PROGRAM REVIEW

DEVELOPMENTAL MATH PROGRAM

(Draft)

November 14, 2016

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I. Program Overview

Introduction

Since our 2012 review of the Developmental Mathematics Program at El Camino College, we find we have many notable student-success achievements to report and that we have a larger, more diversely talented pool of instructors participating in developmental mathematics than ever before. However, despite the positive results we can share about our noncredit (Summer) Math Academies and our reform courses, Basic Accelerated Math (BAM – Math 37) and General Education Algebra (GE – Math 67), both scale-up and buy-in issues stand in the way of attaining our 2012 target goal that *all students placing below transfer in mathematics will have a one- or two-course pathway to transfer-level mathematics, regardless of program of study.*

Even as we continue chipping away at this goal, we find that the scope and nature of our mission is shifting. What were distant opportunities four years ago are now at our doorsteps. Many of these require us to reach outside our department, across our campus, and even beyond El Camino College. We are under gentle but insistent pressure to create adult education pathways; contextualized mathematics pathways for CTE students; and develop high school pathways leading directly into transfer-level courses. Now that noncredit courses that are part of an approved noncredit program receive nearly the same apportionment as credit courses, we have a new tool for enhancing student learning and success that might be used in a number of ways, including offering students, whose numeracy may be extremely deficient, serious options for preparing for credit math courses. If new multiple placement measures work, we may see a growing number students more effectively placed at all levels of mathematics, which itself is likely to offer us new challenges.

The team of instructors dedicated to developmental mathematics is eager to face these new directions. We have a track record of basing our innovations on sound research and we are better positioned now than we were four years ago to step up to the plate, but we argue in this program review that we currently lack the personnel capacity and resources to surmount these tasks successfully.

Despite the talented pool of instructors on the committee, we need more fulltime instructors whose primary professional interest is in developmental mathematics, as well as administrators to help manage every aspect of our program, including our inter-segmental efforts. We are learning from our attempts to scale up successful programs (such as our Math Academies, BAM and GEA) that there is an urgent need to transform how we recruit, assign and train new instructors for these programs and courses – and how we conduct sustained professional development, particularly for our part-time colleagues. We must review local and college-wide practices and policies that hobble our ability to leverage capable adjunct instructors.

Rising to these challenges also requires that we have the space and resources to meet them. Although we celebrate much in our new building, we are also keenly aware that our capacity to support student learning (for all students, but particularly for developmental students) contracted noticeably with the move from the old MCS building into the new MBA building. While we have a smattering of tables and chairs available on the first floor (only), most students can no longer find tables and chairs in our space. Faculty offices have always been insufficient to serve the volume of students who seek help. In the old MCS building, spacious hallways with tables and chairs enabled office hours to spill out into these spaces. Somehow, our developmental mathematics students and their instructors need to regain the space we once enjoyed. Sufficient classrooms, properly equipped classrooms with working technology and basic supplies, are crucial for our day-to-day work. Stable and instantly available funding for replacing broken equipment is essential.

Only about 5% of new developmental math students start in our new reform courses, but the impact on our division's computer laboratory resources of sections of these two courses alone underscores how efficiently and tightly the Mathematical Sciences Division schedules its assigned classrooms. There is little to no wiggle room for expanding the offerings of successful courses. An external and impartial examination of how efficiently all of the programs in the MBA building utilize rooms is long overdue.

Also overdue is incorporating student voices more directly and significantly into our decision-making processes. More than anything, our experience with the new "Analysis of Student Feedback" suggests how difficult it is to design a survey from which reasonably justified conclusions may be drawn. In the next years, as we expand the types of students we serve, we would benefit from a robust and diverse student advisory group to assist us with everything from course design and review to issues of equity.

We look forward to the day when El Camino College begins using the database of students' educational plans to decide our course offerings, rather than simply turning over a schedule from the year prior.

And finally, achieving equity among all of our students must be front and center in all we do.

Program Description

The Developmental Mathematics Program consists of a collection of non-transferable math courses. There are two primary, intertwined sequences: a traditional four-course sequence,

Basic Arithmetic → Pre-Algebra → Elementary Algebra → Intermediate Algebra,

and an accelerated two-course sequence,

Basic Accelerated Mathematics (BAM) → General Education Algebra (GEA).

The accelerated sequence is new and still under development. Students move between sequences as appropriate. Together, the two sequences support all developmental mathematics students, regardless of their educational goals. We include more details about our new accelerated sequence in our Institutional Research, Curriculum and Staffing/Professional Development sections.

Success Measures

Our mission in the Developmental Mathematics Program is

> To provide all students, regardless of their academic preparation, with the means to develop the foundational mathematical skills necessary to meet their educational plans.

In other words, each student should attain the appropriate conceptual and computational preparation to succeed in the necessary mathematics courses for their certificate, major, or transfer plans. Each student should have valuable and meaningful mathematical experiences through which the student gains an appreciation for, an understanding of, and the basic utility with the mathematics and quantitative reasoning required in everyday life.

It is common to describe the success of a program by looking at course completion, retention, and persistence rates. One might also look at the number and rate at which students earn the certificates and degrees within a program and if possible, gauge student success in job attainment or transfer. But for students who are in developmental mathematics courses, it is important to remember that *few if any students attend El Camino College solely to explore developmental mathematics courses. Students are in developmental mathematics in order to get out of developmental mathematics and move on with their lives.*

Rather than look at course measures of success, we use cohort measures to examine the program's overall success. A cohort is a group of students with common characteristics at a given point in time. For example, the fall 2009 African-American cohort would be, for the purpose of this document, all African-American students whose first mathematics course at ECC was developmental and taken in fall, 2009.

Our three main cohort measures of success:

1. **Developmental Mathematics Completion Rate:** A cohort of students is identified and tracked over a period of time. The percent of students who complete developmental mathematics within that time period is **the developmental completion rate (DCR)** for that cohort over that period of time.

2. **Progress to Transfer Rate:** A cohort of students is identified and tracked over a period of time. The percent of students who attempt at least one transfer-level mathematics course within that time period is **the progress to transfer rate (PTR)** for that cohort over that period of time.
3. **Transfer-Level Mathematics Completion Rate:** A cohort of students is identified and tracked over a period of time. The percent of students who pass at least one transfer-level mathematics course within that time period is **the transfer-level mathematics completion rate (TCR)** for that cohort over that period of time.

Generally, we look at two-year or three-year time periods for cohorts of students starting in a particular fall semester. Focusing only on fall semester cohorts is in line with common practice in the ECC Office of Institutional Research. For this program review, our chief sources of data are the ECC IR Office and the Chancellor's Office Data Mart. We have confirmed with ECC IR our confidence in the Data Mart information since the fall 2009 developmental mathematics cohort.

How Well Are We Doing?

It is useful to think of the entire developmental mathematics program as a dynamical system that is near equilibrium. Fall term after fall term, new students enter the system, are distributed fairly consistently by our current placement process among four levels of courses in roughly the same proportion. These students join thousands of other students from other cohorts. Each cohort is completing developmental mathematics, progressing to transfer, and completing a transfer-level at roughly the same rates as any other cohort. In Table 1 (on the next page) we see a great deal of consistency in the two-year and three-year cohort measures for the fall cohorts, 2009 through 2014. The table is organized by the top courses students at each placement levels can enter. We should keep in mind that students may enroll in any mathematics course at or below their placement level. Reading down the columns, most of the measures stay relatively stable, but with some mild trends. First, we see in this time frame a steady decline in all measures for students starting in intermediate algebra (Math 73 and Math 80). For students starting in Math 40 and Math 67, we see a clear drop in the fall 2011 cohort measures, with a slight rebound since then. At three and four levels below transfer (Math 12, Math 23, and Math 37), we see a steady increase in all measures over the time period.

Roughly speaking, three years after a typical cohort begins in this dynamical system, fewer than half complete developmental mathematics, just over a third enroll in a transfer-level mathematics course, and only a fourth of the original cohort passes a transfer-level course. Looking out four, five, or six years improves matters only marginally. The Chancellor's Office 2015 Scorecard for our college indicated that after six years, only 28% of students who took a first developmental mathematics course at El Camino College completed a transfer-level mathematics course *anywhere* in the California Community College system.

Placement Level	1 Level Below Transfer (Math 73, 80)				2 Levels Below Transfer (Math 40, 67)				3 & 4 Levels Below Transfer (Math 12, 23, 37)			
Two-Year	% of Cohort	DCR	PTR	TCR	% of Cohort	DCR	PTR	TCR	% of Cohort	DCR	PTR	TCR
F09	45%	76%	55%	39%	11%	40%	23%	13%	44%	11%	4%	3%
F10	43%	77%	51%	37%	9%	38%	21%	13%	48%	15%	6%	4%
F11	42%	72%	47%	34%	10%	31%	15%	11%	47%	19%	8%	4%
F12	44%	72%	49%	34%	11%	38%	20%	12%	45%	17%	7%	5%
F13	47%	69%	50%	36%	11%	37%	19%	13%	42%	18%	7%	5%
F14	51%	70%	51%	36%	10%	38%	25%	14%	39%	19%	7%	6%

Placement Level	1 Level Below Transfer (Math 73, 80)				2 Levels Below Transfer (Math 40, 67)				3 & 4 Levels Below Transfer (Math 12, 23, 37)			
Three-Year	% of Cohort	DCR	PTR	TCR	% of Cohort	DCR	PTR	TCR	% of Cohort	DCR	PTR	TCR
F09	45%	77%	59%	45%	11%	45%	30%	23%	44%	16%	9%	5%
F10	43%	78%	57%	45%	9%	41%	30%	20%	48%	21%	12%	8%
F11	42%	75%	55%	41%	10%	33%	28%	18%	47%	24%	16%	9%
F12	44%	74%	55%	42%	11%	40%	26%	16%	45%	23%	15%	8%
F13	47%	70%	55%	41%	11%	40%	25%	18%	42%	24%	16%	8%
F14	three-year data unavailable				three-year data unavailable				three-year data unavailable			

Table 1

The data for BAM (Math 37) students (n=255), who place three or four levels below transfer, show promise, with 44% completing developmental mathematics and 20% completing transfer-level mathematics after three years, compared with the non-BAM students at this level (DCR ≈ 18% and TCR ≈ 6%). The sample size for GEA (Math 67) students is still too small to conclude anything from the results (n=18), but 14 (78%) completed developmental math and 10 (56%) completed transfer-level mathematics after three years. In the two fall cohorts with any BAM or GEA students (2012 and 2013), the 273 students who started their mathematics in BAM or GEA represent less than 5% of the total. Even so, in Figure 1, we can see the slight impact of these courses in the developmental completion rates in the fall 2013 and fall 2014 cohorts among students starting.

If we are able to grow our offerings of both of these courses and increase the number of students appropriately placed in these courses, we are hopeful to see a much greater impact. We will examine these and similar data in much greater detail in the Research section of the program review.

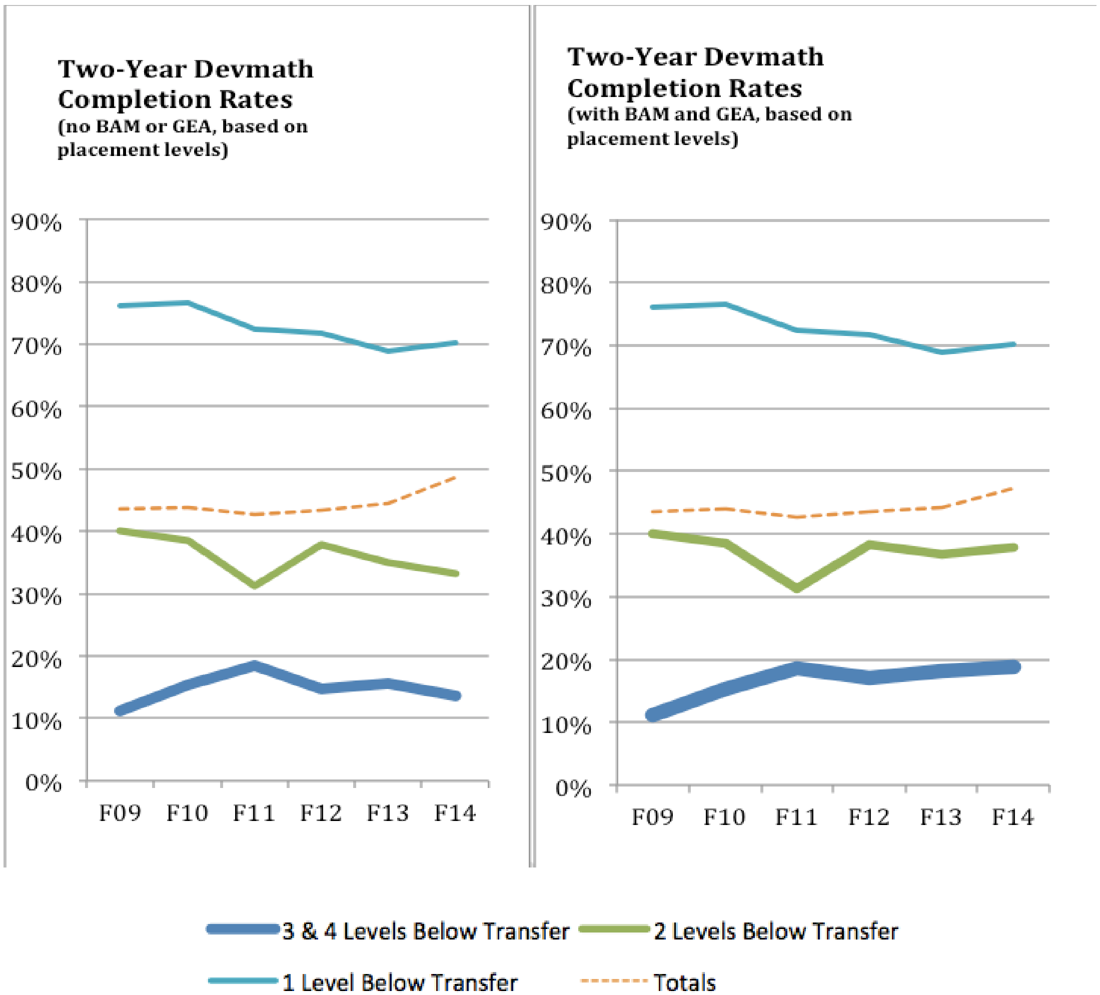


Figure 1

Equity Gaps

We have spent considerable time examining the outcome gaps with respect to race and ethnicity. The distribution of race and ethnicity of students in the developmental mathematics program varies more from cohort to cohort than does gender or placement, as we see in Table 2 on the next page, where the fall 2009 cohort and the fall 2012 cohort are typical.

	ECC Overall	F09	F12
African-American	17%	17%	14%
Asian	15%	20%	14%
Latino	48%	35%	38%
White Non-Hispanic	14%	14%	8%
Other	6%	14%	6%

Table 2

There are serious performance gaps among these groups that must be addressed. In Table 3, we see the percent of each race or ethnicity cohort that completed developmental mathematics or transfer-level mathematics within three years. The TCR Gap Multiplier compares each group to the performance of the White Non-Hispanic cohort. It answers the question, by what would one need to multiply a cohort's performance rate in order to match the performance seen in the White Non-Hispanic group.

	F09			F12		
	DCR	TCR	TCR Gap Multiplier	DCR	TCR	TCR Gap Multiplier
African-American	22%	9%	4.44	27%	11%	3.64
Asian	56%	32%	1.25	59%	34%	1.18
Latino(a)	49%	24%	1.67	46%	23%	1.74
White Non-Hispanic	67%	40%	1.00	69%	40%	1.00
Other	47%	25%	1.60	48%	24%	1.67

Table 3

Only about a tenth of African-Americans starting at any level of developmental mathematics complete transfer-level math after three years. White students performed four-and-a-half times better, on average. Roughly a fourth of Latino students completes transfer-level mathematics after three years, a rate slightly better than half the rate of white students.

We will share more about racial/ethnic and gender equity issues in the Research section of the program review. (We have not focused too much attention on existing gender inequities in developmental mathematics – see the appendix for some initial results.)

Finally, as a group of teaching professionals, the instructors in the Developmental Mathematics Program are guided in our decision-making by research and data, both from local sources and from the broader community. As a result, the Research and Data section of our program review is rather extensive. Later sections of the program review will frequently refer back to the Research and Data section.

Status of 2012 Recommendations

Below we provide a brief status report for each of our 2012 Recommendations. These recommendations were organized into five categories: Professional Development, Management, Staffing and Course Offerings, Instructional Support Services, and Placement and College Readiness.

Recommendation 2012A.1 (Professional Development – Classroom Observation Opportunities for BAM and GEA Instructors) During the expansion of the accelerated courses, offer compensated opportunities for fulltime and adjunct instructors interested in teaching BAM or GEA to observe current instructors in their classrooms and labs and attend weekly meetings.

> *Using Title V Graduation Initiative funds, only a very small number of instructors were able to take advantage of the opportunity to shadow, for two reasons. First, we failed to identify many future BAM and GEA instructors in time to offer them this experience. More often than not, conditions beyond our control result in last-minute assignments to these courses, particularly adjunct instructors. Instead, when an adjunct instructor was assigned to BAM or GEA and his or her workload allowed it, we were able to provide these instructors with some compensation for attending weekly meetings and creating course material.*

Recommendation 2012A.2 (Professional Development – Future Opportunities) In addition to continuing the Summer Institute for Developmental Education (SIDE), offer compensated workshop series every year, in which fulltime and adjunct instructors explore issues such as Culturally Responsive Teaching, peer teaching evaluations and mentoring, active learning methods and effective group work management.

> *We have not had these since 2012, but with our new Basic Skills and Student Outcomes Transformation Grant, we will offer these again starting spring, 2017.*

Recommendation 2012B.1 (Management – Developmental Mathematics Program Coordinator) Assign a faculty coordinator or the associate dean to coordinate developmental mathematics. Duties may include assisting the dean with class schedules and teaching assignments; facilitating faculty collaboration; coordinating course reviews and program reviews; researching program effectiveness; supervising SLO assessments and reports; reviewing program technology and facility needs; organizing professional development; applying for external funding and managing grants.

> *The Division of Mathematical Sciences now has an associate dean, but this position is not dedicated to coordinating the Developmental Mathematics Program.*

Recommendation 2012B.2 (Management – Course Coordinators) Provide reassigned time for a course coordinator for each developmental mathematics course with ten or more sections. Duties may include assisting instructors with course materials, student activities, and other resources, promoting professional development opportunities, coordinating faculty cohorts and shared office hours, managing course SLO assessments, conducting ongoing surveys of students and instructors, disseminating research results, and evaluating adjunct instructors.

Over the last four years, multiple discussions have occurred about course coordinators. Although there is general acknowledgment that all of the duties described above are desirable and most are required, and despite the fact that there are already individuals are putting in many extra hours struggling to complete these tasks in a meaningful way, we still do not have course coordinators.

Recommendation 2012C.1 (Staffing and Course Offerings – Growth and Study of BAM and GEA) Increase the number of sections of BAM (Mathematics 37) and GEA (Mathematics 67) through reducing sections of Mathematics 12, 23 and 73.

The expansion of BAM and GEA has taken place in much the way described above, but we are now facing facility and resource barriers to further expansion of these two courses. Our new building was specifically designed for NO GROWTH in our programs and our division's resources were always inadequate and stretched thin. But our thinking on this issue has also been evolving. Instead of thinking of BAM and GEA simply replacing other courses, we need to do the hard work of right-sizing our offerings to fit the needs of our students.

Recommendation 2012C.2 (Staffing and Course Offerings – Fulltime and Adjunct Instructor Recruitment) Hire full-time and adjunct instructors, who are interested in and committed to serving developmental mathematics students.

While we hired 11 new fulltime instructors in the last four years, and all have participated to some degree in with developmental mathematics, still the burdens of managing the Developmental Mathematics Program are falling on too few shoulders. In general, this concern reflects the fact that the entire Mathematics Program has grown too large to manage without substantially more fulltime instructors and additional administrators.

Recommendation 2012C.3 (Staffing and Course Offerings – Faculty Course Cohorts) Consider instructors' desire to form faculty course cohorts in scheduling and teaching assignments.

No progress has been made on this recommendation. The idea of facilitating the formation of faculty cohorts with fulltime and adjunct instructors as part of the process of creating schedules and teaching assignments remains seemingly outside the realm of possibilities. We continue to see these faculty cohorts as likely the only long-term strategy for transforming the teaching in developmental mathematics.

Recommendation 2012D.1 (Instructional Support Services – Expand Supplemental Instruction Program) Increase the number of adjunct instructors teaching developmental mathematics courses with Supplemental Instruction.

Supplemental Instruction has expanded substantially during the past four years. However, students in evening classes are far less likely to have SI than students in day classes.

Recommendation 2012D.2 (Instructional Support Services – Expand Counselor Intervention) Increase the number of sections offering Counselor Intervention to include all sections of Mathematics 12 and Mathematics 37.

This recommendation has been met successfully.

Recommendation 2012D.3 (Instructional Support Services – Equitable Student Access to Instructors) Provide offices for adjunct instructors and compensate them for one or two office hours per week.

The serious equity implications of failing to meet this recommendation continue.

Recommendation 2012D.4 (Instructional Support Services –Technological upgrade: Tablet PC or iPad) Provide instructors the option of choosing a tablet PC or iPad instead of a laptop for their primary computer.

This recommendation has been met successfully across campus.

Recommendation 2012E.1 (Placement and College Readiness – Expand the Summer Math Academies) Expand the number of Summer Math Academies offered each summer.

This recommendation has been met successfully. The Summer Math Academies have been approved as noncredit courses and will be offered at all times of the year as our capacity to offer them grows.

Recommendation 2012E.2 (Placement and College Readiness – MyMathTest Preparation for Placement) Integrate MyMathTest Preparation into the matriculation process prior to taking the placement exam and require MyMathTest Preparation before retaking the placement exam.

This recommendation was not met successfully. In light of the school moving toward a more robust multiple-measure placement process, it is doubtful we will revisit this recommendation in the near future. Until there is a more clear sense of how these multiple measures work, we will not know how to assist students in preparing.

Recommendation 2012F.1 (Student Learning Outcome Assessments – Improve the Quality of Assessment Cycles) Create more comprehensive assessment instruments, involve more voices throughout the assessment process, and have more thorough follow-up on each assessment cycle.

This recommendation has been implemented to some extent in Math 67 (GEA) and will be included in our list of recommendations for the 2016 Program Review.

II. Research Data Analysis

Instructors in the Developmental Mathematics Program are committed to using research data to drive decisions. Since the 2012 Program Review, research has been conducted on (a) evaluation reports from the El Camino College Office of Institutional Research (ECC IR) of continuing programs and (b) benchmark, peer-reviewed research studies relevant to the developmental mathematics program. We have gathered information from the ECC IR Office, the Community College Research Center (CCRC), the American Mathematical Association for Two-Year Colleges (AMATYC), the Research and Planning Group for California Community Colleges (The RP Group), the California Community Colleges Chancellor's Office (CCCCO - Student Success Task Force Report), the National Center for Developmental Education (NCDE), and Professional research studies in peer-reviewed journals. Scholastic literature informs the committee's actions as much as local ECC studies and regular program evaluations and serves as the theoretical framework for the program. Evidence will be presented in this report, to address the following guiding questions:

1. How effective are acceleration programs in general, and in particular Math 37 and Math 67, in preparing students for transfer level course mathematics?
2. What evidence-based, best teaching practices are recommended by research studies or educational institutions?
3. How successful are math assessment tests at predicting student success at El Camino College?
4. How effective have the ECC Summer Math Academies been in improving placement scores?
5. What effects has the embedded counseling program had at El Camino College?

1. ACCELERATING STUDENTS THROUGH REMEDIATION

Peter Bahr (2011) conducted an analysis of the relationship between levels of math placement and persistence and developed a probability model for successful remediation in math. Within the context of lengthy sequences of developmental math programs (three or four levels below college-level math), the likelihood of successfully navigating these courses and moving to college-level coursework is predicated on advancing through the program *without a break*. There is no latitude for a failed semester. Persistence becomes the primary concern for successful completion of remediation. According to Bahr, unless a student starts one step below a college-level course, the probability of successfully completing remediation does not exceed 60% regardless of the length enrollment.

Students are significantly less likely to complete math remediation if they start at the lowest levels of math. Fail even one course in the sequence dramatically or postpone their first remedial math course and the likelihood of completion drops dramatically (Bahr 2012; Perry, Bahr & Woodward, 2010). Bahr (2013) studied attrition rates in mathematics using a longitudinal study from the National Center for Educational Statistics and the system database from the California Community College Chancellor's Office (CCCCO). He found attrition from lengthy developmental mathematics sequences stemmed from three factors: (a) students who are placed at the lowest levels of remediation were likely to be deficient in math skills as well as the general student success skills, (b) elementary algebra was a disproportionately challenging course for many remedial students due in large part to the abstract nature of the curriculum, and (c) the loss of students who pass one course but fail to enroll in the subsequent course contributes to a significant portion of the total attrition (Bahr, 2013).

