Department of Mathematics and Computer Science
Mathematics Program
Six-Year Report
September 15, 2014

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APPENDICES

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INTRODUCTION

The process of reviewing the mathematics program over the past six years has provided our department with opportunities to consider a range of questions about our curriculum and our methods of assessing student learning. We have refined our assessment tools and made some adjustments to our curriculum. For the most part, we have not explored large-scale changes to the mathematics program. Nationally, liberal arts colleges have a fairly established consensus on what core classes should be included in a mathematics major. Given our limited size (both number of faculty and number of majors), we have little flexibility to expand or adjust our offerings beyond that core if we want to give students the kind of preparation for jobs and graduate school that any liberal arts college provides. Nor have we had much freedom to modify the courses that serve other programs (70% of our offerings), since we are committed to providing what those client programs say is most important for their students.

While we recognize the importance of using data to inform our decisions about curriculum and program, the limited size of our program (we average between 4 and 5 graduates per year) makes any data set comparable to anecdotes rather than Big Data that might reveal patterns of clear strengths and weaknesses of the program. For this reason, we have made decisions about program changes with those anecdotes in mind, but also with careful attention to good practices at other institutions and in light of our knowledge of the Westmont context.

The report that follows describes the efforts we have made to refine and improve our major program and our service courses, informed by our personal knowledge of our students and good mathematics programs, and with the aim of being faithful stewards of the limited resources of our department.

FINDINGS

Student Learning

We adopted our four Program Learning Outcomes (PLOs) in the 2006-2007 academic year, and have been using them to assess student learning since 2007-2008. In what follows, we describe our PLOs and discuss

1) what we learned about students' learning, relative to each PLO;
2) changes we have made and plan to make to improve student learning as a result of the information we gained from our assessment of student learning;
3) the effectiveness of our current methods for assessing student achievement;
4) proposed changes we plan to make to improve our assessment work.

CORE KNOWLEDGE

STUDENTS WILL DEMONSTRATE KNOWLEDGE OF THE MAIN CONCEPTS, SKILLS, AND FACTS OF THE DISCIPLINE OF MATHEMATICS.

For 2008 to 2012, our graduating seniors took the Major Field Test (MFT) in Mathematics at the end of the academic year.

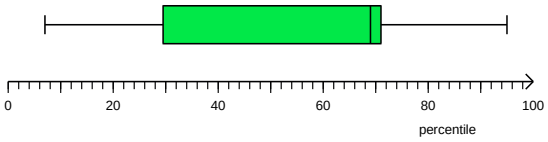
The MFT is a multiple-choice exam administered online by the Educational Testing Service for a fee of $25 per student. It contains 50 questions drawn from the courses of study most commonly offered as part of an undergraduate mathematics curriculum. A single score for each student is reported to the department. The department is able to obtain a subscore report if five or more students have taken the test. The subscore report gives the mean score for the cohort on five subareas of the test. In most years, we have fewer than five students taking the exam, so we chose to get a subscore report for all 22 students who took the test from 2008 to 2012.

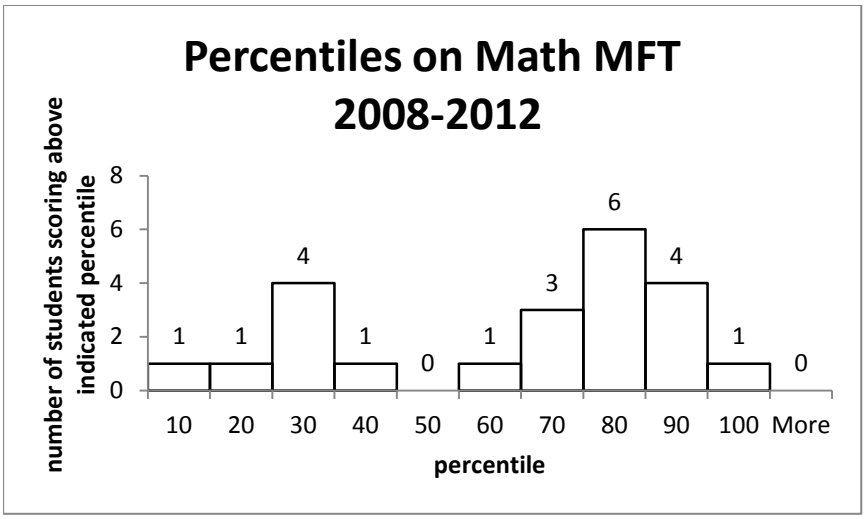
In 2008, when we began administering the MFT, we chose as a benchmark that 50% of students would score above the 75th percentile. This choice was somewhat arbitrary and we made it knowing that we might want to revise our expectations once we had a better understanding of the exam and how students performed on it.

1) What we learned about students' learning

In Spring 2012, we analyzed the scores of the 22 students who took the MFT between 2008 and 2012. The mean score was 161, which puts Westmont in the 79th percentile of all institutions whose scores are collected by ETS. Eleven of the 22 students scored in the 71st percentile or above, so we came close to meeting the benchmark.

The histogram and boxplot below provide summary of the percentiles for the 22 students.





The table below shows the subscore report. Note that this gives the mean percent correct and percentile for all 22 students on each section of the test.

Assessment Indicator Title	Mean Percent Correct	percentile
Calculus	42	85
Algebra	39	50
Routine	40	66
Nonroutine	34	91
Applied	40	75

Our students' performance on the algebra portion of the exam was the weakest overall. The content of this part of the course is described by ETS:

> **Linear Algebra**: matrices, linear transformations, characteristic polynomials, eigenvalues and eigenvectors, vector spaces, systems of linear equations;
> **Abstract Algebra**: elementary theory of groups, rings and fields; elementary topics from number theory

Students take the MFT two to three years after completing Linear Algebra, which may explain their low scores on this part of the exam. More generally, we believe that students are forgetting some of what they learned earlier in their careers.

Because the subscore report combines the scores of all 22 students, who had such a wide range (from a percentile of 7 to a percentile of 95), the subscore report is of limited value in giving us information about our students' performance in these subcategories.

2) Changes we have made and plan to make to improve student learning

Over the last few years, we have considered two changes to our curriculum in response to what we have learned about students' mastery of the main concepts, skills, and facts of the discipline of mathematics. First, we would like to explore ways of spiraling back to earlier topics in subsequent courses (e.g., do more linear algebra in geometry) in order to increase the likelihood that students retain relevant material. Second, we have explored the possibility of adding a Senior Seminar to our required courses for the major. We offered a pilot version of this course in Spring 2012, which included a systematic review of central topics in major curriculum. (See section (C) for further discussion of the Senior Seminar.) Only three students took the course. The percentiles of their MFT scores and those of the students who didn't take the course are shown in the table below.

