Executive Summary:

In 2014, Golden West College President Wes Bryan recommended an extensive review of the mathematics program be completed to address concerns over low student completion, barriers to student success, and persistence toward the next math level. Through the Program Vitality Review process, a committee was formed to evaluate the basic skills mathematics coursework, and in a second phase, transfer level mathematics. The focus on both PVR processes is the success of the students as defined by satisfactory completion of a course.

The second phase of Math PVR focuses on transfer-level math courses. The committee convened during Spring 2015 and continued work throughout the Fall 2015 semester. The committee consisted of two full-time math faculty, one member of the science faculty from chemistry, one math professor from within the district (Coastline College) assigned as the CFE representative, one counselor/transfer center coordinator, and one administrator from criminal justice. The campus research team joined on a regular basis and assisted with data collection and survey administration. The Criminal Justice administrator and Counseling faculty served as co-chairs for the committee. The main charges of this committee include:

1. Identify and recommend strategies that have the potential to improve student success rates.
2. Consider how the STEM-related courses might be modified to strengthen their connection between math content and STEM applications.
3. Consider and create new transferable math courses that are more specifically contextualized for non-STEM students.
4. Consider how existing courses might be changed in terms of method of delivery, class size, class scheduling, technology support, pedagogical and/or programmatic changes, staff development and other strategies.

Based on robust discussions around the literature on mathematics and best teaching practices and data analysis (both qualitative and quantitative), the committee reached consensus on the following outcomes and recommendations:

1. Consistent and Sustained Professional Development
2. Establish Course Coordinator for each course
3. Common Final Exams for all transfer-level mathematics coursework
4. Increase student access to faculty
5. Reduce class size on large-class size factor courses.
6. Work with Institutional Research to determine impact of class size reduction, common exams, and new teaching models.
7. Establishment of a formalized Supplemental Instruction model is needed to provide the necessary curricular and personal support for students.
8. Establish support for STEM-courses that are “gateway” courses
9. Establish Learning Communities centered on STEM coursework.
10. Support in-class technology.
11. Realign math programs creating two departments in one unified division
12. Commitment by college to success in Math and STEM.

These recommendations are supported unanimously by the Math PVR 2.0 committee, and were reached without regard to funding, current infrastructure, and hiring guidelines.

A careful review of President Bryan's directive for Math PVR 2.0 was made emphasizing the "two major areas" of focus provided by the president. Each area was itemized, examined and addressed as a group, with consensus being reached on each one. A review of current literature and programs at each campus was conducted and a summary of findings is presented.

Brief History:

In 2014, Golden West College President Wes Bryan recommended an extensive review of the mathematics program be completed to address concerns over low student completion, barriers to student success, and persistence toward the next math level. Through the Program Vitality Review process, a committee was formed to evaluate the remedial (developmental) / basic skills mathematics coursework, and in a second phase, transfer level mathematics. The focus on both PVR processes is the success of the students as defined by satisfactory completion of a course.

Upon completion of the Remedial Math PVR 1.0, the College President reorganized the math department by separating the remedial math program (consisting of Math G010: Beginning Algebra and Math G030: Intermediate Algebra) and relocating the program to a new College Readiness in the Learning Resources Center (LRC) under the supervision of then interim-Dean Alex Miranda. The relocation of the developmental math program allowed for alignment with local high schools to better prepare students entering the college, explore pre-assessment preparation workshops and math refresher programs, and experiment with class size variations and teaching options. The transfer-level math program continued under the supervision of Dean Jeff Courchaine. Transfer-level math courses include all courses numbered G100 and above, and are generally accepted for transfer to four-year colleges and universities. At Golden West College, there are 13 transfer-level math courses that consist of the following:

Math G100: Liberal Arts Mathematics,
Math G104: Math for Elementary Teachers,
Math G115: College Algebra,
Math G120: Trigonometry,
Math G140: Business Calculus,
Math G160: Introduction to Statistics,
Math G170: Pre-Calculus,
Math G180: Calculus 1,
Math G185: Calculus 2,
Math G235: Applied Linear Algebra,
Math G280: Calculus 3,
Math G282: Ordinary Differential Equations, and
Math G285: Introduction to Linear Algebra and Ordinary Differential Equations.

These courses meet the needs of students who plan to transfer to four-year colleges and universities, and satisfy general education requirements as well as lower-division major coursework in science, engineering, mathematics, nursing, psychology and other social sciences. It is this coursework and completion, student success, and persistence that the Math PVR 2.0 will direct its focus.

During the Spring 2015 term and continuing throughout the Fall 2015 semester, the Math PVR 2.0 process convened. The directive was similar to that of the Math PVR 1.0 and a comparable campus-wide committee was formed. The committee consisted of two full-time math faculty, one member of the science faculty from chemistry, one math professor from within the district (Coastline College) assigned as the CFE representative, one counselor/transfer center coordinator, and one administrator from criminal justice. As well, the campus research team joined on a regular basis and assisted with data collection and survey administration. The Criminal Justice administrator and Counseling faculty served as co-chairs for the committee. Based on lessons learned from the PVR 1.0 process, designated meeting dates were calendared for the semester, committee chairs established and detailed agendas and minutes were recorded.

The main charges of this committee include:

1. Identify and recommend strategies that have the potential to improve student success rates.
2. Consider how the STEM-related courses might be modified to strengthen their connection between math content and STEM applications.
3. Consider and create new transferable math courses that are more specifically contextualized for non-STEM students.
4. Consider how existing courses might be changed in terms of method of delivery, class size, class scheduling, technology support, pedagogical and/or programmatic changes, staff development and other strategies.

As well, the committee was encouraged to look into creating consistent evaluation strategies and teaching methodologies across all sections of the same course in a manner to increase both student success and math competence, and evaluate and adopt different math pathways that are more closely connected to a students' program of choice.

Based on these directives, a review of the course completion and student success rates was evaluated. Additionally, an investigation into current practices of faculty including course coordinators (leads), training and professional development, common assessments, evaluation, and instructional methodologies was conducted. Several insights were revealed.

Directive 1: Student Success and Completion

1a: Faculty Load

The number of full-time faculty to support a transfer-level math program has declined dramatically, and can no longer support the level of coursework necessary to build a strong transfer program. The number of full-time, tenured faculty in the department has decreased from 7 in fall 2013 to just 3 in spring 2016. Also during this period, several of the department's stronger part-time faculty left, as they were hired for full-time positions at our neighboring colleges. These reductions in faculty left the department needing to hire new part-time instructors, some with little or no teaching experience at the community college level. As such, over 75% of the transfer-level math courses are now taught by part-time faculty. The table below demonstrates the decrease in percentage of sections taught by full-time faculty over the last three academic years (Fall and Spring semesters only). Since the 2012-13 academic year, the percentage of math sections taught by full-time faculty have dropped from 58% to 34%. In contrast, the percentage of all GWC sections taught by full-time faculty dropped from 56% to 51%.

TABLE D1 – Percentage of Sections Taught by Full-time Faculty from 2012-13 to 2014-15

		2012-13	2013-14	2014-15
GWC Total	**FT Sections**	1007	1057	1063
	PT Sections	796	940	1025
	Total Sections	1803	1997	2088
	% sections taught by full-time	56%	53%	51%
Math	**FT Sections**	75	82	57
	PT Sections	55	80	113
	Total Sections	130	162	170
	% sections taught by full-time	58%	51%	34%

The Math department is increasing its utilization of part-time faculty, who have teaching assignments at several other colleges and are not available for office hours due to their stretched workload. Evaluation and

mentoring of the part-time faculty has also become increasingly challenging with the limited number of full-time faculty. Each full-time faculty has taken on the responsibilities of being a course coordinator for multiple courses, and uses this process to communicate with the part-time faculty on a variety of topics including teaching to the course outline of record, adhering to campus processes, and coordinating SLO data from each of their respective courses. Continued discussions about SLO data and other course matters take place at the department meetings throughout each semester. Although part-time faculty has the option to attend the meetings, they never do, arguing their limited availability outside of their teaching assignment makes attendance challenging.

1b: Course Demand and Enrollment Trends

Since 2010-2011, each of the transfer-level courses has seen major growth in demand. This has led to an increase in the number of transfer-level courses offered with double the number of sections of each course offered by 2015-2016. In particular, Statistics (Math G160) has seen the greatest enrollment increase, and the number of sections offered has increased from 4 sections in 2010-2011 to 12 sections in 2015-2016. Courses offered during summer (8-weeks) and winter (4-weeks) sessions have been limited due to budgetary constraints; however, Statistics has consistently been offered during both sessions.

The limited number of full-time faculty has also led to an increase in class size and difficulty with alternative scheduling patterns. All offered sections of Statistics, Liberal Arts Math (Math G100), and College Algebra (Math G115) are scheduled as Large Class Factor (LCF) consisting of 72 or more students per section while the other math courses are kept at class sizes of 36.

The Golden West College Transfer Mathematics program maintains strong student demand and is a requirement in a number of college degrees and certificates. For the eight semester time frame (Summer 2013 through Fall 2015) examined, the program has an average census date enrollment for the two major terms (Fall, Spring) of 1,874.2 students and an average census enrollment of 355 students for Summer terms (see table D1). Compared with a similar campus program, English, over the same time frame (Summer 2013 through Fall 2015) shows similar enrollment figures. The average census date enrollment (English) for the major terms (Fall, Spring) was 1,937 students and the average census enrollment (English) for Summer terms was 255 students. These numbers display a nearly equivalent demand for the two programs.

A total of 37 programs require at least one transfer level Mathematics course. This number includes 21 Associate Degree Transfer (ADT), 12 Associate of Arts Degrees (AA) and 4 certificate programs. Several degrees require multiple transfer level Mathematics courses. (See Table D3). With new transfer degrees being developed (7 additional subject areas available), the demand for transfer-level mathematics courses will continue to increase.

TABLE D1 – Transfer Mathematics Program Demand Summer 2013 – Spring 2015

Academic Year		2013-2014											
Semester		Summer				Fall				Spring			
Subject	CourseID	Sections (adj)	Enrollment (Census)	Max Seats	Fill Rate (adj)	Sections (adj)	Enrollment (Census)	Max Seats	Fill Rate (adj)	Sections (adj)	Enrollment (Census)	Max Seats	Fill Rate (adj)
Mathematics	MATH 100	0.0	0	0	0.0%	2.0	119	144	82.6%	2.0	140	144	97.2%
	MATH 104	0.0	0	0	0.0%	1.0	33	36	91.7%	1.0	35	36	97.2%
	MATH 115	1.0	68	72	94.4%	4.0	355	360	98.6%	4.0	329	360	91.4%
	MATH 120	1.0	41	36	113.9%	4.0	150	144	104.2%	4.0	151	144	104.9%
	MATH 140	0.0	0	0	0.0%	2.0	81	72	112.5%	2.0	89	71	125.4%
	MATH 160	2.0	136	144	94.4%	7.0	455	432	105.3%	8.0	489	468	104.5%
	MATH 170	1.0	38	36	105.6%	4.0	159	144	110.4%	4.0	147	144	102.1%
	MATH 180	1.0	30	36	83.3%	7.0	259	252	102.8%	7.0	210	252	83.3%
	MATH 185	1.0	38	36	105.6%	4.0	168	144	116.7%	4.0	147	144	102.1%
	MATH 235	0.0	0	0	0.0%	0.0	0	0	0.0%	1.0	28	36	77.8%
	MATH 280	0.0	0	0	0.0%	1.0	47	36	130.6%	2.0	78	72	108.3%
	MATH 282	0.0	0	0	0.0%	1.0	9	36	25.0%	0.0	0	0	0.0%
	MATH 285	0.0	0	0	0.0%	0.0	0	0	0.0%	0.0	0	0	0.0%
Total by COLUMNS		7.0	351	360	**99.5%**	37.0	1,835	1,800	**98.2%**	39.0	1,843	1,871	**99.5%**

