the tables included. In terms of student unit load, the range that has the largest percentage of students is “3 to less than 6 units.” This information may create a tension with trending corequisite models for a mathematics and quantitative reasoning course and an English course that are showing a minimum of 10 semester units if taken during the same term, four for English and six for mathematics and quantitative reasoning. First time student enrollment is quite low, and first time transfer student is less than 8% each term. As 57.65% of the students during the 2017-18 academic year were under the age of 25 and 0.58% were unknown regarding age, the remaining 42.77% were age 25 or greater.

CCC Enrollment by Unit Load

Semester Units	**Fall 2016**	**Spring 2017**	**Fall 2017**	**Spring 2018**
0 Units	0.00 %	0.00 %	0.00 %	0.00 %
0.1 - 2.9^	5.53 %	5.83 %	5.12 %	6.05 %
3.0 - 5.9^	23.56 %	24.55 %	24.50 %	25.21 %
6.0 - 8.9^	17.71 %	17.97 %	17.65 %	17.77 %
9.0 - 11.9	15.35 %	15.29 %	15.13 %	14.98 %
12.0 -14.9*	20.79 %	18.68 %	20.34 %	18.08 %
15 +*	8.06 %	8.14 %	8.11 %	8.32 %
Non-Credit	8.99 %	9.54 %	9.14 %	9.59 %
Unknown	0.00 %	0.00 %	0.00 %	0.00 %

[8] February 2018 Rostrum article: https://asccc.org/content/local-implementation-ab-705—-what-we-know-and-what-remains-be-answered

[9] CMC³ Newsletter Summer 2018, page 3: https://www.cmc3.org/Newsletters/CMC3Summer18.pdf

[10] CMC³ Newsletter Spring 2018, page 15: https://www.cmc3.org/Newsletters/CMC3Spring18.pdf

[11] CCCCO MIS Datamart: https://datamart.cccco.edu

CCC Enrollment by Unit Load

Semester Units	Fall 2016	Spring 2017	Fall 2017	Spring 2018
Less than 6^	29.09 %	30.38 %	29.62 %	31.26 %
6 to less than 12	33.06 %	33.26 %	32.78 %	32.75 %
12 or more*	28.85 %	26.82 %	28.45 %	26.40 %
Non-Credit	8.99 %	9.54 %	9.14 %	9.59 %
Unknown	0.00 %	0.00 %	0.00 %	0.00 %

*full-time student
^not feasible to take mathematics/quantitative reasoning and English courses with corequisites during same term

CCC Student Enrollment by Status

Status	Fall 2016	Spring 2017	Fall 2017	Spring 2018
First-Time Student	17.27 %	7.85 %	17.08 %	6.78 %
First-Time Transfer Student	7.75 %	6.88 %	7.72 %	6.65 %
Returning Student	10.98 %	9.57 %	11.15 %	10.16 %
Continuing Student	57.20 %	68.24 %	56.45 %	68.66 %
Uncollected/Unreported	2.87 %	2.98 %	3.14 %	3.13 %
Special Admit Student	3.93 %	4.48 %	4.46 %	4.63 %

CCC Enrollment Education Status

(Highest Education level of Student at Enrollment)

	Fall 2017	Fall 2017
College Degree Total	10.05 %	10.05 %
Received a Bachelor degree or higher	63.50 %	6.38 % of all students
Received an Associate Degree	36.50 %	3.67 % of all students
High School Graduate Without A College Degree Total	79.18 %	79.18 %
Foreign Secondary School Diploma / Certificate of Graduation	5.23 %	4.14 % of all students
Passed the GED, or received a High School Certificate of Equivalency	5.09 %	4.03 % of all students
Received a California High School Proficiency Certificate	1.75 %	1.39 % of all students
Received High School Diploma	87.93 %	69.62 % of all students
Not A High School Graduate Total	2.05 %	2.05 %
Currently enrolled in adult school	18.19 %	.37 % of all students
Not a graduate of, and no longer enrolled in high school	81.81 %	1.68 % of all students
Special Admit student Total	4.80 %	4.80 %
Special Admit student currently enrolled in K-12	100.00 %	4.80 % of all students
Unknown Total	3.91 %	3.91 %
Unknown / unreported	100.00 %	3.91 % of all students

CCC Student Demographics for the 2017-18 Academic Year

Age	2017-18
19 or Less	27.71 %
20 to 24	29.94 %
25 to 29	13.81 %
30 to 34	7.69 %
35 to 39	5.27 %
40 to 49	6.75 %
50 +	8.25 %
Unknown	0.58 %

Gender	2017-18
Female	53.65 %
Male	44.54 %
Unknown	1.81 %

Ethnicity	2017-18
African-American	5.89 %
American Indian/Alaskan Native	0.42 %
Asian	11.50 %
Filipino	2.69 %
Hispanic	44.13 %
Multi-Ethnicity	3.81 %
Pacific Islander	0.41 %
Unknown	4.61 %
White Non-Hispanic	26.54 %

High School Coursework and Transcript Data

The California Community College System includes 114 colleges in 72 districts across the state. Within these college districts are 344 unified school districts and 76 high school districts. These districts include over 1,311 regular high schools, 435 continuation high schools, and 268 charter schools. These numbers do not include alternative, special day, and special education schools.[12] Each of these districts is able to set its own graduation requirements in mathematics, provided that the state minimum requirement for mathematics is met.[13] Throughout the state, the demographics in each high school district can vary widely. Given these variables, local control must be maintained throughout the implementation of AB 705.