2012 Graduates

Took Senior Seminar	Percentile on MFT
Yes	61
Yes	85
Yes	55
No	21
No	34
No	83

This was clearly too small a sample to draw meaningful conclusions about the value of the senior seminar we offered. See the report section on Curriculum Review and Sustainability for further discussion of our thinking about this course.

3) Effectiveness of our current methods for assessing student achievement

We are not satisfied with the MFT as an assessment tool for this PLO. The reports provided by the ETS are of limited usefulness. Students have no extrinsic incentive to do well on the test, so may not be putting forth their best effort.

4) Potential changes to our assessment work

In the next cycle of program review, we plan to consider additional and alternative tools for assessing student learning relative to this PLO.

COMMUNICATION PLO

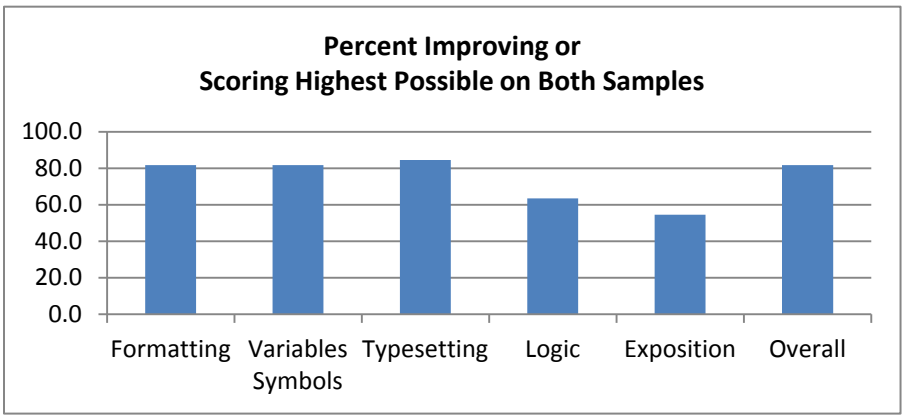
STUDENTS WILL BE ABLE TO COMMUNICATE MATHEMATICAL IDEAS FOLLOWING THE STANDARD CONVENTIONS OF WRITING OR SPEAKING IN THE DISCIPLINE.

To assess this PLO, we developed a rubric for use in evaluating student writing in our upper division writing-intensive courses, MA 108 (Mathematical Analysis) and MA 110 (Modern Algebra). The instructor of the course collects an early writing sample from each student at the beginning of the semester, and a sample from the end of the semester. Multiple graders view each sample and scores are agreed upon after a consensus is reached. The department's benchmark is that 75% of students would show improvement overall from one sample to the next. The rubric is shown in Appendix 1.

1) What we learned about students' learning

The table and graph below show the results of our assessment. They indicate which students (and what percentage) either received the highest possible score (3) on both sample papers or showed improvement from the early to the later sample.

Score was highest possible on both samples or improved						
Student	**Format-ting**	**Variables Symbols**	**Type-setting**	**Logic**	**Exposi-tion**	**Over-all**
2009A	x	x	x			x
2009B		x	x			
2009C	x	x	x	x	x	x
2009D			x			x
2009E	x	x	x	x	x	x
2009F	x	x	x	x		x
2009G	x	x	x			x
2009H	x	x	x	x	x	x
2009J	x	x	x	x	x	x
2010A	x	x	NA	x	x	x
2010B	x	x	NA		x	x
2010C	x		NA	x		
2010D	x	x	NA	x	x	x
2010E	x		NA			
2010F	x	x	NA	x		x
2010G			NA			
2010H	x	x	NA	x		x
2010J	x	x	NA	x	x	x
2011A	x	x	x	x	x	x
2011B	x	x	x	x	x	x
2011C	x	x			x	x
2011D		x		x	x	x
% improving	81.8	81.8	84.6	63.6	54.5	81.8



Our students met the benchmark in their overall writing, though fewer showed improvement in the categories of logic and exposition. Most students are writing at or above an acceptable level for the type of writing elicited by the prompts, according to the standards in the discipline of mathematics. They make appropriate choices in the layout, alignment, and formatting of their text. They choose appropriate variable names and make appropriate use of symbols. They generally apply definitions correctly, making only occasional logical errors. Their exposition is generally complete and economical and they make proper use of prose.

Our assessment of student work has confirmed the value of software that allows students to typeset mathematics.

2) Changes we have made and plan to make to improve student learning

In the courses where we used the rubric, students commented that it was a helpful way for them to understand our expectations for their writing. They suggested that we introduce the rubric in lower division courses so that they can begin to see its use on their writing in those courses. We have already implemented this change.

Currently, not all our courses require students to typeset their work—a process we believe helps them to self-monitor their writing style. We have made typesetting available in some lower division courses and plan to discuss the feasibility of wider implementation. In 2011, we upgraded our license for a typesetting software package to make it available to more students.

While the writing-intensive courses are the places where students get the most focused attention on their writing, they have opportunities to write for publication in their Problem Solving course (MA 180). Students must take this course twice. Our assessment of their writing has led us to advise students to delay taking MA 180 for the second time until they have had one of the writing-intensive courses. This will enable them to put their skills into practice for a broader audience, and will give us another place to assess their writing abilities.

3) Effectiveness of our current methods for assessing student achievement

In scoring and discussing the writing samples, we determined that our assessment methods are not giving us all the information we need about student learning and the effectiveness of our curriculum and teaching. In particular, we determined that our benchmark is more appropriate for an individual course than for the program as a whole. Moreover, the prompts, which consist of individual problems, do not give students sufficient opportunity to display the full range of their knowledge and skills in the area of written communication. We also found that some categories on the rubric need changing.

4) Potential changes to our assessment work

In response to what we have learned from assessing this data, our department has decided to do the following:

1. Modify the rubric so that the categories conform more to the outcomes we desire.
2. Collect samples of writing from MA 180 from students taking the course for the second time. These samples will be in response to a prompt that is already being used in the course. Writing in MA 180 is in response to challenging problems published in mathematics journals. Consequently the writing is more sustained and creative.
3. Assess the communication SLO using these samples by collectively using the modified rubric.
4. Make use of the rubric in writing instruction in lower division courses, specifically MA 019, MA 015, and MA 020.