The Original 2012 Progression Study:

In the 2012 Program Review report, a four-year tracking study from the ECC IR was presented. It followed a 2008 cohort of 1069 students placed in Arithmetic (four levels below transfer) for four years (2008-2012) and found only 10% of the original cohort completed the developmental mathematics sequence in four years (passed intermediate algebra). Moreover, after four years, only 6% of the original cohort had passed a transfer-level course.

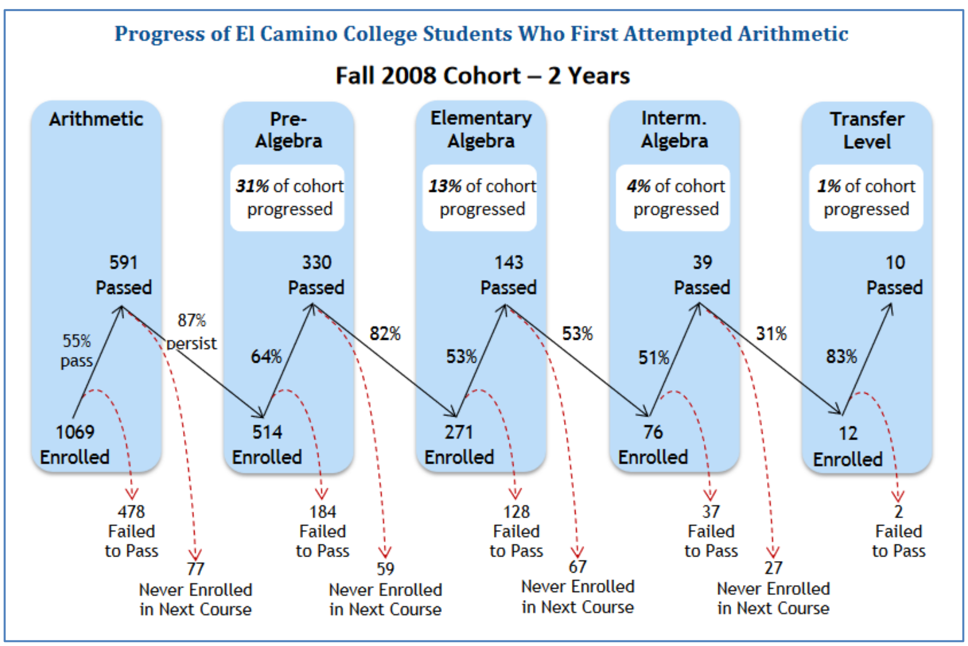


Figure 3: Two- year developmental math tracking study 2008 – 2010 (Pre-Acceleration program)

Community colleges are often referred to as "two-year" colleges and many students use community colleges to prepare and transfer to four-year universities. Using a two-year time frame, the tracking study below finds only 4% of the same 2008 cohort (N = 1069) completed remediation in two years and only 1% completes a transfer level math course.

These results spurred the committee to seek ways to accelerate developmental math students through the program and became the motivation for the creation of two acceleration programs Math 37 Basic Accelerated Mathematics (BAM) and Math 67 General Education Algebra (GEA). The 2008 progression study will serve as a baseline for comparison. Two acceleration programs that serve as a guided pathway to transfer-level mathematics have been operating for the past five years. This section will show that student participating in the accelerated courses are more likely to pass a transfer level course than students that take the traditional pathway shown below.

The 2015 BAM and GEA Progression Studies (2011 – 2015)

An ECC Institutional Research Study in 2015, in which multiple two-year progression studies of BAM (Math 37) and GEA (Math 67,) between Fall 2011 through Summer 2015, were pooled found that 39% of BAM students placed at the arithmetic level progressed through Intermediate Algebra and 9% successfully completed a Transfer-level course (Math-120 and Math-150), compared to rates of 7% and 1%, respectively, for non-accelerated comparison groups.

BAM students, who placed four levels below transfer, were almost six times more likely to compete the developmental math program than non-accelerated students and nine times more likely to pass a transfer level math course within two years. GEA students were twice as likely as their comparison group to complete the developmental math program and more than three times as likely to complete a transfer level math course (See figure 2). The summary report below pools three two-year studies.

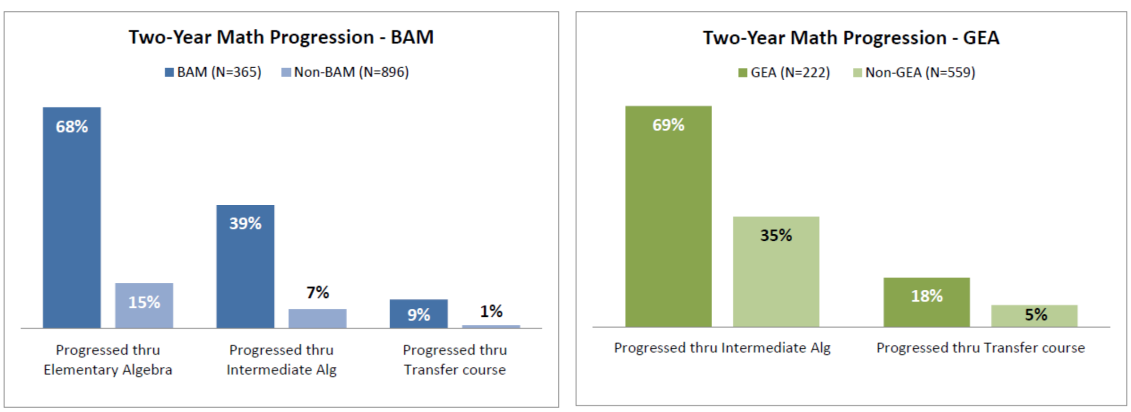
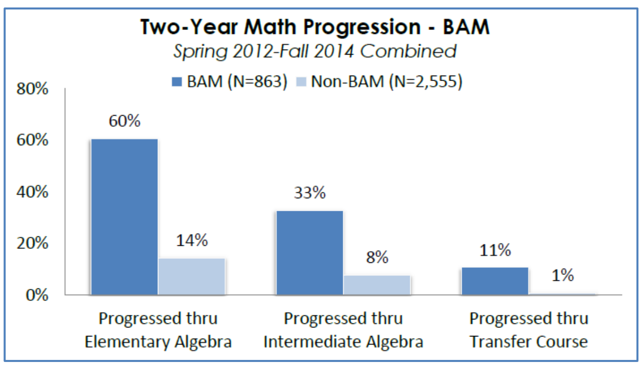


Figure 4: 2015 Progression Study (2011 – 2015) - Completion rates of accelerated students versus non-accelerated students.

The 2016 BAM and GEA Progression Studies (2012 – 2016)

In October of 2016, the ECC Institutional Research Office completed another pooling of multiple year progression studies of BAM and GEA. This time the studies considered two, three and four year time spans. The pooling of two-year cohorts in the 2016 progression study does not appear to have very different results than in the 2015 study (figure 4). The Non-BAM statistics are virtually unchanged, while the BAM statistics appear to have decreased for progression through elementary and intermediate algebra. While it may be encouraging to see that BAM students are progressing through a transfer level course at 11% (compared to 1% for non-BAM student), so few non-BAM students can complete a transfer level course within two years, so it is hard to make a meaningful comparison to BAM students.

A more meaningful analysis may be to consider a three or four year progression study. For the purpose of brevity, only the four-year comparison will be presented. Within four years, BAM students (N = 141) are over three times more likely to complete remediation (intermediate algebra), and over five times more likely to complete a transfer level course, than non-BAM students in the traditional pathway (N = 892). See Figure 5.



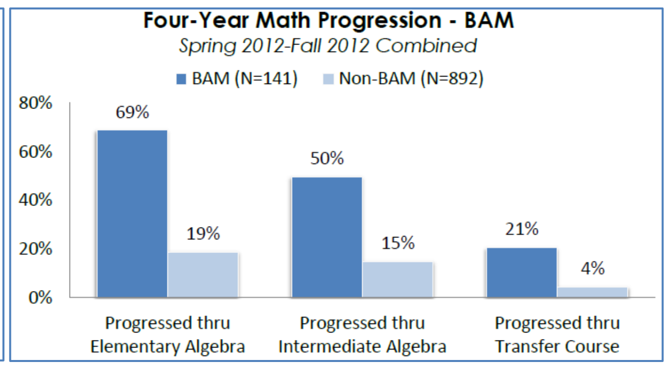


Figure 5: 2016 Progression Study (2012 – 2016) – Two year & four year completion rates of BAM students.

The rate at which students complete a transfer level course should be the defining metric for any developmental math program. This is a legitimate metric because the instructors involved with the acceleration courses rarely teach the transfer-level courses. The BAM instructors feel these impressive results validate the design elements BAM: student-centered pedagogy, mastery learning strategies, and affective domain activities.

The 2015 GEA two-year progression study is nearly identical to the 2016 two-year progression study. When studying the 2016 three-year progression study it apparent that GEA students are twice as likely to complete remediation and become eligible for a transfer level, non-STEM, math course, and twice as likely to complete a transfer level, non-STEM, math course. See Figure 6.

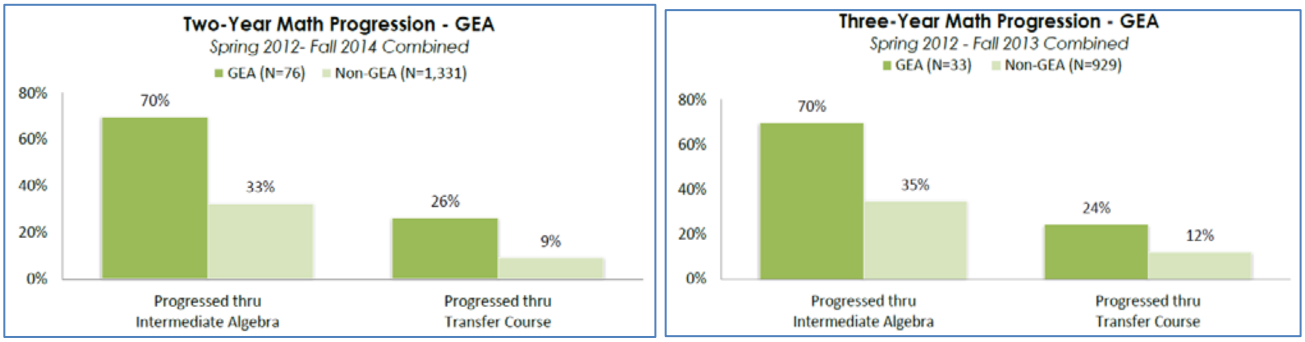


Figure 6: 2016 Progression Study (2012 – 2016) – Two year & four year completion rates of GEA students.

BAM Progression: A closer comparison of the BAM and GEA acceleration pathway versus the traditional pathway shows several contrasts. Below is a two-year progression study for Fall 2014. It shows the progression of a cohort of BAM students against a comparable group of non-accelerated students. Consider the following metrics.

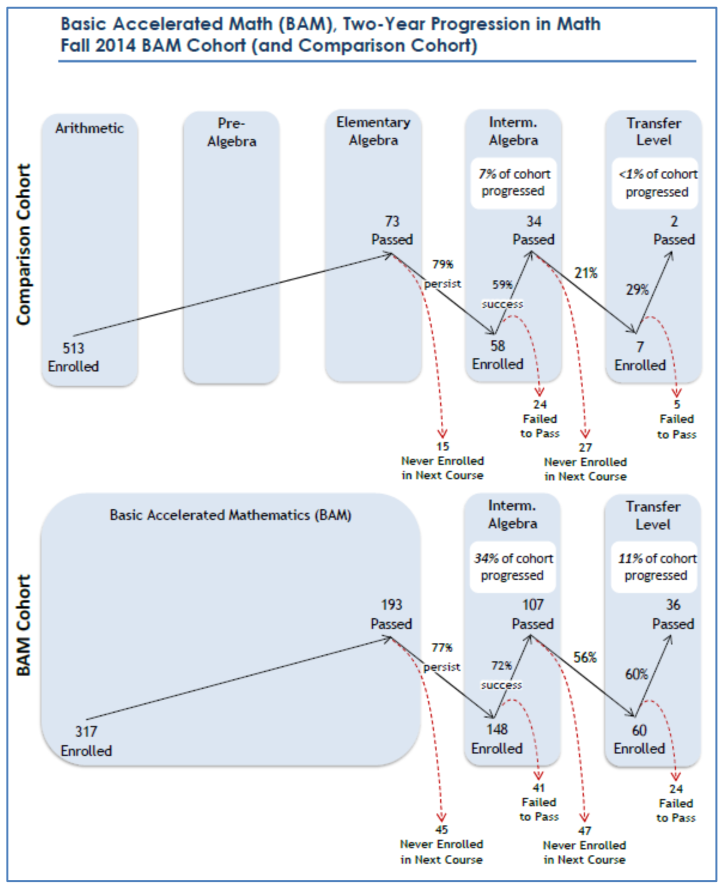


Figure 7: Fall 2014 BAM two –year progression study

Remediation completion: The percentage of BAM students that complete remediation is 34% whereas only 7% of students that start in Math 12 complete remediation within two years. BAM students are five times more likely to complete remediation.

Transfer completion: The percentage of BAM students that complete a transfer level course is 11% whereas the less than 1% of students that start in Math 12 complete remediation. To be more precise, in this cohort, only 2 students of the 513 that started Math 12 completed a transfer level course within two years.

A two-year time frame may be an unfair comparison due to the lengthy course sequence for students that start at the lowest levels of remediation, but that is precisely the point. The traditional developmental math program has too many unnecessary classes with too many exit points for students to drop out. For a more fair comparison, a Fall 2012 four-year progression study is presented below.

Remediation completion: The percentage of BAM students that complete remediation is 51% whereas only 16% of students that start in Math 12 complete remediation within two years. BAM students are three times more likely to complete remediation.

Transfer completion: The percentage of BAM students that complete a transfer level course is 22% whereas only 5% of students that start in Math 12 complete remediation. BAM students are 4.4 times more likely to complete a transfer level course.

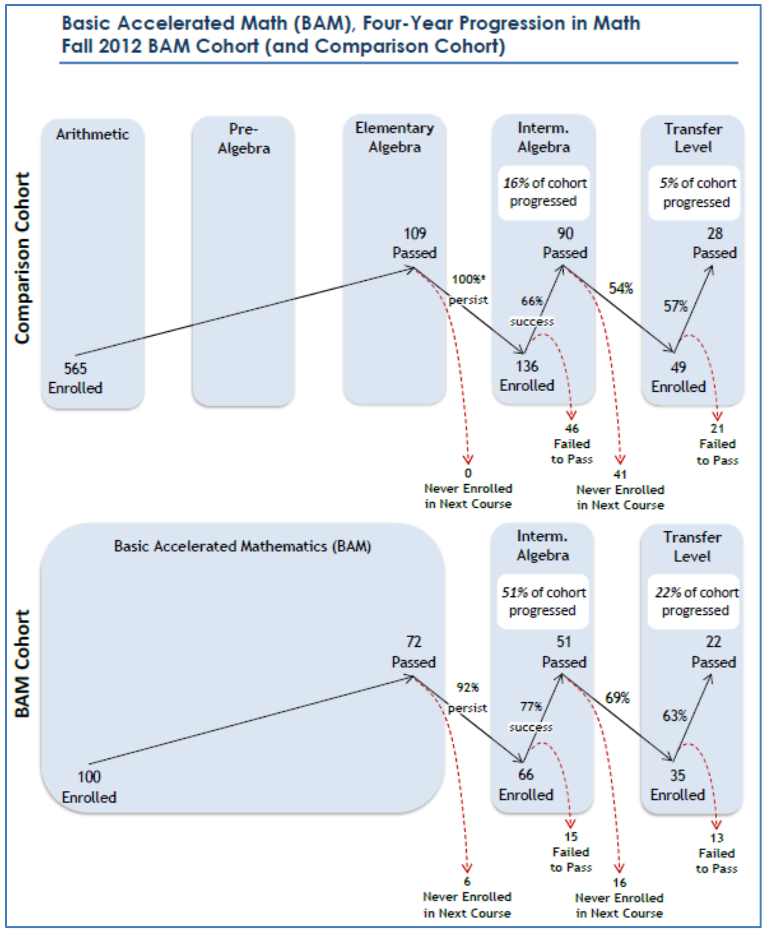


Figure 8: Fall 2014 BAM two –year progression study

GEA Progression: Presented on the next page are the progression study results for student placed two levels below transfer. Students with knowledge of pre-algebra (Math 23) are eligible for Elementary Algebra (Math 40) or General Education Algebra (Math 67), but have a 70% chance of completing remediation via GEA compared to a 35% chance taking the non-accelerated pathway. The sample size for GEA is rather small because GEA is only four years old. A four-year progression study is not available for GEA. For greater sample sizes, pooled two-year studies are necessary. This results in superior success rates.

It is apparent from these progression studies that students with a modicum amount of algebra knowledge are twice as likely to complete remediation and complete a transfer level math course pursuing an accelerated pathway than taking a traditional, non-accelerated pathway.

Transfer completion: The percentage of GEA students that complete a transfer level course is 24% whereas the 12% of students that start in Math 40 complete a transfer level course. GEA students are twice as likely to complete a transfer level course.

Notice that the success rate of GEA students (67%) is greater than the that of studnts taking the traditional pathway (64%). According to the 2016 Progression Study, GEA students are just as successful if not more successful at transfer level than students taking the traditional pathway, in half the time (one semester).

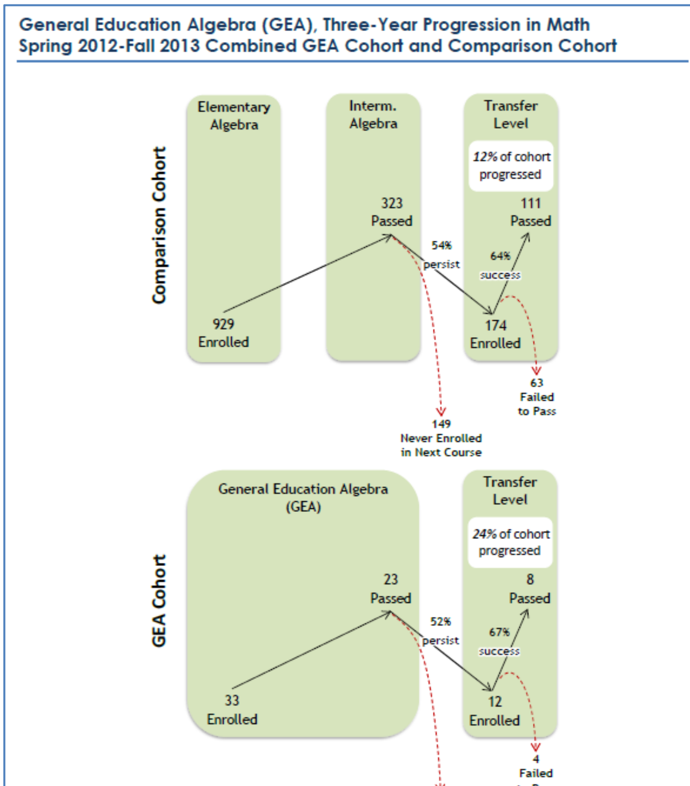


Figure 9: Fall 2012 GEA cohort Progression Study

The reasons accelerated students are more successful are two-fold: (1) the traditional remediation program is composed of too many courses, each with approximately a 50% success rates, and (2) the pedagogical design elements of BAM and GEA prepare students for a transfer level course in a shorter period of time. The combination of BAM and GEA serve as a guided, shorter and more successful pathway to transfer level mathematics for non-STEM and non-business majors.

The greatest challenge for developmental math students to progress to college level mathematics is the sheer number of math courses in a remedial program. There are two dimensions of attrition for students placed in remediation. First, students must pass the course for which they are placed by the standardized assessment exam. Typically, developmental math courses have approximately a 50% success rate. Second, students that pass a developmental math course need to enroll in the subsequent math course in the program. Typically, 75% of remedial math students who pass one course will enroll in the subsequent course. For students placed four levels below college level math, this amounts to exponential attrition (Hern & Snell, 2013).

Accelerated programs strive to merge increase completion of college-level math through shorter developmental pathways; streamlined, backward designed developmental math curricula; relevant, thinking-oriented curricula; just-in-time remediation; collaborative, low-stakes practice; and intentional support for students' affective needs.(Hern, 2013).

Underrepresented Groups and Acceleration

The positive effects of acceleration have been most pronounced for minority racial groups. African-American students have historically been the most challenged student group to succeed in the ECC math department success and retention reports from the IR Office. The data suggest acceleration is a powerful intervention to decrease equity gaps.

From the 2015 BAM and GEA Progression Studies (2011 – 2015)

1. **African-Americans:** African –American accelerated student are **seven times** more likely to complete developmental math than non-accelerated African-American students. The progression study below (figure 7) shows a 22% African-American developmental math completion rate within two years for accelerated BAM students compared to a 3% African-American developmental completion rate for non-accelerated students. And 6% of African-American accelerated BAM students passed a transfer level math course compared to **zero** non-accelerated African-American students.

   A two-year study tracked the progress of a cohort of African-American students in the spring of 2012 through GEA (Math 67). African-American Students enrolled in GEA completed developmental math and become eligible for a college level course at twice the rate as students tacking the traditional pathway. The respective completion rates were 58% (N = 48) for GEA students versus 25% for non-GEA students (N = 111). Within this two-year period, 8% of GEA students completed a transfer level course compared to 6% of non-GEA African-American students.

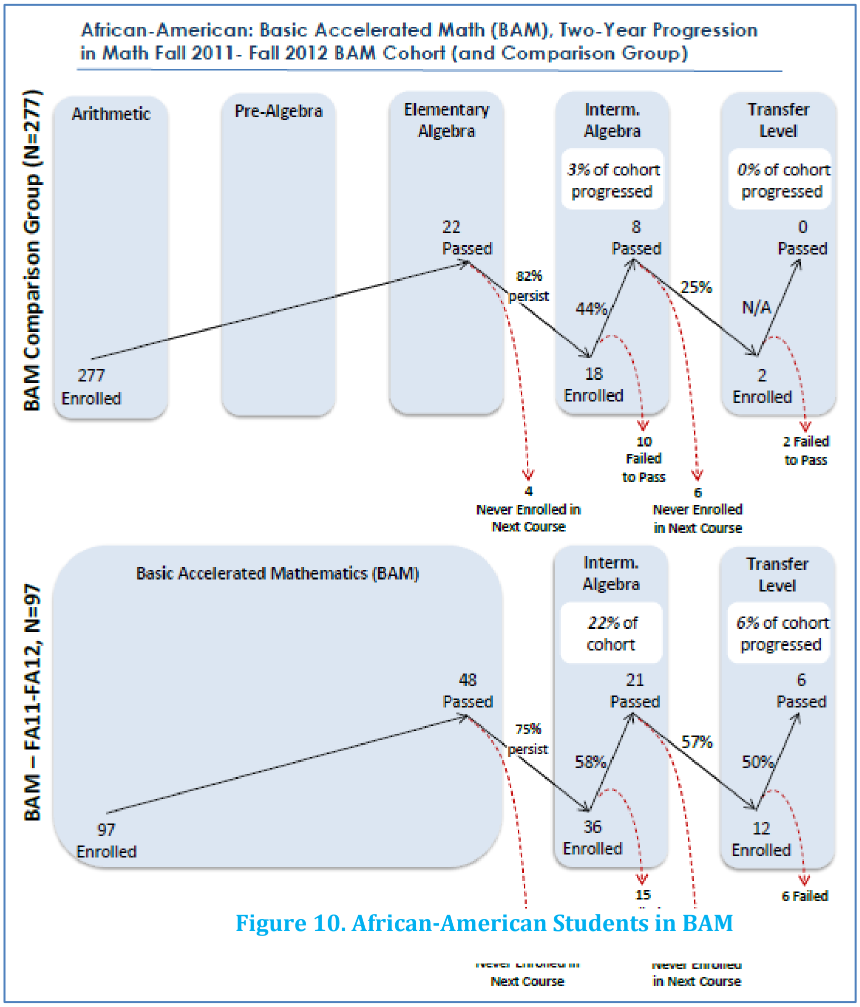


Figure 10. African-American Students in BAM

2. Latino students are **five** times more likely to complete remediation if placed in BAM. Of the 471 non-accelerated Latino students placed four-levels below transfer, only three passed a transfer level course within two years (0.6%). Of the 212 Latino students in BAM, 20 passed a transfer level course within two years (9%). While 9% is not a celebratory statistic, it is a significant improvement over 0.6%.

   Latino students enrolled in GEA (Math 67), are over twice as likely to complete developmental math. Of 136 Latino students enrolled in GEA in the spring of 2012, 100 passed and became eligible for a transfer level math class (73%), compared to 32% of non-GEA Latino students taking the traditional pathway.