The State of California has not updated its graduation requirements for mathematics to meet the standards of its university systems and now lags behind many other states in ensuring that high school graduates are well-prepared for transfer-level courses in mathematics. Community Colleges become the default college option for these students.

[12] California Department of Education https://www.cde.ca.gov/ds/sd/cb/ceffingertipfacts.asp
[13] California Department of Education https://www.cde.ca.gov/ci/gs/hs/hsgrgen.asp

High School	Community College	CSU	UC
Two years of mathematics, including Algebra I, beginning in 2003-04 (EC 51224.5)	High school diploma or the equivalent or any person over the age of 18 who, in the judgment of the board, is capable of profiting from the instruction offered.	Three years of mathematics, including algebra, geometry, and intermediate algebra	Three years of mathematics, including algebra, geometry, and intermediate algebra (four years recommended)

Table 1 Comparison of Graduation and Admission Requirements[14]

Although some students who attend California's community colleges have met the minimum requirements for entry to the CSU and UC systems, many have not. Less than half of California's high school graduates have met the a-g requirements.[15] The percentage of students without courses in Algebra I, Geometry, and Intermediate Algebra varies by high school district. In addition to the disparity in course requirements, some schools offer more than one level of an Algebra I course: one course that qualifies as college-prep and is accepted by the CSU and UC systems and another that meets California's minimum standards but focuses more on pre-algebra content than a rigorous treatment of algebra. These courses are sometimes called Basic Algebra, Algebra Essentials, Fundamentals of Algebra, or Introduction to Algebra. The increased popularity of Integrated Math programs often means that the first course in the Integrated Math series meets the local high school graduation requirement.

In 2012-13, 30 percent of high school students in grades 11 and 12 were enrolled in Algebra II. Enrollment in high school Algebra II coursework has risen since 1997-98 but still remains low, and racial disparities exist. For example, Latino students are often tracked away from college-preparatory coursework.[16] Completion rates for the a-g sequence are highest for low-minority and low-poverty schools. The number of high-minority and high-poverty schools has steadily increased, and the number of low-minority and low-poverty schools has correspondingly descreased. In the year 2000, 7 percent of high schools were high poverty; in 2013, the share was 34 percent. Forty-four percent of schools were low-poverty in 2000; the share decreased to 15 percent in 2013.[17] These disparities mean that community college districts that are in high-minority or high-poverty areas are more likely to have students who are not prepared for college-level coursework in mathematics.

As colleges consider the innovations they will use to implement AB705, data and analysis from sources seeking to assist with reform must be put into context. For example, while California requires 2 years of mathematics in high school, with Algebra I being the highest required level, Tennessee requires 4 years of mathematics, which must include Algebra I and II, Geometry, and

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[14] California Department of Education https://www.cde.ca.gov/ci/gs/hs/hsgrtable.asp and https://www.cde.ca.gov/ci/gs/ps/cefcollegereqs.asp

[15] Gao, Niu, *College Readiness in California: A Look at Rigorous High School Course Taking,* Public Policy Institute of California*,* 2016

[16] *The Majority Report: Supporting the Success of Latino Students in California***,** The Education Trust-West, 2017

[17] Gao, Niu, *College Readiness in California: A Look at Rigorous High School Course Taking,* Public Policy Institute of California*,* 2016

a fourth higher-level math course.[18] No analysis is complete that does not take into account disparities in high school coursework in addition to other measures such as GPA and assessments for college-readiness.

In contrast to California's minimum graduation requirement, the California Common Core Standards in Mathematics (CCCSM), adopted in 2010 and revised in 2013, more accurately reflect the content and standards of mathematical practice that are required for high school graduates to be successful in transfer-level mathematics. The University of California BOARS Statement "Basic Math for all Admitted UC Students" notes that "students who do not successfully complete the CCSSM curriculum in high school may resolve any gaps in their studies at a California Community College by taking appropriate prerequisite coursework before enrolling in a UC-transferable math or statistics course." Furthermore, the BOARS statement "closes with the expectation that future UC-transferable courses will have prerequisites that align with the Common Core, not prerequisites that have a particular name."[19] This statement should not be construed as a lowering of the standards of admission for the UC system but rather as a clarification that the full content of the CCSSM is expected.