CREATIVITY PLO

STUDENTS WILL DEMONSTRATE THE ABILITY TO FORMULATE AND MAKE PROGRESS TOWARD SOLVING NONROUTINE PROBLEMS.

Problems and exercises that students encounter in mathematics courses typically give them practice applying material they are learning in the course and enable them to demonstrate their mastery of that material. As they mature as mathematicians, our students are expected to demonstrate creativity and an ability to solve problems that require the creative application of ideas from a range of disciplines. This type of work is the focus of the problem-solving course, MA 180, which students take twice in the program—once in their first two years, and once in their last two years. This course functions as a workshop, with students selecting problems from mathematics journals, working on them in and out of class, and discussing their efforts and results with the class. Their goal for the semester is to submit at least one problem solution to a journal for refereeing and perhaps publication.

To assess this outcome, we collect data on student submissions of solutions to journals. Our benchmark is that at least 50% of students will submit a correct solution to a journal.

1) What we learned about students' learning

The table below shows the results of students from our most recent analysis of the relevant data. Students are performing at the level of our benchmark. More students are solving problems than submitting them. In some cases, this is because they are completing their solutions after the journal's deadline for submission.

student	correct solution	submitted
2008A	x	x
2009A	x	x
2009B	x	x
2009C	x	x
2009D	x	x
2009E		
2009A	x	
2010B		
2010C		
2010D	x	
2010E	x	
2010F	x	x
%	75	50

2) Changes we have made and plan to make to improve student learning

While we are satisfied with our students' level of achievement on this outcome, we have determined that they are better equipped to engage in the course if they have had MA 15 or MA 20 before they take it for the first time, and if they have had one of the writing-intensive courses before they take it for the second time. Consequently, we have changed the co- and pre-requisites for MA 180 to reflect that observation.

3) Effectiveness of our current methods for assessing student achievement

We are satisfied with our current methods for assessing student achievement relative to this PLO.

4) Potential changes to our assessment work

We have no plans to change our assessment work in this area.

CHRISTIAN CONNECTIONS PLO

STUDENTS WILL INCORPORATE THEIR MATHEMATICAL SKILLS AND KNOWLEDGE INTO THEIR THINKING ABOUT THEIR VOCATIONS AS FOLLOWERS OF CHRIST.

Seniors in the year's capstone course (MA 136, MA 140, or MA 155) write an essay at the end of the semester reflecting on aspects of mathematics and the Christian faith. Multiple graders read each paper and score it on a rubric, giving a score of Superior (= 3), Adequate (=2), or Lacking (=1) in two categories: (1) whether the paper exhibits a mature perspective on the discipline, and (2) whether the paper makes a substantive connection between faith and mathematics. Scores are agreed upon after a consensus is reached. The department's initial benchmark was that 50% of students' papers would be rated superior. The rubric is shown in Appendix 2

1) What we learned about students' learning

The table below shows the scores from students from 2008, 2011, 2012, and 2013. Note that we stopped averaging scores and moved toward a consensus rating after 2008.

student	2008A	2008B	2008C	2008D	2008E	2011A	2011B	2011C	2011D	2012A	2012B	2013A
Subst. connect	2.1	2.1	2	2.4	2.3	2	2	2	2	2	2	2
Mature persp	1.8	1.9	1.7	1.7	1.8	2	2	2	2	2	2	2

Students are not achieving the level of performance we would like on this outcome.

2) Changes we have made and plan to make to improve student learning

We plan to discuss appropriate changes to improve student learning in this area during our upcoming 6-year cycle.

3) Effectiveness of our current methods for assessing student achievement

We are not satisified with the effectiveness of our current assessment methods in this area. The essay assignment is not tied effectively to the material of the course. The three courses in which we do this assessment are sufficiently different that it is difficult to create an appropriate common essay prompt. Moreover, because of the structure of our course offerings, students often take their capstone course before their senior year. This means that students are not always writing this essay as seniors, so we're not able to assess student learning in this area at the senior level.

4) Potential changes to our assessment work

We plan to discuss appropriate changes to our assessment methods in this area during our upcoming 6-year cycle.

Alumni Survey

INTRODUCTION

On June 16, 2014 the department sent an e-mail to 180 alumni (1979–2014) inviting them to complete a Survey Monkey questionnaire. As of this writing 72 responses have been received (thus giving a 40% return, with 60% of the respondents being male and 40% female). Appendix 3 contains the survey questions and the free-form responses.

One weakness of the information provided by our alumni survey comes from the fact that but the responses were not coded by major, making it difficult to interpret some results.

ALUMNI ATTITUDE TOWARDS THE DEPARTMENTAL PROGRAM

Alumni were enthusiastic regarding the teaching in the department, as the following table of responses demonstrates

	Superior	Strong	Adequate	Weak	Very Weak
Effectiveness of teaching	36%	60%	4%	0%	0%

Written comments corresponded with these percentages. All but one alumnus responded to the free-form question regarding strengths of the department. Of the responses, 60% listed either faculty access, care, attention, or teaching capability as the best aspect of the program. Other comments mentioned high standards, the rigor of the curriculum, small class size, and collaboration as strengths. All but two respondents would likely recommend Westmont to others.

Regarding suggested improvements to the program, 68% gave suggestions, although 17% indicated either that no improvements were necessary or didn't feel qualified to offer any suggestions (usually because too much time had elapsed since graduation). Many of the suggestions could only be implemented with an increased budget, such as offering upper-division courses every year, having more faculty, or offering a larger selection of courses. The survey was sent to graduates in mathematics and computer science, but the responses weren't coded by major, making it difficult to interpret some suggestions. For example, several alumni recommended that the program have a greater emphasis on applied areas, class projects, or practicum opportunities, but it is not clear whether these suggestions apply to the CS program or the math program.

PREPARATION FOR LIFE AFTER WESTMONT

Alumni similarly gave high marks regarding the preparation they received as compared with their co-workers, peers, or colleagues: stronger (38%), above average (49%), average (10%), less than average (4%), weaker (0%). As the following table depicts, they also gave high marks (shown in percentages) for the department's four Program Learning Outcomes.

	Importance for Life's Work			**Degree of Achievement**		
PLOs	**Very**	**Somewhat**	**Irrelevant**	**Good**	**Average**	**Poor**
Core Knowledge	51	40	8	63	33	4

Communication	90	10	0	78	21	1
Creativity	81	19	0	72	26	1
Christian Connection	29	38	33	63	35	3

About 54% of the respondents have received advanced degrees of various kinds, with 12% listing a Ph.D. Vocationally our alumni are engaged in a variety of pursuits.