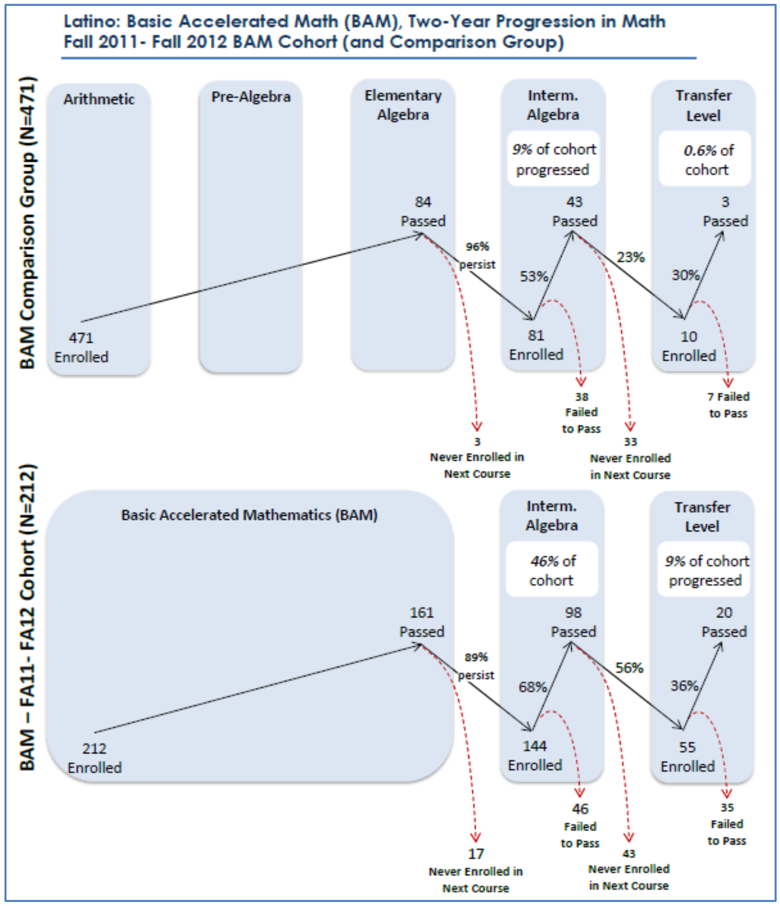


Figure 11: Latino students in BAM

Under Represented Groups in the 2016 BAM and GEA Progression Studies (2012 – 2016)

The 2016 ECC BAM and GEA progression study compared the completion rates for the four largest ethnic groups: African-Americans, Asian, Latino, and White students. Focusing on the four-year progression chart, and the remediation completion rate (progressed through intermediate algebra), it shows that 19% of African-American BAM students completed remediation versus just 5% of the non-BAM students. While this is only a 14% improvement, it represents a 3.8 fold improvement. Latinos BAM students completed remediation at a rate of 55% compared to 18% of non-BAM Latino students. This represents a 3-fold improvement. In terms of these multiplicity factors, the African-American students made the greatest improvement by this relativistic measure (BAM N=141, Non-BAM N=892).

Focusing on the transfer level completion in the four-year progression study, BAM improved the African-Americans completion rates from 2% to 13%. African-American students in BAM did 6.5 times better than non-BAM African-American students. Latino completion rates improved from 5% to 18%. Latino students in BAM did 3.6 times better than non-BAM students. African-American student made the greatest improvement by this relativistic measure.

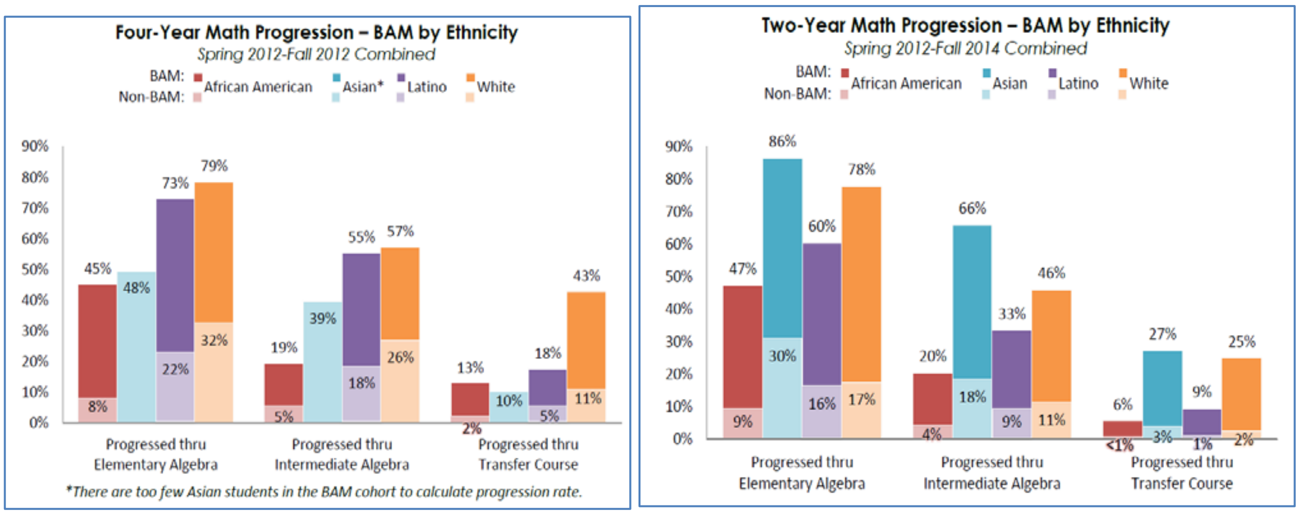


Figure 12: Underrepresented ethnic groups from the 2016 BAM/GEA progression study

Even though minority students are more likely to complete remediation, more work must be done to close the equity gaps. There are notable improvements in the four-year progression through intermediate algebra: Latino completion rates (55%) are very close to White completion rates (57%). This is 2% gap is an improvement over non-BAM equity gaps of 8%. White student completion rates are 3.3 times better than African-American completion rates in BAM (43% versus 13%), but they are 5.5 times better in the traditional pathways.

BAM and GEA are both effective and could serve more than the 5% of our developmental cohorts. The recommendations offered here support the scaling up of these course offerings in a way that maintains the quality of instruction and fits students' needs.

> **CMD Recommendation 2016A_– *pay adjuncts for office hours, professional development and committee work***
> Compensate adjunct instructors teaching developmental mathematics for up to four hours a week, in order to participate more fully in the work of Committee D (including SLO assessments and discussions), professional development activities, and to provide students with office hours (potentially having them held in the tutoring center), at an estimated cost per adjunct instructor: 16 - 32 hours per semester @ ~$48/hr = $720 - $1440 (MODIFIED Recommendation 2012D.3; Research, SLO, Student Feedback, *equity, instructional support, Strategic Initiative B)*

CMD Recommendation 2016B - course coordinators
Create course coordinators for each developmental mathematics course with ten or more sections, in order to aid in the effectiveness of the SLO assessments through adjunct participation; to coordinate, orient, and mentor adjunct instructors; to expedite the creation and implementation of a comprehensive SLO assessment instrument; to provide and to promote professional development opportunities; and to conduct surveys of students and instructors and to disseminate research results. (MODIFIED Recommendation 2012B.2; Research, SLO, Staff, *instructional support, institutional effectiveness, Strategic Initiatives B and E)*

CMD Recommendation 2016C - scheduling based on education plans and research
Adjust the number of sections of Arithmetic (Mathematics 12), Pre-Algebra (Mathematics 23) and BAM (Mathematics 37) to better fit the needs of students as indicated in educational plans and research. Adjust the number of sections of GEA (Mathematics 67), Intermediate Algebra for General Education (Mathematics 73) and Intermediate Algebra (Mathematics 80) to better fit the needs of students, as indicated by educational plans and research. Conduct research on who is taking math 73 and for what purpose (anecdotal evidence shows most/many should be in math 67 or math 80). (Research, Curriculum, SLO, Staffing **–** *equity, progress toward completion, Strategic Initiative B)*

CMD Recommendation 2016D – materials for threads spanning multiple courses
Create summer special assignments for faculty to create Culturally Relevant Teaching (CRT)-aligned activity packets (arcs) for quantitative reasoning (Math 12/23/37), for problem solving (Math 37/40/67/73), and for linear modeling (Math 37/67), for use in professional development workshop series mentioned above and for use in indicated courses. (Research, Curriculum, Staffing, *equity, instructional support, Strategic Initiatives A and B)*

CMD Recommendation 2016E – faculty development/best practices
Create and offer a professional development workshop series to recruit and to train new developmental mathematics instructors in equity-minded teaching, cultural literacy, learner-centered teaching strategies, as recommended by AMATYC, and effective faculty collaboration, in order to increase the pool of instructors prepared to do an excellent job teaching our developmental courses, with adjunct faculty paid for the training and target start date fall, 2017. (Research, Curriculum, SLO, Staffing, *equity, progress toward completion, and student success, Strategic Initiative B)*

2. EVIDENCE BASED “BEST PRACTICES” AS INFORMED FROM RESEARCH

Improving math instruction has been a continual struggle for community colleges. Grubb (2013) interviewed 323 instructors and administrators of California community colleges from 169 classes, in 20 community colleges, and observed a dominant form of instruction in developmental mathematics that impeded student progression in lengthy course sequences.

Grubb (2013) referred to this as “remedial pedagogy” and described this as the most prevalent form of instruction across the state. It is “the most passive form of learning… it is relentlessly teacher-centered, with almost no chance for students to participate in their own learning… [and] relentless in their emphasis on drill and practice, without any application to the world outside” (p. 55). Colleges are responsible for the quality of instruction, but few colleges prioritize pedagogical reform. According to Grubb (2013), there are many reasons for the dominance of this ineffectual instructional practice: math instructors lack formal educational training, adjunct instructors are not compensated for instructional preparation, and textbooks, computer programs, and tutoring all reinforce a culture of remedial pedagogy.

Developmental math programs should be promoting effective teaching practices to improve the completion and graduation rates. The American Mathematics Association of Two-Year Colleges (AMATYC) established standards for instructional pedagogy influenced by constructivist educational philosophies. These guidelines emphasize active learning methods, meaningful problem solving, and collaborative learning (Foley, 2007). According to Kuh, Kinzie, Buckley, Bridges, & Hayek (2006), effective pedagogical practices include creating a student-centered learning environment, which promotes high expectations for students, raising academic standards, and emphasizing alternative ways of understanding mathematics. Hodara (2011) argues for greater student collaboration, and an emphasis on metacognition, or an awareness of one’s thought processes. Booth et al. (2013) conducted a survey of over 900 community college students from 13 California colleges and noted that students listed six affective factors as necessary for their success. Among the six affective factors for success, students said they want to feel valued, nurtured, and connected in the learning process.

The American Mathematics Association of Two Year Colleges Recommendations

The American Mathematics Association of Two Year Colleges created three sets of standards for mathematical understanding found in the Crossroads in Mathematics and Beyond Crossroads Mathematics. The goal of these documents is to improve mathematics education and to encourage more students to study mathematics. They are intended to stimulate faculty, departments, and institutions to examine, assess, and improve every component of mathematics education in the first two years of college (Blair, 2006).

Standards for Intellectual Development describes desired modes of student thinking and goals for student outcomes. All students should develop certain intellectual mathematical abilities as well as other competencies and knowledge. The eight Standards for Intellectual Development are presented below:

(1) problem solving, (2) modeling, (3) reasoning, (4) connecting with other disciplines, (5) communicating, (6) using technology, (7) developing mathematical power, and (8) linking multiple representations.

Students will learn mathematics through modeling real-world situations and developing convincing mathematical arguments. They need to read, write, listen to, and speak mathematics. Appropriate technology should be used to enhance their mathematical thinking and understanding and to solve mathematical problems and judge the reasonableness of their results. Students should use and translate among different mathematical representations–numerical, graphical, symbolic, and verbal–to organize information and solve problems using a variety of techniques (Blair, 2006).

Standards for Content outline guidelines for selecting the content that will be taught. The meaning and use of mathematical ideas should be emphasized and attention to rote manipulation de-emphasized:

(1) number sense, (2) symbolism and algebra, (3) geometry and measurement, (4) function sense, (5) continuous and discrete models, (6) data analysis, statistics, and probability, and (7) deductive proof.

Students will understand the use of algebraic symbolism, be able to translate problem situations into symbolic representations, and use those representations to solve problems. Students will demonstrate understanding of the concept of function–numerically, graphically, symbolically, and verbally–and incorporate this concept into their use of mathematics. Students will be able to recognize and use models to solve real-world problems. Students will collect, organize, analyze, and interpret data, and use that information to make informed decisions (Blair, 2006).

Standards for Pedagogy outline guidelines for instructional strategies in active student learning. Students should understand mathematics as opposed to performing memorized procedures. Knowledge cannot be "given" to students. Students should construct their own knowledge, and monitor and guide their own learning and thinking:

(1) teaching with technology, (2) active and interactive learning, (3) making connections, (4) using multiple strategies, and (5) experiencing mathematics

Mathematics faculty should model the use of appropriate technology in the teaching of mathematics so that students can benefit from the opportunities technology presents as a medium of instruction. Faculty should foster interactive learning through student writing, reading, speaking, and collaborative activities so that students can learn to work effectively in groups and communicate about mathematics both orally and in writing. Faculty should use multiple instructional strategies, such as interactive lecturing, presentations, guided discovery, teaching through questioning, and collaborative learning to help students learn mathematics (Blair, 2006).

Mastery Learning

Accelerating students through a long sequence of developmental math courses will require intense review of a wide range of material. It will require quality math instruction appealing to the student's cognitive and affective domain. Mastery learning, as a theoretical framework, requires an evaluation of these factors when assessing educational strategies. Developed by Benjamin Bloom, mastery learning primarily involves dividing the curriculum into components and assessing mastery of each component before proceeding to the subsequent unit (Bloom, 1968). In addition, master learning recommends an optimum approach to teaching utilizing the appropriate strategies to maximize the student's learning capacity. In other words, quality instruction includes any methods necessary for the individual student to learn. This offers a student-centered interpretation of quality instruction for the critical review of acceleration programs. According to Block and Burns (1976), the principle elements of mastery learning include subunit mastery, summative and formative assessments, collaborative group learning, self-paced learning, and cognitive as well affective outcomes.

Mastery learning reflects on two domains of learning that are inextricably intertwined: the cognitive domain pertains to mental knowledge and the affective domain pertains to emotional attitudes (Bloom, 1974; Block & Burns, 1976; Motamedi & Sumrall, 2000). Bloom (1974) elaborates on these two domains with taxonomies of educational learning objectives.

The cognitive taxonomy lists lower levels of learning such as simple knowledge of facts, and higher-order learning such as analysis, synthesis, and evaluation of information. The Affective taxonomy is a hierarchy of attitudes from the lower levels, tolerating new ideas, to the higher levels, valuing new ideas (Krathwohl, Bloom, & Masia, 1973; Redding, 2014). Though these taxonomies are not formal components of mastery learning, they clarify the concepts found in mastery learning. These cognitive and affective domain taxonomies allow for a broader assessment of accelerated program design systems.

Mastery learning is acclaimed in computer-aided instruction (CAI) programs that test student competencies and offer students immediate feedback and corrective measures. It has been strongly endorsed for instruction of remedial students (Kulik & Kulik, 1991), and is often referenced as a strategy in accelerating students through lengthy remedial courses sequences (Guskey, 1990). Mastery learning in CAI program is especially popular in developmental math programs that emphasize drill and practice for procedural mastery. According to Motamedi and

Sumrall (2000, p. 35), "Mastery learning and computer-assisted instruction provide a perfect match as schools become more reliant on technology." Computer aided instruction offers students self-paced mastery opportunities that evidence suggest may support learning (Kulik, Kulik, & Bangert-Drowns, 1990; Block & Burns, 1976). Squires, Faulkner, and Hite (2009) credited self-paced mastery learning techniques in Cleveland State Community College's developmental for creating an "atmosphere of continuous assessment" (p. 884).

Acceleration programs that integrate mastery learning with cooperative group instruction enhance the learning experience (Guskey, 1990). Slow learners no longer need to rely solely on the instructor for help; they benefit from high-quality, corrective assistance from their friends and classmates. Furthermore, programs that emphasize cooperative group work often emphasize constructivist, conceptual and problem-solving pedagogies. Motamedi and Sunrall (2000), recommend mastery learning, CAI and constructivist instruction as a powerful combination.

Mastery learning has served as an influential theoretical framework for BAM and GEA. It requires assessment of educational programs by cognitive and affective factors as essential for developmental math programs. In support of cognitive understanding, mastery learning has been identified as an effective instruction strategy for developmental courses (Bonham & Boylan, 2012; Boylan & Saxon, 1998; Roueche & Wheeler, 1973; Schwartz & Jenkins, 2007; Twigg, 2011); and Chickering (1987) refers to it as one of seven principles of good practice for educators to improve teaching and learning. However, developmental students greatly need affective support in their pursuit of a college education (Booth, Cooper, Karandjeff, Purnell, Schiorring & Willett, 2013; Hodara, 2011) and affect is an especially valuable factor in student success since motivation and perseverance are critical in intense acceleration programs (Booth, Cooper, Karandjeff, Purnell, Schiorring, & Willett, 2013; Hern & Snell, 2013). Many CAI programs focus on the mastery component in accelerating students while ignoring affective and quality instruction.

Affective Domain

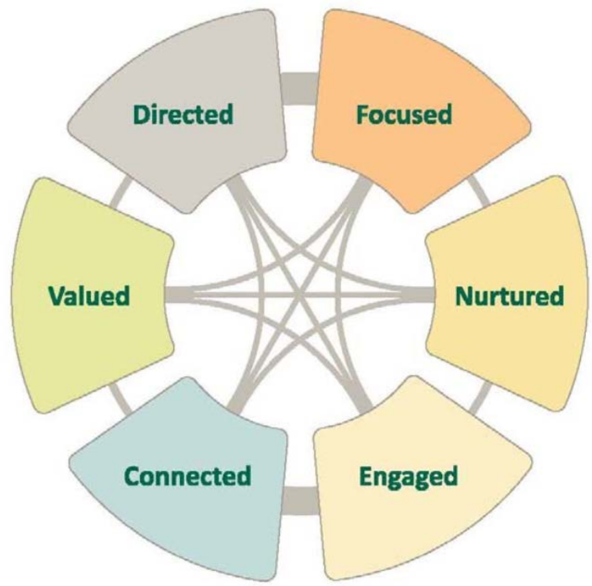
The RP Group is the research and planning affiliate of the California Community Colleges Chancellor's Office (CCCCO). The RP Group conducted a survey to ascertain what factors are most important to student success in California community colleges. Nearly 900 students, from13 California community colleges were asked what they think supports their educational success, paying special attention to the factors African Americans and Latinos cite as important to their achievement.

According to the Community College Research Center's (CCRC) 2011 Assessment of Evidence Series (Bailey, Jaggars & Jenkins, 2011) and a review of hundreds of studies on strategies designed to increase student success, two key findings emerged. Student support activities must be:

- Integrated into students' daily experience
- Included in the overall curriculum

When reviewed collectively, research indicates that students are more likely to succeed when: (1) they have a goal and a path leading to this goal, (2) they stay motivated to achieve this outcome, (3) they are engaged in the classroom, (4) they feel connected to the college community, (5) they believe that their success matters to others and (6) they feel they are contributing positively to the college culture and community. The RP Group summarized these factors as "directed," "focused," "nurtured," "engaged," "connected" and "valued" (Booth, 2013). These factors were redefined as:

- **Directed**: Students have a goal and know how to achieve it
- **Focused**: Students stay on track—keeping their eyes on the prize
- **Nurtured**: Students feel somebody wants and helps them to succeed
- **Engaged**: Students actively participate in class and extracurricular activities
- **Connected**: Students feel like they are part of the college community
- **Valued**: Students' skills, talents, abilities and experiences are recognized; they have opportunities to contribute on campus and feel their contributions are appreciated



It is recommended that these six success factors be integrated into developmental math courses curricula and incorporated in daily instruction.

BAM and GEA Design Elements "Putting Theory into Practice"

The design principles of BAM and GEA have are based on the recommendations of AMATYC and on the strategies of Mastery Learning theory from educational psychology, and align with the RP Group's recommendations.

- Students arrive with and can create greater capacity than we often acknowledge.
- Students do better with a greater number of structured contact hours.
- Students benefit when affective domain skills are addressed in the course.

- Students can develop strong arithmetic and algebra skills through activities that integrate both.
- Student learning is deeper and longer lasting when students engage with fewer topics at greater depth, within authentic and meaningful contexts, and using multiple mathematical representations.

In-depth activities that activate students' higher-order thinking are crucial for our students; through these experiences, students are learning how to learn and are reflecting on how that learning occurs (metacognition). At the same time, when they use their arithmetic and algebraic skills in these settings, students are more likely to see their value and internalize them. Since BAM and GEA students have online homework systems that allow students to master procedural skills outside of class, there is now space and time in which we (both students and instructors) can engage in activities that deepen critical thinking, communication, and affective domain skills.

Students, in their lives, will use their numeracy, algebra and mathematical reasoning skills most often in the context of making or understanding the decisions based on information (data and statistics). GEA is a course that focuses on the algebra techniques and critical thinking skills to fit the needs of the students learning how to pose questions about data and to interpret data in a way that is meaningful. Student use descriptive statistics as the primary application throughout the course, developing the algebraic and mathematical reasoning skills that are necessary to succeed in most transfer-level mathematics courses and which are important for a generally educated populace.

Widespread evidence suggests that curriculum that aligns with the guidelines described in this subsection result in greater student success, persistence, and progression. However, even though BAM and GEA were designed using the principles described, it is extremely difficult to put these into practice when instructors have limited knowledge and understanding of these ideas. How can instructors incorporate strategies they do not know about? The recommendations offered below will hopefully help create a community where the best practice guidelines described above become the general practice throughout all developmental mathematics courses. (The specifics of a recommendation are included only when the recommendation is first introduced and in the Recommendation Section.)

CMD Recommendation 2016A_– pay adjuncts for office hours, professional development and committee work

CMD Recommendation 2016D – materials for threads spanning multiple courses

CMD Recommendation 2016E – faculty development/best practices

CMD Recommendation 2016F – fulltime faculty hires for developmental math
Hire more fulltime faculty committed to designing, teaching, and assessing effective developmental mathematics. *(5* Modified 2012C.2, Research, SLO, Student Feedback, Staffing, *equity, progress to completion, Strategic Initiative B)*

CMD Recommendation 2016G – fulltime faculty participation in CMD
Have more fulltime instructors participate in Committee D work to effectively and thoroughly participate in SLO assessment, textbook selection, course review and program review. *(6* Research, SLO, Student Feedback, Staffing, *equity, progress to completion, Strategic Initiative B)*

3. MULTIPLE MEASURES ASSESSMENT PLACEMENT - AN EQUITY ISSUE

Ninety-two percent of community colleges use standardized assessment tests for placement into remedial education (Hughes & Scott-Clayton, 2011), and only 21% use anything other than the assessment test for mathematics (Fields & Parsad, 2012). This single exam is usually the only instrument to determine college readiness and can potentially require students to take four courses of remediation and greatly delay their achievement by years. The scores on these standardized assessment exams are not interpreted universally; a given score will place students into different levels of remediation for different community colleges. In correlation tests between assessment scores and success in transfer-level courses, there appears to be no correlation between the two (Belfield & Crosta, 2012). In other words, assessment tests are not good predictors of college success (Scott-Clayton, 2012). To make matter worse, Bailey et al. (2009) found 45% of White students were placed into developmental math, whereas 86% of African-American and 82% of Hispanic students were placed into developmental math. These studies suggest standardized assessment tests are ineffective at assessing college-level readiness and disproportionately place African-American and Hispanic students into the lowest levels of remediation. Reasons for this disparity cannot be solely due to deficient preparation in these groups, given how poorly these placement scores predict success.

ACCUPLACER is the current assessment test used at ECC to determine student readiness for college-level courses. ACCUPLACER suffers from all of the maladies of placement exams described above. When 68% of community college students are placed into at least one level of remediation, the potential impact of these policies is great.

Proper assessment of student capacity is critical for student success (Boylan et al. 1997), but the predictive value of ACCUPLACER is highly questionable. In correlation tests between placement test scores and success in transfer-level courses, there appears to be no correlation between the two (Belfield & Crosta, 2012). In other words, assessment tests are not good predictors of college success (Scott Clayton, 2012). What was discovered as a good predictor of college success was a student's overall high school grade point average (GPA), provided that GPA is less than ten years old. Belfield & Crosta (2012) found “the relationship between HS GPA and college GPA is so powerful that it would seem important for colleges to more fully consider this measure in deciding on placement” (pg. 39). Even when assessment scores were combined with the high school GPA to form a new metric, no addition to the predictive value was gained. The high school GPA is the single most important metric for making placement decisions. “Our results underscore the reality that it is difficult to predict who will succeed in college by any means: regardless of the screening tool we examine, one-fifth to one-third of students are likely to be severely misplaced. Yet among a set of feasible, if imperfect screening devices, high school transcript information is at least as useful as and often superior to placement test scores. In both math and English, using high school GPA/units alone as a placement screen results in fewer severe placement mistakes than using test scores alone (pg. 27). Our estimates suggest that one-quarter to one-third of students assigned to remediation could have earned a B or better had they been admitted directly to college-level work (pg. 28).” (Scott-Clayton, Crosta & Belfield, 2014).