While California has adopted the CCCSM, implementation in the form of required coursework that meets these standards is currently optional for California's school districts. That is, "implementation of specific academic content standards is a local decision and not specifically mandated by *EC [ed code]*, California strongly recommends their local use. Statewide assessments which are mandated by *EC* are based upon California's adopted academic content standards."[20] The disparity in requirements throughout California's high schools speaks to the need for local decision-making led by discipline faculty familiar with student preparation in both placement and pathways; however, requiring students to take challenging courses that meet the CCCSM standards and prepare students for college and career success should be part of the overall strategy to address the under-preparedness of California's high school graduates. California community college local discipline faculty and local administrators may want to explore working with high school districts to increase graduation requirements in mathematics in those districts that currently require only the minimum California requirement of 2 years of mathematics that includes 1 year of Algebra I.

State-wide testing of the CCCSM standards for high school occurs in the eleventh grade. The most widely-used test is the Smarter Balanced Assessment (SBAC), which includes three areas of sub-score assessment in mathematics: Concepts and Procedures, Problem-solving/Modeling and Data Analysis, and Communicating Reasoning.[21] Development of the SBAC assessments included attempts to support equitable assessment across student groups. The assessments were developed using the concepts of universal design, and guidelines were in place to reduce context-irrelevant language complexities for English learners. Furthermore, measurement bias was

[18] *Graduation Requirements*, Tennessee Department of Education, https://www.tn.gov/education/instruction/graduation-requirements.html

[19] *Basic Math for all Admitted UC Students*, University of California Board of Admissions and Relations with Schools (BOARS), December 12, 2013

[20] California Department of Education, https://www.cde.ca.gov/re/cc/ccssfaqs.asp

[21] Smarter Balanced Assessment Consortium: 2015-16 Summative Technical Report https://portal.smarterbalanced.org/library/en/2015-16-summative-technical-report.pdf

investigated using differential item functioning methods.[22] In 2017, California enjoyed high rates of participation in these assessments: less than 1% of students had a parental exemption. The results, however, were disappointing, with only 32.17% of students meeting or exceeding the standard.[23] Community colleges should be mindful of these facts as they consider both placement and pathways to transfer-level mathematics.

While the data do suggest that high school GPA has a higher predictive value of college success than other measures, the correlation coefficient between high school GPA and both success in the first year at a four-year university and persistence to the second year is weak to moderate at best, varying between 0.3 and 0.45 depending on various demographic factors[24]. Evidence strongly suggests that pairing high school GPA with other measures, such as Smarter Balanced Assessment results and high school courses taken, can significantly increase the correlation coefficient.[25]

High school GPA, when compared to SAT scores or the combination of high school GPA and SAT scores, is a slightly more optimal predictor of student success. However, the degree to which high school GPA predicts student success in the first year of college is not significantly better than the degree to which SAT scores do this alone. Claims that high school GPA is the only reliable predictor of success in college are exaggerated. Furthermore, when looking at a student's continuation or persistence to the second year of college upon completing the first year, high school GPA holds a very low correlation coefficient, .25 when adjusted for student demographics, which is nearly identical to the correlation coefficient for SAT scores at .22.[26]

The tables below present the adjusted and raw multiple correlation coefficients of the main predictors—HSGPA, SBAC, and SAT—and first year GPA (Panel A), second-year persistence rate (Panel B), and total credits accumulated in the first year (Panel C) for the CSU analysis. Each cell of the table reflects a separate model. Column 1 includes only the respective predictor variables without additional controls. Column 2 includes the respective predictor variables and controls for student demographics, such as gender, race or ethnicity, socioeconomic disadvantage, or English learner status. Column 3 includes the high school CCI indicator, while Column 4 also includes controls for enrollment at different CSU campuses.[27]

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[22] Smarter Balanced Assessment Consortium: 2015-16 Summative Technical Report https://portal.smarterbalanced.org/library/en/2015-16-summative-technical-report.pdf

[23] *State Schools Chief Tom Torlakson Announces Results of California Assessment of Student Performance and Progess Online Tests,* California Dept. of Education News Release #17-67a, Sept. 27, 2017

[24] Kurleander, M, Kramer, K.A., Jackson, E., *Predicting College Success: How Do Different High School Assessments Measure Up?,* Policy Analysis for California Education, Stanford Graduate School of Education, https://edpolicyinca.org/sites/default/files/SBAC-SAT%20Paper.pdf

[25] Kurleander, M, Kramer, K.A., Jackson, E., *Predicting College Success: How Do Different High School Assessments Measure Up?,* Policy Analysis for California Education, Stanford Graduate School of Education, https://edpolicyinca.org/sites/default/files/SBAC-SAT%20Paper.pdf