Academic Year	2014-2015

Semester		Summer				Fall				Spring			
Subject	CourseID	Sections (adj)	Enrollment (Census)	Max Seats	Fill Rate (adj)	Sections (adj)	Enrollment (Census)	Max Seats	Fill Rate (adj)	Sections (adj)	Enrollment (Census)	Max Seats	Fill Rate (adj)
Mathematics	MATH 100	0.0	0	0	0.0%	2.0	123	144	85.4%	2.0	103	144	71.5%
	MATH 104	0.0	0	0	0.0%	1.0	42	36	116.7%	1.0	40	36	111.1%
	MATH 115	1.0	59	72	81.9%	4.0	350	360	97.2%	4.0	345	360	95.8%
	MATH 120	1.0	42	36	116.7%	4.0	167	144	116.0%	4.0	163	144	113.2%
	MATH 140	1.0	27	36	75.0%	2.0	86	72	119.4%	2.0	88	72	122.2%
	MATH 160	2.0	143	144	99.3%	7.0	450	432	104.2%	9.0	550	612	89.9%
	MATH 170	1.0	36	36	100.0%	4.0	160	144	111.1%	4.0	129	144	89.6%
	MATH 180	1.0	38	36	105.6%	7.0	254	252	100.8%	7.0	218	252	86.5%
	MATH 185	1.0	38	36	105.6%	4.0	141	144	97.9%	4.0	145	144	100.7%
	MATH 235	0.0	0	0	0.0%	0.0	0	0	0.0%	1.0	26	36	72.2%
	MATH 280	0.0	0	0	0.0%	2.0	74	72	102.8%	2.0	76	72	105.6%
	MATH 282	0.0	0	0	0.0%	0.0	0	0	0.0%	0.0	0	0	0.0%
	MATH 285	0.0	0	0	0.0%	1.0	34	36	94.4%	0.0	0	0	0.0%
Total by COLUMNS		8.0	383	396	**97.7%**	38.0	1,881	1,836	**104.2%**	40.0	1,883	2,016	**96.2%**

Academic Year	2015-2016		
Semester	Summer	Fall	Total

Subject	CourseID	Sections (adj)	Enrollment (Census)	Max Seats	Fill Rate (adj)	Sections (adj)	Enrollment (Census)	Max Seats	Fill Rate (adj)	Sections (adj)	Enrollment (Census)	Max Seats	Fill Rate (adj)
Mathematics	MATH 100	0.0	0	0	0.0%	2.0	123	144	85.4%	10.0	608.0	720.0	84.4%
	MATH 104	0.0	0	0	0.0%	1.0	37	36	102.8%	5.0	187.0	180.0	103.9%
	MATH 115	1.0	59	72	81.9%	4.0	359	360	99.7%	23.0	1,924.0	2,016.0	95.4%
	MATH 120	1.0	34	36	94.4%	4.0	171	144	118.8%	23.0	919.0	828.0	111.0%
	MATH 140	1.0	29	36	80.6%	2.0	71	72	98.6%	12.0	471.0	431.0	109.3%
	MATH 160	2.0	111	144	77.1%	9.0	559	612	91.3%	46.0	2,893.0	2,988.0	96.8%
	MATH 170	1.0	31	36	86.1%	4.0	130	144	90.3%	23.0	830.0	828.0	100.2%
	MATH 180	1.0	30	36	83.3%	7.0	249	252	98.8%	38.0	1,288.0	1,368.0	94.2%
	MATH 185	1.0	36	36	100.0%	4.0	131	144	91.0%	23.0	844.0	828.0	101.9%
	MATH 235	0.0	0	0	0.0%	0.0	0	0	0.0%	2.0	54.0	72.0	75.0%
	MATH 280	0.0	0	0	0.0%	2.0	74	72	102.8%	9.0	349.0	324.0	107.7%
	MATH 282	0.0	0	0	0.0%	0.0	0	0	0.0%	1.0	9.0	36.0	25.0%
	MATH 285	0.0	0	0	0.0%	1.0	25	36	69.4%	2.0	59.0	72.0	81.9%
Total by COLUMNS		8.0	330	396	**86.2%**	40	1,929	2,016	**95.4%**	217.0	10,435.0	10,691.0	**91.3%**

TABLE D3 – Programs requiring Transfer Mathematics Courses

PROGRAM	Math G100	Math G103 [1]	Math G104	Math G115/ G120	Math G140	Math G160	Math G170	Math G180	Math G185	*Math G155*[1]	OTHER
Administration of Justice ADT						X					
Anthropology ADT						X					
Art ADT (one from):	X	X		X	X	X	X	X	X		
Studio Art ADT (one from):	X	X		X	X	X	X	X	X		
Business Administration ADT					X	X					
Communication Studies (one from):											
Elementary Teacher ADT		X	X			X					
English ADT (one from):	X	X		X	X	X	X	X	X		
Computer Science ADT								X	X		
Geography ADT						X					
Geology ADT								X	X		
Human Resources Option Cert. of Achievement						X					
Kinesiology ADT						X					
Mathematics ADT						X (optn)		X	X		Math G280 Math G282 Math G235 Math G285
Music ADT (one from):	X	X		X	X	X	X	X	X		
Philosophy ADT (one from):	X	X		X	X	X	X	X	X		
Physics ADT								X	X		Math G280
Political Science ADT						X					
Psychology ADT						X					
Sociology ADT						X					
Spanish ADT (One from):	X	X		X	X	X	X	X	X		
Theatre Arts ADT (One from):	X	X		X	X	X	X	X	X		
Nursing: LVN to RN						X					

[1] Math G103 and Math G155 are currently suspended, but still approved courses for these degrees.

PROGRAM	Math G100	Math G103 [2]	Math G104	Math G115/ G120	Math G140	Math G160	Math G170	Math G180	Math G185	*Math G155*[1]	OTHER
Nursing: RN						X					
Chemistry AA								X			
Elementary Teacher A.A.											Math G104
General Biology A.A.							X or	X			
Liberal Arts: Emphasis in Science				X							
Liberal Arts: Emphasis in Bus. & Technology					X	X				*X*	
Liberal Arts: Emphasis in Mathematics (select from)		X		X	X	X	X	X	X	*X*	
Liberal Studies for Elementary Educ. A.A.	X	X		X							Math G104
Mathematics AA								X	X		Math G280 Math G282 Math G235 Math G285
Physics AA								X	X		
Psychology AA						X					
General Management Cert. of Achievement						X					
CSU-GE Breadth Certification	X	X	X	X	X	X	X	X	X	*X*	
IGETC Certification	X			X	X	X	X	X	X		
PROGRAM	**Math G100**	**Math G103 [3]**	**Math G104**	**Math G115/ G120**	**Math G140**	**Math G160**	**Math G170**	**Math G180**	**Math G185**	***Math G155*[1]**	**OTHER**

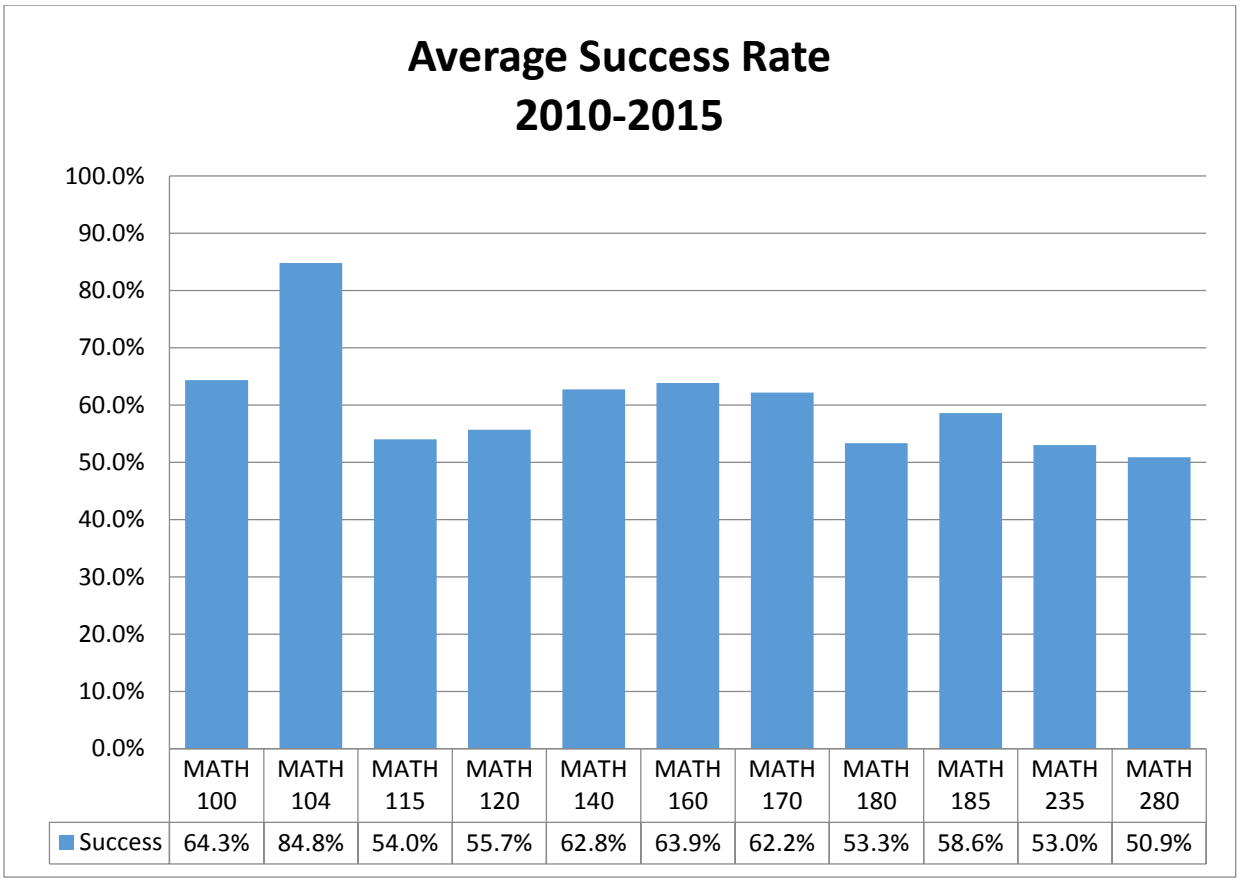
[2] Math G103 and Math G155 are currently suspended, but still approved courses for these degrees.

1c: Course Completion

In recent years, there have been at least 2 full-time faculty dedicated to teaching most of the Statistics sections and the annual average success rate in Statistics has increased from 56.2% in 2010-2011 to 67.3% in 2014-2015. Similar trends can be seen in Math G120: Trigonometry with a 13.4% increase in average success rate from 2010 to 2015. In Math G115: College Algebra, the average success rate has remained relatively steady at 55.6% in 2014-2015.

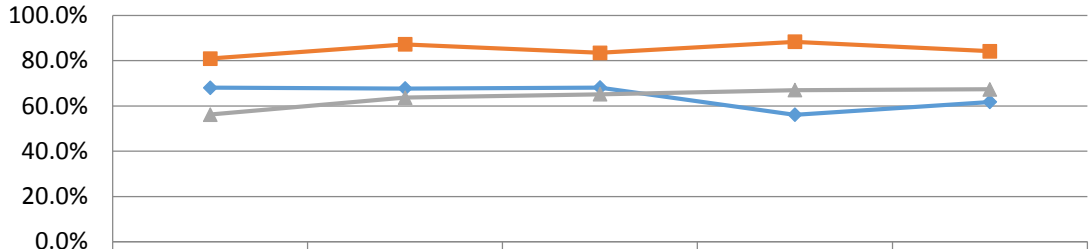
Conversely, during the same time period the annual average success rates for Math G170: Pre-Calculus, Math G140: Business Calculus, Math G180: Calculus I, Math G185: Calculus 2, Math G280: Calculus 3, and Math G235: Linear Algebra have decreased. Upon examination of the 5-year (2010 – 2015) average success rate for each course, it is clear that the STEM pathway courses have below 60% average success rates while non-STEM courses are above 60%. This is of great concern to the department since these courses are part of the required core courses for the Mathematics ADT, and many other transfer programs.