Eboni Martin (2015), from the El Camino College Institutional Research Office, found African-American and Hispanic students were disproportionately placed into the lowest levels of remediation at El Camino College. Approximately 5% of African American students are placed into transfer-level math and 51% are placed into remediation. The math placement test disproportionately places African-American and Latino students into the lowest levels of remediation with very little chance to complete the program and achieve a transfer level course.

Using high school GPA as an alternative measurement for assessing and placement of students has been advocated by the Multiple Measures Assessment Project (MMAP) in collaboration with the Research and Planning Group for California Community Colleges (RP Group) and the California Community Colleges Chancellor’s Office (CCCCO). Multiple measures assessment will be integrated as a component of the California Assessment Initiative (CAI) in 2017, and the CAI will replace ACCUPLACER and COMPASS[1] as assessment tests.

Researchers working with the Multiple Measures Assessment Project (part of the statewide Common Assessment Initiative) are recommending a much more robust use of high school transcript information. They recommend a "disjunctive" approach, under which colleges provide multiple ways for students to qualify for a transfer-level course, such as through test scores OR key high school measures, whichever is higher (http://accelerationproject.org/Placement, 2016).

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[1] COMPASS is another standardized test used to determine college readiness from the American College Testing organization (ACT). “It was first created in 1983, but will be eliminated by the end of 2016. The test’s limitations in measuring college readiness was a factor in the decision, according Ed Colby, a spokesman for the nonprofit organization. Many adult students who place into remedial courses with Compass might be able to thrive in college-level courses after taking a brief refresher on academic material they haven’t seen for a while. The tests themselves weren’t as effective at determining readiness as we would like.’” - Inside Higher Education, Paul Fain June 18, 2015.

"Ever since the 1988 lawsuit brought by the Mexican American Legal Defense and Education Fund (MALDEF) against the California Community College Chancellor's Office (CCCCO), California's community colleges that employ an assessment test must also draw on other sources of information about students' academic potential when placing students into math and language arts coursework (CCCCO, 2011). These additional sources of information, commonly referred to as "multiple measures", may include writing samples, past educational experiences, attitudinal surveys, other distinct tests, interviews, self-reported GPA, completion of high school coursework, students' academic plans, and other, similar sources. The Academic Senate for California Community Colleges (ASCCC) recently reaffirmed the importance of multiple measures, passing a resolution in support of using multiple measures for placement (ASCCC, 2013). Moreover, an ASCCC task force concluded that —inclusion of multiple measures in our assessment processes is an important step toward improving the accuracy of placement processes (Grimes-Hillman, Holcroft, Fulks, Lee, & Smith, 2014, p. 7)."

Willett, Hayward, Nguyen, Newell, Bahr, Hetts, Lamoree, Sorey, and Duran, 2015

If these studies are true, then our assessment tests are poor predictors of success. If Latino and African-American students are disproportionately placed into the lowest levels of remediation, significantly decreasing their chances of achieving their education, then placement is a significant equity issue.

We recognize that placement is a complex process, the success of which depends on more than just a test score and high school records, but also on the conversation and connection that takes place between the student and a highly informed, compassionate counselor. Below are recommendations related to placement.

CMD Recommendation 2016H – redesign placement process using multiple measures/research
In light of the research that highlights the general ineffectiveness of placement exams and the inequities exacerbates among SEP-targeted populations, replace our current placement process with a multiple measure placement process using high school records and GPA, among other measures. *(23* Research, Curriculum, SLO, Student Feedback, *equity, progress toward completion, and student success, Strategic Initiative B)*

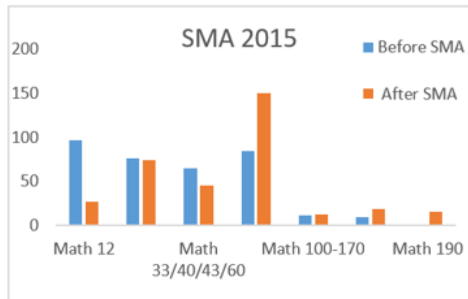
CMD Recommendation 2016I – improve information about multiple pathways
Conduct regular (once per semester) information drives about different pathways for different students. This needs to go to students, faculty and counselors. *(29* Research, Curriculum, Student Feedback, *equity, progress toward completion, Strategic Initiative B)*

4. Math Academies

The Summer Math Academy (SMA) has a long history of successfully preparing students to retake the ECC ACCUPLACER math assessment exam. Since 2008, the program has scaled up significantly. In 2015, 19 sections of SMA were offered with 263 students completing the program. The program now serves new incoming students as well as students currently enrolled in the college. Approximately 55% of new students and 63% of current students completing the academies successfully improved their math placement by at least one course. Presented below are the distributions of placements before and after SMA for the past two years.

2015 SMA	Before SMA	After SMA
Math 12	97	27
Math 23	76	74
Math 33/40/43/60	65	45
Math 73/80	85	150
Math 100-170	12	13
Math 180	9	19
Math 190		16
Total	344	344

218 students tested higher (63%)



2016 SMA	Before SMA	After SMA
Math 12	81	34
Math 23	81	56
Math 33/40/43/60	46	28
Math 73/80	61	130
Math 100-170	4	8
Math 180	4	12
Math 190		9
Total	277	277

151 students tested higher (55%)

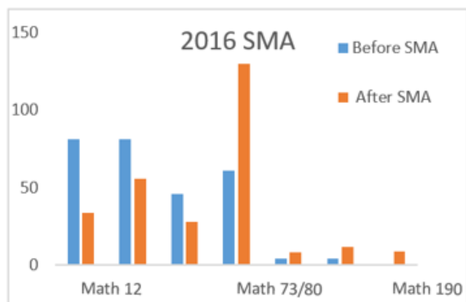


Figure 13: Summer Math Academy results 2015 & 2016

The success of the Summer Math Academy can be attributed to two factors: (1) the quality of instruction in the program, and (2) the weakness of ACCUPLACER as a predictive instrument of student success in college. With only three weeks of math review, 63% of the students who completed and took the placement test in the 2015 SMA placed at least one course higher. Furthermore, 75% of students in SMA 2015, Math 12 were placed at least one class higher; 66% of students in SMA 2015, Math 23 were placed at least one class higher. If a large majority of students are able to place higher after only three weeks of math review, it questions the validity of the ACCUPLACER assessment.

2015 SMA Level of Placement (n = 417)	No. Students	Percentage
Tested up one level	148	148/417 = 35%
Tested up two levels	99	99/417 = 24%
Tested up three levels	16	16/417= 4%
Total that Placed in Higher Math	263	63 %
Math 12, (4-Sections)	No. Students	
Completed and took Placement Test	79	
Placed in higher Math after took Placement Test	59 (75%)	
Math 23/40 (9-Sections)	No. Students	
Completed and took Placement Test	220	
Placed in higher Math after took Placement Test	147 (66%)	

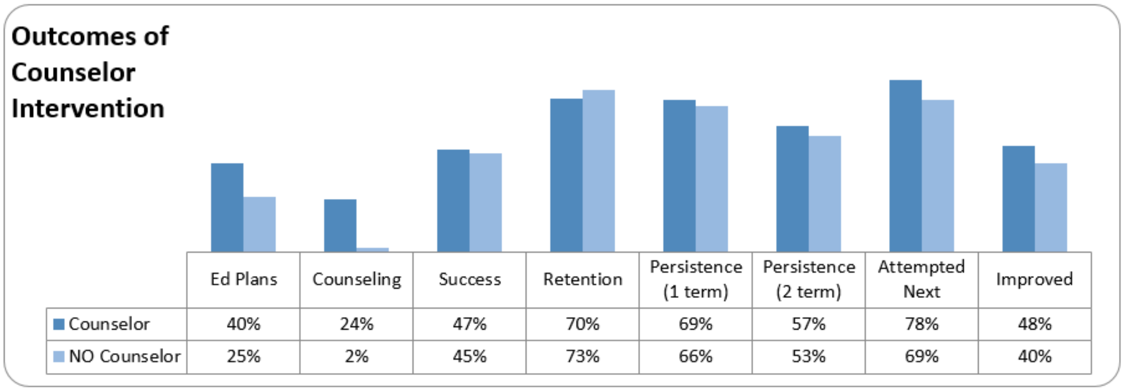
Table 5: Summer Math Academy results 2015

CMD Recommendation 2016J – expand effective programs, including math academies, SI, and counselor intervention
Continue and expand programs that have shown to be effective, particularly for SEP-targeted students and in sections of courses taught by adjunct instructors. In particular, we should expand Supplemental Instruction to include more sections of developmental mathematics. Expand counselor intervention should to increase persistence. Offer noncredit math academies (Math 17A, 27A, 47A) frequently during the entire year. *(25* Modified 2012B Research, Curriculum, Student Feedback, *equity, progress toward completion, Strategic Initiative B)*

5. EMBEDDED COUNSELING – THE OPPORTUNITY PROJECT (TOP)

The 2012 Embedded Counseling Study: Counselors embedded in a basic skills math course conduct 30 minute presentations every two weeks on topics related to student achievement. These topics include, but are not limited to financial aid, transfer information to a four-year university, on campus student support programs, and affective domain activities.

In 2012, several single-term, single-year, and multiple-year studies were conducted on the effect of embedded counselors in basic skills math courses. A few underlying patterns emerged from the various studies. Basic skills math classes with embedded counseling experience greater persistence and improvement rates than classrooms without embedded counseling. The data suggested students with education plans use it as a road map to accomplish their educational goals and are more likely to persist in their math education. This is an important issue for basic skills students facing a lengthy pathway to compete the developmental math program. Based on these results of embedded counseling was expanded for the courses in the lowest levels of remediation, Arithmetic (Math 12), Pre-Algebra (Math 23), and BAM (Math 37).



	Ed Plans	Counseling	Success	Retention	Persistence (1 term)	Persistence (2 term)	Attempted Next	Improved
Counselor	40%	24%	47%	70%	69%	57%	78%	48%
NO Counselor	25%	2%	45%	73%	66%	53%	69%	40%

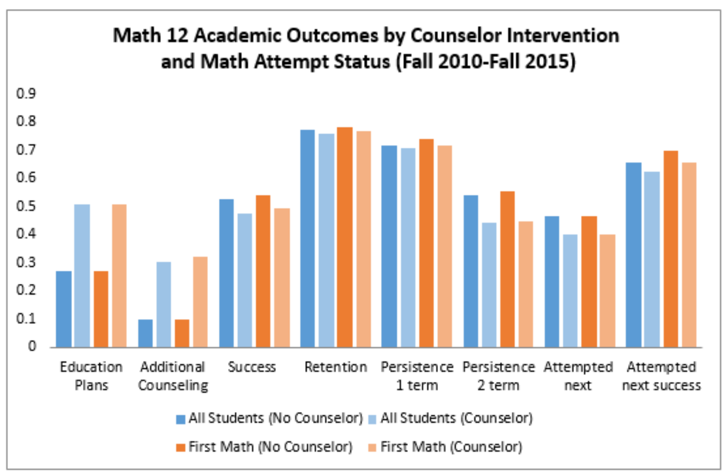
Figure 14: Comparing Arithmetic Sections with and without Counselor Intervention

The Opportunity Program

The Opportunity Program (TOP) coordinates the embedded counseling program in the math courses. A spring 2016 survey of 174 students participating in the embedded counseling program found 87% of the students agreed or strongly agreed that the information presented by counselor was helpful. Another 84% agreed or strongly agreed that the information presented by the counselor would help them achieve their educational goals. A majority of students identified transferring to a four-year university as their goal (73%), and 46% identified earning an Associate's degree as their primary educational goal.

The 2016 Embedded Counseling Study:

The ECC Institutional Research Office completed a 2016 a study on the embedded counseling program for Fall 2010 – Fall 2015. The study compared students that participated in embedded counseling with students that did not for the categories: all students, and students taking the math course for the first time.



Group	Education Plans	Counseling	Success	Retention	Persistence 1 term	Persistence 2 term	Attempted next	Attempted next success
All Students (No Counselor)	27%	10%	53%	77%	72%	54%	47%	66%
All Students (Counselor)	51%	30%	48%	76%	71%	44%	40%	63%
First Math (No Counselor)	27%	10%	54%	78%	74%	56%	47%	70%
First Math (Counselor)	51%	32%	50%	77%	72%	45%	40%	66%

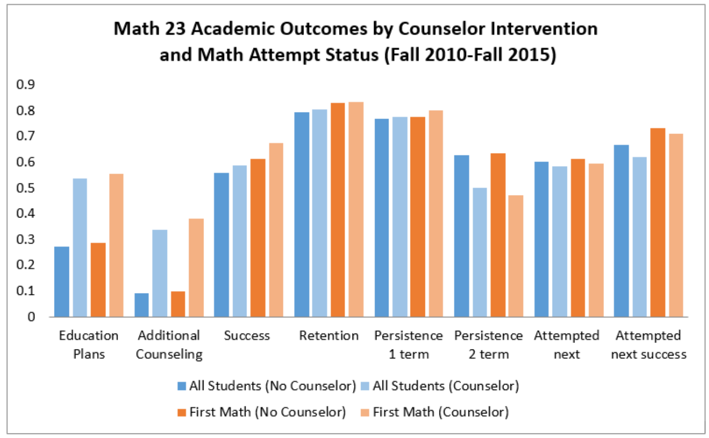
Figure 15: 2016 Embedded Counseling (Math 12)

Math 12:

For Math 12, embedded counseling had strong positive effects in increasing education plans and seeking additional counseling, for all students and first time math students. The results also showed small to moderate negative effects in success, retention, persistence, and attempted next math class or passing the next math class.

Math 23:

For Math 23, embedded counseling had a strong positive effect for increasing education plans and for students seeking additional counseling. It had a small, positive effect on success, retention, and persistence in one term for all students and students taking the math course for the first time. The results showed small to moderate negative effects in persistence over two terms, attempted next math class, and passed the next math class.

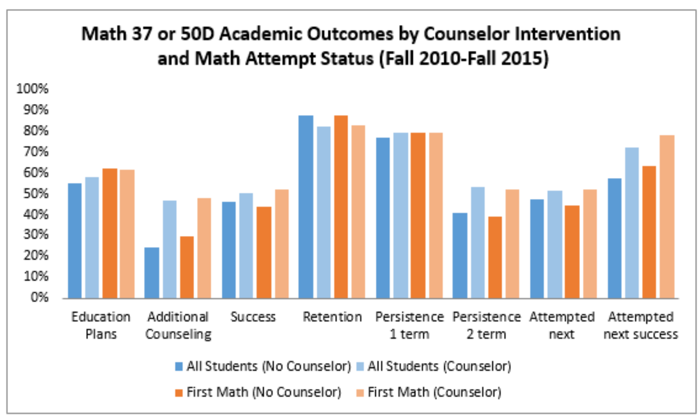


Group	Education Plans	Counseling	Success	Retention	Persistence 1 term	Persistence 2 term	Attempted next	Attempted next success
All Students (No Counselor)	27%	9%	56%	79%	77%	63%	60%	67%
All Students (Counselor)	54%	34%	59%	81%	78%	50%	58%	62%
First Math (No Counselor)	29%	10%	61%	83%	78%	64%	61%	73%
First Math (Counselor)	56%	38%	67%	83%	80%	47%	60%	71%

Figure 16: 2016 Embedded Counseling (Math 23)

Math 37:

For Math 37, embedded counseling had a positive effect for increasing education plans, students seeking additional counseling, success, retention, persistence in one term, persistence in two terms, attempted next math class, and success in the next math class for all students and students taking the math course for the first time. The results showed negative effect in retention.



Group	Education Plans	Counseling	Success	Retention	Persistence 1 term	Persistence 2 term	Attempted next	Attempted next success
All Students (No Counselor)	55%	25%	46%	87%	77%	41%	47%	57%
All Students (Counselor)	58%	47%	50%	82%	79%	53%	52%	72%
First Math (No Counselor)	62%	30%	44%	87%	79%	39%	44%	63%
First Math (Counselor)	61%	48%	52%	83%	79%	52%	52%	78%

Figure 17: 2016 Embedded Counseling Study (Math 37)

The results are mixed. In 2012, embedded counseling was a volunteer program. Instructors volunteered to participate in the program: these instructors were generally full-time instructors, who valued educational plans because they help students progress through a lengthy developmental math program. The counselors were often full time counselors in the early days of the program. As the program scaled up, the counselors have used more part-time counselors. It is interesting to note the study finds embedded counseling to be generally unsuccessful in Math 12, partially successful in Math 23, and generally successful in Math 37 (BAM). Part of the success in Math 37

(BAM) might be explained by the fact that, with its multiple exit levels, instructors emphasize the importance for students to have an educational plan.

CMD Recommendation 2016J – expand effective programs, including math academies, SI, and counselor intervention

6. ECC Developmental Math Committee – Evidence of Efficacy

Improving Completion Rates:

Presented below are two-year developmental completion rates for students placing three or four levels below transfer, starting with Spring 2009 (based on the Basic Skills Progress Tracker on the CCCCO Data Mart). We certainly see a pleasing upward trend in the last several years. During this time, we introduced a number of interventions.

- Summer Math Academy started in 2008 with Basic Skills funding and has been scaled up since.
- A second version of intermediate algebra (Math 73) was introduced for general education students in 2009.
- BAM was introduced in 2011.
- GEA was introduced in 2012.
- Supplemental Instruction started receiving general funds in 2011 and expanded their program in developmental mathematics with support from Basic Skills funding.

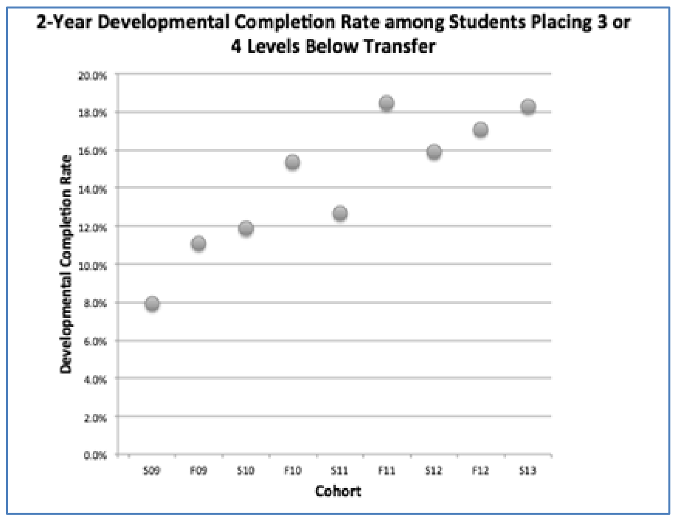


Figure 18: Completion rates 2009 - 2013

Correlation does not imply causation; isolating the cause of our improving completion rates in the program overall is difficult. The big picture at least suggests the possibility of some positive effect from our efforts.

The Institutional Effectiveness Report

The Institutional Research Office published ECC Institutional Effectiveness Outcomes report for 2015-2015. The results were very encouraging. Among 14 metrics to assess the college's efficacy, only remedial math completion achieved the 2019-2020 goals. The 2019-2020 goal is for 29.6% of students starting math in remediation will complete a transfer level course within six years. In 2012-13 the math department rating was 26.9%, in 2014-15 the rating was 30.4% (see Figure 19 on the next page).

Although we have made progress in transforming our program into one that improves its quality guided by evidence and research, we have far to go. As the scope and nature of our program shifts over the next several years, we offer a few additional research-related recommendations, suggesting ways of increasing our capacity for research, some new directions for research and some management suggestions.

El Camino College
Institutional Effectiveness Outcomes 2014-2015

Achievement Measure	2012-13 Baseline	2014-15	On Target With Goal	2019-2020 Goal
Readiness				
Student Readiness Rate (Completion of Orientation, Assessment, and Education Plan)	N/A	54.8% Fall 2015	☐	100.0%
Progress				
Successful Course Completion Rate	70.2%	68.8%	☐	73.7%
Remedial Writing Completion Rate	49.4%	51.5%	☑	54.3%
Remedial Math Completion Rate	26.9%	30.4%	☑	29.6% ★
Three-Term Persistence Rate	68.7%	72.0%	☑	72.1%
30-Units Achievement Rate	66.0%	68.3%	☑	69.3%
Completion				
Degrees Awarded	2,029	1,977	☐	2,232
Certificates Awarded	599	410	☐	659
Number of Transfers	1,437	1,478	☑	1,509
Overall Completion Rate	48.5%	48.9%	☑	50.9%
Prepared Completion Rate	73.8%	71.9%	☐	78.0%
Unprepared Completion Rate	39.0%	39.1%	☑	40.1%
Transfer Rate	39.1%	Coming Soon	☐	41.1%
Career Technical Education (CTE) Completion Rate	57.3%	58.4%	☑	60.2%

Board Policy 1200 March 2016

Figure 19: Institutional Effectiveness Report 2015

Research-Related Recommendations

Recommendations 4, 24, 30, 32

CMD Recommendation 2016K_– program coordinator

Hire a coordinator to manage developmental mathematics; to coordinate noncredit, adult education pathways, and high school dual enrollment programs (as they develop). Duties may include assisting with the hiring and training of noncredit instructors, coordinating professional development for adult education and dual enrollment instructors; administering the noncredit mathematics program; class schedules and teaching assignments; facilitating faculty course cohorts; mentoring and evaluating instructors; coordinating course reviews and program reviews; researching program effectiveness; supervising SLO assessments and reports; reviewing program technology and facility needs; organizing professional development; applying for external funding and managing grants. *(4* Modified 2012B.1, Research, SLO, Staffing, *instructional support, institutional effectiveness, Strategic Initiatives B and E)*

CMD Recommendation 2016L – expand our research capacity

Expand our research capacity at both the college and department level in order to obtain the data we need to make good decisions. In particular, we need the ability to measure how changes to curriculum and pedagogy affect learning and student attitude; to survey students and instructors for course reviews; and capture student voices and student input. *(24* Research, SLO, Student Feedback, *equity, instructional support, institutional effectiveness, Strategic Initiatives B and E)*

CMD Recommendation 2016M – student advisory group

Create/recruit a sustainable Developmental Mathematics Student Equity Advisory Student Group with students from such groups on campus as ASO, EOPS, KEAS, Project Success, Puente, and FYE. Students would work with Committee D to create research questions and gather data for developmental mathematics program review, particularly related to student equity, but also to help the committee with SLO assessment review and course review. *(30,* Research, Curriculum, SLO, Student Feedback, *equity, learning support, instructional effectiveness, Strategic Initiatives B and E)*

CMD Recommendation 2016N – access to transfer-level courses
Conduct research into students' access to transfer-level courses, in particular Math 120, 130, 150, and 170. Plan a general education math "catch-up year" for Math 120 and Math 150 sections based on research results. Offer more Math 150 sections in various formats, including hybrid, large lecture sections, weekend classes, at least on a temporary basis, in order to catch up with demand. *(equity, progress toward completion, and student success, Strategic Initiatives B and E)*

Annotated Bibliography

Bailey, T. (2009). Challenge and opportunity: Rethinking the role and function of developmental education in community college. *New Directions for Community Colleges*, 2009, vol. 145, pp. 11-30.

Bailey tracked underprepared students using longitudinal data sets from the National Education Longitudinal Study (NELS) and an Achieving the Dream Study from the Lumina Foundation. He advocates for a broad developmental education reform agenda which includes: better placement policies, accelerated structural reform of long course sequences, and wrap-around support services for students. He contends that there is no clear consensus about how to carry out developmental education effectively because of the wide variety of pedagogical methods, educational structures, and student attributes which makes statistical controls difficult. He described the failure of long developmental math sequences. Recommendations are given for reform and for further research.

Edgecombe, N. D. (2011). Accelerating the academic achievement of students referred to developmental education. (Working Paper No. 40). Columbia University Academic Commons, http://hdl.handle.net/10022/AC:P:13142.

Nikki Edgecombe reviews the literature on acceleration and categorizes the many different acceleration models across the nation. She finds that long developmental math sequences with multiple exit points are harmful to students. She defines several models of acceleration as: course-restructuring models (compressed course, paired courses, curricular redesign), mainstreaming models (with supplemental support, basic skills integration). Results from the two aforementioned models are reviewed. She notes that while reducing the number of exit points is valuable, "it diverts attention from pedagogy, a dimension that is critical." Edgecombe continue to emphasize the opportunity to redesign pedagogical practices as structural revisions are made. Recommendations to policy, assessment and placement, faculty resistance, and financial sustainability are discussed.

Jaggars, S. S., Hodara, M., Cho, S. W., & Xu, D. (2015). Three Accelerated Developmental Education Programs Features, Student Outcomes, and Implications. *Community College Review*, *43*(1), 3-26.

This quantitative study examined three acceleration programs, two in English and one in math. Control groups are used in this study. The author notes that most although most studies on acceleration have

posted positive results, most did not use a control groups, not measure pre-existing characteristics of the students in the groups. The acceleration programs Jaggers studies are: FastStart Math at Community College of Denver, Reading/Writing Acceleration at Chabot College, and Accelerated Learning Program at the Community College of Baltimore County. Jaggers' study focused on gatekeeper performance, college level credit accrual, underprepared students and found that accelerated students were more likely to complete a college level course. The results suggest that "supported acceleration" program work best. This study will greatly inform my own dissertation, and serve as a good model.