[26] Kurleander, M, Kramer, K.A., Jackson, E., *Predicting College Success: How Do Different High School Assessments Measure Up?* Policy Analysis for California Education, Stanford Graduate School of Education, https://edpolicyinca.org/sites/default/files/SBAC-SAT%20Paper.pdf

[27] Kurleander, M, Kramer, K.A., Jackson, E., *Predicting College Success: How Do Different High School Assessments Measure Up?* Policy Analysis for California Education, Stanford Graduate School of Education, https://edpolicyinca.org/sites/default/files/SBAC-SAT%20Paper.pdf

PANEL A: First Year GPA (N=36519)

	1	**2**	**3**	**4**
HSGPA	.45(.35)	.48(.39)	.48(.39)	.49(.40)
SAT	.38(.28)	.41(.33)	.42(.33)	.42(.34)
SBAC	.37(.28)	.41(.33)	.41(.33)	.42(.34)
HSGPA&SAT	.48(.38)	.50(.41)	.50(.41)	.51(.42)
HSGPA&SBAC	.48(.38)	.50(.41)	.50(.41)	.51(.42)
HSGPA, SAT&SBAC	.49(.39)	.50(.41)	.51(.41)	.51(.42)
Demographics*	N	Y	Y	Y
HS CCI**	N	N	Y	Y
Campus FE***	N	N	N	Y

*Inclusion of control for demographics
** Inclusion of control for high school College/Career Indicator[28]
*** Inclusion of control for enrollment at different CSU campuses

PANEL B: Persistence to Second Year(N=43791)

	1	**2**	**3**	**4**
HSGPA	.22(.17)	.24(.18)	.24(.19)	.25(.20)
SAT	.19(.14)	.21(.16)	.21(.16)	.22(.17)
SBAC	.20(15)	.21(.17)	.22(.17)	.22(.18)
HSGPA&SAT	.24(.18)	.24(.19)	.25(.20)	.25(.20)
HSGPA&SBAC	.24(.19)	.25(.20)	.25(.20)	.25(.21)
HSGPA, SAT&SBAC	.24(.19)	.25(.20)	.25(.20)	.25(.21)
Demographics	N	Y	Y	Y
HS CCI	N	N	Y	Y
Campus FE	N	N	N	Y

PANEL C: Total Units, End of First Year (N = 41573)

	1	**2**	**3**	**4**
HSGPA	.50(.39)	.54(.43)	.58(.45)	.60(.50)
SAT	.60(.51)	.61(.52)	.63(.52)	.63(.55)
SBAC	.55(.46)	.56(.47)	.59(.47)	.60(.52)
HSGPA&SAT	.64(.55)	.64(.55)	.66(.55)	.66(.58)
HSGPA&SBAC	.61(.51)	.61(.52)	.63(.52)	.64(.55)
HSGPA, SAT&SBAC	.64(.55)	.65(.56)	.66(.56)	.67(.58)
Demographics	N	Y	Y	Y
HS CCI	N	N	Y	Y
Campus FE	N	N	N	Y

[28] *College/Career Indicator Performance Levels*, California Department of Education, https://www.cde.ca.gov/ta/ac/cm/cci.asp

Given that not all California high schools offer courses that satisfy the a-g requirements of the CSU/UC systems and that student performance and demographics vary greatly from district to district, high school GPA will not have the same meaning from one district to the next. A 2.0 GPA in one district, perhaps one where the high schools are able to offer or require the full scope of a-g courses, may mean something very different from a 2.0 GPA in another district where the same scope of courses is not offered. Additionally, while a statewide average of high school GPA may exist, roughly half of districts will fall below and half above it. Using one GPA cut-off for all districts state-wide is therefore not a good prediction mechanism for success.

With the introduction of the Common Core Standards in the state of California, districts are split in the modality of implementation. While some districts are choosing to pursue a traditional course sequence such as Algebra I, Geometry, and Algebra II, others are moving forward with an integrated mathematics approach where the topics of the different "traditional" courses are not taught in sequence but instead in an interlocked, synergetic manner.[29] While research suggests that the integrated approach may be more effective[30], the different approaches taken by different districts underscore the importance of local discipline faculty in the various community college districts working with their feeder high school districts to formulate their understanding of their students' mathematics backgrounds.

Finally, the question of course title versus course content needs to be considered. While two high schools from two different districts may offer an "Algebra I" course, the course content, as well as the rigor of that content, will not necessarily be the same.

In light of these factors, community college districts must retain the power to work with their local high school districts. Through working with local high schools and in consultation with discipline faculty, colleges must be able to retain a significant degree of local control when determining best practices for serving their unique student populations.

What about STEM?