Due to a variety of factors, including those already discussed, the quality of the transfer math program has been put at risk. This has a negative impact on a student's pathway through the coursework, degree completion at GWC, and transfer to four-year colleges and universities.

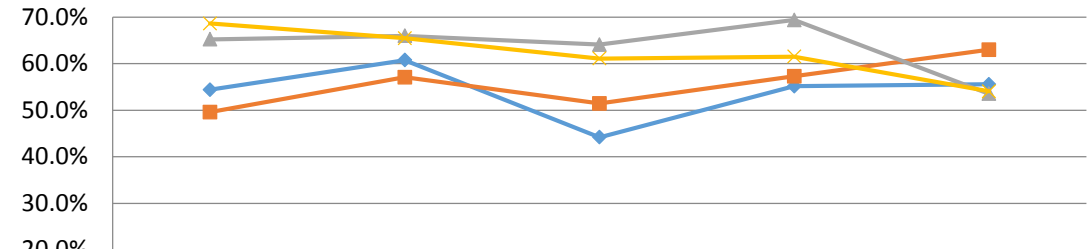


	MATH 100	MATH 104	MATH 115	MATH 120	MATH 140	MATH 160	MATH 170	MATH 180	MATH 185	MATH 235	MATH 280
Success	64.3%	84.8%	54.0%	55.7%	62.8%	63.9%	62.2%	53.3%	58.6%	53.0%	50.9%

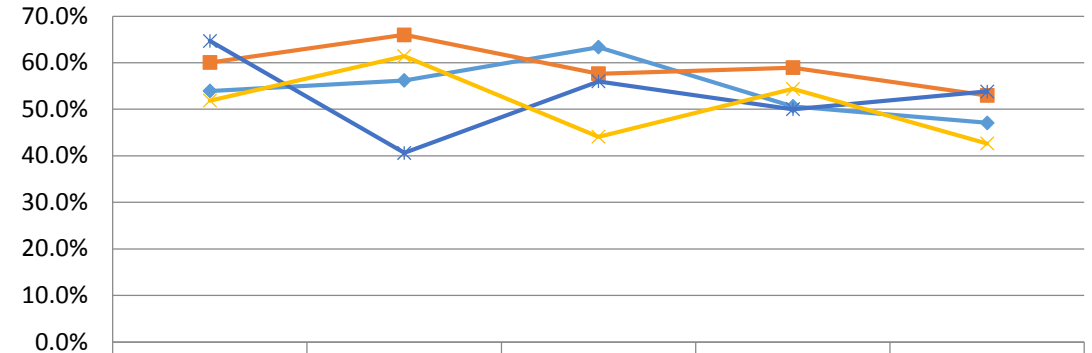
Average Success Rate (Summer, Fall, Spring)



	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015
MATH 100	68.0%	67.7%	68.1%	56.1%	61.8%
MATH 104	81.0%	87.2%	83.5%	88.3%	84.2%
MATH 160	56.2%	63.6%	65.2%	67.0%	67.3%



	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015
MATH 115	54.4%	60.8%	44.2%	55.2%	55.6%
MATH 120	49.6%	57.1%	51.4%	57.3%	63.0%
MATH 140	65.2%	66.0%	64.1%	69.4%	53.6%
MATH 170	68.6%	65.5%	61.1%	61.5%	54.1%



	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015
MATH 180	53.9%	56.2%	63.4%	50.6%	47.1%
MATH 185	60.0%	66.0%	57.6%	59.0%	53.0%
MATH 235	64.7%	40.6%	56.0%	50.0%	53.8%
MATH 280	51.9%	61.4%	44.1%	54.4%	42.7%

While the rates of success in each area are improving in some courses, there is a documented need to increase focus and success in STEM-based math coursework. The committee agrees that additional professional development, standardization in evaluation methods, and increasing student success in these courses are a priority.

Directive 2.0: Adopt different math pathways that are more closely connected to the students' program of choice

An examination of varying pathways to college-level mathematics was conducted, and included a review of both programmatic structure and implementation of new and emerging initiatives to mathematics pathways. Included in this review was the examination of Statway and Quantway, the California Acceleration Project, and the New Mathways Project.

Statway and Quantway

Based on the information provided in the Math PVR 1.0 project, Statway and Quantway programs were reviewed and colleges that utilize the new pathways were examined. Statway is a one-year program that combines developmental math skills and college-level statistics into a collaborative, problem-focused class. The year-long pathway enables students to complete all developmental math requirements and earn college credit for statistics within their first year. Quantway 1 is a single-semester quantitative reasoning course that fulfills students' remedial math requirements and prepares them for success in college-level math. Students who pass Quantway 1 are then eligible to enroll in Quantway 2, a quantitative reasoning course that awards college credit (Sowers & Yamada, 2015).

California Acceleration Project

The RP Group recently conducted a quasi-experimental study of the accelerated remedial pathways at participating CAP institutions (Hayward & Willett, 2014). The CAP study included 16 colleges and 48,450 developmental education students (2,489 accelerated students and 45,961 comparison students in traditional remedial courses). The study followed the students from their initial enrollment in fall 2011 through the spring 2013 semester. The specific acceleration strategies differed across the campuses, though the cumulative effects were large and robust across the participating colleges. Key findings include:

- *Accelerated pathways increased the odds of completing a transferable math course.* After controlling for potentially confounding demographic and academic variables, the completion rate of a transfer-level math course for students in an accelerated pathway was 38%, compared to just 12% of students in the traditional developmental math sequence.
- *Acceleration was effective for students of all backgrounds.* A range of students showed higher outcomes in the accelerated pathways, regardless of ethnicity, gender, financial need, disability status, and prior coursework in ESL.
- *Acceleration worked for students at all placement levels.* Participation in accelerated pathways was associated with increased odds of completing remediation requirements and passing a transfer-level course for students at all levels of the basic skills sequence, in both math and English.

New Mathways Project

MDRC, a research organization dedicated to the professional development in math study, has been working with the Dana Center at UT-Austin since 2012 to study the development and implementation of the NMP initiative. MDRC collected descriptive data on developmental education students at the 8 NMP co-development colleges from fall 2010 through spring 2014. Student outcome data for NMP students is largely positive. Out of 233 students enrolled in the NMP Foundations course in the fall 2013 semester, close to 65% passed the course with a grade of C or higher, which fulfilled their remediation requirements. By the end of the spring 2014 semester, 46% of the NMP students had enrolled in a college-level math course, and 30% of the original NMP cohort had passed the college-level course. By comparison, among non-NMP students enrolled in developmental math, only 25% completed their remedial math requirements and just 8.3% completed a college-level math course, on average. However, it's important to note that these findings are purely descriptive and do not control for any confounding variables. Researchers from MDRC and CCRC are currently working with the Dana Center at UT-Austin to conduct a rigorous random assignment study of NMP that will include about 2,000 students at four to six Texas community colleges, which will provide greater insight into the effectiveness of the model.

While the early research findings show significant improvements in student outcomes for various developmental math acceleration strategies, participating colleges have faced many different challenges in implementing and scaling new developmental math pathways or redesigning their remedial math curriculum. Multiple sources mentioned the challenge colleges faced with developing a shared understanding of the problem, effectively engaging faculty to support redesign

efforts, changing the culture of an institution to focus on data-based decision-making, and finding the resources needed to make the up-front investments in course redesign and faculty training.

Beyond the Quantway, Statway and California Acceleration Project, campuses that have conducted their own needs assessment and have redesigned their own curriculum at the pre-baccalaureate level have been inspected. Among those, Santa Ana College's redesign of Algebra level mathematics coursework was reviewed.

Santa Ana College's math faculty examined the above programs and decided to restructure their curriculum and combine the 4-unit Beginning and Intermediate Algebra courses into one 6-unit course with two unique pathways: B-STEM for students needing traditional intermediate algebra concepts for STEM based college-level coursework, and Statistics and Liberal Arts Math (SLAM) for those students who need liberal arts and/or statistics college-level mathematics. Along with the combined curriculum, changes included intensive focus on group work, one-on-one assistance, and continued implementation of sustained faculty development. While the program is in its infancy, the faculty teaching the coursework believes the redesign is beneficial for student learning. When asked how a student that completes the SLAM-pathway jumps into a B-STEM path, there wasn't a clear answer. While the faculty have considered a 1-unit "bridge" course, there currently is not a system in place for moving students who have a "SLAM" course to a "STEM" course pathway. See Figure 1.

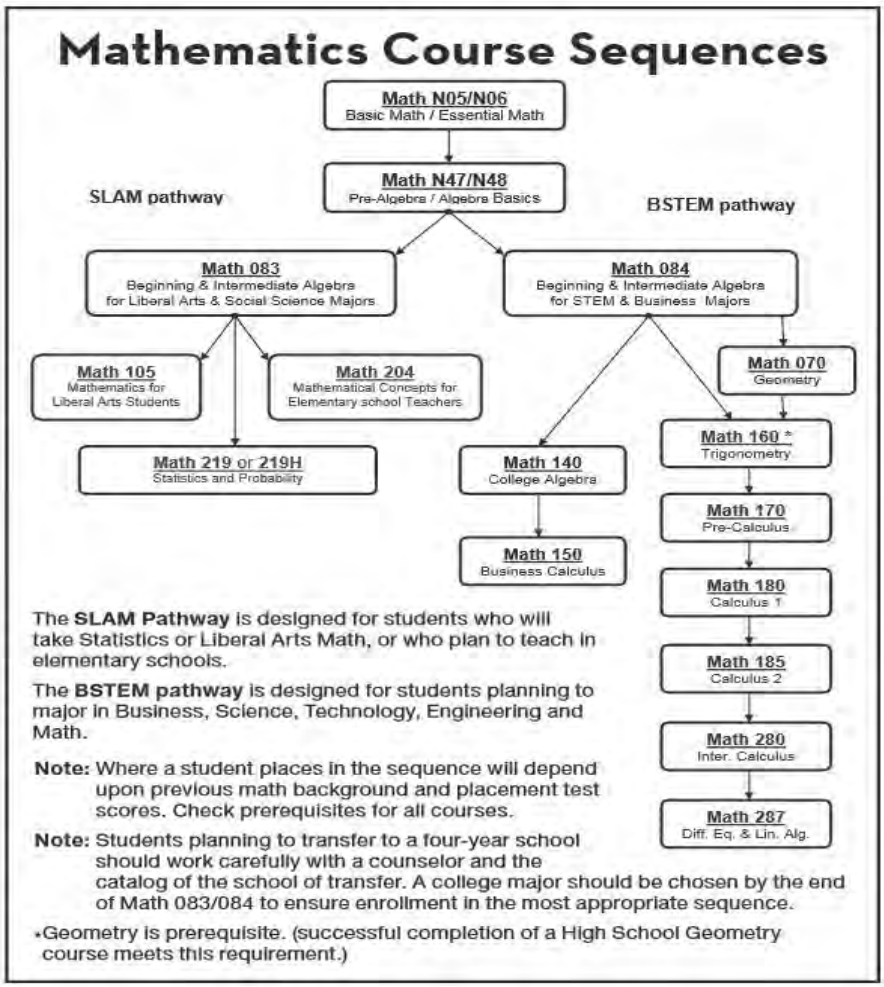


Figure 1

The lack of a clear bridge between the "statistics / liberal arts" and "STEM" algebra pathways seems to be the main resistance for implementation at other campuses, and the limitations on STEM course enrollment after completing a liberal arts/statistics only pathway are of concern. With many entering college students either undecided or uncommitted to their major, the limitations of the Statistics / Liberal Arts pathway are topics that cannot be discounted and must be resolved prior to moving forward with any proposal to redesign or realign developmental / statistics pathways. Furthermore, the context of developmental math is not the purview of this committee, nor the domain of the current mathematics faculty and department.