Logue, A. W., Watanabe-Rose, M., & Douglas, D. (2016). Should Students Assessed as Needing Remedial Mathematics Take College-Level Quantitative Courses Instead? A Randomized Controlled Trial. *Educational Evaluation and Policy Analysis*, *38*(3), 578-598.

Many college students never take, or do not pass, required remedial mathematics courses theorized to increase college-level performance. Some colleges and states are therefore instituting policies allowing students to take college-level courses without first taking remedial courses. However, no experiments have compared the effectiveness of these approaches, and other data are mixed. We randomly assigned 907 students to (a) remedial elementary algebra, (b) that course with workshops, or (c) college-level statistics with workshops (corequisite remediation). Students assigned to statistics passed at a rate 16 percentage points higher than those assigned to algebra ($p < .001$), and subsequently accumulated more credits. A majority of enrolled statistics students passed. Policies allowing students to take college-level instead of remedial quantitative courses can increase student success.

Grubb, W. N. (2010). The Quandaries of Basic Skills in Community Colleges: Views from the Classroom. An NCPR Working Paper. *National Center for Postsecondary Research*.

This paper presents preliminary findings from observations in 13 California community colleges. The clearest finding is that "remedial pedagogy" predominates — this is a pedagogy involving drill and practice on small sub-skills, stressing correct answers rather than conceptual understanding, with very little contextualization.

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III. Developmental Mathematics Curriculum

History

The developmental mathematics curriculum at El Camino College has seen many changes in the forty years since the first three-course pre-transfer mathematics course sequence was established in 1977:

(Self-Paced) Arithmetic → Elementary Algebra → Intermediate Algebra → …

No new courses were introduced until 1988, when a two-unit pre-algebra review was inserted into the sequence in response to the low pass rate of successful arithmetic students in elementary algebra. Six years later, a four-unit pre-algebra course was introduced that included group work activities for students. Over the next decade, the four-unit pre-algebra course slowly replaced the two-unit pre-algebra. By the year 2000, our developmental mathematics sequence fit the standard four-course sequence seen at many California community colleges. While we fidgeted a bit over the best structure for our arithmetic course and even created a two-course slowed down version of elementary algebra, most students were placed somewhere in the four-course sequence

Arithmetic → Pre-Algebra → Elementary Algebra → Intermediate Algebra → …

and from that point on, tried to complete intermediate algebra and then (at least for most) tried to complete at least one transfer-level mathematics courses. In addition to this sequence, we also have had a geometry course that was at its time of origin, closely aligned with high school geometry.

In anticipation of the change in the associate degree mathematics requirement, we introduced two versions of intermediate algebra in 2009, one for general education students and one for STEM and business students.

All of these courses were created with the intention of helping students succeed. But we now know that students who find themselves in long sequences of courses are highly unlikely ever to finish developmental mathematics, let alone a transfer-level mathematics course. This phenomenon is now well known as the pipeline problem. In Table 6 below, we examine the fall 2009 cohort after three years and again after six years, using the Chancellor's Office Basic Skills Cohort Tracker. (We focus only students in the cohort who started in one of the four standard developmental courses and we omit students who started in the two-semester version of elementary algebra.) The pattern is clear: the longer the sequence to transfer, the more unlikely it is for a student to complete. It is not pleasant to acknowledge, but after six years, 49% of this cohort had not completed developmental mathematics at El Camino College.

		F09 3-Year Tracking/6-Year Tracking		Students not completing developmental mathematics in six years
	N	Developmental Completion Rate	Transfer-Level Completion Rate	
Arithmetic (Math 12)	884	10%/17%	3%/8%	83%
Pre-Algebra (Math 23)	547	24%/32%	9%/17%	68%
Elementary Algebra (Math 40)	370	45%/47%	23%/30%	53%
Intermediate Algebra (Math 73)	1168	77%/78%	42%/47%	22%
Intermediate Algebra (Math 80)	356	78%/80%	52%/60%	20%
Totals	3325			49% (1629)

Table 6

In order for more students to succeed, one obvious strategy is to improve the success rates in each course, but we know there is a multiplicative effect at each stage. Even if we were able to achieve a 70% success rates in all of these classes with 100% persistence to the next course, still only about a fourth of students starting four levels below travel would complete developmental mathematics after two years. Naturally, we would be thrilled with this result, of course, but how could we achieve this?

Improving Student Success

In a 2010 ECC IR study, "Do Differences in Elementary Algebra Sections Affect Success in Intermediate Algebra?", the only curricular changes that increased student success in significant, measurable and lasting ways occurred in those courses where we shifted the instructional methods away from lecture toward more active learning, increased student time-on-task, and in courses where we adjusted the content to increase the depth of students' experience with each topic. Pre-Algebra, in which group work was incorporated into the course outline of record, consistently reveals the highest individual success rate among the developmental courses (averaging around 60% compared to elementary algebra, with a success rate that averages about 45%). Creating Intermediate Algebra for General Education (Math 73) increased the success rate slightly in both intermediate algebra courses, at least initially.

Shifting Teaching Methods

In the past twelve years, we have encouraged the use of more active learning and student-centered teaching in a number of ways. Faculty cohorts, which are groups of faculty teaching sections of the same course, who have made a commitment to work together to create student-centered activities, began in 2004 and continued robustly through 2011. At one time or another, there was a faculty cohort for all developmental mathematics courses (except geometry), as well as for trigonometry, precalculus, and statistics. With the support of the Math Title V Cooperative Grant with Santa Monica College (2006 – 2011), there were semesters with six or seven active faculty cohorts in play. Both adjunct and fulltime faculty participated.

With the introduction of the Basic Skills Initiative, we were able to offer workshop series to explore best teaching practices. although we have not been able to do so for a number of years now, our new Basic Skills and Student Outcomes Transformation Grant will allow us to offer these again, this time with equity-minded and culturally-relevant teaching methods included. To that effect, the following two recommendations are offered, both of which were described in greater detail earlier:

> **CMD Recommendation 2016D – materials for threads spanning multiple courses**
>
> **CMD Recommendation 2016E – faculty development/best practices**

Academic and Student Support Interventions

For many of our courses, we offer Supplemental Instruction and in courses for students placing three or four levels below transfer, we offer counselor intervention, now called The Opportunity Project (TOP). Supplemental Instruction has a proven track record of supporting student success and TOP increases student persistence over all. Both should be expanded, particularly for students whose first mathematics course is only one or two levels below transfer.

> **CMD Recommendation 2016J – expand effective programs, including math academies, SI, and counselor intervention**

However, while all of these curricular and pedagogical reforms and student support interventions are likely to have some limited positive impact on the developmental program overall, really moving the needle on cohort completion rates requires larger, structural changes.

Shortening the Pipeline: Basic Accelerated Mathematics (BAM) and General Education Algebra (GEA)

We decided to shorten the pipeline. We created a developmental mathematics pathway that allows students to reach a transfer-level mathematics courses within two semesters. For students placing below the elementary-algebra level, BAM provides a pathway to a course that is one level below transfer (GEA or intermediate algebra). For students ready for elementary algebra, GEA offers a one-semester alternative to the two-semester elementary/intermediate algebra sequence. Students completing GEA may take any entry-level transferable mathematics courses except college algebra or trigonometry. The elementary/intermediate algebra sequence is the pathway for students considering a STEM (or Business) major. Students that place at the intermediate algebra level will take GEA or intermediate algebra, depending on their education plans. (See Figure 19 below.)

Basic Accelerated Mathematics (BAM) is a pass/no pass, degree-applicable, five credit-unit version of elementary algebra, in which students gain the arithmetic and algebra competencies needed for success in a course one level below transfer after one semester of work. This course is recommended for all ECC students who place below the elementary algebra level. Students and instructors spend four hours a week in a classroom, where we engage with activities that promote problem solving skills, conceptual understanding, critical thinking skills, and affective learning. Students also spend four hours a week in a computer laboratory, in which students use a self-paced, mastery-learning online program designed to reinforce procedural knowledge. The course has three levels, which students encounter in a blended fashion. Level A tackles arithmetic skills and includes a quantitative reasoning project. Level B covers basic algebraic concepts and graphing in the context of studying linear functions. Level B culminates with a linear modeling project. Level C addresses the remaining topics from a typical elementary algebra course.

General Education Algebra (GEA) is a graded, degree-applicable, four credit-unit course, which fuses a range of elements of algebra from the elementary and intermediate level. Concepts are presented in a contextualized manner, which allows students to achieve understanding of mathematics as relevant to their varied disciplines. GEA is intended for students who place into elementary algebra and prepares them for the general education transfer-level mathematics courses: Nature of Mathematics - Math 120, Finite Mathematics-Math 140, Elementary Statistics with Probability - Math 150, and the Mathematics for Future Teachers courses (Math 110, Math 111, and Math 115). GEA attempts to modify the curriculum and transform the relationship between the instructor and the student, addressing the basic skills content as well as prepare students for success in college.

First, algebraic concepts are introduced in context, using real-world applications, often using real data. Students work on group activities with intermittent mini-lectures in a regular classroom to develop better conceptual understanding of algebra as well as awareness of the use of mathematics in everyday life. Second, students work in a computer classroom to further these ideas as well as working on basic procedural skills. Finally, students are introduced to a variety of strategies for success, which provide non-academic skills that are necessary for academic success. Figure 19 gives an overview of how these new courses fit the overall developmental mathematics program.

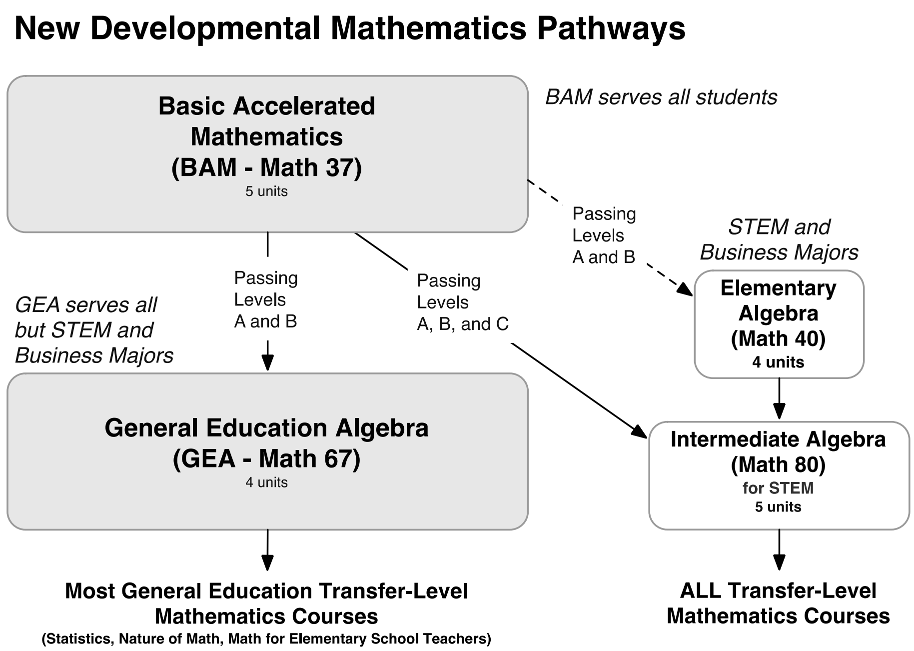

Figure 19

For an analysis of the effectiveness of these two courses and the pathways they help create, please see the detailed discussion in the Research section.

Course Offerings and Schedules

Integrating BAM and GEA into our developmental mathematics course offerings has shed some additional light on the problem of how to decide how many sections of which courses to offer each semester. Currently for each semester, our dean rolls over the schedule from the year before and makes adjustments from there based on some evidence from the previous year and through consultation with the departments' committees, but little else. The result is a new schedule that may fix the problems that arose a year ago, but which is unlikely to address problems that will appear the next time around. Soon, the college will have a database of students' educational plans. We hope these will be used to inform future course offerings and schedules.

Using educational plans for scheduling will only work if the educational plans represent the most appropriate pathways for each student. Before the introduction of BAM and GEA, there was essentially one pathway; now, there are many. More information needs to be disseminated every semester about which pathway is best for which students, based on their major. Every semester we find students who are not STEM and not studying business, but enrolled in elementary or intermediate algebra. Many of these students could be re-directed to GEA. Misinformation about Math 37 and Math 67 persists. Namely, that these are multiple courses in one semester that go through the material at a very fast pace and are therefore not appropriate for all students. Work should be done to ensure students, counselors, and mathematics instructors understand the various pathways.

CMD Recommendation 2016C - scheduling based on education plans and research

CMD Recommendation 2016I – improve information about multiple pathways

Course Creation and Review Procedures

Full-time and adjunct instructors from both the Torrance Campus and the Compton Center review the developmental mathematics programs on a regular, six-year cycle. Figure 20 presents the review schedule for courses in the Developmental Mathematics Program.

Course	Last Course Review	YEAR 1		YEAR 2		YEAR 3		YEAR 4		YEAR 5		YEAR 6	
		FA 12	SP 13	FA 13	SP 14	FA 14	SP 15	FA 15	SP 16	FA 16	SP 17	FA 17	SP 18
Math - Developmental		P							P	P			
MATH-100	2007-2008					X							
MATH-10A	2009-2010	I											
MATH-10B	2009-2010	I											
MATH-12	2007-2008							X					
MATH-23	2007-2008		X										
MATH-25	2006-2007		X										
MATH-33	2011-2012												X
MATH-50D/37	2010-2011	X											
MATH-40	2011-2012												X
MATH-43	2011-2012												X
MATH-60	2007-2008				X								
MATH-50C/67	2010-2011	X											
MATH-73	2008-2009	X											
MATH-80	2008-2009							X					

Figure 20: Six-year Course Review Cycle

Our course review process is extensive and designed to include multiple voices. The process starts at the program committee level, which is made up of faculty who generally teach these developmental mathematics courses. The committee often begins by doing some research, including student success numbers; surveys of instructors teaching the course and instructors teaching subsequent courses; results of student learning assessments; and comparisons of the course with similar courses at other colleges. The committee then reviews the course outline of record for clarity; determines if all topics are still relevant and appropriate for the course and makes other adjustments, such as updating the representative textbook. Course reviews then undergo technical review by the Division Curriculum Committee (DCC) and are presented to the entire department for final approval. We contend that this process allows for a thorough investigation of each course and continual improvement of its content and instruction. New courses are also subjected to a detailed design and approval process.

We would like to further enhance our course design and review processes. We would like the ability to conduct more research than we are currently able, particularly on how changes to curriculum and pedagogical approaches affect student learning and attitudes. One area where we still need work is incorporating student voices more systematically and directly into our decision-making. We would like to expand our capacity to gather information directly from our students and our instructors, in the form of surveys or focus groups. Gathering more information in multiple ways will help guide us in assessing the effectiveness of various endeavors.

CMD Recommendation 2016L – expand our research capacity

CMD Recommendation 2016M – student advisory group

Other Curricular Developments on the Horizon

1. Gateways to Engineering

Gateways to Engineering is a pathway created to help students ready for intermediate algebra move from to calculus in one year's time. Students take Intermediate Algebra and Geometry concurrently the first semester and then Trigonometry and Pre-Calculus concurrently the second semester. The purpose of creating accelerated pathways is two-fold: to help students move more efficiently through the Science Technology Engineering and Mathematics (STEM) major required courses and to address retention and persistence issues for students seeking STEM major based careers. Similar to the pipeline problem described above. There is a stated statewide concern about the large proportion of students who express an interest in a STEM major, but who test into the developmental math level are not persisting to the transfer level. This program crosses over between the developmental committee (CM D) and the committee that deals with the transfer level STEM courses (CM 1). Intermediate Algebra and Geometry are under the purview of Committee D.

This program began Fall 2015 with a single cohort of 33 students enrolled in Math 80 and Math 60. Of the 33 students 18 (60%) passed both Geometry and Intermediate Algebra. In Spring 2016 the paired Trigonometry and Pre-Calculus classes again had an enrollment of 33 students (some from the previous semester; some new students). The sample size is currently too small to make any analysis of the program. We will need to wait for further data as we continue the program and in the next program review re-analyze the pathway's success rates.

Gateways to Engineering currently requires students to enroll concurrently in two courses for each of the two semesters. Concurrent enrollment is a cumbersome approach to acceleration, requiring students to take more credit units than needed to become proficient with the material. Not all content from geometry is necessary for future calculus students, and there is quite a bit of overlap of content among intermediate algebra, trigonometry and precalculus. We need to investigate and experiment with a two-course pathway that still prepares these students for calculus in two semesters. The first course, GTE 1, would integrate appropriate elements of Geometry and all of Intermediate Algebra into ONE course to eliminate concurrent enrollment in two courses. Trigonometry and Pre-Calculus would be integrated into ONE course as GTE 2. These two single courses would also provide the advantage of having students work with only one instructor per semester and having the coursework offered cohesively without unnecessary overlap of instruction.

> **CMD Recommendation 2016O – new GTE course**
> Investigate possibilities of a two-semester pathway from elementary algebra to calculus. For CMD, this would mean developing an integrated algebra/geometry course that would serve as a prerequisite for an integrated trigonometry/precalculus course. *(18* Curriculum, *equity, progress toward completion, Strategic Initiative B)*

2. Noncredit Courses and Programs – An Opportunity to Accelerate Student Success

The new enhanced funding available for noncredit courses that a part of an approved noncredit programs opens areas of possibilities for creating pathways from high schools or adult education schools, as well as offering students with weaker placement data noncredit corequisite courses that might make it possible to succeed (with support) in a higher level course. For example, a student who needs statistics as her transfer-level course, but who whose placement data puts her near or just below the normal cut score for statistics, might be admitted to statistics if she also signs up for a noncredit basic skills support course. Already, noncredit ESL for math courses are in the curriculum creation process. Similarly, students in adult education transitioning to the community college may complete a three course noncredit set of courses to prepare them for our placement process, culminating in the appropriate noncredit Math Academy.

CMD Recommendation – noncredit and corequisite courses
Investigate and create a certificate program of noncredit mathematics courses that could function in several ways, including as co-requisites for credit courses such as math 120 and math 150, or as part of an adult education pathway (AB86). *(16,* Curriculum, *equity, progress toward completion, student success, Strategic Initiative B)*

CMD Recommendation 2016Q – new pathways with co-requisite support
Investigate possibilities of one-semester or two-semester pathways to completion of a transfer-level course. This might be creating sections of intermediate algebra with a co-requisite or creating co-requisite courses for math 120 and math 150. *(17,* Curriculum *equity, progress toward completion, Strategic Initiative B)*

3. Competency and Challenge Tests:

The yet-to-be-released Common Assessment Instrument, when it does appear, may or may not make an appropriate mathematics competency exam for the associate degree mathematics requirement. Even if a suitable way to use this new instrument is found, it will need to undergo a normalizing process. We also need to revisit our other prerequisite challenge tests and normalize them as well.

CMD Recommendation 2016R_ – normalize competency and challenge tests Norm our associate degree math competency test and all other challenge tests. *(21* Curriculum, *compliance with Title 5 regulations, equity, progress toward completion, Strategic Initiative B)*

IV. Assessment of Student Learning (SLOs)

Assessment and Student and Program Learning Outcomes (SLOs & PLOs)

In a typical year, the Developmental Mathematics Program offers roughly 335 sections (65-70% of the sections offered by the department) and serves roughly 5200 students each semester (15.8% of the student population). Adjunct instructors teach roughly 65-70% of all developmental mathematics course sections. Our committee is composed of 16 fulltime instructors who are responsible for coordinating student learning outcome assessments for eight courses (as well as all other overview work, such as course review, textbook selection, and program review). We are convinced of the value of the systematic course and program learning outcome assessments, but the burden of conducting new assessments every semester is becoming a bit overwhelming. We find ourselves assessing our courses and programs only to meet deadlines and rarely have the time and resources to reflect and share our information with faculty in more than a perfunctory manner that just barely meets the ACCJC standards for proficiency. Without a larger team of administrators, instructors, and students committed to the Development Mathematics Program, it is doubtful that many lessons we may learn in our assessment cycles will ever be widely disseminated and adopted. While it is recommended that we hire more fulltime faculty whose main interests and talents lie in developmental mathematics and while it is possible to increase the number of fulltime instructors actively engaged in the program, what would be most useful is to leverage the energy and experience of adjunct instructors. The recommendation below was described in detail earlier.

CMD Recommendation 2016G – fulltime faculty participation in CMD

The most important lesson we have learned in the last four years of assessment cycles is the necessity of an assessment infrastructure designed with our adjunct instructors in mind. Resources and time must be devoted to the training and the support of our part-time faculty in every aspect of student learning outcome assessment; without their active participation, we cannot say with a great deal of confidence whether or not we are truly reaching our learning outcome goals. While we cannot responsibly ask our adjuncts to take on the planning and leadership role on these assessments without remuneration, we need to find ways of encouraging broader and more meaningful participation in learning assessments and reflection. Our current system is rather hit-and-miss and seems focused on the willing participants.

CMD Recommendation 2016A – pay adjuncts for office hours, professional development and committee work

CMD Recommendation 2016B - course coordinators

CMD Recommendation 2016F – fulltime faculty hires for developmental math

Each of our eight courses has four student learning outcomes, which are aligned with our four program SLOs. All outcomes have been assessed at least once, and the results have indicated a few concerns that we have tried to address. However, the assessment process has not been cost-effective; the very modest changes we have tried to make in our teaching in response to our assessments do not justify the time and effort needed to conduct the assessments, using our current methods. Based on broader measures of the success of our program i.e. the cohort completion rates, we believe that the Developmental Mathematics Program has major structural and curricular issues that need our energy at this time.

We plan to develop a standard outcome assessment instrument for each course that will be used to assess student learning for all course SLOs every semester. We will continue to focus on one program SLO assessment each semester, but we will be able to use data from multiple semesters. This will allow us to do a better job of long-term tracking of student learning, as well as faculty participation.

Despite our plan to reshape our assessment process, the Developmental Mathematics Program has attained the *proficiency* level for SLOs and Assessments, using the ACCJC rubric. Our justifications are detailed below, using the ACCJC Rubric for SLO Proficiency as a guide.

<u>SLO PROFICIENCIES (ACCJC Rubric):</u>

1) *Student learning outcomes and authentic assessments are in place for courses, programs and degrees*
   All the courses in the Developmental Mathematics Program have SLOs that are aligned with the program SLOs. There are no certificates or degrees associated with this program. Specific assessment tools have been redesigned during each assessment cycle. More permanent authentic assessment instruments are being developed this year. Fulltime instructors record all work in TracDat.

2) *There is widespread institutional (departmental) dialogue about the results of assessment and identification of gaps.*
   The discussion of the student learning outcome assessment process has mostly focused on how we can increase effectiveness and participation by all instructors of developmental mathematics courses. Our chief concerns are that the suggested changes in our teaching resulting from our assessment cycles are modest and that we have no systematic way of tracking who has actually implemented these changes. As a result of our dialogue, we are in the process of reshaping our assessment procedures to

require broader participation both in the assessments and in the follow-up discussions and teaching modifications. Participation in assessment cycles by fulltime faculty is widespread and consistent. Participation by adjunct faculty continues to be a bit spotty, but our new assessment instruments should encourage more consistent participation.

At this point, instructors are using SLO assessments for self-evaluation of their instructional methods. Dialogue between evaluator and evaluatee regarding participation in and the results of SLO assessments is now a formal part of the evaluation process for all instructors, including those teaching in the Developmental Mathematics Program.

3) *Decision-making includes dialogue on the results of assessment and is purposefully directed toward aligning institution-wide practices to support and improve student learning.*
While instructors in the Developmental Mathematics Program have learned from the SLO assessment process and have used our results in local decision-making to some degree, it is quite difficult to measure the impact this has had on decision-making related to institutional-wide practices to support and improve student learning.

4) *Appropriate resources continue to be allocated and fine-tuned.*
It is too soon to expect much evidence that the results of SLO assessments have had any measurable influence on the use and allocation of resources for instructional purposes. As the new annual updates for program review get underway, we expect that recommendations based on SLO assessments will make their way into our program's plan-builder.

5) *Comprehensive assessment reports exist and are completed and updated on a regular basis.*
Most course SLOs and all program SLOs have been assessed at least once, with a comprehensive report submitted that includes reflections on the results and suggestions for future directions. Results have been mostly modest in scope.

6) *Course student learning outcomes are aligned with degree student learning outcomes*
Our course SLOs are aligned with program SLOs and the institutional core competencies. There are no degrees associated with this program.

7) *Students demonstrate awareness of goals and purposes of courses and programs in which they are enrolled.*
Course syllabi contain course SLO statements, which inform students about what they will gain from taking that course. Since our program level outcomes are aligned with the course level outcomes students are made aware of the program level outcomes through their syllabi for each developmental course.

Summary of SLO and PLO Assessment Results

The developmental committee has 32 SLOs, from eight courses with four SLO's each. By the end of the Spring 2016 semester, the committee will have assessed 31 out of the 32 SLO's, a 97% completion rate. SLO #3 for Math 12 will be missing due to an assessment error (a different SLO was erroneously assessed twice). The developmental committee has four PLO's and by the end of the Fall 2016 semester all four PLO's will be assessed.