With AB 705 implementation and the Student Centered Funding Formula, both a perceived push and an actual incentive exist to steer students who enter college not ready for a transfer-level STEM pathway into a non-STEM pathway or a SLAM pathway. The July 2018 CCCCO/ASCCC implementation memo[31] states that, "good practice suggests [the students] should be informed that Algebra 2 is highly recommended as preparation for a STEM-oriented gateway mathematics course and that their likelihood of success will be higher in a statistics course." Data show that underrepresented and socio-economically disadvantaged students are much more likely to enter college needing STEM preparation, as their high schools often do not adequately prepare them to enter a college level STEM major[32]. Furthermore, the Student

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[29] Fensterwald, J., *Districts Split on High School Math Choices*, https://edsource.org/2014/districts-split-between-choices-for-high-school-math/66169

[30] *Supporting an Integrated Mathematics Curriculum,* Hanover Research, 2015, https://www.gssaweb.org/wp-content/uploads/2015/11/Supporting-an-Integrated-Mathematics-Curriculum.pdf

[31] The July 10 implementation memo: https://asccc.org/sites/default/files/AA%2018-40%20AB%20705%20Implementation%20Memorandum__0_0.pdf

[32] The Journal: https://thejournal.com/articles/2016/11/17/many-high-school-graduates-want-to-pursue-stem-careers-but-are-unprepared-for-stem-college-courses.aspx

Centered Funding Formula provides monetary incentives to college districts for each student that completes a transfer-level mathematics and English course during his or her first academic year[33].

Yet, one of the major stated reasons for both AB 705 and the Student Centered Funding Formula is to close the achievement gaps for underrepresented and socio-economically disadvantaged students. While more of these students may earn degrees, those degrees appear unlikely to be in STEM fields where such achievement differentials have been historically high, if indeed students are steered away from a STEM path to maximize throughput. Faculty, including counseling faculty, as well as staff and administrators, will need to work closely with students and not guide students away from considering a STEM or B-STEM major simply because another major has a shorter path, especially those students who express a desire to pursue a B-STEM pathway even when underprepared.

The National Science Foundation Science and Engineering (S&E) Indicators 2018 Report[34] states that "Nearly one in five U.S. citizens or permanent residents who received an S&E doctoral degree from 2011 to 2015 had earned some college credit from a community or 2-year college." It also states that "Community colleges play a significant role in the education of individuals who go on to acquire advanced S&E credentials. Among U.S. citizen and permanent resident S&E doctorate holders who received their doctorates between 2007 and 2011, nearly 20% indicated that they had earned college credit from a community or 2-year college."

Table 311.90 from the National Center of Education Statistics[35] shows a steady increase at a national level in most STEM related disciplines. Colleges should therefore monitor STEM major trends as they implement AB 705 and the Student Centered Funding Formula.

Also, Education Code states that one of the roles of California Community Colleges is to provide remedial instruction to those that need it[36]. Studies show that remediation in and of itself may not be the failure, but rather the failure may be due to how that remediation is provided and how student course taking patterns affect the effectiveness of such remediation[37].

Research shows us that the lower a student begins in the mathematics sequence, the less likely the student is to succeed. A strong correlation exists between two variables: the level below transfer that a student begins and the probability of completing transfer-level mathematics or quantitative reasoning. So, as academics we must consider all possibilities for causation. One of the most common reasons that a student does not reach transfer-level mathematics is that the student quits. A student may quit for many reasons that go beyond a simplistic view that the cause is the mathematics curriculum, and as educators we must consider these possibilities.

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[33] CCCCO Student Centered Funding Formula: http://extranet.cccco.edu/Divisions/FinanceFacilities/StudentCenteredFundingFormula.aspx

[34] NSF 2018 Report: https://www.nsf.gov/statistics/2018/nsb20181/report/sections/higher-education-in-science-and-engineering/highlights

[35] Table 311.90 NCES: https://nces.ed.gov/programs/digest/d17/tables/dt17_311.90.asp

[36] Education Code §66010.4: https://leginfo.legislature.ca.gov/faces/codes_displaySection.xhtml?lawCode=EDC&sectionNum=66010.4.

[37] National Center for Developmental Education: https://ncde.appstate.edu/node/103

Further study in this area could identify statistically significant factors that the California Community College system may, or may not, be able to address effectively.

Collecting and Considering Data

As of the writing of this report and as stated in Chancellor's Office Memo AA 18-40[38], colleges have two years to collect data and demonstrate that students benefit from the placement under the college-determined placement rules in comparison with the default placement rules. Under AB 705, colleges are prohibited from placing students into a pre-transfer course in mathematics unless the following conditions exist:

1. Students must be highly unlikely to succeed in the transfer-level course AND
2. Enrollment in the pre-transfer course will improve the students' likelihood of completing the transfer-level course in a one-year time frame.