Fifty-four respondents indicated their current job or career. The table below shows their responses. Note that this table does not distinguish between mathematics graduates and computer science graduates.

Job Description or Title	**Number of alumni**
Mathematics teacher	15
Software engineer	6
College professor	4
Graduate Student	3
missionary	3
Software developer	3
Information Technology	2
Tax accountant	2
Teacher	2
Airline pilot	1
College administrator	1
Cyber operations planner	1

Job Description or Title	**Number of alumni**
Engineer, defense industry	1
Epidemiologist	1
Equity portfolio manager	1
Lawyer	1
Quality assurance engineer	1
Sales and marketing	1
School administrator	1
Senior manager, federal government	1
Senior technical generalist for computing infrastructure	1
Small business CEO	1
Software consultant	1

RECOMMENDED CHANGES

The strong positive responses that alumni gave on all aspects of our program suggest that they are satisfied with their experiences. Some of the recommended changes are beyond departmental control (e.g., hire more faculty, increase course offerings). Many of the suggestions are good ones (have more social events, advise students to study abroad, provide more career development), and we will take them into account as we enhance our program. Since there is no pattern to the suggestions and none that get repeated more than a twice, they must be seen as reflecting the experiences of the individuals who made them, and not strong data to support widespread change.

Curriculum Review

The mathematics curriculum at Westmont provides the opportunity for students to obtain a strong, if somewhat constrained background in the subject. The success of Westmont graduates attending graduate school attests to the strength of the curriculum. As is the case for other science programs, the mathematics curriculum is strongly developmental. A student pursuing a degree in mathematics will need to complete a prerequisite chain of minimal length four for a B.A. and of length five for a B.S. Such prerequisite chains are unavoidable in the mathematics curriculum. Without the prerequisites, students are simply unprepared to do the work in the more advanced courses. The prerequisite chains become problematic when there are multiple required courses that are only offered once every two years appearing at the ends of such chains. The extent to which such courses should be mandated was one of the major themes in our departmental discussions for this review cycle. The presence of such courses (1) makes it more difficult to complete the major and (2) results in serious conflicts for students desiring to participate in some off-campus programs.

The Mathematics department currently requires two specific upper division courses: MA 108 Mathematical Analysis and MA 110 Modern Algebra.[1] Other upper division requirements are fulfilled by selecting courses from a menu of options. Mathematical Analysis and Modern Algebra are known throughout the mathematical community as being the two most rigorous, and therefore most difficult, courses in the undergraduate mathematics curriculum. A survey of other mathematics programs (see Appendix 4) found that approximately half of the programs required both Mathematical Analysis and Modern Algebra. Of particular note is the fact that Saint Olaf, which has a flourishing and nationally recognized mathematics program, does not require both courses. In addition, the Saint Olaf program allows graduates to freely select 50% of their mathematics courses. In contrast, the Westmont mathematics program contains 15% elective courses.

We will modify the B.A. program so that only one of MA 108 Mathematical Analysis or MA 110 Abstract Algebra is required. Students will be encouraged to take both. We will reevaluate at the end of the next program review cycle.

The B.S. program not only requires MA 108 Mathematical Analysis and MA 110 Modern Algebra but also an advanced course in one of the areas. Since these two areas are critical for graduate-school-bound students, it would be a great disservice to those students to allow a choice between the two. Likewise, taking an advanced course in some area is important, but not critical, in preparing students for graduate school. Because of the small pool of eligible students resulting from the long prerequisite chain, eliminating the requirement that B.S. students take an advanced theoretical course would likely result in enrollments too low to support the continued offering of the courses – even on an alternate year basis.

[1] Graduates are also required to take two semesters of MA 180 Problem Solving. However, this is a 1-unit class that is offered every term.

We will not change the requirement that B.S. students take an advanced course. However, we will routinely use course substitutions to enable B.S. students to participate in off-campus programs.

The topic of potentially weak areas of the mathematics curriculum was the other discussion thread in our departmental review. Specifically, the conversation centered on a shared capstone experience and applied mathematics options.

Currently, mathematics students select from a menu of three courses for their capstone course. Since these courses are offered in alternate years and some students have taken the prerequisite courses by the end of their second or third semester, it is possible for a student to fulfill the capstone requirement in the second semester of the freshman or sophomore year. This situation is hardly ideal. However, the creation of a dedicated capstone course that students would take in their senior year would mean either the elimination of two other upper-division courses that are currently offered in alternate years or an increase in the departmental course offerings. Since we lack both the faculty resources and the student enrollment for the latter option as well as the willingness to trim two courses from our current curriculum, we will not pursue a dedicated capstone course option at this time.

One attractive option for increasing the applied mathematics offerings in the department would be to increase our statistics offerings. People with strong statistical skills are in high demand. The obvious first step would be to split our current Probability and Statistics (MA 130) course into two separate courses – one dedicated to probability and the other to statistics. This structure is very common in mathematics departments that offer courses on an annual basis. Unfortunately, splitting MA 130 into two courses would create a five-course prerequisite sequence, as Probability would be a prerequisite for Statistics. This long sequence would likely result in low enrollments in the second course. Additionally, students taking only Probability would be negatively impacted by their lack of exposure to statistical methods. Consequently, we will not pursue the creation of separate Probability and Statistics courses at this time.

Another option for a more applied option would be to offer a data science class. This course might have appeal to both mathematics and computer science students. This conversation is in the beginning stages.

We will investigate the possibility of creating a data science course. We will also investigate the option of including a project in the capstone courses. A recommendation will be made by the end of the next program review cycle.

Given the shifting expectations that employers have of graduates with a degree in mathematics, it is troubling that, currently, a Westmont mathematics graduate may not have any computer programming skills. This situation may be acceptable for students pursuing a B.A. in mathematics, but is problematic for B.S. graduates.

For the B.S. degree, we will eliminate the options under "applied courses" and require that graduates complete CS 010 and CS 030.

The topic of the mathematics concentration for Liberal Studies students was broached but not developed in any significant way.

We will initiate a conversation with the Education Department about the courses in the Liberal Studies Mathematics concentration. A recommendation will be made early in the next review cycle.

Program Sustainability

All of our lower division mathematics courses (MA 004, MA-005, MA-008, MA-009, MA-010, MA-019, MA-020) and two upper division courses (MA-160, MA-165) serve students in other programs. These courses account for approximately 70% of our course offerings and most of our enrollments. Over the past six years, these courses have been consistently well enrolled. The need for mathematics as "service department" is historically clear. By contrast, mathematics courses that serve the mathematics major tend to have low enrollments, and the department would like to increase the number of Westmont students who major or minor in mathematics.