Additionally, a recent report by the Academic Senate for the California Community Colleges (ASCCC, 2015) indicated that CSU faculty have serious reservations regarding the preparation and competency of students that complete the statistics-based pathway. The CSU Council of Math Chairs' concern is that "these pathways do not prepare students for college level courses" (ASCCC, 2015). The CSU Council of Math Chairs reported to GEAC that Statway at the CSU does not prepare students for college level courses, the program is not scalable, and has poor outcomes. Their study is based on the results of other remediation completers ELM scores versus those that have completed the Statway programs' scores.

2b: Review percentage of students in STEM and non-STEM majors enrolled in college-level mathematics.

Examining the Golden West Student population over a three year period netted numbers that are a sampling at best. Using information from Banner and DegreeWorks, the number of "declared" majors in each area were tallied. It must be noted that not all students have an official "program of study" on file, and the numbers represent only those students who have updated their program of study with a counselor within the last three years (since release of DegreeWorks Degree Audit program).

For purposes of this report, STEM degrees were those that reside under traditional disciplines of Biology, Chemistry, Computer Science, Mathematics, Geology, and Physics. Engineering is not included as Golden West College does not offer degrees in this area, and most Engineering students seeking a bachelor's degree are listed under mathematics disciplines. Other disciplines were coded based on the general education category that the majority of their coursework would be found. Only those degrees that included a transfer-level mathematics course for completion were included.

PROGRAM	Main Discipline Area	Student Count in each area		
		Other	*STEM*	*Social Science / Humanities*
Administration of Justice ADT	S			195
Anthropology ADT	S			35
Art History ADT	H			14
Studio Art ADT	H			126
Business Administration ADT	O	1541		
Communication Studies	H			356
Elementary Teacher ADT	S			175
English ADT	H			188
Computer Science ADT (Not Active)				
Geography ADT	S			15
Geology ADT	MS		8	
History ADT (one from)	S			187
Human Resources Option Cert. of Achievement	O			8
Kinesiology ADT	O	272		
Mathematics ADT	MS		131	
Music ADT	H			36
Philosophy ADT	H			26
Physics ADT	MS		4	
Political Science ADT	S			71
Psychology ADT	S			761
Sociology ADT	S			224
Spanish ADT	H			15
Theatre Arts ADT	H			50
Nursing: LVN to RN	O	47		
Nursing: RN	O	2010		
Chemistry AA	MS		152	
General Biology A.A.	MS		388	
Liberal Arts: Emphasis in Science	MS		1149	

Liberal Arts: Emphasis in Bus. & Technology	O	636		
Liberal Arts: Emphasis in Mathematics	MS		547	
Liberal Studies for Elementary Educ. A.A.	H			
Mathematics AA	MS		182	
Physics AA	MS		45	
Psychology AA	S			60
General Management Cert. of Achievement	O			3
CSU-GE Breadth Certification	O	692		
IGETC Certification	O	435		
Totals		5633	2606	2544

MS = Math/Science. Biology, Chemistry, Computer Science, Mathematics, Physics
S = Social Science. Administration of Justice, Anthropology, Elementary Teacher Education, Geography, History, Political Science, Psychology, Sociology
H = Humanities. Art (Studio Art), Art History, Communication Studies, English, Music, Philosophy, Spanish, Theatre Arts.
O = Other. Includes Business Administration, Kinesiology, Nursing (RN, and LVN-RN degrees), Liberal Arts Business and Technology. Certificate of Achievement in CSU-GE Breadth and IGETC, Human Resources and General Management.

Based on the numbers of declared majors, there is an equal number of STEM and non-STEM majors. Nursing and Business Administration are the two largest majors, and their classification as "other" is due to the nature of their coursework. While it can be argued that Nursing majors could fall under the STEM category, as the major calls for no less than 4 college-level math and science courses (5 for transfer students), this major traditionally does not fall under a STEM category. Furthermore, Business Administration is difficult to classify as the required coursework falls under mathematics, social science, and discipline specific coursework (accounting, computer information systems, business writing, and business law). IGETC and CSU-GE Breadth students are often undecided, yet have a goal of transferring to a four-year college/university. These numbers may shift as students declare a formal discipline major, or transfer without completing an Associate Degree at Golden West College.

While it's understood that STEM majors will enroll in multiple college-level mathematics courses, Social Science and Humanities majors must also complete at least one college-level mathematics course to meet the degree requirements. Business and Nursing majors must also complete at least one, sometimes two, designated courses including Statistics.

Clearly the demand for college-level mathematics is at an all-time high. As the student's program of study is unique to each student, it can be argued that 10,783 students will need at least one college-level mathematics course, not including any college-level prerequisites (such as Math G115: College Algebra for entry into Math G140: Calculus for Business Majors). Higher level mathematics courses (beyond Math G280: Calculus 3) for STEM programs have not been consistently offered at Golden West College each semester. When available, these courses have lower enrollment than other courses (such as Calculus 1 and 2). Students accustomed to the lack of higher level course offerings have been taking these classes at neighboring colleges, including Orange Coast College. As these courses are brought back to Golden West College, time to build enrollment and consistency of offerings must be supported. Current faculty levels cannot sustain this demand, and with the overwhelming majority of courses being taught by part-time faculty, students are clearly the ones who suffer.

Given that a large number of non-STEM students take Math 115 and Math 160, the table below compares success rates between STEM and various non-STEM students in Math 115 and Math 160 for the last three academic terms. The yellow highlights indicate the groups with success rates lower than the class average for the given semester. The data show that for the most part, STEM major students have higher success rates than non-STEM major students. Additionally, Business and Nursing students typically have higher success rates than the course average success rate.

Comparison of Success Rates between STEM and various Non-STEM Majors in Math G115

MATH G115							
		2012-13		2013-14		2014-15	
		Fall	Spring	Fall	Spring	Fall	Spring
STEM	Enr	29	36	42	36	61	60

	Success	59%	69%	60%	47%	61%	48%
	Enr	211	178	188	160	159	156
Non-Stem	Success	36%	48%	49%	45%	51%	46%
	Enr	80	85	92	99	105	107
Business	Success	38%	58%	64%	54%	52%	54%
	Enr	20	13	16	13	11	9
Nursing	Success	50%	69%	63%	62%	82%	33%
	Enr	16	13	13	17	13	9
Psychology	Success	31%	54%	69%	53%	46%	0%
	Enr	356	325	351	325	349	341
MATH G115 Avg	Success	39%	54%	56%	49%	54%	48%

Comparison of Success Rates between STEM and various Non-STEM Majors in Math G160

MATH G160							
		2012-13		2013-14		2014-15	
		Fall	Spring	Fall	Spring	Fall	Spring
	Enr	52	69	55	86	57	72
STEM	Success	73%	72%	71%	77%	70%	76%
	Enr	191	234	203	166	177	216
Non-Stem	Success	66%	59%	54%	48%	64%	56%
	Enr	57	78	59	85	61	83
Business	Success	77%	67%	63%	71%	70%	59%
	Enr	79	77	82	90	89	91
Nursing	Success	75%	73%	65%	70%	65%	64%
	Enr	41	44	57	55	64	78
Psychology	Success	71%	57%	54%	51%	63%	55%
	Enr	420	502	456	482	448	540
MATH G160 Avg	Success	70%	64%	59%	61%	66%	60%

2c: Consider and create new transferable math courses that are more specifically contextualized for non-STEM majors

Based on the results of the survey of the Golden West College statistics course, the overwhelming majority of students completing Math G160 come from Nursing, Social Science, and Business majors. A current review of Associate Degree for Transfer requirements indicate that 13 degrees require statistics exclusively, and 10 list the course as an option for completing the quantitative reasoning requirement. Of the 13 that require statistics, two Certificate of Achievement programs (CSU-GE Breadth and IGETC) also include statistics as an option. Eight (8) of the 13 ADT programs that require statistics are from a social science discipline. Given the overwhelming majority of majors that require statistics, it would be beneficial to explore the creation of a "Statistics for Social Science Majors" course.

Unlike STEM-based mathematics coursework, Statistics does not lead to another sequential course other than PSYC G280: Research Methods in Psychology. Professor Isonio, the lead faculty member for the research methods course, was interviewed and he believed the largest problem with preparation for students in the target course is understanding context-based materials. Professor Isonio indicated that while the math-based statistics course provided preparation for the Research Methods course, he felt it fell short in real-world applications and dealing with live data (Isonio, S., Personal communication, 11/16/2015). Using an example of an assignment he requires in class, he indicated that students have difficulty with analysis of their projects including "selecting appropriate data analysis procedures, conducting the analysis, and formulating appropriate conclusions." Further, he indicated that the TMC for the Psychology Associate Degree for Transfer recommends a discipline specific statistics course, and he supports this recommendation.

Social Science-based statistics courses hold the same articulation and approval as a standard statistics course offered in a math department, provided the prerequisite process is the same for entry. Contextualized coursework could be offered in the Psychology department, and offer content specific to social sciences, and information to better prepare students for a research methods or advanced social science based course after transfer.

In addition to discipline specific social science statistics coursework, many CSU campuses require Statistics for Business Administration majors. A section of the currently offered Math G160 course could be offered with Business-based data, and incorporated into the CSU in 2 cohort/timeline. There is also interest in the creation of a Biostatistics course that would satisfy major preparation requirements and align with the CSU Long Beach Biology program and other science majors.

Contextualized coursework in other areas has already been offered in Mathematics, including Math G009 - Medical Calculations course for nursing students. Additional modular coursework has been developed for the Automotive Technology program, yet was never a formalized unit-bearing course. Rather, it was a modular based workshop model for incorporation into the Automotive Technology program addressing the specific needs of their graduates. Despite the creation of the modules and the willingness to incorporate these into the Automotive Technology curriculum, this was never offered. The modules are still available for use.

Beyond the current courses offered, there are no further general or STEM-based coursework that could be developed. Directive on transfer-level coursework often comes from majors and programs at four-year colleges and universities, and with the exception of discipline specific statistics coursework (Statistics for Social Science / Business / Biostatistics), GWC currently offers the entire range of coursework that would be found at most all California State University, University of California, and Private/Independent colleges and universities. Additionally, the lack of full-time faculty available to teach expanded course offerings is a hindrance to expanding any curricular offerings in mathematics at this time.

2d: Consider how STEM-related courses might be modified to strengthen their connection between math content and STEM applications

Increasing connections in STEM based coursework is vital to increasing student success in this area. Women and minority students in particular come into the college setting with negative perceptions of math and science coursework, often deep rooted and established in primary school levels (Else-Quest, Mineo & Higgins, 2013). Overcoming these non-cognitive obstacles requires a structured and comprehensive program that provides mentoring, tutoring, career exploration, and emotional support.

Increased student integration into the social and academic systems of the college will lead to commitment to the college and completion of a student's academic and career goals (Nakajima, Dembo, & Mossler, 2012). Participation in a MESA-type center would allow for not only underrepresented students, but all students to deepen their connections to their chosen major, and by default, their STEM-based coursework.