Each college may determine its own threshold for what "highly unlikely to succeed" means; this definition is a local decision. "Throughput" has been defined to be the baseline metric where students must have a better completion rate within one year if placed below transfer than the baseline rate from the data analysis. This data analysis, based on Multiple Measures Assessment Project[39] (MMAP) data from 2007 to 2014, represents an analysis of students who were given a placement recommendation using the Accuplacer assessment test and then correlated to their high school grade point averages and success in the class in which they first enrolled.

During the time of the MMAP data collection, many changes were taking place in the California Community College System. Graduation requirements changed for students entering a community college for the first time in fall of 2009. Intermediate Algebra or equivalent became the requirement for an associate degree, whereas previously the associate degree required only elementary algebra or the equivalent. Furthermore, a transfer-level mathematics or quantitative reasoning course did not become a requirement for an associate degree until Associate Degrees for Transfer were established in fall 2011 as a result of SB 1440 (Padilla, 2010)[40].

The Chancellor's Office recommends that colleges use the following placement rules for students who have graduated from high school within the last ten years and who indicate a goal of transfer or degree attainment.

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[38] The Memo: https://asccc.org/sites/default/files/AA%2018-40%20AB%20705%20Implementation%20Memorandum__0_0.pdf
[39] MMAP: http://rpgroup.org/All-Projects/ctl/ArticleView/mid/1686/articleId/118/Multiple-Measures-Assessment-Project-MMAP
[40] SB 1440 (Padilla, 2010): https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=200920100SB1440

Default Placement Rules for SLAM:

High School Performance Metric for Statistics/Liberal Arts Mathematics - SLAM	**Recommended AB 705 Placement for Statistics/Liberal Arts Mathematics**
HSGPA ≥ 3.0 Success rate = 75%	Transfer-Level Statistics/Liberal Arts Mathematics No additional academic or concurrent support required for students
HSGPA from 2.3 to 2.9 Success rate = 50%	Transfer-Level Statistics/Liberal Arts Mathematics Additional academic and concurrent support recommended for students
HSGPA < 2.3 Success rate of 29%	Transfer-Level Statistics/Liberal Arts Mathematics Additional academic and concurrent support strongly recommended for students

Default Placement Rules for B-STEM:

High School Performance Metric B-STEM Mathematics	**Recommended AB 705 Placement for B-STEM Mathematics**
HSGPA ≥ 3.4 OR HSGPA ≥ 2.6 AND enrolled in a HS Calculus course Success rate = 75%	Transfer-Level BSTEM Mathematics No additional academic or concurrent support required for students
HSGPA ≥2.6 or Enrolled in HS Precalculus Success rate = 53%	Transfer-Level BSTEM Mathematics Additional academic and concurrent support recommended for students
HSGPA ≤ 2.6 and no Precalculus Success rate = 28%	Transfer-Level BSTEM Mathematics Additional academic and concurrent support strongly recommended for students

The following is a footnote in Chancellor's Office Memo AA 18-40 in regard to B-STEM placement:

> Note: The B-STEM table presumes student completion of Intermediate Algebra/Algebra 2, an equivalent such as Integrated Math III, or higher course in high school. Students who have not completed Algebra 2 or higher in high school but who enter college with intentions to major in STEM fields are rare. However, good practice suggests they should be informed that Algebra 2 is highly recommended as preparation for a STEM-oriented gateway mathematics course and that their likelihood of success will be higher in a statistics course.

These default placement rules clearly do not actually provide placement guidance nor assess students, since they recommend that all students be placed in transfer-level mathematics. Colleges are responsible for assessing students and placing them in the courses that will give the students best possible chance to achieve their goals. The default placement rules are for consideration by faculty in the discipline as they deliberate regarding how their colleges will implement their innovations in order to meet the requirements of AB 705. For example, a college may choose to require rather than recommend corequisite support if the college determines that an underprepared student is "highly unlikely to succeed" without such support.

As colleges use the next two years to collect and analyze data on student placement, success, and throughput, the following considerations could shed more light on why students may or may not move through transfer-level mathematics successfully:

1. Data on student success in all mathematics and quantitative reasoning courses. Examples of transfer-level mathematics and quantitative reasoning courses may include the following:
    a. Mathematical Ideas
    b. Statistics and Probability (Statistics, Mathematics, Psychology, Business, Sociology, Economics)
    c. Discrete Structures for Computer Science (Computer Science, Mathematics)
    d. Trigonometry
    e. College Algebra
    f. Precalculus
    g. Finite Mathematics
    h. Personal Finance
    i. Others

    Faculty should work with their local administrations and research analysts to ascertain the coding of all such courses so that data analysis on the collection of students completing transfer-level mathematics and quantitative reasoning courses is as accurate as possible. Such codes to consider include TOP Code 1701.00 (mathematics) and other TOP Codes that have quantitative reasoning courses including but not limited to 0707.10, 2204.00, 2001.00, 2208.00.