Over the past eight years, 37 students have graduated from Westmont with a degree in mathematics. Of these, 17 were male, 20 were female, and 7 were students of color. For a STEM discipline, the heterogeneity of our graduates is encouraging. The total quantity is not.

The department continues to speculate on the reasons for the scarcity of mathematics majors. A contributing factor may be the type of incoming student that Westmont tends to attract. High school students who excel in the STEM disciplines are often encouraged to attend large engineering schools; those who attend Christian liberal arts colleges tend to be predisposed to the humanities. In addition, many students are motivated by a desire to serve others with their major studies, and it is clearer to them how other disciplines offer these opportunities. It is also easier to see the aesthetic and interesting side of other disciplines.

The sequential nature of the subject is another factor that may steer students away from mathematics. It is very difficult to complete the major in four years without taking mathematics courses in the first year; students need to commit early to this program of study. All of our upper-division courses are offered every other year; since some of these are specifically required for the major, scheduling is inflexible. This inflexibility also limits the choices students have when considering an off-campus program.

Compared to other institutions, our program is fairly rigorous. Alumni report that they have been well-prepared for graduate study. Many of our graduates find interesting and rewarding careers in industry, and report that their Westmont education—and their

mathematics courses in particular—are professional assets. (See the alumni survey for more information.)

These findings provide some of the justification for the changes highlighted in the previous section.

Additional Analysis

GENERAL EDUCATION

Mathematics courses make up 60% of courses that meet the GE requirement of Abstract Reasoning. In 2009, we asked to have MA 005 Introduction to Statistics decertified as a course meeting the requirement, believing that it did not meet the certification criteria. In light of changes made to the certification criteria in 2013-14, and in response to a request from Academic Senate, we applied to have it recertified. Sensing that students were still in need of additional ways to meet this requirement we also applied to have MA 008 certified. Both applications were approved by the GE Committee.

Approximately 40% of courses meeting the Quantitative and Analytical Reasoning requirement of the GE are offered by our department.

FINANCES

We believe that our current operating budget is sufficient for the needs of our program.

FACILITIES

We believe that our current facilities are sufficient for the needs of our program.

INTERACTION WITH OTHER DEPARTMENTS

During the 2011-12 academic year, we met with client departments to determine whether our calculus courses were meeting their students' needs. They had no suggestions for improvement.

LOOKING FORWARD:
CHANGES AND KEY QUESTIONS

Over the past six years, the core elements of our mathematics program have remained largely unchanged. We have made modest adjustments to major requirements, sometimes in response to our experiences assessing student learning, and in part with the goal of creating more flexibility for students. As we have gained experience in assessing student learning, we have changed some of the tools and methods for that assessment.

The most significant change to the program that we contemplated was the addition of a senior seminar. Our interest in this change was prompted by the recognition that such a course could enhance student learning as well as make assessing learning simpler and possibly more effective. As described above, the size of our program (number of faculty and students) and our commitment to offering all the courses in a standard, rigorous bachelor's program in mathematics seem to make the inclusion of a senior seminar in the curriculum impractical and undesirable.

Other curricular changes to the program included (1)the addition of the requirement of **MA 15 Discrete Mathematics**; (2)changes to the co-requisites of **MA 180 Problem Solving** so that students were better prepared for the work; (3) the addition of a pre-calculus course (**MA 008 Functions and Models**) to create an additional entry point into the major and the calculus sequence; (4) the addition of a practicum course as an alternative to one of the required sections of MA 180; (5)the exploration of various calculus textbooks; (6)greater use of inquiry-based methods of instruction in all courses. Changes we plan to implement in the coming cycle are listed below.

Our efforts to assess student learning have improved over the past six years. We have gradually found ways to articulate and measure what we want to know about their learning. We are energized by our mission statement and believe that our Program Learning Outcomes capture the essential goals we have for our majors. During our next program review cycle, we hope to continue developing our methods of assessing learning so that they become more meaningful and manageable. We are particularly interested in finding more effective ways to assess student learning relative to the Core Knowledge and the Christian Connections program learning outcomes.

An additional interest of ours for the next cycle, is in exploring ways to increase the number of majors in our program. We suspect that increased opportunities for students to see the post-baccalaureate options that will be open to them with a degree in mathematics may help with that goal.

Proposed Changes Related to Program Learning Outcomes and Assessment

In the next cycle of program review, we plan to consider additional and alternative tools for assessing student learning relative to the Core Knowledge PLO.

In response to what we have learned from assessing data on our Communication PLO, we plan to:

Modify the writing rubric so that the categories conform more to the outcomes we desire.

Collect samples of writing from MA 180 from students taking the course for the second time. These samples will be in response to a prompt that is already being used in the course. Writing in MA 180 is in response to challenging problems published in mathematics journals. Consequently the writing is more sustained and creative.

Assess the communication SLO using these samples by collectively using the modified rubric.
Make use of the rubric in writing instruction in lower division courses, specifically MA 019, MA 015, and MA 020.

We plan to discuss appropriate changes to improve student learning and assessment in the area of the Christian Connection PLO.

Proposed Changes to Curriculum

We will modify the B.A. program so that only one of MA 108 Mathematical Analysis or MA 110 Abstract Algebra is required. Students will be encouraged to take both. We will reevaluate at the end of the next program review cycle.

We will investigate the possibility of creating a data science course. We will also investigate the option of including a project in the capstone courses. A recommendation will be made by the end of the next program review cycle.

For the B.S. degree, we will eliminate the options under "applied courses" and require that graduates complete CS 010 and CS 030.

We will initiate a conversation with the Education Department about the courses in the Liberal Studies Mathematics concentration. A recommendation will be made early in the next review cycle.

Continue to implement student-centered pedagogies such as inquiry-based learning.

Intensify our efforts to educate current and future majors about the career possibilities available to mathematics graduates.