We have anecdotal evidence that the results of the SLO and PLO have led to improved student learning for numerous reasons. Every semester the course coordinators share the SLO reports from pervious semesters with current instructors, along with recommended actions and supplements, providing current instructors with a number of resources to help their students. For instance, at the beginning of the spring 2016 semester, the Math 40 course coordinator emailed the SLO assessments from the past three years to all Math 40 instructors, which included the SLO, the method of assessment, the results, and any recommended actions. In addition, the course coordinator also provided activities related to the SLO's to help the students obtain deeper understanding and mastery of the material. The activities not only provide current instructors with insight to specific student struggles, they also introduce new methodologies of teaching the material. By having an experienced instructor reach out to other instructors, the course coordinator also serves as an informal mentor for new Math 40 instructors. The SLO assessments give instructors access to all of these additional resources, which in turn help our students reach their full potential in the developmental math courses.

CMD Recommendation 2016B - course coordinators

Common themes in the recommendations should be noted, as it indicates an effective and universal method for student success. One main idea from the recommendations, regardless of the course and SLO being assessed, was for instructors to use real world examples, allowing students to see connections between the mathematics they are learning and their lives. Another common theme was encouraging instructors to try something different and innovative in their classes, such as group work, lecturing, activities, projects, flipping the classroom, etc. Making the instructor more flexible and accessible is pivotal for student success at the developmental level.

CMD Recommendation 2016E – faculty development/best practices

Based on the assessment results, the developmental committee has increased the number of sections of the accelerated courses, specifically Math 37 and 67, but more needs to be done. An adjustment of course offering needs to take place based on student need generated from student's educational plans and research. This has allowed more students the opportunity to move through the developmental math program within two semesters. These accelerated courses have increased the persistence rate to reach the transfer level math courses.

CMD Recommendation 2016C - scheduling based on education plans and research

CMD Recommendation 2016Q – new pathways with co-requisite support

SLO Process Improvements

More instructors are implementing the SLO assessments. Since a larger sample size more accurately portrays the student population taking developmental math courses, the assessments can be used to determine deficiencies and strengths of the courses/program more precisely. The SLO's and the PLO's were not as well aligned four years ago. They are now, with four for each course, all of which align with one of the four PLOs. A new, more manageable timeline of SLO assessment was created, as well.

We are working toward a common scale of grading and rubric in each course for better results of the program-level assessment.

A single instrument was developed for Math 67 that assesses all SLOs in one semester. A report would then be created depending on SLO timeline. This allows for a holistic analysis of all learning outcomes, instead of focusing on one each year. Eventually, a single instrument would ideally be developed to assess all SLOs each semester for each course.

Assessment Results and Dialogue

The dialogue portion is still a challenge for the committee. The committee is overwhelmed with subjects ranging from student success to student equity. In the future the committee will be further encumbered with issues of adult education and new placement processes. In addition, a majority of the instructors of the developmental courses are part-time faculty and there are few part-time faculty that participate in the committee meetings. Time dedicated for dialogue specific to SLO assessments, as well as part-time faculty participation in said dialogue, is an area that will be improved going into the next four years.

CMD Recommendation 2016A_– pay adjuncts for office hours, professional development and committee work

CMD Recommendation 2016E – faculty development/best practices

On the next pages, please find the alignment grid and timeline for our SLOs and PLOs.

Alignment Grid

FACILITATORS: DUE DATE TO SLO COORDINATORS IS FRIDAY, SEPTEMBER 5, 2014.

MATHEMATICAL SCIENCES
Institutional (ILO), Program (PLO), and Course (SLO) Alignment

Program: **Developmental Math**	Number of Courses: 10	Date Updated: 08.18.2014	Submitted by: Susanne Bucher, ext. 3221

ILOs	1. Critical Thinking	2. Communication	3. Community and Personal Development	4. Information Literacy
	Students apply critical, creative and analytical skills to identify and solve problems, analyze information, synthesize and evaluate ideas, and transform existing ideas into new forms.	*Students effectively communicate with and respond to varied audiences in written, spoken or signed, and artistic forms.*	*Students are productive and engaged members of society, demonstrating personal responsibility, and community and social awareness through their engagement in campus programs and services.*	*Students determine an information need and use various media and formats to develop a research strategy and locate, evaluate, document, and use information to accomplish a specific purpose. Students demonstrate an understanding of the legal, social, and ethical aspects related to information use.*

SLO-PLO-ILO ALIGNMENT NOTES:

Mark boxes with an 'X' if: SLO/PLO is a major focus or an important part of the course/program; direct instruction or some direct instruction is provided; students are evaluated multiple times (and possibly in various ways) throughout the course or are evaluated on the concepts once or twice within the course.

DO NOT mark with an 'X' if: SLO/PLO is a minor focus of the course/program and some instruction is given in the area but students are not formally evaluated on the concepts; or if the SLO/PLO is minimally or not at all part of the course/program.

PLOs	PLO to ILO Alignment (Mark with an X) 1	2	3	4
PLO #1 Solving Application Problems A students completing PreCollegiate Mathematics will recognize the underlying mathematical concepts in a given context (word problems, data, diagrams, etc.) and apply those concepts correctly.	X	X	X	
PLO #2 Solving Equations and Manipulating Expressions A student completing Pre-Collegiate Mathematics will demonstrate the ability to identify and correctly implement techniques to symbolically solve equations and manipulate expressions.	X			
PLO #3 Visual and Graphical Methods A student completing Pre-Collegiate Mathematics will use visual and graphical methods to represent and analyze information and to solve problems.	X	X		
PLO #4 Articulating Mathematical Reasoning A student completing Pre-Collegiate Mathematics will verbally articulate (orally or in writing) the mathematical reasoning they used to solve a problem or analyze a situation.	X	X		

SLOs	SLO to PLO Alignment (Mark with an X) P1	P2	P3	P4	COURSE to ILO Alignment *FOR OFFICE USE ONLY* 1	2	3	4
MATH 12 Basic Arithmetic Skills: SLO #1 Application Problems Students will be able to recognize addition, subtraction, multiplication, division, exponentiation, factoring and order of operations in a given context (word problem, data, diagram, etc.) involving non-negative real numbers to write corresponding mathematical expressions and solve authentic, real-world application problems.	X							
MATH 12 Basic Arithmetic Skills: SLO #2 Solving Equations and Manipulating Expressions Students will be able to use numerical and symbolic representations to correctly perform operations (addition, subtraction, multiplication, division, exponentiation, factoring, and order of operations) on non-negative real numbers to simplify expressions.		X						
MATH 12 Basic Arithmetic Skills: SLO #3 Visual and Graphical Methods A student completing Pre-Collegiate mathematics will use visual and graphical methods to represent and analyze information and to solve problems using non negative real numbers, including demonstrating correct ordering of values and testing reasonableness of solutions.			X					
MATH 12 Basic Arithmetic Skills: SLO #4 Articulating Mathematical Reasoning A student completing Pre collegiate mathematics will verbally articulate (orally or in written form) the mathematical reasoning they used to solve a problem or analyze a situation.				X				

MATH 23 Pre-Algebra: SLO #1 Application Problems Students will recognize the underlying mathematical concepts in order to successfully evaluate expressions and formulas in a given context (word problems, data, diagrams, etc.) and apply those concepts correctly in authentic, real-world application problems.	X							
MATH 23 Pre-Algebra: SLO #2 Solving Equations and Manipulating Expressions Students will use numerical and symbolic representations of mathematical ideas to simplify linear expressions and solve linear equations.		X						
MATH 23 Pre-Algebra: SLO #3 Visual and Graphical Methods Students will be able to use visual or graphical methods to solve linear equations and problems involving geometry and measurement.			X					
MATH 23 Pre-Algebra: SLO #4 Articulating Mathematical Reasoning Students will verbally articulate (orally or in written form) the mathematical reasoning they used to solve a numeric or linear problem or analyze a numeric or linear situation.				X				

MATH 37 Basic Accelerated Mathematics: SLO #1 Application Problems A student will be able to recognize the underlying mathematical concepts, with an emphasis on linear relations, in a given context (word problems, data, diagrams, etc.) and apply those concepts correctly.	X							
MATH 37 Basic Accelerated Mathematics: SLO #2 Solving Equations and Manipulating Expressions A student will be able to demonstrate the ability to identify and correctly implement techniques to symbolically solve equations, with an emphasis on linear equations, and manipulate expressions.		X						
MATH 37 Basic Accelerated Mathematics: SLO #3 Visual and Graphical Methods A student will be able to use visual and graphical methods to represent and analyze information and to solve problems, with an emphasis on linear graphs.			X					
MATH 37 Basic Accelerated Mathematics: SLO #4 Articulating Mathematical Reasoning A student will be able to articulate orally or in written form the mathematical reasoning they used to solve a problem or analyze a situation.				X				

MATH 40 Elementary Algebra: SLO #1 Application Problems Students will be able to recognize linear and quadratic equations in a given context, and use mathematical reasoning and problem solving skills to solve authentic, real world application problems.	X							
MATH 40 Elementary Algebra: SLO #2 Solving Equations and Manipulating Expressions Students will be able to use numerical and symbolic representations of mathematical ideas to simplify or solve linear, quadratic, rational, and radical expressions or equations.		X						
MATH 40 Elementary Algebra: SLO #3 Visual and Graphical Methods Students will be able to use graphical methods to represent linear and quadratic relations as well as systems of linear relations and to find solutions to linear and quadratic equations, as well as solve systems of linear equations.			X					
MATH 40 Elementary Algebra: SLO #4 Articulating Mathematical Reasoning Students will be able to articulate the mathematical reasoning used in a variety of problems, orally or in writing.				X				

MATH 60 Elementary Geometry: SLO #1 Application Problems Students will be able to define geometric terms, polygons, and shapes and apply characteristics of the shapes to solve geometric problems.	X							
MATH 60 Elementary Geometry: SLO #2 Solving Equations and Manipulating Expressions Students will be able to calculate perimeter, area, surface area and volume for various 2D and 3D geometric shapes.		X						
MATH 60 Elementary Geometry: SLO #3 Visual and Graphical Methods Students will be able to construct geometric shapes using the compass and straightedge.			X					
MATH 60 Elementary Geometry: SLO #4 Articulating Mathematical Reasoning Students will be able to prove geometric conjectures and theorems using deductive logic.				X				

MATH 67 General Education Algebra: SLO #1 Application Problems Students will be able to recognize and apply appropriate mathematical concepts and models involving a variety of functions to contextualized problems involving authentic, real-world data.	X							
MATH 67 General Education Algebra: SLO #2 Solving Equations and Manipulating Expressions Students will be able to symbolically (algebraically) solve a variety of equations, inequalities and linear systems and manipulate symbolic (algebraic) expressions that arise in contextualized problems using authentic, real-world data.		X						
MATH 67 General Education Algebra: SLO #3 Visual and Graphical Methods Students will use visual and graphical methods to represent, analyze and solve contextualized problems involving authentic, real-world data.			X					
MATH 67 General Education Algebra: SLO #4 Articulating Mathematical Reasoning Students will be able to articulate the mathematical reasoning used in solving a variety of contextualized problems using authentic, real-world data, orally or in writing.				X				

MATH 73 Intermediate Algebra for General Education: SLO #1 Application Problems Students will be able to recognize and apply appropriate mathematical concepts and models involving a variety of functions to contextualized problems (authentic, real-world applications).	X							
MATH 73 Intermediate Algebra for General Education: SLO #2 Solving Equations and Manipulating Expressions Students will be able to symbolically (algebraically) solve a variety of equations, inequalities and linear systems and manipulate symbolic (algebraic) expressions that arise in contextualized problems.		X						
MATH 73 Intermediate Algebra for General Education: SLO #3 Visual and Graphical Methods Students will use visual and graphical methods to represent, analyze and solve contextualized problems.			X					
MATH 73 Intermediate Algebra for General Education: SLO #4 Articulating Mathematical Reasoning Students will be able to articulate the mathematical reasoning used in solving a variety of contextualized problems, both orally and in writing.				X				

MATH 80 Intermediate Algebra for Science, Technology, Engineering, and Mathematics: SLO #1 Application Problems Students will be able to solve application problems involving linear, quadratic, polynomial, rational, radical, exponential and logarithmic functions.	X							
MATH 80 Intermediate Algebra for Science, Technology, Engineering, and Mathematics: SLO #2 Solving Equations and Manipulating Expressions Students will be able to evaluate numerical operations and manipulate algebraic expressions involving rational and negative exponents, radicals, complex numbers, exponents and logarithms and be able to solve linear, quadratic, polynomial, rational, radical, absolute value, exponential and logarithmic equations and inequalities.		X						
MATH 80 Intermediate Algebra for Science, Technology, Engineering, and Mathematics: SLO #3 Visual and Graphical Methods Students will be able to use visual and graphical methods to represent, analyze and solve problem involving linear, quadratic, polynomial, rational, absolute value, radical, exponential, logarithmic functions, conic sections, linear and nonlinear systems of equations. Students will also be able to solve such functions and equations using graphical methods.			X					
MATH 80 Intermediate Algebra for Science, Technology, Engineering, and Mathematics: SLO #4 Articulating Mathematical Reasoning Students will be able to explain verbally, both orally or in writing, and the mathematical reasoning used in an application problem involving linear, quadratic, polynomial, rational, radical, absolute value, exponential and logarithmic equations and inequalities.				X				

Timeline for Course and Program Level SLO Assessments

SLO and PLO Assessment Timeline Division: Math	Program: Developmental Math	Program Review Date: SP16/FA16
Semester and Year	**SLO to be Assessed** **Include the SLO# and Short Title**	**PLO to be Assessed** **Include the PLO# and Short Title**
Spring 2014	Math 12 SLO #2 - Solving Equations and Manipulating Expressions Math 23 SLO #2 - Solving Equations and Manipulating Expressions Math 40 SLO #2 - Solving Equations and Manipulating Expressions Math 67 SLO #2 - Solving Equations and Manipulating Expressions Math 37 SLO #2 - Solving Equations and Manipulating Expressions Math 60 SLO #2 - Solving Equations and Manipulating Expressions Math 73 SLO #2 - Solving Equations and Manipulating Expressions Math 80 SLO #2 - Solving Equations and Manipulating Expressions	
Summer 2014 (If applicable)		
Fall 2014		PLO #2: A student completing Pre-Collegiate Mathematics will demonstrate the ability to identify and correctly implement techniques to symbolically solve equations and manipulate expressions.
Spring 2015	Math 12 SLO #1 - Application Problems Math 23 SLO #1 - Application Problems Math 40 SLO #1 - Application Problems Math 67 SLO #1 - Application Problems Math 37 SLO #1 - Application Problems Math 60 SLO #1 - Application Problems Math 73 SLO #1 - Application Problems Math 80 SLO #1 - Application Problems	
Summer 2015 (if applicable)		
Fall 2015		PLO #1: A student completing Pre-Collegiate Mathematics will recognize the underlying mathematical concepts in a given context (word problems, data, diagrams, etc.) and apply those concepts correctly.
Spring 2016	Math 12 SLO #4 - Articulating Mathematical Reasoning Math 23 SLO #4 - Articulating Mathematical Reasoning Math 40 SLO #4 - Articulating Mathematical Reasoning Math 67 SLO #4 - Articulating Mathematical Reasoning Math 37 SLO #4 - Articulating Mathematical Reasoning Math 60 SLO #4 - Articulating Mathematical Reasoning Math 73 SLO #4 - Articulating Mathematical Reasoning Math 80 SLO #4 - Articulating Mathematical Reasoning	

Summer 2016 **(If applicable)**		
Fall 2016		PLO #4: A student completing Pre-Collegiate Mathematics will verbally articulate (orally or in writing) the mathematical reasoning they used to solve a problem or analyze a situation.
Spring 2017	Math 12 SLO #3 - Visual and Graphical Methods Math 23 SLO #3 - Visual and Graphical Methods Math 40 SLO #3 - Visual and Graphical Methods Math 67 SLO #3 - Visual and Graphical Methods Math 37 SLO #3 - Visual and Graphical Methods Math 60 SLO #3 - Visual and Graphical Methods Math 73 SLO #3 - Visual and Graphical Methods Math 80 SLO #3 - Visual and Graphical Methods	
Summer 2017 **(If applicable)**		
Fall 2017		PLO #3: A student completing Pre-Collegiate Mathematics will use visual and graphical methods to represent and analyze information and to solve problems.

V. Analysis of Student Feedback

We surveyed 192 students from Math 12, 23, 37 and 40 during the Spring 2016 term. The questions were developed by the Developmental Math Committee and adapted into a survey format by Institutional Research and Planning. The students were given the survey by randomly selected instructors and the results were tabulated by Institutional Research and Planning. The complete set of data can be found in the appendix.

Background

Since the students were enrolled in developmental math courses, one of the first questions asked was what other developmental math classes they had completed. As expected the most common responses were Math 12 (39.06%) or that they had not taken a math class before (46.88%). This corresponded with the fact that most of the students were new students with less than 15 units completed at El Camino (59.38%). The low accumulation of units may indicate that students who need to take developmental math classes do start to do so at the beginning of their ECC career. This early start is a good sign, considering that the majority of students (62.5%) in developmental math classes indicated that they wanted to achieve an educational degree of bachelors or higher, which requires transferring. Students will have to complete a course one level below transfer (Math 67, 73, or 80) and one (or more) transfer level mathematics courses as well (depending on major). Additionally, since we do have multiple pathways through our developmental curriculum, it is imperative that students are made aware of the differences of the pathways and which is appropriate to their goals. Since the developmental program has a vested interest in our students being well informed before choosing classes, undertaking a consistent information campaign each year would be useful in helping to inform everyone of all their options.

CMD Recommendation 2016I – improve information about multiple pathways

Enrollment and Placement

A second focus of the survey was to see if there are enough and appropriate sections of each developmental mathematics course available each semester. While overall, our program seemed to be handling the demand pretty well, there was a substantial portion (26.56%) of the students who said that at least once they could not enroll in a math class because all sections were full. A majority of those could not enroll (59.7%) were not able to enroll in sections of Math 12 or Math 23. [Provide full details here.] It is critical we align our offerings of developmental classes with student education plans to ensure that our students who want to get an immediate start on their math education are able to do so.

Another important question on our survey was about the placement exam that we use to evaluate students when they first attend El Camino College. The vast majority of our students took the placement exam (96.6%). The survey then asked students their opinion on their placement level. The answers were basically split between the students saying they were at an appropriate level (48.6%) or that they were placed at too low of a level (50.3%). Generally speaking, we might understand why some students are disappointed with their low placement, in light of the long sequence of courses they face, but surprisingly the research suggests that some of these students might be right. The fact that half of the students believe their placement is low strengthens the argument we have some reason to consider reviewing the placement exam and look at other information upon which to base placement. For thirty years, Title 5 regulations have required California community colleges to consider multiple measures when placing students, a practice El Camino College (and many other community colleges) has not done in any formal way. The research also indicates that colleges have replaced strict placement exams with multiple measure placement, placements are higher without a drop in success rates in the higher classes.

So, while our placement process requires some modifications to be compliant with Title 5 regulations, one good sign is that the students who have taken more than one math course are feeling prepared for the next course. In our survey of those students who did take more than one math class, the vast majority (87.4%) of them reported that they did feel prepared for the next class. This shows that our current sequence of courses is really working for the students that pass since the successful students are seeing the connections between each class and feeling like the material they are learning in a pre-requisite class is actually paying off in the follow on class.

> **CMD Recommendation 2016H – redesign placement process using multiple measures/research**

Student Success and Challenges

The other major area our survey focused on was student success. We asked the students to rate what they felt impacted their success the most. The results are displayed in Figure 21 on the next page. As seen in this chart, from the items we surveyed, students rated the instructor and the students self-studying as the most important factors for student success. However, more germane to our program, is to note that the Math Study Center (MSC) was noted as most impactful out of all the outside resources closely followed by study groups. We will return to these in the resource section.

Interestingly, office hours were not mentioned frequently as a factor for student success. We had a question that investigated office hours further. It turns out that the issue with office hours is actual use. Close to half of our students (48%) reported that they never used office hours once. Out of those that did use office hours all of them reported that it was useful with the majority (81.5%) reporting that office hours were very helpful. This means that our program needs to continue to find ways to encourage students to attend office hours. Students that are attending them are finding them beneficial.

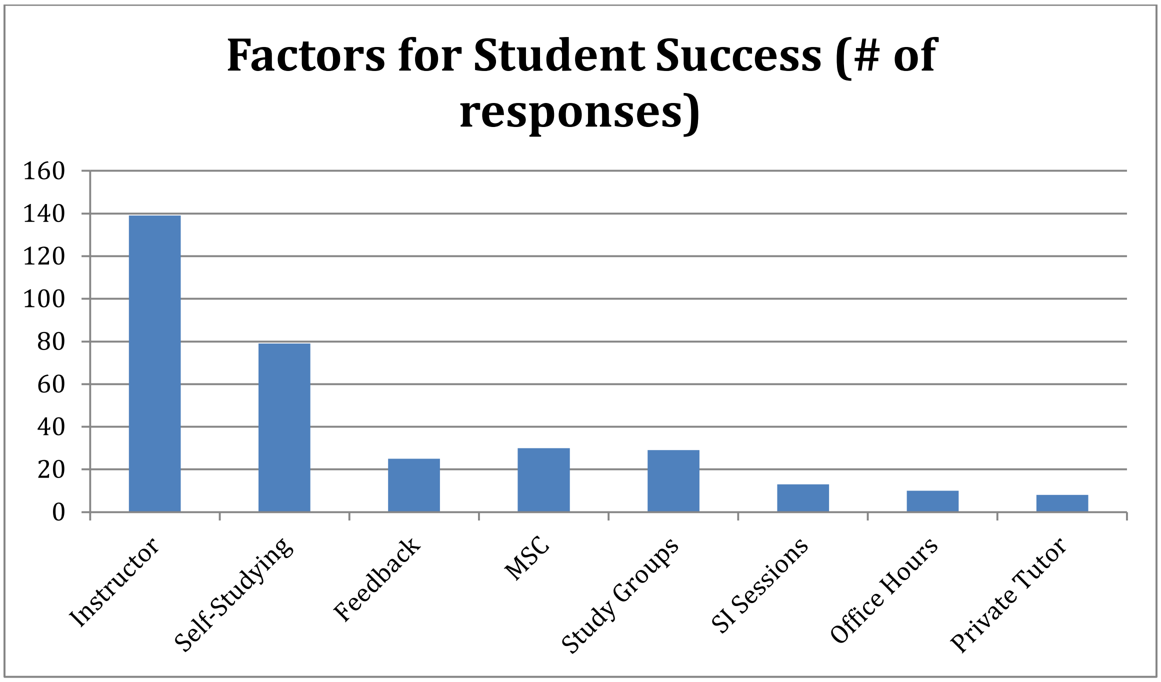

Figure 21

In terms of a formal recommendation, considering that the majority of our developmental classes are taught by part-time instructors, we recommend that part-time instructors be paid for holding office hours each week. This would contribute directly to student success. In addition since instructors hold such a high level of importance for developmental students, having more full time faculty dedicated to developmental instruction would insure consistency for students.

CMD Recommendation 2016A_– pay adjuncts for office hours, professional development and committee work

CMD Recommendation 2016F_– fulltime faculty hires for developmental math

Turning to challenges, in Figure 22 we see what the students listed as the biggest obstacles to success in math classes. The results here are pretty striking. Test anxiety was reported more than twice the amount of any other challenge. This means that our program needs to consider something to help combat this issue, perhaps workshops on test strategies, studying, and antianxiety methods or perhaps embedding these strategies directly into the course. That motivation and life/work issues are significant factors are not surprising, but how to respond to these is tricky. Earlier, we noted that the majority of students are feeling prepared for their math classes, so we are not surprised that few students pointed to this is a challenging factor. Finally, based on this question, it seems students feel that their largest challenge is not the lack of sufficient outside resources.