2. The probability that a student passes transfer-level mathematics or quantitative reasoning within a one-year time frame given that the student starts one level below transfer and takes transfer the very next term compared to the student that does not pass transfer-level mathematics or quantitative reasoning the first time and repeats transfer-level mathematics or quantitative reasoning the very next term.

3. Number or percentage of students in financial aid trouble after one semester or term and two semesters or terms, disaggregated by course taking patterns such as transfer-level mathematics or quantitative reasoning first term vs below transfer-level mathematics or quantitative reasoning first term.

4. Number or percentage of students in majors that require transfer level mathematics or quantitative reasoning.

5. Number or percentage of students taking transfer-level mathematics or quantitative reasoning that are not required to take it; not all majors require a transfer level mathematics or quantitative reasoning course.

6. Number or percentage of students that indicate an interest in a B-STEM field but are guided or directed to a SLAM pathway. The data should be disaggregated by demographics, and how the number or percentage of B-STEM majors trend over time, both before and after AB 705 and Student Centered Funding Formula implementation, should be analyzed.

7. New course offerings such as corequisite course bundles and effects on students such as financial aid implications, success in future courses, success after leaving the college, and success at the transfer institution or work place.

8. Self-reported student data regarding reasons for dropping out of a mathematics course, not continuing in a math sequence after successfully completing a course, and dropping out of college.

9. Trends in employment opportunities and salary differences for B-STEM vs SLAM majors.

10. Comparison of success rates for students who place directly into transfer level math with those who are successful in their first math class, based on a very recently released study[41] that suggests that while students placing directly into transfer level have a higher throughput than those who start below, success in the first math class a student takes is a higher predictor of overall college success and competency.

11. Flexible and innovative scheduling.

Legislation and Regulations

California Education Code[42] is statute passed by the California legislature or through the budget process and then signed into law by the governor of California. The California Code of Regulations[43] Title 5 Division 6, often referred to as Title 5 Regulations or just Title 5, is approved by the Board of Governors for the California Community Colleges and has the force of law. Title 5 Regulations give the colleges parameters for how to implement the law.

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[41] *Deconstructing Developmental Pathways and Outcomes at Bakersfield College* by Peter Bahr, Center for the Study of Higher and Postsecondary Education, University of Michigan, October 2018

[42] Education Code – EDC: http://leginfo.legislature.ca.gov/faces/codesTOCSelected.xhtml?tocCode=EDC

[43] California Code of Regulations: https://govt.westlaw.com/calregs/Index?transitionType=Default&contextData=(sc.Default)

AB 1725 (Vasconcellos, 1988) was signed into law in September of 1988 and ensured the right of the academic senates to assume primary responsibility for making recommendations to local governing boards in areas of curriculum and academic standards[44]. Title 5 Regulations clarify the role of the academic senates. In particular, the academic senate has the primary responsibility for making recommendations to the local governing board in areas of academic and professional matters[45]. The governing board shall "rely primarily upon the advice and judgment of" or "reach mutual agreement with" the academic senate in these areas[46]. In addition, the ASCCC is recognized by the CCCCO Board of Governors as the representative of the local academic senates in regard to academic and professional matters at the state level. This structure provides the community college faculty of California with a formal and effective procedure for participating in the formation of state policies on academic and professional matters[47].

AB 705 (Irwin, 2017) was signed into law by Governor Brown on October 13, 2017. It became effective January 1, 2018, although colleges have been given until fall 2019 for full implementation in mathematics and English and until fall 2020 in English as a second language. It amended section 78213 of the Education Code, relating to community colleges.

As of the writing of this report, changes to Title 5 Regulations for consistency and implementation of AB 705 are being drafted following the consultative process for such changes in the California Community College System. The California Community Colleges Curriculum Committee (5C) is responsible for the development and revision of all Title 5 Regulations related to curriculum and instruction[48]. Until such regulations are approved by the California Community Colleges Board of Governors, guidelines have been created by the California Community Colleges Chancellor's Office and the Academic Senate for California Community Colleges after considering recommendations from other stakeholders.

Recommendations – Part II

As colleges move forward with AB 705 implementation, data collection, and improvement plans, they should consider the following:

1. Use the pre-transfer level C-ID descriptors at the college's discretion. Experiment with them and adapt them to fit students' educational needs, as determined by discipline faculty.