The establishment of a STEM Center at Golden West College would require the same start-up as building a MESA center. The support of a program such as a STEM center would need to include several constituents on campus, including but not limited to discipline faculty in mathematics, chemistry, biology, physics, geology, computer science, and technology. As well, counseling faculty, college success faculty, librarians, and tutoring departments must be involved in the process. Using a comparison program at a California Community College, Hartnell College, a Hispanic Serving Institution, documented their implementation of a MESA program. Among the considerations were students' financial status, employment issues, faculty and campus collaboration, and student participation. Included in the infrastructure of the program were outreach and recruitment, orientation activities, a permanent space on campus for the center and related activities, cohort-based clustering and formalized supplemental instruction to support and improve performance in math and science coursework. Additionally, consistent and sustained academic planning, counseling support, academic excellence workshops, professional development, and transfer-related activities including university campus tours and transfer application assistance were provided. The results of thes systematic and coordinated efforts resulted in increased participation in STEM majors, increased enrollment in math and science coursework, and increase in overall academic performance by participants (Kane, Beals, Valeau, & Johnson, 2004).

2e: Existing courses might be changed with respect to method of delivery, class size, scheduling, technology support, staff development, pedagogical changes

Each of these sub-areas was discussed and incorporated into the evaluation process with questions on a student survey distributed to statistics courses, and a review of literature on the same topics was conducted.

Time of course offering

Studies have been conducted on the days and times courses are offered, the length of course (accelerated 8-week or full semester length), the class size, and instructional methods utilized. Research shows that students perform better in morning classes than evening courses (Lazari, 2009) and have higher rates of retention. One speculation is that evening courses are primarily filled with working students, making concentration in difficult content a barrier to learning. Additionally, the research revealed that evening sections are overwhelmingly taught by less-experienced, part-time faculty whose limited student access makes getting help with supplementary information on course materials difficult.

Students at Golden West College were surveyed to determine course taking patterns including number of days per week the course should meet for success and preference for course offerings. Unfortunately, the question did not yield the results desired and further inquiry may be needed to address the unique needs of our campus population. One suggestion was to keep the current course offerings and include a Friday "lab" or supplemental instruction section that would support the various levels of college mathematics.

Length of course

The length of the course has also been studied to determine if an accelerated format or full-semester coursework yielded greater success. Sheldon, & Durdella (2009) examined community college coursework in mathematics and found that while there was some increased success in completion in the condensed 8-week format, the researchers speculated the success was tied to intensity and time of offering (summer) when the student may not be enrolled in many other courses and focused only on this one subject.

Success rates at Golden West College revealed similar results. With the exception of the 2012 summer term, students enrolled in intensive 7-week section of Math G115: College Algebra and Math G120: Trigonometry in summer sessions were more successful than in fall and spring terms. Faculty in these courses suspect the same holds true of the research findings: students are enrolled in this one course, and focusing all their efforts on this one topic.

Other college level math coursework, including statistics, pre-calculus, and calculus had mixed results with some summer sessions yielding higher completion rates than fall and spring terms, and other sessions showing lower completion rates.

Alternative scheduling patterns are being explored by the GWC Math department. All math courses including evening sections have traditionally been scheduled as 2-days-per-week (M/W or T/Th) conforming to the college's block scheduling model. Over the last 5 years, the fill rates of Math G120, G140, G170, G180, G185, and G280 have consistently been over 100%.

The current statistics survey indicates students' strong preference for a course meeting two days per week, and 89% want a full-semester length (16-week) course. This is consistent with current offerings, and examination into a change in structure to increasing number of meetings per week will need to be carefully considered. Further needs assessment from students may need to take place prior to making any changes to scheduling.

In addition to offering more sections with morning, mid-afternoon, and evening courses, in the fall 2015 term the department offered an 2nd 8-week Statistics course, and a Saturday-only course is scheduled for Spring 2016. The Fall course had very low enrollment. This may have been due to the time and/or three-day per week meeting schedule. At this point, the low enrollment reasoning is speculative only. Continued conversation over the number of days per week a course meets will continue, and adjustments may be made based on room availability and student demand.

Technology / Method of Delivery

Method of delivery was also examined. New and emerging technology can dramatically assist with classroom instruction and student learning, guiding students to additional content and mastery. While gains in mastery were found with use of math software, the software was incorporated into an instructional-based lab and not individual student use. Group work and the availability of an instructor to answer questions while students were "doing math" were necessary to overcome any technological and content mastery barriers that may exist (Thiel, Peterman & Brown, 2008). Additionally, increasing the percentage of the grade assigned to homework is linked to students increased performance in College Algebra

coursework (Lazari & Reid, 2013); however, this could also have a negative impact on performance when students choose not to submit the required assignments.

The common thread in all the literature is that greater emphasis on individual instruction and one-on-one interaction leads to greater persistence and completion of college-level coursework, College Algebra in particular. College Algebra seems to be the course identified as the largest barrier to degree completion at colleges and universities nationwide (Reyes, 2010). Completion results at GWC indicate similar findings, with Math G115 having a lower pass rate than most all other college-level mathematics courses. The consensus of the PVR group was to focus on increasing success in College Algebra, and pathways to calculus level mathematics coursework over any emphasis on Statistics, as the retention and completion in the two gateway STEM coursework is of greater concern.

According to Thiel, Peterman, & Brown (2008), the major problem with persistence and completion in college-level algebra and other coursework is not the content, but rather the non-cognitive factors that students face. In addition to difficulties with work/life balance and time management, math specific study skills continue to be a problem for students, and underrepresented students in particular. While several studies indicate that women and underrepresented minorities study as many hours as other "successful" students, their lower completion rates were found to be the result of *how* these students study (Treisman, 1992; Nelson 1996; Moreno & Muller, 1999; Thiel, Peterman, & Brown, 2008; Reyes, 2010; Brakke & Halpern, 2014). Underrepresented, first-generation college students have been found to study independently, reviewing lecture notes, reading required text, and working through homework problems in isolation. Successful students in other groups however, work collaboratively after completing independent work. Treisman (1992) found that while African American students studied about 10 hours per week, they tended to work alone and had a different definition of what consisted of "studying." Asian students in the comparison group studied independently for about 8-10 hours, then formed groups sharing meals, reviewing homework as a group, and learned from each other. The formation of study groups was expected and students in these groups knew where they stood in the class in comparison to their peers. African-American students, on the other hand, knew little about their actual standing in the course in comparison to their classmates. The information these students learned in "study skills" courses and workshops did little to benefit their actual learning process (Treisman, p. 367) indicating that specific math-based study skills need to be incorporated for these underrepresented groups.

Each of these studies indicated a strong need for formal supplemental instruction and study skills that focus on math-specific study skills, including collaboration, group review and peer-testing, and utilizing faculty office hours. Based on this information, formalized supplemental instruction using models established from the Dana center, and creation of a STEM center for student support will go a long way in improving student completion in college-level mathematics. While having the added benefit of increased learning in quantitative reasoning, there would also be a reduction in overall cost due to the reduced number of students needing to repeat coursework (Twigg, 2013).

2f: Student Satisfaction

Students in the Math G160 Statistics course were surveyed to determine course enrollment patterns, program of study, preference for course offering (two days per week versus three or four), and reasons for enrollment. Of the 273 students that completed the survey, the overwhelming majority of students were nursing majors. Eighty-six percent (86%) of the students were completing the course for the first time, and enrolled in statistics to fulfill a requirement for their major to graduate and/or transfer. More than half of the students (52%) placed directly into Statistics based on their assessment test results. With less than half of the students completing Intermediate Algebra to meet prerequisite requirements for entry, we do not feel that an alternate pathway to statistics is needed at Golden West College. Rather, additional support to increase course completion should be implemented. As well, the establishment of contextualized statistics courses to ensure students connection to the course material should be explored.

2g: Options for contextualized learning

As mentioned, contextualized coursework could be offered easily in Statistics, and an interdisciplinary task force can determine best practices for meeting the needs of multiple disciplines. Social science faculty can collaborate on a social-science based statistics course in their division, biological science and other STEM faculty can establish a biostatistics course for STEM majors. Further, a standardized section of Math G160 can be tailored with content specific to business and economics to meet the needs of students in this area. With the addition of contextualized materials for these courses, ongoing and sustained professional development on emerging teaching pedagogies and methodologies must be established. This would allow for cohesive course planning, coordinated outcomes, and collaborative student-faculty interaction.

Research on collaborative teaching and planning based on outcomes in key mathematics coursework supports the committee recommendations for interdisciplinary collaboration and professional development for faculty in the mathematics and statistics areas.

Behavior differences between successful and non-successful students.

An extensive review of literature has been conducted to determine behavioral differences between successful and non-successful college students. Using models from Student Development Theory, behaviors can be examined in psychosocial, cognitive-structural, and developmental domains. Some of the research has to do with student integration into the college campus leading to greater student retention (Astin, 1984; Tinto, 1987), other models focus on personal development and identity (Chickering & Reisser, 1993). While the students can be taught fundamental study skills, there are some structural differences that incoming students still struggle with despite college success coursework.

Early differences in student/teacher contact, grades, counseling, motivation, and freedom/distractions were identified so that colleges and universities can address the transitional needs of incoming students.

	High School	College
Teacher/Student Contact	Contact closer and more frequent (5 days /week)	Contact minimal during lecture. Full-time faculty available during office hours and by appointment
Competition / Grades	Academic competition may not be as strong. Good grades can often be obtained with minimal effort and time.	Academic competition is stronger. Effort must be increased for success. Minimal effort and time based on high school success leads to poor grades at college level.
Status	Students establish a personal status in academic and social activities based on family and community factors.	Students build their own status as they wish. High school behaviors can be repeated or changed depending on student needs.
Counseling /Dependence	Students rely on parents, teachers, and counselors to make decisions and advice. Student passivity.	Students must rely on themselves; see the results of their own decisions. Their responsibility to seek advice and guidance as needed.
Motivation	Students get stimulation to achieve or participate from parents, teachers, and counselors.	Students must apply their own motivation to their work and activities, as they wish.
Freedom	Freedom is limited. Parents, teachers, and counselors often help students out of a crisis should one arise.	Students have more freedom and responsibility. Must solve own crisis should it arise.
Distractions	While present, distractions are partially controlled by school and home.	Opportunity for increased distractions exist. Time management and dedication will become more important.
Value Judgments	Students often make value judgments based on parental values, many decisions made for the student.	Values and opinions of the student are paramount. Must make own decisions. Values can be unclear and lead to poor choices and decisions.
Reprinted from: Mullendore, R.H. & Hatch, C (2000). Helping your first year college-student succeed: A guide for parents. Columbia, SC: University of South Carolina, National Resource Center for the First Year Experience and Students in Transition.		

Beyond the factors that differ between high school and college, additional student behaviors contribute negatively to success in college-level mathematics. Research on the intersection of ethnicity and gender reveal that women of color have lower levels of success in college level math, and in STEM fields in particular (Else-Quest,Mineo, C. & Higgins, 2013). Additionally, increasingly diverse student populations necessitate a change in approaches to college teaching. Different learning and study styles are found among underrepresented students and students of color. Beyond the adjustment to learning and study styles, underrepresented students are not accustomed to group work or asking for help when needed. There is a social stigma attached to "asking for help" and unfortunately, the students that need the most assistance are the ones most reluctant to ask for it when needed (Nelson, 1996). Increases in student anxiety, particularly around math and science content, must also be addressed. Students are in need of more one-on-one interaction from faculty, positive reinforcement and constructive criticism supported by motivational statements, and encouragement to continue to learn the

content (Andrews & Brown, 2015). In addition, reduction of anxiety surrounding math coursework should be integrated for all students.

In the survey conducted with Math G160 students during the Fall 2015 semester, the results indicate similar findings. While understanding course content was the number one factor prohibiting student success, other highly ranked responses included work-school conflicts, time management, use of technology (calculator, MyMathLab), and "other" barriers.