APPENDIX 1 RUBRIC FOR COMMUNICATION PLO

I. Logic	*Weak*	*Acceptable*	*Outstanding*
Deductions	☐ Many or significant unjustified steps ☐ Critical logical errors	☐ Occasional, minor unjustified steps ☐ Minor logical errors	☐ Free of logical errors with all nontrivial steps justified
Definitions.	☐ Incorrect definitions used	☐ Occasional use of informal definitions	☐ Proper definitions are used correctly
II. Exposition			
Writing	Awkward/Confusing ☐ Incomplete thoughts ☐ Missing words ☐ Excessive wordiness ☐ Confusing word choices ☐ Improper sentence structure ☐ Excessive structural repetition	Generally Clear ☐ Occasional wordiness ☐ Some repetition ☐ A few awkward word choices ☐ Use of "=/<" outside of an equation	☐ Clear, complete, and concise with good word choice and a variety of sentence structures.
Spelling and grammar	☐ Many grammatical errors ☐ Many spelling errors ☐ Many punctuation errors	☐ Occasional grammatical errors ☐ Occasional spelling errors ☐ Occasional punctuation errors	☐ Error free
Variables	☐ Misleading/confusing variable names ☐ Variables are not introduced	☐ Some nonstandard/ambiguous name choices ☐ Some variables are not defined, but appear in a context that makes the meaning clear.	☐ Consistently good choices, always introduced
Symbols	Excessive misuse of symbols ☐ = ☐ → ☐ limit ☐ Other	Occasional misuse of symbols ☐ = ☐ → ☐ limit ☐ Other	☐ Consistently appropriate use of symbols
III. Formatting and Typesetting			
Layout	☐ No discernible/ inconsistent alignment protocol ☐ Numerous violations of layout conventions	☐ Non-standard alignment in displayed sequences of equations ☐ Some single-line expressions not displayed ☐ Some paragraphs inappropriately broken ☐ Page appears too dense ☐ Page appears too sparse	☐ Pleasing appearance with standard alignment used throughout
Formatting	☐ Poor or inconsistent choices ☐ Improper sub/super-scripting	Generally appropriate choices ☐ Some mathematics formatted as regular text ☐ Related, but incorrect, symbols used	☐ Consistent use of appropriate mathematical formatting

COMMENTS:

APPENDIX 2 PROMPTS AND RUBRIC FOR CHRISTIAN CONNECTION PLO

Mathematics and Faith: Final Exam Essay
MA 155

"Not all those who wander are lost." J. R. R. Tolkien, *The Fellowship of the Ring*

The Destination
As a capstone course in the mathematics major, this class has been one more opportunity to wander through the terrain of mathematics. It has given you an opportunity to make connections among some of the many parts of the discipline of mathematics. In addition to seeing how some important mathematical ideas came into existence (or were discovered…) and evolved, you have reviewed ideas familiar from previous courses and come to a deeper understanding of them.

By now, as a result of this course and your previous courses, you have encountered the varied landscapes of mathematics from a distance and up close. Your encounter has been both *deep* and *wide*, surveying some of the vastness of the mathematical seas and diving down deep into some of their crevices. Whether you are about to graduate, or have a few mathematics courses left to take before you graduate, your understanding of (and, hopefully, your appreciation for) sophisticated mathematical ideas should be more mature at the end of this course.

Moreover, in the process of acquiring this sophisticated understanding and appreciation, you are getting opportunities to think about the connections between the discipline and practice of mathematics and the Christian faith. In this course (as in the other capstone courses for the major), you have an opportunity to demonstrate your ability to articulate those connections.

That opportunity has now come—in the form of a 1000-1500-word essay which will make up a major component of your final exam for this course (35% of the final exam, which amounts to 7% of your total grade for the course).

The essay will demonstrate your perspective on the discipline of mathematics and your ability to make connections between faith and mathematics. You will be free to draw from the whole spectrum of your knowledge of mathematics, including ideas you have studied in this course or any of your other mathematics courses.

The essay will be due at the beginning of the exam period (Wednesday, May 1, 8am) or before. You must turn in a hard copy and email me an electronic copy by the due date in order to get full credit.

The rubrics on the next page, which will be used for evaluating the content of your essay, give more details about my expectations for this assignment.

Be aware that most students will require significant time to reflect on their mathematical knowledge and their own opinions in order to write an essay of good or superior quality. You will most likely want to review material from this course or previous courses in order to develop your ideas sufficiently. You may want to discuss your thoughts with me or another mathematics professor before you complete the essay.

If your perspective on the discipline of mathematics is mature and if you have the ability to make substantive connections between mathematics and faith, it will take time and careful thought to demonstrate them.

Take the time.

Mathematics and Faith: Final Exam Essay
MA 140

As a capstone course in the mathematics major, Complex Analysis has given you an opportunity to make connections among many parts of the discipline of mathematics. Regardless of your previous mathematical
experience, this course should have helped develop your appreciation and understanding of a variety of mathematical ideas.

In learning new material and connecting it with other topics this course has also (directly or indirectly) offered potential points of contact with the Christian faith. As part of Westmont's assessment requirements
you now have an opportunity to compose an essay demonstrating your ability to articulate those connections.

Ten percent of your final exam grade will be based on this essay of approximately three pages (double-spaced,
one-inch margins, 12-point font). It should demonstrate your perspective on the discipline of mathematics
and, where appropriate, your ability to make connections between faith and mathematics. Of course, you should include ideas from this course, but you are free to draw from all courses studied.

The essay is due at the beginning of the final exam period (Thursday, May 1, noon). Please submit
a hard copy and e-mail me an electronic copy. as this essay will be read by the entire department.

The rubrics on the next page will be used for evaluating your work.

Doing a good job in composing your thoughts will require significant time to reflect on your mathematical knowledge. You are free to discuss your thinking with others in the class, with me, or with other mathematics
professors.

Rubric

The following rubric will be used to evaluate the content of your essay.

<table>
<tr><td rowspan="2">Mature perspective on the discipline</td><td>Lacking (D or F range)
Essay contains none of the following characteristics.</td><td>Adequate (C or B range)
Essay contains one or more of the following characteristics, but fails to develop any of these ideas in depth.</td><td>Superior (A range)
Essay contains one or more of the following characteristics, and develops at least one of these ideas in depth.</td></tr>
<tr><td colspan="3">Examples:

• Displays a sophisticated understanding of a specific mathematical idea.
• Describes specific connections between different areas of mathematics.
• Describes specific connections between mathematics and another discipline.
• Displays an authentic appreciation for mathematics.
• Displays an understanding of what it means to do mathematics.</td></tr>
<tr><td rowspan="2">Connections between faith and</td><td>Lacking (D or F range)
Essay does not identify any substantive connections between faith and mathematics</td><td>Adequate (C or B range)
Essay identifies one or more substantive connections of the type listed below, but these connections are not developed completely.</td><td>Superior (A range)
Essay contains well-developed, substantive connections of one or more of the types listed below.</td></tr>
<tr><td colspan="3">Examples:

• Describes how studying mathematics has shaped life goals, especially as a disciple of Christ.
• Describes how studying mathematics has informed a Christian world view.
• Uses ideas from mathematics as a basis for Christian apologetics.
• Uses ideas from mathematics to illustrate or illuminate a theological concept.
• Describes how Christian values influence one's approach to the discipline of mathematics.</td></tr>
</table>

APPENDIX 3
ALUMNI SURVEY

Survey Questions

Program

1. How effective was the teaching in the Department Mathematics and Computer Science?
• superior
• strong
• average/ adequate
• weak
• very weak

2. How well would you say your Westmont experience in mathematics or computer science prepared you for your current work relative to your co-workers, peers, or colleagues?
• stronger
• above average
• average
• less than average
• weaker

3. What was the best aspect of the departmental program?
4. What improvements would you suggest for the departmental program?
5. If a family member, friend, or business acquaintance asked you to recommend an educational institution, how likely would you recommend Westmont?
• very likely
• somewhat likely
• not very likely

A follow-up question for those who responded not very likely: Why you would you not recommend Westmont?
6. How important has the non-technical (General Education, faith-learning, etc.) part of your Westmont education been to your life's work?
• Very important
• Somewhat important
• Irrelevant

Outcomes

The following set of questions asks how important the department's program learning outcomes are for your current work, and how successfully you think you have achieved them.
• Outcome 1–Learning the Core Content of the Discipline:
How important is this outcome for your current work?
– Very
– Somewhat
– Irrelevant

To what degree would you say you have achieved this outcome?
– Good
– Average
– Poor

• Outcome 2: Communicating Clearly (written and oral forms)
How important is this outcome for your current work?
– Very
– Somewhat
– Irrelevant

To what degree would you say you have achieved this outcome?
– Good
– Average
– Poor

• Outcome 3: Creativity (ability to deal with non-standard problems or situations)
How important is this outcome for your current work?
– Very
– Somewhat
– Irrelevant

To what degree would you say you have achieved this outcome?
– Good
– Average
– Poor

• Outcome 4: Connecting your Faith and Major Discipline
How important is this outcome for your current work?
– Very
– Somewhat
– Irrelevant

To what degree would you say you have achieved this outcome?
– Good
– Average
– Poor

Demographic Data
7. Year of your degree from Westmont

8. Check the majors you completed at Westmont
• Mathematics
• Computer Science
• Other(s) (please list):

9. Gender
• M
• F

10. What graduate degree(s) (if any) have you received or are now pursuing?

11. What is your current role in society, and what do you consider to be your vocational calling?

Responses to Free-Form Questions

3. What is the best aspect of the departmental program?

• Collaboration of Mathematics and Computer Science, and size of classes allowing for close interaction between students and teachers.
• The personal attention we received from our professors. They always made time for students. They are also passionate about math and the bring that to the classroom every day.
• The heavy theoretical foundation has proven useful over and over.
• Excellent teaching. Excellent breadth of curriculum. Excellent preparation for post-college work and life.
• The care that the professors took in the students
• Access to the professors. This was true of more than just the Math and CS profs. But working with professors outside the classroom taught quite a bit.
• Teaching effective thinking and reasoning techniques.
• The fantastic student to prof ratio and the amount of 1-1 attention they were able to provide through their office hours.
• Professors
• Excellent teaching complemented by small class size.
• Professors had a high grading standards, and personal attention from professors was always available, both during class instruction time and office hours.
• A strong connection between the faculty and students lead to a deep understanding of the material and a confidence to put it into practice that other peers don't have.
• The rigor of the curriculum and the mentoring by the professors.
• In my year the ratio was 1-to-1 and the professors knew me personally. This was the greatest strength followed closely by the close ties of me and my classmates since they were only four math majors.
• Small classes– I should have taken more advantage of the opportunity to ask questions.
• High expectations combined with personal accountability.
• The teachers cared about you as a person and they shared their faith in their teaching.
• The small class setting and the interaction between students and professors.
• Discussions about the interconnectedness of between sub-disciplines of the field as well as discussions about the integration of computer science with the liberal arts and social justice.
• Small class sizes, and the personal interest taken by the faculty.
• At the time, it was small, lots of personal attention from professors rather than what you would get at a large school.
• Genuine and sincere care for individual students and their learning.
• The Support/help From The Professors
• The small class size was the best aspect of the department. It really allowed the students to get to know each other and the professors on a personal level. It also allowed me to fell more comfortable asking questions in class.
• Individual attention!! Access to professors and resources, openness to teach outside of the classroom and bring slower students up to speed. Very strong professors that are passionate about the subject.
• Personalization. Every professor seems to try and make time for the students
• The availability of the professors. If I ever had problems, each and every one of them was willing to help.
• Small class sizes and having teachers who truly took the time to work with their students.
• Ability to work closely with professors one-on-one. Professors and adjuncts are well connected in the SoCal computer science community and are great about linking students to internships and job opportunities.

• Genuine care by the professors for students' academic and overall well-being.
• Dr. Howell allowed me to run his math labs since I wanted to be a math teacher. It helped me learn the TI-83 graphing calculator.
• Finite automata, data structures and algorithm, math classes
• The teachers.
• The group study sessions in the math building. Collaborating with other students brought out our best critical thinking efforts.
• The low student to professor ratio. To me, it made the experience more personal and valuable by being able to develop relationships with both the professors and fellow students.
• Individual attention, small class sizes for the junior / senior classes.
• The interest the faculty demonstrated toward each individual student.
• The small department was great, as I got to know the professors and they knew me. Different from a big university.
• The Professor's accessibility and care for the students' success.
• Small class size, teachers making sure that each student is understanding, offering office hours
• Personal communication with the professors as well as availability to students greatly enhanced the learning environment.
• Drs. Iba and Kihlstrom were very strong in understanding of their topics. They also understood their weaknesses and brought in adjunct professors to assist in their various fields.
• I received awesome instruction from super-caring professors.
• The culture of the department encouraged student to be competitive and still work as a group of students to help everyone reach their potential.
• Investment of teachers into development of math skills
• Small classrooms. Greater access to professors. Hands on work with computers.
• The faculty and their connection to the students.
• The professors
• The professors are truly invested in their students and genuinely care about their students' success
• The personal interaction with the professors and with the other members of my cohort. Developing an enjoyment of learning.
• I loved how accessible the professors were. I spent many hours doing homework in the math dept front office, and having the ability to simply walk back to my professor's offices and ask questions was crucial to my understanding the material.
• Small teacher / student ratio allowed for strong learning and relationships with educators
• Close relationships with/access to professors
• Learning the fundamentals of programming gave a good footing to learn on the job later on, even if I didn't learn the specific skills in school.
• The size, the community that was encouraged, and the hearts/passion of the professors
• The care and attention of the faculty.
• The ability to get to know the professors–personal-ness of the teachers. I believed that each professor really wanted me to learn and wanted to know me as an individual.
• Close contact with students Individual nurturing of talent
• The size of the program at Westmont meant I was able to work closely with my instructors and peers to better comprehend the concepts presented.
• The close contact with Professors. I don't know of any university or college that would promote and encourage the instructive 1-1 tutoring (essentially) I received from my advisor/professor
• Relationship between students and professors, availability of professors for discussion and help (also about life, not just about academics), professor's strong knowledge of mathematics
• Close knit, great professors who cared about each of us individually