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[44] Ed Code §70902:
https://leginfo.legislature.ca.gov/faces/codes_displaySection.xhtml?sectionNum=70902.&lawCode=EDC

[45] Title 5 §53200:
https://govt.westlaw.com/calregs/Document/I6EED7180D48411DEBC02831C6D6C108E?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=(sc.Default)

[46] Title 5 §53203:
https://govt.westlaw.com/calregs/Document/I6FD671F0D48411DEBC02831C6D6C108E?bhcp=1&transitionType=Default&contextData=(sc.Default)

[47] Title 5 §53206:
https://govt.westlaw.com/calregs/Document/I751B6470B6CB11DFB199EEE3FF08959C?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=(sc.Default)

[48] 5C:
http://extranet.cccco.edu/Divisions/AcademicAffairs/CurriculumandInstructionUnit/CaliforniaCommunityCollegeCurriculumCommittee.aspx

2. Establish placement rules that are compliant with AB 705 and also optimize student success, minimize loss of financial aid, and minimize creating new equity and achievement gaps for underrepresented and socio-economically disadvantaged students. Discipline faculty should advise their academic senates, curriculum committees, other colleagues, administrations, and governing boards on the educational needs and appropriate programs that best meet the needs of the student population and community. Colleges should be innovative in response to the educational needs of the local student population. In a multiple-measures world, colleges should not rely on a single measure for a complex situation and should examine the confounding variables that impact completion rates.

3. Maintain local control over curriculum development, design, and student placement.

4. Teach to the affective domain as well as the cognitive domain. Many students still need to learn how to be a good student and will especially need to overcome math anxiety.

   Many students have some general academic risk factors as they enter college that may be described by some as a lack of self-discipline, being unmotivated, having a fixed mindset, having little meta-cognition, and having no self–efficacy. In addition, some risk factors are specific to mathematics, including learning processes structured around memorization of examples, lack of sound command of prerequisite knowledge, little ability to read mathematics, minimal to mediocre critical thinking skills applied to quantitative reasoning, and an aversion to struggle.

   One of the many ways to improve student learning performance is to provide environments where students can work on improving behavioral characteristics that are known to be associated with academic success. Some of these characteristics are general, yet several are related to mathematics: skeptical, precise, struggles productively, makes conjectures, uses counter-examples, abstracts, visualizes, makes connections, interprets data, interprets notation, uses examples effectively, is logical, transfers knowledge, identifies key issues, and uses mathematical language. These characteristics can be learned and taught.

5. Provide professional development by discipline faculty and counseling faculty for all discipline faculty and counseling faculty.

   Engage in collaboration and collegiality among all constituent groups.

6.

7. As much as possible, do not limit course taking options for students. A one-size-fits-all model does not really fit all.

8. Collect robust data and analyze it annually.

9. Establish a Guided Self-Placement process that is available for all students. The ASCCC has developed a document for building guided self-placement titled “The Basics of Guided Self-Placement”[49].

10. Review college placement rules regularly, updating them as needed to optimize student success.

References and Resources

CDE data on districts and schools
https://www.cde.ca.gov/ds/sd/cb/ceffingertipfacts.asp

CAL Ed Facts
https://www.cde.ca.gov/re/pn/fb/index.asp

PPIC College Readiness & Rigorous HS course taking
http://www.ppic.org/publication/college-readiness-in-california-a-look-at-rigorous-high-school-course-taking/

PPIC Upgrading high school math requirements
http://www.ppic.org/blog/upgrading-high-school-math-requirements/

PPIC Improving college pathways
http://www.ppic.org/wp-content/uploads/r_1117ngr.pdf

PPIC Remedial education reforms (corequisite model)
http://www.ppic.org/wp-content/uploads/remedial-education-reforms-at-californias-community-colleges-august-2018.pdf

CCCSM (see pg. 58 and following)
https://www.cde.ca.gov/be/st/ss/documents/ccssmathstandardaug2013.pdf

CCCSM FAQs (standards not required, minimum grad requirement supports this)
https://www.cde.ca.gov/re/cc/ccssfaqs.asp

CCCSM testing results
https://www.cde.ca.gov/nr/ne/yr17/yr17rel67a.asp

American Progress (states meeting admission requirements)
https://www.americanprogress.org/issues/education-k-12/reports/2018/04/02/447717/high-school-diplomas/

Trends in mathematics course taking

[49] Basics of Guided Self-Placement:
https://asccc.org/sites/default/files/The%20Basics%20of%20Guided%20Self_8_30_2018final.pdf

https://nces.ed.gov/pubs2018/2018118.pdf

CCC demographics
http://californiacommunitycolleges.cccco.edu/PolicyInAction/KeyFacts.aspx

CCC Datamart (includes CCC mission)
https://datamart.cccco.edu/students/default.aspx

Majority Report (Latinos)
https://west.edtrust.org/resource/the-majority-report/

Ed Source CA comparison (HS)
https://edsource.org/wp-content/publications/08HowCAComparesWeb.pdf

The Condition of STEM – National ACT
http://www.act.org/content/dam/act/unsecured/documents/STEM2016_52_National.pdf

Barbara Oakley (2014), *A Mind for Numbers – How to Excel at Math and Science (Even if you Flunked Algebra)*, https://barbaraoakley.com/books/a-mind-for-numbers/

Uri Treisman's work http://learningandtheadolescentmind.org/people_05.html,

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