Students requested additional tutoring, group tutoring, and tips on time management, study skills, and other study resources as necessary to their success in the course. The survey distributed to students is included in Appendix 1. Faculty was also surveyed. Despite the low response rate, results indicated that the physical environment may be prohibitive to new teaching methodologies including collaborative learning. Comments included "The classroom is packed with desks making it very difficult to implement collaborative learning exercises." Resources recommended to help improve student learning included a dedicated math lab for tutoring and study groups, supplemental instruction in statistics, algebra and trigonometry review sessions to assist with preparation for course, and increased technology access. (Appendix 2)

Summary and Recommendations

After extensive review of published literature on best practices and outcomes in transfer level mathematics, a survey of GWC students in statistics course, interviews with various discipline faculty, consultation with programs at other community colleges, and research on GWC courses, the committee has reached the following conclusions and recommendations:

1. Consistent and Sustained Professional Development
    a. Faculty need current and relevant instruction in new teaching models, including flipped classrooms, group work, inquiry based learning, and collaborative learning models, and addressing various student learning styles and behavioral needs.
        i. Support for faculty to collaborate, develop, and attend training must be supported.
        ii. Professional development is necessary for both full-time and part-time faculty. Support at all levels for all faculty is needed.
    b. Current practice includes collaboration in syllabus development amongst full- and part-time faculty, sharing of assignments, and training in MyMathLab for those that have not previously used this method of instruction.
        i. These practices will continue and be evaluated for improvement via feedback from the part-time faculty.
    c. Implementation Plan: Faculty will attend professional development institutes during the Spring and Summer 2016 terms, and funding will be supported by the Math PVR 2.0 budget.

    d. Continued professional development continued throughout 2016-17 and gain mastery in teaching methodologies. Full time faculty can then train part-time instructors in new teaching methodologies.

2. Establish Course Coordinator for each course
    a. This currently exists, however with the current number of full-time faculty in the department, each faculty member "coordinates" multiple courses.
    b. Increased number of faculty, at levels that would allow for a course coordinator for each transfer level course are recommended for implementation in the immediate future.
    c. SharePoint will be utilized for course materials and coordination of documents.
    d. Implementation Plan: Fill full-time faculty vacancies. Full time faculty will need to be hired to allow for coordination of coursework. Committee Recommendation: Hire 2 Full-Time faculty immediately for Fall 2016 and within the next five years, fill 1 full-time faculty vacancy member each year for a total of 9 Full Time Faculty by Fall 2020.
    e. In Fall 2016 with the 2 full-time faculty positions, course coordinators will be assigned in the following manner:
    f. Coordinator 1: Math G100 / Math G104; Math G280, Math G235, Math G285 (7 sections)
    Coordinator 2: Math G115 / Math G140 (9 sections)
    Coordinator 3: Math G120 / Math G170 (9 sections)
    Coordinator 4: Math G180 / Math G185 (11 sections)
    Coordinator 5: Math G160 (10-12 sections)

g. The hiring will also stabilize offerings of higher level math courses beyond the Math G280.

3. Common Final Exams for all transfer-level mathematics coursework
    a. The faculty will work to establish common final exams with grading rubrics for all courses, and provide both the course outline of record, SLO information, and final examination to all part-time faculty upon awarding teaching assignment.
        i. This will allow for course development aligned to Student Learning Outcomes, and expected competencies at the end of the course.

    b. Implementation plan: Full time faculty will start development of common exams in the Spring 2016 term, and continue refinement of examinations for Fall 2017 implementation. Five full time faculty in 2016-17 academic year will develop comprehensive final examinations for courses they coordinate, SLO assessment analysis and improvement.

    c. In Fall 2017: with an additional full-time faculty members (6 total), the redistribution of course coordinators will be:
    d. Coordinator 1: Math G100 / Math G104 (4 sections)
    Coordinator 2: Math G115 / Math G140 (9 sections)
    Coordinator 3: Math G120 / Math G170 (9 sections)
    Coordinator 4: Math G180 / Math G185 (11 sections)
    Coordinator 5: Math G160 (10-12 sections)
    Coordinator 6: Math G280, Math G235, Math G285 (3 sections), plus additional STEM coordination with grant and oversight of center.
    e. Additional full time faculty will also allow for full participation on campus committees, mentoring of part-time faculty, and participating as a contributing member to the department to enrich the math program overall. Future additional faculty would split statistics sections leaving two coordinators for statistics, development of contextualized sections, formalized learning communities, STEM partnerships, and other math-based initiatives. Additionally, an ending total of 9 faculty by 2020 would allow for increased student engagement, mentorship, and course completion, and completion of student's educational goals (degree completion and transfer). As well, a full department faculty would potentially allow for decreasing class size and increasing new instructional models as they are developed.

4. Increase student access to faculty
    a. Create additional avenues for faculty and students to interact
    b. Support and expand STEM center and STEM project.
        i. Allows for common space to gather and collaborate
        ii. Less formalized structure reduces anxiety over faculty-student interaction
    c. Increase in-class student-faculty contact via alternative teaching and learning strategies.
    d. Establishment of incentive for part-time faculty to be available for student interaction outside of class.
    e. Implementation Plan: Explore incentives for part-time faculty office hours.
    Cost Analysis: TBD by college

5. Reduce class size on large-class size factor courses.
    a. Modeled after cost analysis established by the Vice President of Instruction and Student Learning for developmental math program, reduce Math G115 and Math G160 courses to 45 students per section. (Models provided on pages 24 and 25)
        i. Projected cost increase of approximately $22,000 per academic year
    b. Allows for increased student access to faculty.
    c. Facilitates active learning strategies in classroom settings.
    d. Allows for growth in FTES due to increase in additional seats in key courses for graduation and transfer.
        i. Potential increase of 10 FTES per course.
    e. Supports campus-wide goal of increasing FTES.

    Implementation Plan: Explore multiple funding sources including Equity, HSI /STEM grants, general funds. .

MATH G115 Fall & Spring Semesters (Equal Number of sections offered in both terms)

		Hours	seats	sections	LCF/Lab Fac	LHE/Section	Total LHE	Total Seats	FTES
Current	Math 115	72	72	6	1.5	6	36	432	59.25
A							**36**	432	**59**
							$ 52,200		
							Seats/Sem	432	59
							Seats/Yr	864	118
						Total/Term	**$ 52,200**	Apportionment	$ 550,560
						Total/Year	**$ 104,400**	$ to Instruction	$ 214,718
								Delta	$ 110,318

FTEF 1.2

		Hours	seats	sections	LCF/Lab Fac	LHE/Section	Total LHE	Total Seats	FTES
Proposed	Math 115	72	45	10	1	4	40	450	61.71
A							**40**	450	**62**
							$ 58,000		
							Seats/Sem	450	62
							Seats/Yr	900	124
						Total/Term	**$ 58,000**	Apportionment	$ 576,600
						Total/Year	**$ 116,000**	$ to Instruction	$ 224,874
								Delta	$ 108,874

FTEF 1.3

	Per Semester	**Per Year**
Change in FTES Generated:	2.47	4.94
Increase in Apportionment:	$11,478.86	$22,957.71
Increase to Instruction:	$4,476.75	$8,953.51
Delta:	$ 3,032.35	$6,064.71

MATH G160 Fall & Spring Semesters (Equal Number of sections offered in both terms)

		Hours	seats	sections	LCF/Lab Fac	LHE/Section	Total LHE	Total Seats	FTES
Current	Math 160	72	72	11	1.5	6	66	792	108.62
A							**66**	792	**109**
							$ 95,700		
							Seats/Sem	792	109
							Seats/Yr	1584	218
						Total/Term	**$ 95,700**	Apportionment	$ 1,013,700
						Total/Year	**$ 191,400**	$ to Instruction	$ 395,343
								Delta	$ 203,943

FTEF 2.2

		Hours	seats	sections	LCF/Lab Fac	LHE/Section	Total LHE	Total Seats	FTES
Proposed	Math 160	72	45	18	1	4	72	810	111.09
A							**72**	810	**111**
							$ 104,400		
							Seats/Sem	810	111
							Seats/Yr	1620	222
						Total/Term	**$ 104,400**	Apportionment	$ 1,033,230
						Total/Year	**$ 208,800**	$ to Instruction	$ 402,960
								Delta	$ 194,160

FTEF 2.4

	Per Semester	Per Year	
Change in FTES Generated:	2.47	4.94	
Increase in Apportionment:	$11,478.86	$22,957.71	
Increase to Instruction:	$4,476.75	$8,953.51	
Delta:	($5,306.55)	($10,613.09)	Total Annual Delta: ($4,548.38)

Proposed section maximum seat count is 45 students. Scheduling single sized sections of 45 is larger than the single section sizes currently scheduled in English (32), Transfer Mathematics (36) and is comparable to the single section seat sizes scheduled in Social Sciences.

6. Work with Institutional Research to determine impact of class size reduction, common exams, and new teaching models.
    a. Implementation Plan: Lead faculty and department chair will coordinate with Instructional Research to study outcomes of department changes.
7. Establishment of a formalized Supplemental Instruction model is needed to provide the necessary curricular and personal support for students.
    b. Model Supplemental Instruction after the formal structure created at University of Missouri, Kansas City, and locally at California State University, Fullerton.
        i. GWC Developmental Math faculty have embraced this model, and have been trained by these leads, with additional training to those hired to provide supplemental instruction.
        ii. Current Supplemental Instruction model relies on student instructors. Students are not versed in instructional techniques, and lack the competency for "instruction" at this level.
            1. Students should be retained in this model as mentors, and SI support staff to assist the formal instructional process as well as providing interactive strategies for student-to-student support.
        iii. The committee recommends establishment of a formal SI model including a full-time coordinator, and hiring degree-certificated individuals with a minimum of a baccalaureate degree in the subject area.
            1. Allows for increased competency in the subject area.
            2. Understanding of knowledge necessary for next level coursework.
            3. Less turnover of full-time employees will reduce cost, increase success due to consistency of teaching structure, support, and highly competent personnel.
            4. Locate the SI model for Mathematics in the STEM center.
                a. Allows for connection to department, faculty, curriculum, and college as a whole.
    c. Implementation Plan: Hire Supplemental Instructors that are baccalaureate degree qualified. Require SI instructors to participate during lecture, allowing for more one-on-one interaction during the course.
8. Establish support for STEM-courses that are "gateway" courses
    d. Golden West College data, as well as national research, indicates that support for college algebra, trigonometry, and statistics, is key to achieving student success.
    e. Establishment of boot camps, summer institutes, supplemental instruction, college success, directed counseling, and personal support models are some of the recommendations.
    f. Implementation Plan: Explore methods for providing additional student support services. Hire dedicated STEM counselor and/or student success instructor using Student Equity funding. Coordinate with Counseling and College Success during the Spring 2016 term to establish a series of workshops that are needed to support this population, and in coordination with math faculty, host workshops on a regular and consistent basis starting in the Fall 2016 term.
9. Establish Learning Communities centered on STEM coursework.
    g. Models such as First-Year Experience, Freshman Experience, and MESA programs should be examined to link instructional coursework with counseling / student success courses to increase connection to the materials, the college, and provide behavioral strategies that lead to student success.
    h. Models could be continued at foundational STEM levels (Math G115/G120) and "advanced" levels (Math G180/G185).
        i. Established models exist at other colleges, including Santa Ana College and Cerritos College.
    i. Allows for deeper connection to material
        i. Increased time with faculty
    j. Addresses behavioral factors leading to success.
        i. Student success strategies to address non-cognitive factors impeding successful course completion.
    k. Implementation Plan: Campus administration, faculty from Math, Counseling, and Student Success attend the California Learning Communities Consortium Conference in April 2016 (http://evergreen.edu/washingtoncenter/networks/clcc/events.html), and consult with local colleges that have established successful Learning Communities in order to establish coordination and implementation of STEM based learning communities at Golden West College.
10. Support in-class technology.

l. New infrastructures, including the development of a new Math/Science building must include current and future technologies that can be utilized to achieve student success goals. Included in these instruments must be:
    i. State of the art Projection Systems
    ii. Infrastructures to support bandwidth
        1. Allows for sharing of student work, interactive quizzing, online instruction in-class.
    iii. Tablet PC capabilities
        1. Ability to use portable equipment and new apps for demonstrating content, interactivity with students.
    iv. Learning Catalytics
        1. Use of portable devices such as tablets, Amazon fire tablets
m. These recommendations would put Golden West College on-par with OCC.
    i. OCC correlation between student participation in courses with clickers and increased success.

n. Implementation Plan: Upgrade of technology infrastructure by college. Installation of Wifi-Routers in classrooms to facilitate use of clickers, cell phone surveys, and other web-based models. Integration of new technology into development plan for new Math/Science building. Explore other online programs beyond MyStatLab to support student learning while reducing costs to students.