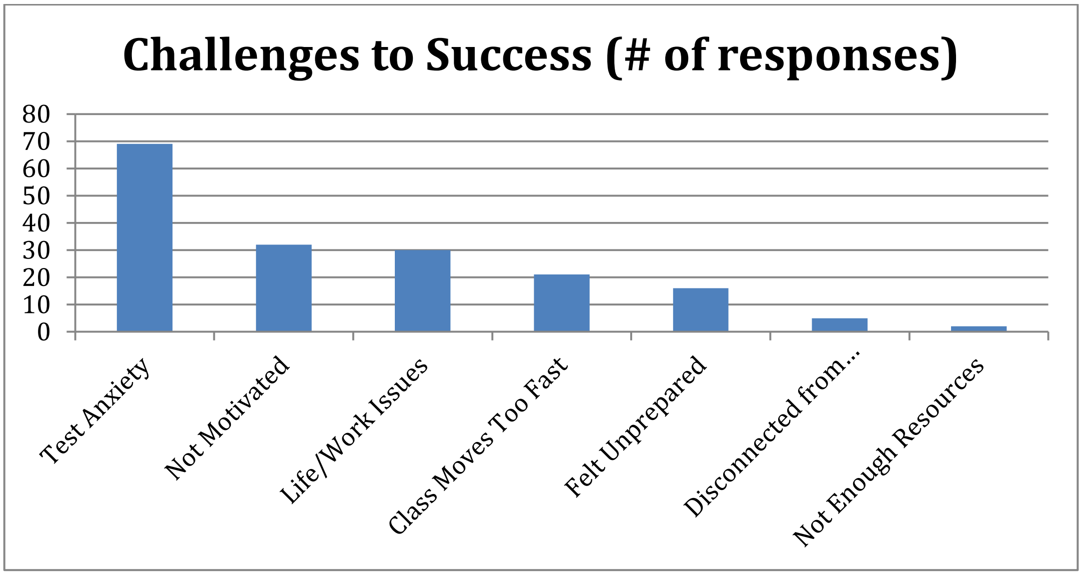

Figure 22

That being said, we know that if students knew about services such as Supplemental instruction, they are more likely to use it. In addition to the recommendation below (mentioned earlier)

> **CMD Recommendation 2016J – expand effective programs, including math academies, SI, and counselor intervention**

we also offer the following recommendation

> **CMD Recommendation 2016S - include support activities in scheduling and registration**
> Create the means in our online registration system so that noncredit co-requisite courses (see Curriculum-1), suitable academic strategies courses, and even SI sessions can be offered as course supplements, enabling students to sign up for these at registration, so that these can be built into a student's schedule of classes. *(20* Student Feedback, *learning support, Strategic Initiative B)*

Resources

We surveyed to see which resources were being used the most frequently. The results are in Figure 23.

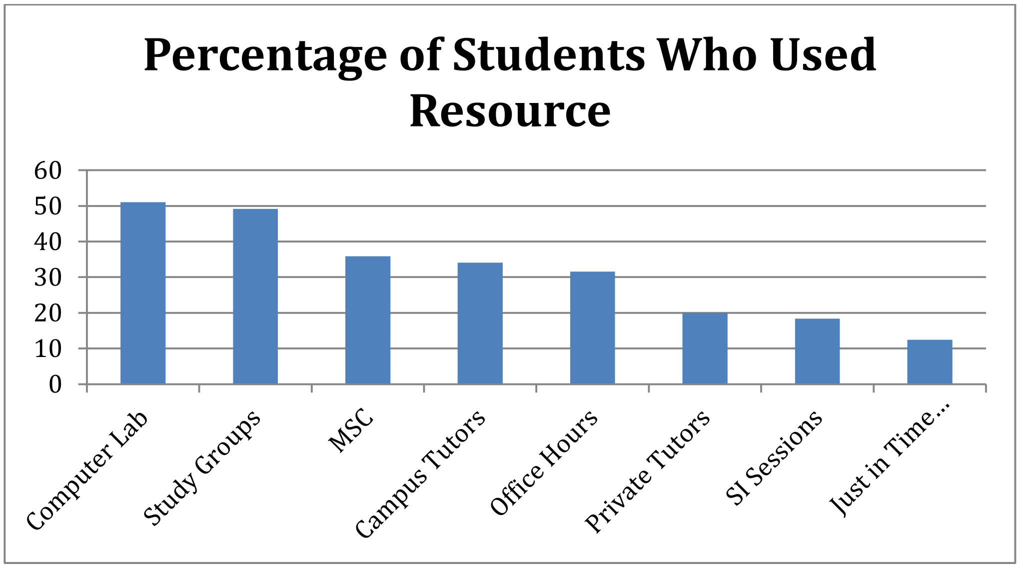

Figure 23

How often each resource that is available is being used to inform several recommendations? First, we need to advertise and promote the use of the Math Study Center, office hours, and Just-in-Time Workshops since all of these have relatively low usage rates and are within our program's jurisdiction. Further, as noted in the previous look at the student survey results, the MSC was identified as a solid factor for student success. The usefulness of the MSC is underscored further with the individual question about the MSC. Of those that used the center, the overwhelming majority (90.2%) reported that they found it useful. This shows that our tutoring center is a positive and dynamic resource for our students. We need to continue supporting and growing this resource. One idea to increase student familiarity with the MSC is to have the tutors visit developmental classrooms.

Again, as a formal recommendation, the Math Study Center needs a full-time coordinator to take over the responsibilities of advertising the center, organizing tutors, increasing efficiency of the tutors and outside programs.

CMD Recommendation 2016T – fulltime tutoring coordinator
Hire a fulltime tutoring coordinator to manage the training of tutors and to expand the use and availability of tutors, e.g., increased tutoring during finals week and tutor outreach to classes during the semester. (Student Feedback, *student learning support, Strategic Initiative B)*

CMD Recommendation 2016U – improve tutoring
Promote greater use of the tutoring center by having student tutors visit classrooms once or twice during each semester and by having student tutors lead review sessions for targeted "just-in-time" topics and increased and improved training. *(28* Student Feedback, *instructional support, Strategic Initiative B)*

We can also see that the computer labs in our department are considered by students to be highly useful indicating that more computer labs would be useful. This was indicated in our data. Out of all the campus resources the computer labs had the highest rate of being used more than once a week (35.2%). More and more classes are starting to include a computer lab component so we need to make sure that students can have access to this resource.

CMD Recommendation 2016V – classroom computing and flexible classrooms
Purchase classroom sets of laptops (or similar equipment) and portable charging carts for use in general classrooms. Plan regular updates, maintenance and replacement. Create more classrooms that can be used as both computer labs and group-work friendly classrooms, utilizing tablets or thin clients or equivalent, as well as smart boards. *(10 and 11 combined,* Student Feedback, Facilities & Equipment, *instructional and student learning support, progress toward completion through greater course offerings, Strategic Initiative B)*

Study groups rank up with the MSC as factors in student success. Marrying study groups with access to instructors and the MSC could be a powerful combination for supporting students who are working together. Having more unstructured student space around the MBA building (inside and, if covered, outside) with tables and chairs that support group work would be ideal. Students would not have to move to other buildings on campus to work in their groups, which would facilitate their use of both the MSC and office hours.

CMD Recommendation 2016W – unstructured student study space
Create more unstructured study space for students in the hallways of the MBA building and in the areas outside surrounding the MBA building, setting up tables, chairs where possible and providing cover as required for year-round use. In general, create more unstructured study space for students across campus wherever possible, available to students whenever the campus is open. (Student Feedback, Facilities & Equipment, *student learning support, Strategic Initiative B)*

We acknowledge that the information we get from students is useful in helping guide department decisions and policy. The survey we conducted should not be done as an isolated incident. Student voice can help us hone our use of limited resources to be most effective. We need to be making sure that gathering student input is a regular part of our self-evaluation process.

CMD Recommendation 2016M – student advisory group

VI. Facilities and Equipment

Existing Program Facilities and Equipment.

The Developmental Mathematics Program and the Mathematics Department, along with other divisions of the college, are in the process of integrating new technology into their instruction. This requires that all classrooms have computing and display technologies readily available, as well as up-to-date software and maintenance to support this equipment.

The new MBA building houses the Division of Mathematical Sciences, as well as the Business Division and Allied Health. The MBA building contains 22 offices designated for full-time instructors, as well as 8 additional offices currently designated for part-time instructors. If needed, these offices can be converted to use by full-time instructors, although students benefit greatly from having access to part-time instructors. Given the demand for new instructors due to increased enrollments, retirements, and attrition, the amount of office space will not be adequate for the long-term faculty needs of the growing Math Department. Due to the high seat fill rate and demand for courses in the Developmental Mathematics Program, there will be a pressing need for additional classroom space.

Each classroom in the MBA building has a computer, a projection system, and a document reader. Although the MBA building is fairly new, there is a need for up-to-date technology, both hardware and software, for instructors and their classrooms. This equipment includes tablet PCs, SMART boards, classroom clicker sets, classroom and department sets of graphing calculators, and other equipment. Please see *Section: Technology and Software* for more details.

Immediate Needs (1-2 years)

Classrooms: Little items can have a large impact on instruction. Many of our classrooms have white boards installed on the back and sidewalls, but the utility of these is limited by the lack of classroom supplies, such as dry erasers. It is extremely difficult to send a group of students to do board work when there is often just one dry eraser in the front of the classroom. We recommend that there should be a dry eraser per white board to encourage class participation, and that our department provide at least 6 dry erasers per whiteboard classroom.   The approximate cost, at $3.79 per eraser with 6 erasers for each of the 31 classrooms, is $704.94 plus tax and shipping.

Larger items can also have a large impact. Many of the document viewers in our classrooms are on their last legs and are difficult to see through the projector, even with all of the lights off –

which defeats their purpose somewhat. Currently, if one of these were to fail, it is unclear how long it would take to replace it. Would it be days, weeks, or months? Do we have equipment to replace these temporarily, such as old school overhead projectors?

CMD Recommendation 2016X – equipment inventory
Maintain an inventory of equipment and supplies essential for effective classroom teaching, to be available in the division office at all times, including intersessions. This should include erasers, erase rags, chalk, dry-erase markers, and document viewer and projector lamps. The inventory should be used to keep and maintain sufficient supplies. *(8* Facilities & Equipment, *student learning support, Strategic Initiative B)*

CMD Recommendation 2016Y – up-to-date and working equipment
Plan for ongoing replacement and regular maintenance of document cameras with equipment that is teaching-friendly in design, as recommended by teaching faculty. Provide high quality scanners in workrooms on both the second and third floors and large wall clocks in the hallways. *(9* Facilities & Equipment, *student learning support, Strategic Initiative B)*

It is also highly recommended that Math 37 (BAM) and Math 67 (GEA) have three to four dedicated classrooms, since each section of this course requires common sets of materials, manipulatives, technological equipment, and statistical software. But this raises the question of WHERE these classrooms will be located? Will they be in the MBA building or across campus? There is virtually no room to expand our programs and course offerings in the MBA building with the current allotment of classrooms.

CMD Recommendation 2016Z– efficient room use in MBA
Conduct a building-wide room-use inventory and reassign rooms in MBA among the divisions in a manner proportional to the number of students served, sharing space as needed to avoid offering math courses outside of the MBA building unnecessarily. *(14* Facilities & Equipment, *student learning support, Strategic Initiative B)*

CMD Recommendation 2016AA – dedicated classrooms
Create three or four classrooms dedicated to Math 37 and Math 67, since each section of this course encourages (but does not require) a common set of materials, manipulatives, technological equipment and software. Current materials could then be stored in these rooms. *(13* Facilities & Equipment, *student learning support, Strategic Initiative B)*

Faculty Workrooms: The two faculty workrooms are equipped with three computers each and two printers (DELL and HP) but the DELL printers are often inoperable and are nearing the end of their lifespan. We recommend that a better HP printer be added to each of the faculty workrooms. The estimated cost for an HP printer is $550-$650. In addition, only the second floor faculty workroom has a scanner that is currently connected to one of the three computers.

However, if a faculty member is already using the computer that is connected to the scanner, no one can access the scanner. We recommend that an additional scanner be added to the second floor faculty workroom and two scanners be installed in the third floor faculty workroom. The estimated cost for a top-of-the-line scanner, which can be used to create class handouts for students, is $1200.

CMD Recommendation 2016Y – up-to-date and working equipment

Common Areas: We are also deeply concerned that our capacity to support student learning (for all students, but particularly for developmental students) shrunk noticeably with the move from the old MCS building into the new MBA building. In the old MCS building, spacious hallways with tables and chairs enabled office hours to spill out into these spaces. Outside the large lecture classrooms, tables and seats for well over a hundred students were available and *used at all hours of the day*. Now, we have a smattering of tables and chairs available on the first floor (only) and most students can no longer find tables and chairs in our space. Faculty offices have always been insufficient to serve the volume of students who seek help. Somehow, our developmental mathematics students and their instructors need to regain the capacity we once enjoyed.

CMD Recommendation 2016W – unstructured student study space

A few oversized (23 inch diameter) wall clocks (approximately $50-$70 each) should be installed in faculty and classroom hallways. Most instructors and their students rely on watches to determine what time to head to their classes. However, watches often are not in sync with the clocks in the classrooms. Therefore, it makes sense to install a few clocks in the faculty hallways and also some in the classroom hallways. It will cost approximately $500 to $700 to install a total of ten clocks on floors 1 through 3 in the MBA building.

CMD Recommendation 2016Y – up-to-date and working equipment

Finally, storing equipment and classroom instruments and manipulatives that many instructors use for multiple courses in an room that one day may be needed for faculty offices AND not giving most faculty access to that room is not efficient. Storing these same things in various classrooms does not provide much flexibility about what can be taught in the room and will likely lead to interruptions in class when other instructors need access to these materials. The MBA building should have sufficient storage areas for instructional equipment and materials outside the classrooms. We strongly recommend working with staff from facilities and the other departments in this division to find reasonable storage solutions.

CMD Recommendation 2016BB – storage space
Create non-classroom storage space in the MBA building for equipment, manipulatives, and other resources, accessible to all instructors at all times. *(15* Facilities & Equipment, *instructional support, Strategic Initiatives A and B)*

Long-Range Needs (2-4+ years)

In order to create a state-of-the-art tutoring center for our students, installation of whiteboard technology such as SMART boards is recommended. This technology is used in many tutoring centers that are more advanced than ours. The cost is estimated to be $2,500 to $5,000 per whiteboard.

Moreover, many of our classrooms in the MBA building are currently shared with other divisions. Additional lecture rooms beyond those currently dedicated to our department and division will need to be dedicated to the entire Division of Mathematical Sciences, especially given the high seat fill rate and demand for courses in the Developmental Mathematics Program.

Finally, we wish to convert 6 classrooms into computer lab classrooms. In the classroom, technology is changing the way students learn, educators teach, and how the two groups communicate with one another. Exposing students to technology prepares them for the workforce where knowledge of technology is essential for success. Since students frequently absorb information through technology in their day-to-day lives, they may be more motivated and interested in lessons when technology is used as a teaching tool.

Online retailers, such as Computer Comforts (http://www.computercomforts.com/hide-away-student-table-g2.html), have many models of hideaway computers which convert from a computer lab to a non-lab classroom easily. It is also important for the department to have desks that are easy to move around, in order to foster preferential learning environments for a variety of instructors' needs. The cost of computers with hideaway desks and accessories, such as monitors, chairs, and network equipment, is $3500 for each unit and across 6 classrooms of 35 seats is approximately $735,000.

CMD Recommendation 2016V – classroom computing and flexible classrooms

VII. Technology and Software

Current State of Technology and Software

In recent years, technology has become a greater and more integrated part of education for students in developmental mathematics. The use of computers, calculators, and a myriad of software programs enables and empowers students to explore mathematics in a way that previous generations would not have thought possible. From interactive software such as WebAssign and MyMathLab to websites such as Wolfram Alpha, students have access to tools for immediate and effective feedback that improves the learning process. Especially at the developmental level, where concepts related to word problems and visualization can be a barrier to comprehension, these available technologies allow students new avenues to learning beyond traditional means.

Based on the results from an intra-departmental survey of the Mathematics Department at El Camino College on the topic of technology and software, over 80% of respondents said that they use technology in the classroom for developmental mathematics courses at least once a week. This utilization of technology comes primarily in the form of using either the PC provided in each classroom or the document camera. In regard to using the PC during class, about one-third of respondents choose the MyMathLab online homework, tutorial, and assessment software for use both inside and out of the class, while another third use it only outside of class. The percentages are slightly lower for WebAssign, a similar online software, at about 20% using it in and out of class, and 20% only outside of class. This means that, of the sample, over half of the faculty teaching developmental math courses are employing online software, such as the aforementioned MyMathLab and WebAssign, to aid in the education of students. One benefit to the software being online is that it is updated by the third-party company to be kept current and to add new features, and faculty are kept informed of any changes both in-person and via email.

One reason that there is a large number of instructors using such methods to supplement lectures and hand-written work is that the companies that manage the software are very active in aiding faculty and periodically checking in to see if help is needed. With such service, it makes the barrier to entry for any instructor to use such tools very low. The representatives will go as far to walk instructors through the process of setting up the site for such a class or do it for them if supplied with basic information. However, there are other technologies and software that are underutilized due to a lack of training or support.

When queried about the use of Scientific Notebook (a software offered to instructors for use by the college for creating documents related to math and science) only about 16% said that they use it regularly but 35% said that they would use it if provided with some training in it. If such training were available to faculty, over 50% of the faculty surveyed would be employing this tool for their classes. While programs such as Microsoft Word can handle rudimentary tasks, using specialized software allows instructors a wider range of options for creating worksheets, quizzes, and exams. A similar result holds true for LaTeX, a free software for making PDFs using a plethora of mathematics and graphical packages, which only a few faculty use due to a lack of training. This could be remedied with funding to run instructional classes, once or twice a year and flex credit available for instructors, to initiate and educate faculty on the use of such software.

It has been mentioned by more than a few instructors that the software on classroom PCs should be better kept up-to-date. This could be accomplished by having someone, possibly a member of ITS, that monitors the status of the current software and applies any necessary updates to keep the classroom PCs in working order.

In terms of current hardware, all classrooms are equipped with a PC for instructor use, a document camera, and a projector. In the survey, some instructors mentioned that new or updated document cameras are needed. Many times, electronic equipment, such as the projectors and document cameras, is left on beyond the end of the class and, as such, wears down faster than expected. With 35% of responding faculty stating that their primary form of technology used in the classroom is the document camera, it is paramount to keep this classroom staple up and running. Document cameras for classrooms sit in the range of $500-$1000. Purchasing, for example, 5 spare document cameras would put expenses at $2500-$5000. For projector bulbs, prices range with a median around $50 so keeping 10 in stock would cost approximately $500.

At the moment, there are three computer labs available to the Math Department, which are often utilized by Computer Science, each with 34 computers. Outside of these frequently used labs, instructors have access to three class sets of iPads, consisting of 30 tablets per set. While these are a useful resource, the current lack of access to a reliable wireless network limits their utility. With demand for these resources growing, steps must be taken to adjust to the changing climate where technology is an important, and almost necessary, aspect of the present landscape of mathematics.

Outside of the classroom, students have access to the calculator loan program where, for a deposit of $20, a student can borrow a calculator for a semester and upon relinquishment of it, are refunded their deposit. In tandem with this, there are classroom sets of calculators available to instructors, as well as some at the library for students to use.

Immediate Needs (1-2 Years)

As mentioned earlier, there is some demand for training in current software that would be useful for teaching developmental math courses. Such training could be executed in-house by current faculty, with compensation in terms of flex credit or otherwise. Much of the desired software is either, as of now, available to faculty or free for download and use. For example, two free software packages not currently used by a most faculty, R and Geogebra, were both of interest to faculty if training were provided (at 58% and 48%, respectively). Training with such software would go a long way to helping instructors enhance the classroom experience for students and making tasks that they may perform by other means, such as by using Word or Excel, easier.

> **CMD Recommendation 2016CC – software for teachers and professional development**
> Make available to all fulltime and adjunct instructors the software needed for teaching effectively and creating course material, as faculty recommend, such as Scientific Notebook and LaTex, Geogebra and Geometer's Sketchpad. Provide funding for faculty to run workshops periodically during the year to train other faculty in current software that is available to use in and out of the classroom. *(7* Technology & Software, *instructional support, Strategic Initiatives A and B)*

Several other instructors requested that more and portable hardware be available for students, in the form of tablets or laptops with moveable desks. This would help to decrease the demand for the existing lab space, which would fall under the long-range needs for developmental math. The cost of quality laptops that will still be useful several years down the line start in the range of $750. A cart, to recharge and store the laptops after use, is in the range of $1000.

> **CMD Recommendation 2016V – classroom computing and flexible classrooms**

Long-Range Needs (2-4+ Years)

One need, that goes hand-in-hand with facilities, is more computers that are accessible for faculty in the form of labs. Many classes at the developmental level, such as Math 37 and 67, use computers regularly in a lab component of the class. Thirty-five percent of faculty cited the accessibility of classrooms with computers as the biggest limiting factor to using technology in the classroom. In the same vein, 55% stated that it would be helpful for students to have access to PCs, laptops, or tablets. If such labs or computer resources were available, 68% of faculty would use them at least once a month with some interested in employing them every day.

In addition, the presence of accessible wireless internet throughout the MBA building would be a great help to both instructors and students who use tablets or laptops in their classes. Especially when using online software, such as MyMathLab or WebAssign, the lack of wireless internet connection in certain areas undermines the value of wireless devices such as laptops and tablets.

CMD Recommendation 2016V – classroom computing and flexible classrooms

VIII. Developmental Mathematics Staffing and Professional Development

Staffing

Each semester, roughly 5200 students (15.8% of the El Camino College student population of 33,000 students) are enrolled in a developmental mathematics course. In the Fall 2016 printed class offerings there were 243 sections of math listed. Of these there were 75 sections (31% of total) of courses two or more levels below transfer (Math 12, 23, 37, and 40) and 83 sections (34% of total) of courses one level below transfer (Math 60, 67, 73, and 80). Enrollment in developmental math represents 64% of math enrollment overall (36% at one level below transfer; 28% two levels or more below transfer).

Table 9 below summarizes each course by number of sections and fulltime/part-time instruction, including the transfer-level courses for comparison, for the Fall 2016 semester. Adjunct instructors comprise 81% of the instructors who teach math courses two or more levels below transfer; adjunct instructors make up 43% of the instructors who teach math courses one level below transfer. This is an increase in proportion from four years ago. In any given semester, adjunct instructors teach about 61% of the developmental math courses.

	Sections of Developmental Mathematics Courses										CM2 and CM3	CM1
Fall 2016 Schedule	**Math 12**	**Math 23**	**Math 37**	**Math 40**	2+ levels below transfer	**Math 60**	**Math 67**	**Math 73**	**Math 80**	1 level below transfer	**General Education Courses**	**STEM Major Courses**
Full-time	1 (5%)	3 (15%)	3 (33%)	7 (35%)	14 (19%)	4 (100%)	2 (29%)	18 (67%)	16 (50%)	30 (50%)	67%	85%
Adjunct	21 (95%)	17 (85%)	10 (67%)	13 (65%)	61 (81%)	0 (0%)	5 (71%)	9 (33%)	16 (50%)	30 (50%)	33%	15%
Totals	22	20	13	20	75	4	7	27	32	60		

TABLE 9: FALL 2016 DISTRIBUTION OF FULLTIME AND ADJUNCT TEACHING ASSIGNMENTS

As noted in the 2012 program review, the large proportion of developmental mathematics courses taught by adjuncts results in uneven access to instructor office hours and Supplemental Instruction for a large number of students, particularly those taking mathematics courses two or more levels below transfer. More than half (>2600 students) each semester find themselves in a class with an instructor who may not hold office hours. For several reasons, sections with adjunct instructors are also less likely to have supplemental instruction (SI). For example evening sections are more likely to be taught by adjuncts, but it is more difficult to find SI coaches to staff evening SI sessions. According to the Chancellor's Office Data Mart, in the fall 2013, 2014, and 2015 cohorts, close to 86% of the students starting mathematics at El Camino four levels below transfer were African-American or Hispanic. Access to office hours and SI for students in courses taught by adjunct instructors is an equity issue **throughout the college**; it is especially pronounced among developmental mathematics students.

CMD Recommendation 2016A – pay adjuncts for office hours, professional development and committee work

Professional Development and Training Opportunities

Full-time and adjunct instructors have varied backgrounds in teaching pedagogy. Access to professional development training, conferences, and workshops are crucial to support faculty in serving our students well. As noted in the 2012 review, in the four-year period from 2008 to 2012 the math department provided professional development opportunities in the form of a Teacher Development Workshop Series, Faculty Cohort Groups, and Affective Domain Activities development (which are still in use). These opportunities were funded from grants including the Basic Skills Initiative (BSI), Mathematics Title V, and the Graduation Initiative. Funds for professional development shrank for a few years, but are slowly bouncing back. Unfortunately, even with a new influx of funds, we are extremely restricted in offering meaningful professional development to our adjuncts, because they are often teaching near the maximum-allowed adjunct load and therefore few can be compensated for workshop series. While the current BSI grant and the new Basic Skills and Student Outcome Transformation grant (BST) provide some funding and a call for more professional development, but we need to institutionalize this so it is ongoing and consistent. As our faculty turn over there is no institutionalized resource for ensuring that our mathematics instructors stays abreast of research and new pedagogical techniques, let alone maintaining consistency in our developmental mathematics program.

CMD Recommendation 2016B - course coordinators

CMD Recommendation 2016K – program coordinator

What has not changed from our previous program review is that professional development is still key to tying in relevant research in math education for adults and to keeping instructors refreshed with new ideas and techniques to think about and try. To have a culture of sharing and considering new ideas there needs to be consistent funding for programs. To promulgate such a culture and keep it alive, our campus needs to commit to a minimum level of consistent funding for professional development. This will be even more imperative as we reach out and work with the Adult Schools under AB 86 (AEBG) and CTE faculty contextualizing mathematical pathways. If grants can be obtained to reach that minimum level, that is good. But, if grants are not available, then the ECC budget needs to include funds to fill in the gaps. Ours is a very dynamic campus in terms of student body and a constant infusion of new faculty. Having an ongoing culture of professional development is critical to a feeling of community among instructors and keeping ECC at the forefront of ideas.