11. Realign math programs creating two departments in one unified division
    o. Allows for increased interaction between faculty and sharing of professional development activities
        i. Current developmental math faculty have training in new and emerging teaching strategies.
    p. Immediately increases number of full-time faculty available to teach all courses
        i. Addresses critical need in transfer-level mathematics coursework
        ii. Assists with establishing course leads for each course.
    q. Alignment of developmental and transfer level math
        i. Consistent Pedagogy and instructional methods will increase student success and reduce variation of outcomes between faculty members in department.
        ii. Consistent and sustained training and professional development, sharing of resources, and division of labor.
        iii. Alignment of exit content and entry content for next-level courses.

    r. Implementation Plan: Immediate coordination from two programs to facilitate student success through mathematics pipeline from developmental to transfer-level mathematics.
    s. Campus administration work to realign two programs in new department within 3-5 years.

12. Commitment by college to success in Math and STEM.
    t. Golden West College as a whole needs to have a “STEM” and Transfer “Culture” established, and support for the math department at all levels.
    u. Promotion of math as a core-factor in student success, as with English, Communication Studies, and other core degree requirements.

Considerations and Discussion

While adopting new teaching methodologies and pedagogies is necessary, implementing these instructional methods cannot be achieved with current class sizes. A current survey of class sizes across California Community Colleges revealed an average size of 32 students' maximum in developmental and transfer level math courses.

In each of the new pedagogical models, the "flipped" and group learning models work best when implemented with a class size of 28 students or less. These instructional models rely heavily on independent preparation by the student, intensive and highly structured learning environments, and a significant amount of in-class activities including but not limited to quizzes, group problem solving, and one-on-many interaction in these group settings (one instructor – many small groups of students). As well, the courses are highly incentivized through grading, in-class activities, and expectations of students to complete out-of-class work both for preparation and homework (Flipped Classroom Field Guide, nd). Current levels of faculty, class size, and student behaviors make this process difficult. Despite the challenges, the full-time faculty is committed to experimenting with these models.

Immediately, additional implementation of an SIA as a full-time staff member with minimum bachelor's degree qualifications in the subject is critical to the success of the transfer-level flipped classrooms. Dedicated instructional training and increasing the number of full time faculty in the department is vital to improving success in the transfer level math coursework. Without a commitment to the math department, and establishment of faculty numbers similar to other foundational transfer coursework (English, Communication Studies), students will continue to be at a disadvantage and will increase their time to course completion, degree completion, and transfer.

These recommendations are supported unanimously by the group and reached giving consideration to increasing FTE's while recognizing that funding, current infrastructure, and hiring guidelines are the purview of administration.

Rick Hicks, Co-Chair

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Yvonne Portillo, Co-Chair

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Pete Bouzar, Math Faculty/Dept. Chair

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Lindsay Lewis, Mathematics Faculty

_____

Teresa Speakman, Academic Senate Representative

_____

Mitchell Alves, Instructor Mathematics and CFE Representative

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Kay Nguyen, ex-officio

_____

Jeff Courchaine, ex-officio

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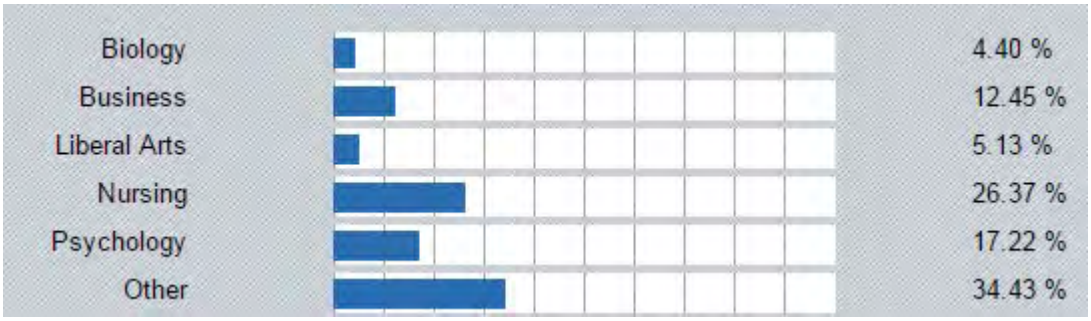
Survey of GWC Current Math G160 Students

GENERAL INFORMATION

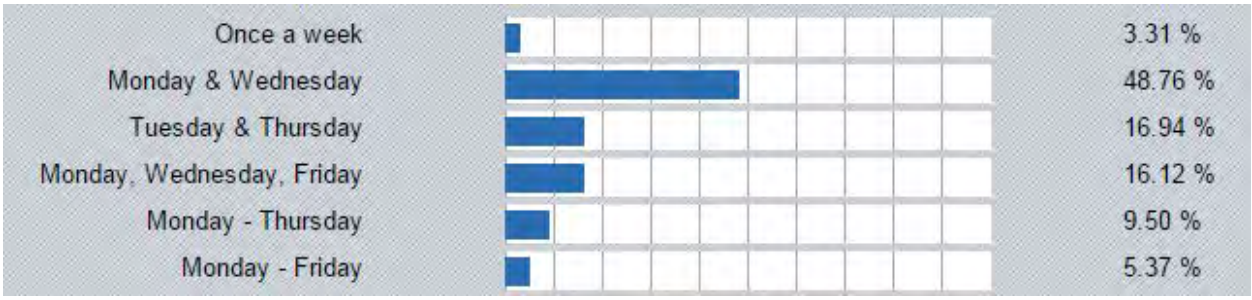
1.1 What is your major? (n=273)



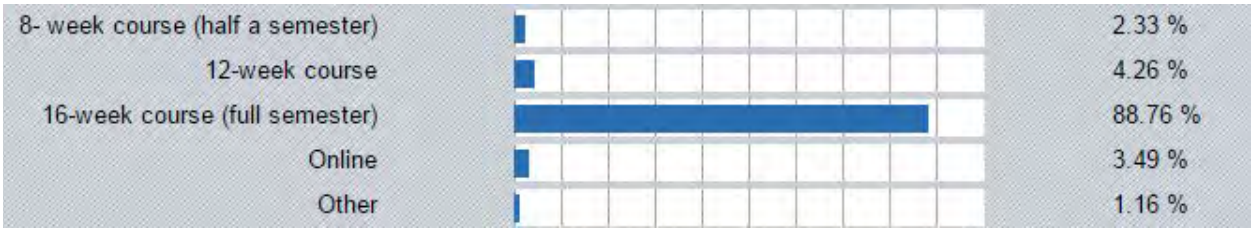
1.2 Open ended "Other"

1.3 Is this your first time taking Math G160? (n=279)

1.4 How many days a week would you prefer this course to be offered? (n=242)



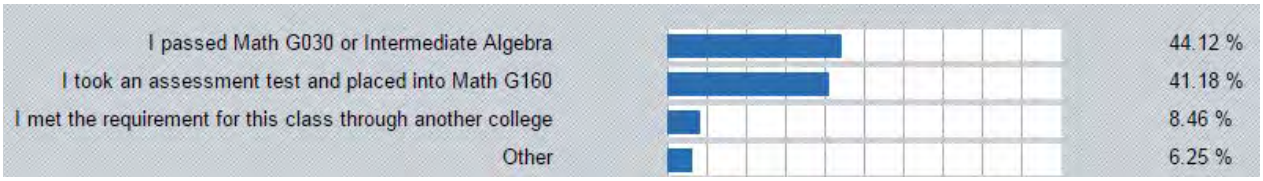
1.5 Which format would you prefer that this course to be offered as? (n=258)



1.6 Open ended "Other"

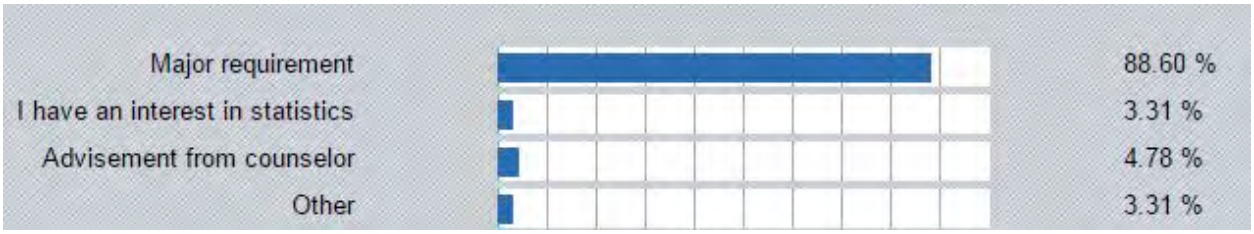
ENROLLMENT INFORMATION

2.1 How did you get into this class? (n=272)



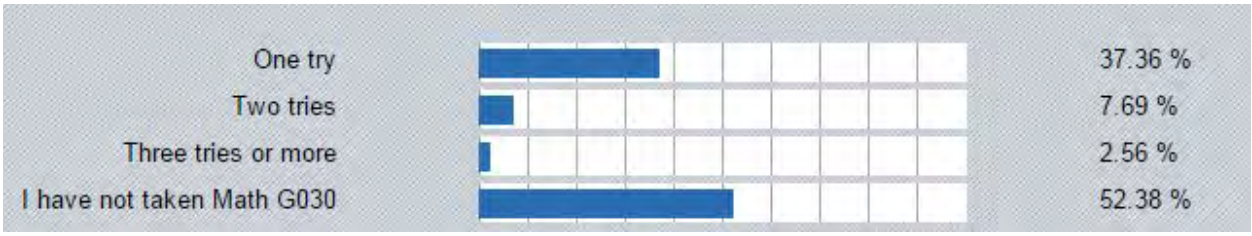
2.2 Open ended "Other"

2.3 Why did you decide to take this class?



2.4 Open ended "Other"

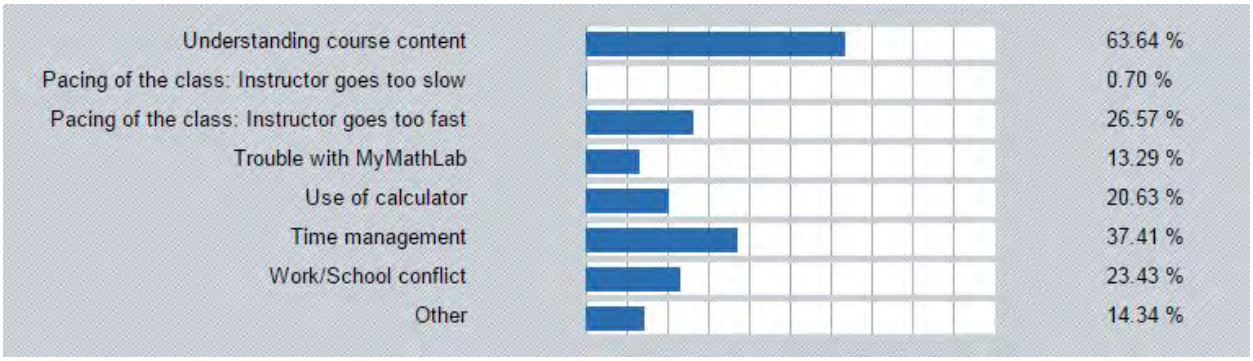
2.5 If you took Math G030 before enrolling in this class, how many times did you take Math G030 before passing it with a grade C or better? (n=273)



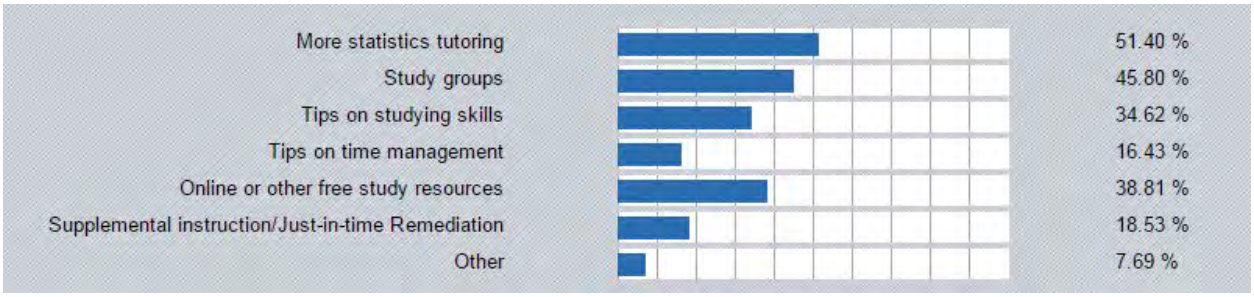
2.6 If you took Intermediate Algebra before, do you feel it adequately prepared you for Math G160? (n=217)

Current Course Information

3.1 What challenges are you struggling with in these courses (check all that apply)



3.2 Open ended "Other"3.3 If available, what resources (on campus or online) would you need to be successful in Math G160 (check all that applies)

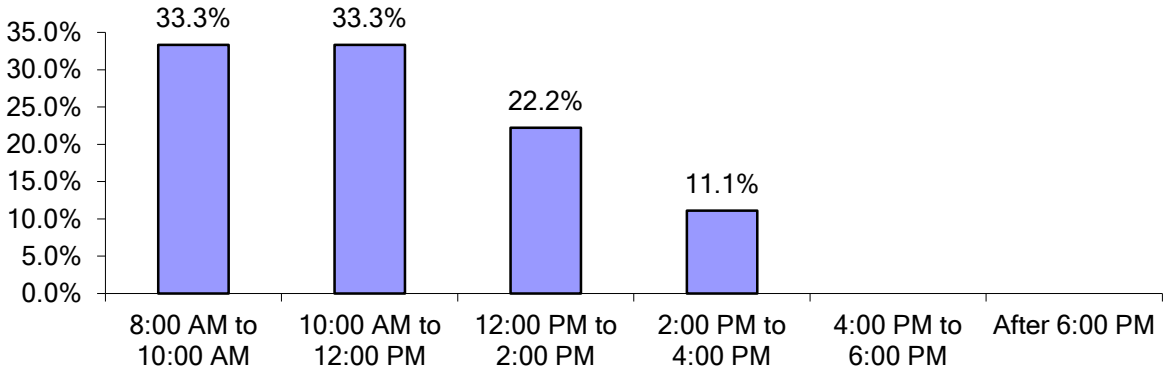


Transfer Math Faculty Survey

What course are you responding to this survey about?

Answer Options	Response Percent	Response Count
MATH G115	0.0%	0
MATH G120	0.0%	0
MATH G160	33.3%	2
MATH G170	0.0%	0
MATH G180	33.3%	2
MATH G185	16.7%	1
MATH G280	16.7%	1
Total	100%	6

At what time does this class start? If you teach multiple sections of the course, please select all the applied time blocks.



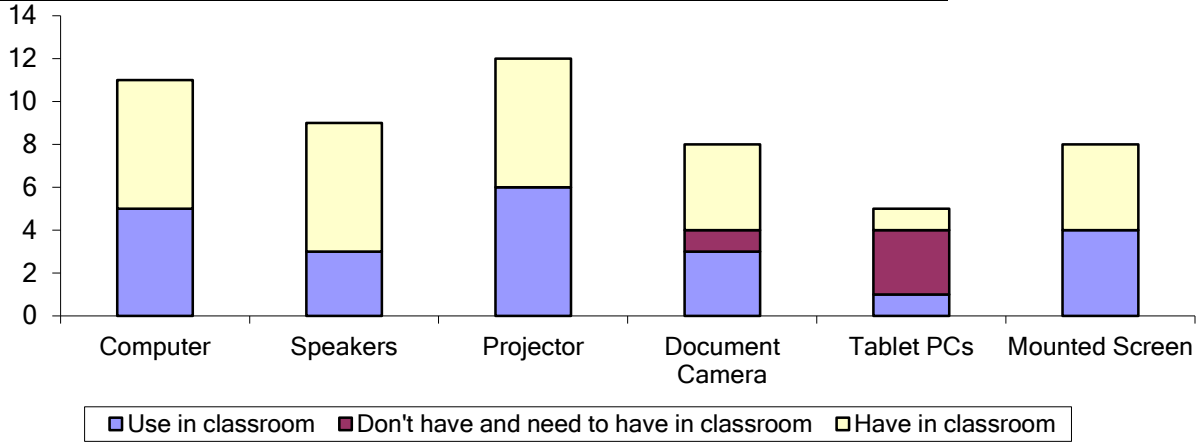
Which methods of instruction do you use in this course?

Answer Options	Response Percent	Response Count	Course Referenced
Lecture only	0.0%	0	
Lecture with guided practice	56%	6	MATH 160, 180, 185, 280
Sponge or warm-up activities	18%	2	MATH 180, 185
Flipped classroom	0.0%	0	
Reading Apprenticeship	18%	2	MATH 180, 185
Other (please specify)	9%	1	
Total	*100.0%*	11	

Comment: Collaborative work on exercises pertaining to the topics covered in that lesson. (2) Applications to real-world situations that implement the topics of the lesson. (Math 160 and 280)

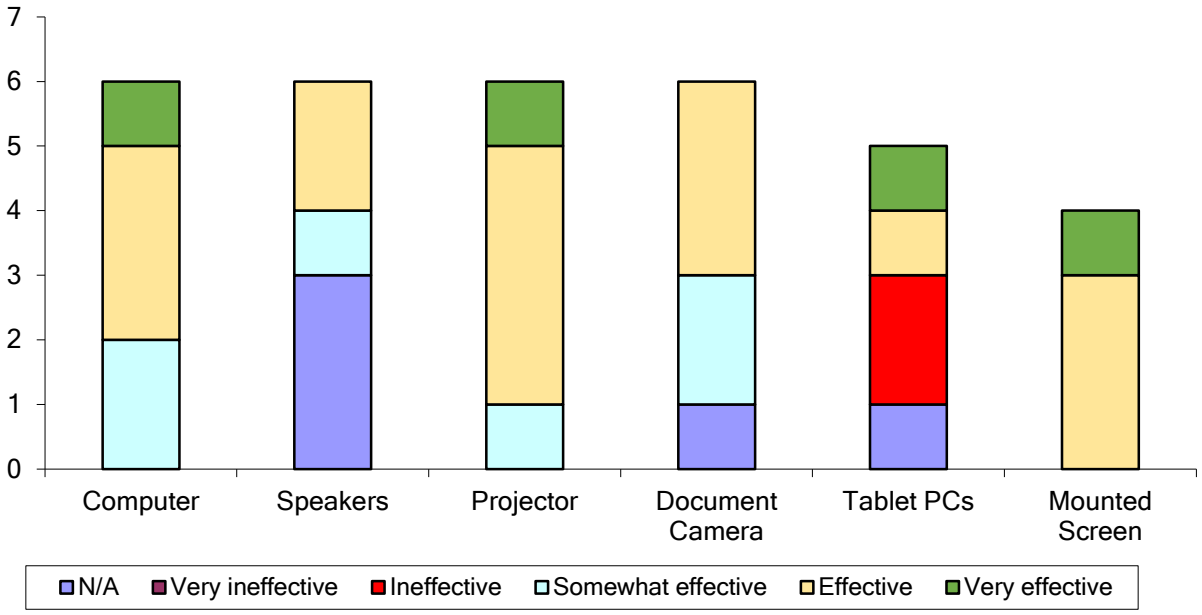
Please select whether the following technologies are available in the classroom for this course, and select the technologies that you use.

Answer Options	Have in classroom	Don't have and need to have in classroom	Use in classroom
Computer	6	0	5
Speakers	6	0	3
Projector	6	0	6
Document Camera	4	1	3
Tablet PCs	1	3	1
Mounted Screen	4	0	4



Please rate the effectiveness of the following technologies in impacting student learning.

Answer Options	Very effective	Effective	Somewhat effective	Ineffective	Very ineffective	N/A
Computer	1	3	2	0	0	0
Speakers	0	2	1	0	0	3
Projector	1	4	1	0	0	0
Document Camera	0	3	2	0	0	1
Tablet PCs	1	1	0	2	0	1
Mounted Screen	1	3	0	0	0	0



Please rate the effectiveness of the physical classroom environment in impacting student learning in this course.

Answer Options	Response Percent	Response Count	Course Refrenced
Very effective	16.7%	1	160
Effective	16.7%	1	185
Somewhat effective	16.7%	1	180
Ineffective	50.0%	3	160,180,280
Very ineffective	0.0%	0	
Total	*100.0%*	6	

"The classroom is packed with desks, making it very difficult to implement collaborative exercises."

Please rate the effectiveness of this class' current enrollment size in impacting student learning.

Answer Options	Response Percent	Response Count	Course Referenced
Very effective	16.7%	1	160
Effective	33.3%	2	180
Somewhat effective	33.3%	2	185,280
Ineffective	0.0%	0	
Very ineffective	16.7%	1	160
	100.0%	6	

Please rate the effectiveness of MyMathLab in impacting student learning in this course.

Answer Options	Response Percent	Response Count	Course Referenced
Very effective	25.0%	1	160
Effective	25.0%	1	160
Somewhat effective	0.0%	0	
Ineffective	0.0%	0	
Very ineffective	50.0%	2	180,280
	100.0%	4	

"MML is not used with this course, and hopefully will never be used."

Do you offer on-campus office hours?

All faculty said yes. One person said “Not regular. Only on student need and/or request basis.”

Approximately, what percentage of students in your current class(es) appear to be prepared for this course?

Answer Options	Response Percent	Response Count	Course Referenced
Less than 25%	33.3%	2	160, 180
25% - 49%	50.0%	3	160, 180, 185
50% - 74%	16.7%	1	280
75% - 100%	0.0%	0	
Total	100.0%	6	

Thinking back to previous semesters that you've taught this course, how much of the course content were you able to cover within a semester?

All faculty indicated that they were able to cover 75% to 100% of the course content.

Are there any resources that you would need to help you improve student learning in this course?

- A math lab dedicated to tutoring/study groups in Math.
- SIAs/Tutoring for Stats Stats Learning Community Workshop series
- Algebra and trigonometry review sessions
- Tablet PC with wifi to projector

Other comments:

I would like to try flipping this class but not too confident that students would come in prepared and ready to discuss and work on contextualized activities. Class time is wasted covering topics they should have somewhat learned before coming to class.