CMD Recommendation 2016A – pay adjuncts for office hours, professional development and committee work

CMD Recommendation 2016D – materials for threads spanning multiple courses

CMD Recommendation 2016E – faculty development/best practices

CMD Recommendation 2016L – expand our research capacity

Management of the Developmental Mathematics Program

Although about 60% of the courses offered in mathematics each semester are developmental, only 40% (16) of fulltime instructors serve on of the Developmental Math Committee this year. This is an increase in proportion of instructors since the last program review. This core of committee members manages a program that serves 5000-6000 students each semester. Having 40% of the instructors serve a program that enrolls 64% of the sections in mathematics is still disproportionate, but there are a few more people to shoulder that workload. While the class schedule and teaching assignments are the dean's responsibilities, the duties of the Developmental Math Committee include conducting program reviews and annual program review updates, creating and implementing new courses, reviewing and modifying all courses, selecting default textbooks, revising course and program student learning outcomes and assessments and program level outcomes and assessments, collecting and analyzing assessment data, working with IR on multiple statistical studies, providing professional development and training opportunities, staying current with emerging research into pedagogy and best practices, and participating in the state and national conversations about the future of developmental mathematics. We noted in the last review that due to increased accountability demanded by accreditation standards and in light of the Student Success Task Force legislation, emphasis on Student equity work, and the work on common student assessment, the duties of this committee have expanded in the last four years. The duties continue to expand as AB 86 (AEBG) proposes having members of the developmental committee be liaisons to the Adult Schools.

CMD Recommendation 2016B - course coordinators

CMD Recommendation 2016K – program coordinator

CMD Recommendation 2016F – fulltime faculty hires for developmental math

CMD Recommendation 2016G – fulltime faculty participation in CMD

Future Directions in Staffing and Professional Development

In the 2012 program review we wrote the following as desired areas for improvement:

"We want to make improvements in the following areas: (1) professional development and training opportunities; (2) course and program management; and (3) instructional support programs and services for all students.

There are still valid desires for improvement in these areas. In addition we wish to be proactive in the blending of the adult school and ECC goals and programs under AB 86.

(1) Professional Development and Training Opportunities

Redesigning the developmental mathematics program increases the need for ongoing, experiential, and collaborative professional development opportunities for both full-time and adjunct instructors. Particularly for the two accelerated courses, BAM and GEA, with their nontraditional approaches to teaching, it is imperative that instructors, as well as supplemental coaches, have the training and support for effective instruction.

We hope to build a community of instructors who are in the habit of implementing proven successful strategies in the developmental courses that they teach. In order to achieve this level of professional development, we must have consistent and grant-independent funding and we must compensate instructors for participating. – Developmental Mathematics 2012 Program Review

Creating this community of instructors is still a great need if we are to scale and implement our redeveloped accelerated courses to their greatest extent. What we have also identified is that, since the developmental courses are staffed primarily by adjuncts, the identification and hiring of adjuncts to teach the accelerated courses must be done in a manner so that there is sufficient time to train them so they feel confident and understand the courses they are undertaking. This fall saw an unusually large number of last minute emergency hires. Some landed in Math 37 and Math 67. With out the access to training for these non-traditional courses, the beginning of the semester has been difficult for both the students and the instructors.

(2) Course and Program Management

Managing the work within the Developmental Mathematics Program is an important challenge we must still address. We now have an Assistant Dean in the Math/ Computer Sciences Division, but her focus is not primarily Developmental Mathematics. In lieu of a dedicated person to oversee the developmental math program reassigned time for faculty in some form (a single Faculty Coordinator for Developmental Mathematics or several Course Coordinators) would be beneficial. It needs to be clear whose job it is to handle the large numbers of projects and tasks that allow the developmental mathematics program to function efficiently and effectively, including Counselor Intervention, Supplemental Instruction, student tutor training, Summer Math Academies, Faculty Cohorts, SLO assessments, AB 86 tasks, input on multiple measures decisions and equity implementation and research to ensure we are using the most effective approaches.

We favor a solution that includes faculty course coordinators. Course coordinators would facilitate both full time and adjunct instructors in helping them incorporate online homework systems, use active learning methods in instruction, allow for sharing of any coordinated materials, conduct SLO assessment cycles with broader participation and help those who wish to integrate affective domain activities. In addition, serving as a course coordinator provides an instructor leadership experience.

(3) Instructional Support Programs and Services

In 2012 we stated, "*We must find the resources and staff to ensure that all students have equitable and reasonable access to quality instructional support programs and services. These include the Summer Math Academies, Counselor Intervention, Supplemental Instruction, drop-in tutoring, and office hours.*

We must find the resources and facilities to ensure that all students have equitable and effective access to instructor office hours. Strategies for achieving this goal may include compensating adjunct instructors for office hours, a more formal system for sharing office hours, or encouraging fulltime and paying adjunct instructors to hold some office hours in the tutoring lab. "

With the exception of the Summer Math Academy, which has become institutionalized, the rest of these are still unrealized and are crucial for students' success and equity. As we become more and more aware of inequitable effects of our placement process, we must attend to the quality and consistency of instruction for the students placed in these courses takes. To have instructional support services be unevenly or even serendipitously distributed among the sections of developmental classes all but guarantees that some students have a greater chance of success than others due, not to ability or work habits, but by chance of the section of a class they choose to take.

> **CMD Recommendation 2016A_– pay adjuncts for office hours, professional development and committee work**
>
> **CMD Recommendation 2016J – expand effective programs, including math academies, SI, and counselor intervention**

VIII. Direction and Vision

Direction: Overview of Developmental Mathematics

The developmental mathematics program serves the varied pre-collegiate mathematics needs of our students. Specifically, it serves the students who need to meet a mathematics competency requirement (for example to earn an associate degree or satisfy the requirements of the nursing program), students who need preparation for a college-level general education mathematics course required for transfer, and students who need preparation for a college-level mathematics course required for a particular program or field of study (for example one of the calculus sequences for Science, Technology, Engineering or Mathematics (STEM) or economics).

Student success is affected by experiences within the classroom as well as the overall structure of the program. Both areas must be addressed. Changes made within the classroom can transform the learning experiences for our students. We can measure the effects of these changes through course success rates, and to some extent in the persistence rates to the next course. However, improvements in the classroom, while important, have only marginal effects on the outcomes of the developmental mathematics program. Structural features, such as placement procedures and the pipeline problem, have a much greater effect on the developmental and transfer-level completion rates. Positive changes made to the structure of the program have the potential to make substantial improvements in student completion rates.

Vision Forward

Succinctly put, the vision is one of transformation: to reduce the size of the credit developmental program altogether by getting more students into transfer-level mathematics and/or completion of competency requirements.

To address the structural interventions we would like to see **one-semester pathways to complete developmental mathematics** (or complete the mathematics competency requirement) for all students. First and foremost this will involve an improved placement process, whereby more students are placed according closer to their true capacity, as measured by more than just a placement exam. Secondly, we need to have a system of noncredit courses (such as the math academies) and noncredit corequisites to support students enrolled in credit courses. Our vision forward is, very simply, to improve the cohort success measures throughout the developmental mathematics program and in those first transfer-level courses. Doing so effectively will likely result in increased course success, retention, and persistence rates, but our focus must remain on students achieving milestone outcomes.

Tied to this vision are two parallel movements: to bring more high school students and students at adult education centers to ECC ready for transfer-level mathematics. This might mean **offering an ECC course in the 12th grade** to prepare students for transfer-level directly or for an appropriate one-semester transfer-preparation course. Similarly, we might be use a **noncredit program of courses** at an adult education center to create a bridge directly into transfer-level mathematics or one level below transfer.

In order to achieve these goals, we will need to develop a broad, ongoing, comprehensive professional development program for all instructors in order to create and nurture a community of practice that includes not only fulltime and adjunct mathematics community college instructors, but also instructors in our high schools and adult education centers. Coordinating such activities is well beyond our current management resources.

In order to achieve these goals, we will need to expand our ability to conduct meaningful research and find ways to include student voices in our decision-making processes.

In order to achieve these goals, we will need the physical space in which to do the work. Well-maintained and updated classrooms are crucial, as are unstructured spaces for student-faculty interactions outside the classroom.

In order to achieve these goals, we will need strong student academic support. We need to expand the capacity and effectiveness of both the Math Tutoring Center and Supplemental Instruction.

Equity – The Final Word

What role have issues of equity played in the 2016 Developmental Mathematics Program Review? It is clear that we have not ignored the issue entirely. We have included data, analysis and even recommendations related directly to race/ethnicity inequities (and yet, we have only mentioned gender inequities in passing). All of the interventions the Developmental Mathematics Committee has instigated in the past four years have been the sort that increases success for all students (a rising tide…). In some instances, equity gaps closed a bit, but we know this is not sufficient in the long run. Achievement gaps weigh heavily on our hearts; for the most part we despair of knowing what we can really do. It is tempting to think that this is just how the world is – that it is all of it is out of our hands. If we ever hope to overcome these achievement inequities, we will need the courage to examine them in light of the very real injury gaps and value gaps that commonly lie beneath the awareness of the privileged. For the past few years, the buzzword has been making students college-ready. We need to be asking if our program is truly student-ready for **all students**.

X. CMD Recommendations (2016 Program Review)

CMD Recommendation 2016A – pay adjuncts for office hours, professional development and committee work Compensate adjunct instructors teaching developmental mathematics for up to four hours a week, in order to participate more fully in the work of Committee D (including SLO assessments and discussions), professional development activities, and to provide students with office hours (potentially having them held in the tutoring center). [cost estimate: per adjunct instructor: 16 - 32 hours per semester @ $63.25/hr = $1012 - $2024] (MODIFIED Recommendation 2012D.3, Research, SLO, Student Feedback, *equity, instructional support, Strategic Initiative B)*

CMD Recommendation 2016B - course coordinators Create course coordinators for each developmental mathematics course with ten or more sections, in order to aid in the effectiveness of the SLO assessments through adjunct participation; to coordinate, orient, and mentor adjunct instructors; to expedite the creation and implementation of a comprehensive SLO assessment instrument; to provide and to promote professional development opportunities; and to conduct surveys of students and instructors and to disseminate research results. [cost estimate: if coordinators receive reassigned time, the cost would be the backfill of adjunct instructors for the course release] (MODIFIED Recommendation 2012B.2; Research, SLO, Staff, *instructional support, institutional effectiveness, Strategic Initiatives B and E)*

CMD Recommendation 2016C - scheduling based on education plans and research Adjust the number of sections of Arithmetic (Mathematics 12), Pre-Algebra (Mathematics 23) and BAM (Mathematics 37) to better fit the needs of students as indicated in educational plans and research. Adjust the number of sections of GEA (Mathematics 67), Intermediate Algebra for General Education (Mathematics 73) and Intermediate Algebra (Mathematics 80) to better fit the needs of students, as indicated by educational plans and research. Conduct research on who is taking math 73 and for what purpose (anecdotal evidence shows most/many should be in math 67 or math 80). [cost estimate: no direct cost to our division – college-wide cost estimate beyond our scope] (Research, Curriculum, SLO, Staffing **–** *equity, progress toward completion, Strategic Initiative B)*

CMD Recommendation 2016D – materials for threads spanning multiple courses Create summer special assignments for faculty to create Culturally Relevant Teaching (CRT)-aligned activity packets (arcs) for quantitative reasoning (Math 12/23/37), for problem solving (Math 37/40/67/73), and for linear modeling (Math 37/67), for use in professional development workshop series mentioned above and for use in indicated courses. [cost estimate: over two years, 3 – 6 instructors, 50 hours each @ $47.43 = $7114.50 - $14,229] (Research, Curriculum, Staffing, *equity, instructional support, Strategic Initiatives A and B)*

CMD Recommendation 2016E – faculty development/best practices Create and offer a professional development workshop series to recruit and to train new developmental mathematics instructors in equity-minded teaching, cultural literacy, learner-centered teaching strategies, as recommended by AMATYC, and effective faculty collaboration, in order to increase the pool of instructors prepared to do an excellent job teaching our developmental courses, with adjunct faculty paid for the training and target start date fall, 2017. [cost estimate: 1 workshop leader and 6 instructors per year for ~$14,230] (Research, Curriculum, SLO, Staffing, *equity, progress toward completion, and student success, Strategic Initiative B)*

CMD Recommendation 2016F – fulltime faculty hires for developmental math Hire more fulltime faculty committed to designing, teaching, and assessing effective developmental mathematics. [cost estimate: ~$110,000 per year for each new hire] (Modified 2012C.2, Research, SLO, Student Feedback, Staffing, *equity, progress to completion, Strategic Initiative B)*

CMD Recommendation 2016G – fulltime faculty participation in CMD Incentivize more fulltime instructors participate in Committee D work to effectively and thoroughly participate in SLO assessment, textbook selection, course review and program review. [cost estimate: no direct cost to our division] (Research, SLO, Student Feedback, Staffing, *equity, progress to completion, Strategic Initiative B)*

CMD Recommendation 2016H – redesign placement process using multiple measures/research In light of the research that highlights the general ineffectiveness of placement exams and the inequities exacerbates among SEP-targeted populations, replace our current placement process with a multiple measure placement process using high school records and GPA, among other measures. [cost estimate: no direct cost to our division – college-wide cost estimate beyond our scope] (Research, Curriculum, SLO, Student Feedback, *equity, progress toward completion, and student success, Strategic Initiative B)*

CMD Recommendation 2016I – improve information about multiple pathways Conduct regular (once per semester) information drives about different pathways for different students. This needs to go to students, faculty and counselors. [cost estimate: no direct cost to our division] (Research, Curriculum, Student Feedback, *equity, progress toward completion, Strategic Initiative B)*

CMD Recommendation 2016J – expand effective programs, including math academies, SI, and counselor intervention Continue and expand programs that have shown to be effective, particularly for SEP-targeted students and in sections of courses taught by adjunct instructors. In particular, we should expand Supplemental Instruction to include more sections of developmental mathematics. Expand counselor intervention should to increase persistence. Offer noncredit math academies (Math 17A, 27A, 47A) frequently during the entire year. [cost estimate: additional 6 per year @ $3000 - $5000 per Math Academy = $18,000 - $30,000; additional 60 SI coaches per year @ $960/semester = $57,600; 156 new sections covered each year (with only 2 hrs/section) @ ~$120/section = $24,336] (Modified 2012B Research, Curriculum, Student Feedback, *equity, progress toward completion, Strategic Initiative B)*

CMD Recommendation 2016K – program coordinator Hire a coordinator to manage developmental mathematics; to coordinate noncredit, adult education pathways, and high school dual enrollment programs (as they develop). Duties may include assisting with the hiring and training of noncredit instructors, coordinating professional development for adult education and dual enrollment instructors; administering the noncredit mathematics program; class schedules and teaching assignments; facilitating faculty course cohorts; mentoring and evaluating instructors; coordinating course reviews and program reviews; researching program effectiveness; supervising SLO assessments and reports; reviewing program technology and facility needs; organizing professional development; applying for external funding and managing grants. [cost estimate: ~$100,000 per year] (Modified 2012B.1, Research, SLO, Staffing, *instructional support, institutional effectiveness, Strategic Initiatives B and E)*

CMD Recommendation 2016L – expand our research capacity Expand our research capacity at both the college and department level in order to obtain the data we need to make good decisions. In particular, we need the ability to measure how changes to curriculum and pedagogy affect learning and student attitude; to survey students and instructors for course reviews; and capture student voices and student input. [cost estimate: no direct cost to our division] (Research, SLO, Student Feedback, *equity, instructional support, institutional effectiveness, Strategic Initiatives B and E)*

CMD Recommendation 2016M – student advisory group Create/recruit a sustainable Developmental Mathematics Student Equity Advisory Student Group with students from such groups on campus as ASO, EOPS, KEAS, Project Success, Puente, and FYE. Students would work with Committee D to create research questions and gather data for developmental mathematics program review, particularly related to student equity, but also to help the committee with SLO assessment review and course review. [cost estimate: marginal cost to our division (food, etc.)] (Research, Curriculum, SLO, Student Feedback, *equity, learning support, instructional effectiveness, Strategic Initiatives B and E)*

CMD Recommendation 2016N – access to transfer-level courses Conduct research into students' access to transfer-level courses, in particular Math 120, 130, 150, and 170. Plan a general education math "catch-up year" for Math 120 and Math 150 sections based on research results. Offer more Math 150 sections in various formats, including hybrid, large lecture sections, weekend classes, at least on a temporary basis, in order to catch up with demand. [cost estimate: no direct cost to our division] (Research, *equity, progress toward completion, and student success, Strategic Initiatives B and E)*

CMD Recommendation 2016O – new GTE course Investigate possibilities of a two-semester pathway from elementary algebra to calculus. For CMD, this would mean developing an integrated algebra/geometry course that would serve as a prerequisite for an integrated trigonometry/precalculus course. [cost estimate: 2 instructors, 50 hours each @ $47.43 = $4743] (Curriculum, *equity, progress toward completion, Strategic Initiative B)*

CMD Recommendation 2016P – noncredit and corequisite courses Investigate and create a certificate program of noncredit mathematics courses that could function in several ways, including as co-requisites for credit courses such as math 120 and math 150, or as part of an adult education pathway (AB86). [cost estimate: 2 instructors, 50 hours each @ $47.43 = $4743] (Curriculum, *equity, progress toward completion, student success, Strategic Initiative B)*

CMD Recommendation 2016Q – new pathways with co-requisite support Investigate possibilities of one-semester or two-semester pathways to completion of a transfer-level course. This might be creating sections of intermediate algebra with a co-requisite or creating co-requisite courses for math

120 and math 150. [cost estimate: 2 instructors, 50 hours each @ $47.43 = $4743] (Curriculum *equity, progress toward completion, Strategic Initiative B)*

CMD Recommendation 2016R_ – normalize competency and challenge tests Norm our associate degree math competency test and all other challenge tests. [cost estimate: no direct cost to our division] (Curriculum, *compliance with Title 5 regulations, equity, progress toward completion, Strategic Initiative B)*

CMD Recommendation 2016S - include support activities in scheduling and registration
Create the means in our online registration system so that noncredit co-requisite courses, suitable academic strategies courses, and even SI sessions can be offered as course supplements, enabling students to sign up for these at registration, so that these can be built into a student's schedule of classes. [cost estimate: no direct cost to our division] (Student Feedback, *learning support, Strategic Initiative B)*

CMD Recommendation 2016T – fulltime tutoring coordinator Hire a fulltime tutoring coordinator to manage the training of tutors and to expand the use and availability of tutors, e.g., increased tutoring during finals week and tutor outreach to classes during the semester. [cost estimate: ~$100,000 per year] (Student Feedback, *student learning support, Strategic Initiative B)*

CMD Recommendation 2016U – improve tutoring Promote greater use of the tutoring center by having student tutors visit classrooms once or twice during each semester and by having student tutors lead review sessions for targeted "just-in-time" topics and increased and improved training. [cost estimate: no direct cost to our division] (Student Feedback, *instructional support, Strategic Initiative B)*

CMD Recommendation 2016V – classroom computing and flexible classrooms Purchase classroom sets of laptops (or similar equipment) and portable charging carts for use in general classrooms. Plan regular updates, maintenance and replacement. Create more classrooms that can be used as both computer labs and group-work friendly classrooms, utilizing tablets or thin clients or equivalent, as well as smart boards. [cost estimate: two classroom sets of laptops and carts for ~$30,000; six converted classrooms with hideaway computers for ~$735,000] (Student Feedback, Facilities & Equipment, *instructional and student learning support, progress toward completion through greater course offerings, Strategic Initiative B)*

CMD Recommendation 2016W – unstructured student study space Create more unstructured study space for students in the hallways of the MBA building and in the areas outside surrounding the MBA building, setting up tables, chairs where possible and providing cover as required for year-round use. In general, create more unstructured study space for students across campus wherever possible, available to students whenever the campus is open. [cost estimate: hard to estimate, but for example, 6 tables, 40 chairs, canopies and heat lamps for ~$5,000 - $20,000] (Student Feedback, Facilities & Equipment, *student learning support, Strategic Initiative B)*

CMD Recommendation 2016X – equipment inventory Maintain an inventory of equipment and supplies essential for effective classroom teaching, to be available in the division office at all times, including intersessions. This should include erasers, erase rags, chalk, dry-erase markers, and document viewer and projector lamps. The inventory should be used to keep and maintain sufficient supplies. [cost estimate:] (Facilities & Equipment, *student learning support, Strategic Initiative B)*

CMD Recommendation 2016Y – up-to-date and working equipment Plan for ongoing replacement and regular maintenance of document cameras with equipment that is teaching-friendly in design, as recommended by teaching faculty.   Provide high quality scanners in workrooms on both the second and third floors and large wall clocks in the hallways. [cost estimate: ~$5000] (Facilities & Equipment, *student learning support, Strategic Initiative B)*

CMD Recommendation 2016Z – efficient room use in MBA Conduct a building-wide room-use inventory and reassign rooms in MBA among the divisions in a manner proportional to the number of students served, sharing space as needed to avoid offering math courses outside of the MBA building unnecessarily. [cost estimate: no direct cost to our division]   (Facilities & Equipment, *student learning support, Strategic Initiative B)*

CMD Recommendation 2016AA – dedicated classrooms Create three or four classrooms dedicated to Math 37 and Math 67, since each section of this course encourages (but does not require) a common set of materials, manipulatives, technological equipment and software. Current materials could then be stored in these rooms. [cost estimate: no direct cost to our division]   (Facilities & Equipment, *student learning support, Strategic Initiative B)*

CMD Recommendation 2016BB – storage space Create non-classroom storage space in the MBA building for equipment, manipulatives, and other resources, accessible to all instructors at all times. [cost estimate: no direct cost to our division]   (Facilities & Equipment, *instructional support, Strategic Initiatives A and B)*

CMD Recommendation 2016CC – software for teachers and professional development
Make available to all fulltime and adjunct instructors the software needed for teaching effectively and creating course material, as faculty recommend, such as Scientific Notebook and LaTex, Geogebra and Geometer's Sketchpad.   Provide funding for faculty to run workshops periodically during the year to train other faculty in current software that is available to use in and out of the classroom. [cost estimate: ~$7000 for software and ~$5000 for training for up to 20 instructors per year]   (Technology & Software, *instructional support, Strategic Initiatives A and B)*

The committee's top six recommendations overall were ranked:

1. **CMD Recommendation 2016A – pay adjuncts for office hours, professional development and committee work**
2. **CMD Recommendation 2016Z – efficient room use in MBA**
3. **CMD Recommendation 2016H – redesign placement process using multiple measures/research**
4. **CMD Recommendation 2016T – fulltime tutoring coordinator**
5. **CMD Recommendation 2016F – fulltime faculty hires for developmental math**
6. **CMD Recommendation 2016W – unstructured student study space**

For TracDat, we ranked the recommendations in each funding category:

Staffing:

1. **CMD Recommendation 2016A – pay adjuncts for office hours, professional development and committee work**
2. **CMD Recommendation 2016T – fulltime tutoring coordinator**
3. **CMD Recommendation 2016K – program coordinator**
4. **CMD Recommendation 2016J – expand effective programs, including math academies, SI, and counselor intervention**
5. **CMD Recommendation 2016B - course coordinators**
6. **CMD Recommendation 2016F – fulltime faculty hires for developmental math**

Software/Hardware:

1. **CMD Recommendation 2016CC – software for teachers and professional development**

Instructional Equipment:

1. **CMD Recommendation 2016Y – up-to-date and working equipment**
2. **CMD Recommendation 2016V – classroom computing and flexible classrooms**
3. **CMD Recommendation 2016X – equipment inventory**

Non-Instructional Equipment:

1. **CMD Recommendation 2016Y – up-to-date and working equipment**
2. **CMD Recommendation 2016X – equipment inventory**

Furniture:

1. **CMD Recommendation 2016W – unstructured student study space**

Facilities:

1. **CMD Recommendation 2016Z – efficient room use in MBA**
2. **CMD Recommendation 2016W – unstructured student study space**
3. **CMD Recommendation 2016V – classroom computing and flexible classrooms**
4. **CMD Recommendation 2016AA – dedicated classrooms**
5. **CMD Recommendation 2016BB – storage space**

Other:

1. **CMD Recommendation 2016H – redesign placement process using multiple measures/research**

2. **CMD Recommendation 2016C - scheduling based on education plans and research**
3. **CMD Recommendation 2016U – improve tutoring**
4. **CMD Recommendation 2016R_ – normalize competency and challenge tests**
5. **CMD Recommendation 2016N – access to transfer-level courses**
6. **CMD Recommendation 2016E – faculty development/best practices**
7. **CMD Recommendation 2016G – fulltime faculty participation in CMD**
8. **CMD Recommendation 2016I – improve information about multiple pathways**
9. **CMD Recommendation 2016P – noncredit and corequisite courses**
10. **CMD Recommendation 2016S - include support activities in scheduling and registration**
11. **CMD Recommendation 2016L – expand our research capacity**
12. **CMD Recommendation 2016M – student advisory group**
13. **CMD Recommendation 2016O – new GTE course**
14. **CMD Recommendation 2016Q – new pathways with co-requisite support**
15. **CMD Recommendation 2016D – materials for threads spanning multiple courses**