• Solid fundamentals across the board. Required courses in a variety of subjects from algebra to analysis to probability to number theory. Very well taught and care for the students.
• Small class size of very dedicated and resilient peers, longsuffering of instructors
• Small class size provided comfortable learning environment
• Requiring students to have a solid foundation in Real Analysis, since it is prevalent to a vast majority of mathematics.
• Direct engagement with professors, both in and out of the classroom
• The one on one interaction with faculty and general encouragement from the department.
• I think the problem solving skills and critical thinking that we were taught.
• The one on one time with professors.
• Small class size and awesome professors.

4. What improvements would you suggest for the departmental program?
• Larger variety of class options.
• None
• Maintain or establish strong ties with industry so that graduates have practical experience to help them get a job. This should also serve to help balance the theoretical bias.
• Stronger push for internships and research projects. Also a stronger push towards Sys Admin / Linux type work. It's good to be well-rounded.
• It's been long enough that any suggestions would be outdated.
• More professors, more courses, more coding
• Keep up the good work
• Don't use adjuncts to teach any classes, specifically the lower division ones. I had an adjunct lady teach Calculus, and I thought she was very weak. I always felt I had a hole in my integrating skills because I didn't learn the material that well. Ultimately, what I learn is my responsibility, but at the time, I was young and didn't have a vision for what math could be.
• The only thing I can think of is to offer the courses more than every other year if it is possible.
• It was wonderful!
• There is always a tension between the theoretical and applied aspects of these areas of learning, and although I sense that most of the faculty tend to favor theoretical over applied, in point of fact the latter serves the needs of most students much better. I would favor looking at the curriculum from the perspective of a dual track with expectation that 70 to 80% of the students would choose the applied track.
• More connections to other departments–seminars that combine the specialties of a computer scientist and another type of expert, such as a political scientist or a philosopher.
• More electives
• Additional career development resources- connect students with alumni/resources to explore opportunities for math grads and different applications. More real-world experience opportunities math/stats programming (even just supplemental and extracurricular opportunities), applied math, graduate school, etc.
• More community building, it seemed like every other department did mixers for the students except ours.
• It has been 25 years . . . not sure what is the same and what is different.
• I think that having some more get-togethers amongst the department would be a useful thing.
I know some classes got together within math, but the department as a whole rarely did things together.
• Keep curriculum and projects up to date and easily do-able with widely available technologies.
Ran into several issues where projects were assigned on outdated programs, or where extensive work-arounds were needed to accommodate multiple operating systems.

• Give a little more structure to the senior project class. Especially with the size of the program, division of labor is hard and it might be better for seniors to work on one project together instead of compete for scarce resources (other students).
• Training in technology.
• To treat EVERY student as important; it seemed like only A students were valued. For example, I was not encouraged to go on to grad school, why not? I actually did go and graduated from grad school. Don't pre-judge students.
• All academic advisers should recommend a semester abroad. Not doing that is my biggest regret from Westmont. I also would have liked to hear more about possible career choices once graduated.
• To encourage more exposure to working professionals and career opportunities.
• When I attended Westmont, some upper division courses were only offered once a year or once every other year. Maybe try to offer some courses more often. I will say that knowing you had to take certain classes when they were offered made scheduling much easier.
• More presentations - oral and written. I advocated for Speech as a core requirement, as this was a skill I had to learn on the job.
• I am not in a position to speak to this, with 35 years between then and now. (I would have said the dept. could have done a better job teaching us to master the computer, since it was optional at that time. That, naturally, has already changed!)
• I have no suggestions.
• I can't think of anything. I loved my experience and look back on my time in this department with great memories, even though I was not the best student.
• Many of the modernizing improvements that I would suggest from when I attended 20 years ago have probably already been implemented.
• Obviously the number of professors is lacking. Aside from that nothing springs to mind.
• It's been a long time and probably this has improved since then, but the one thing I missed was a little bit of preparation for the transition to the culture of research university for my PhD program. Two things I remember being pretty clueless about were (1) that I needed to take the GRE (this is my fault, I'm sure. but no one really mentioned it either) and (2) that in a research institution, you're supposed to attend talks. So for example a Westmont expedition out to UCSB to attend a talk would have been a good thing for me.
• This is hard to answer since I have been away from Westmont for so long.
• Increased investment into personal lives of students. (was not done poorly)
• I was in the first graduating class so I don't know what's changed since then, but in general, form partnerships with businesses in the area to give a practical, hands-on element to the program.
• After 35 years I hope they have a new computer, or maybe two! :) I am a little out of date to have any valid suggestions.
• It would be nice if the mathematics department had a more rigorous track that helped better prepare for grad school
• Involving more learning about industry practices such as processes, tools, and technologies.
• Expand software development into two or three courses that focus on trade-specific skills
• A focus on larger projects and/or web development. I mention larger projects because only then do problems with some short-sighted approaches appear.
• Strong focus on team/group work. There was some emphasis on this in my calculus lab, but working together is HUGE in my job. Also, solving real problems.
• Too many years have past. The department has grown beyond what I knew, making it difficult to offer constructive criticism.
• I seem to recall that efforts have been made to make the curriculum more rigorous since my time at Westmont. Would students be interested in earning a BS in math from Westmont and an MS in math from UCSB in 5 years?

• in some instances, professors could enhance their teaching or explanations when students ask for help by gathering and having at their disposal multiple ways to explain the same concept, especially big ideas in abstract mathematics that will be initially unfamiliar to an undergraduate student
• get more CS students! teach more on web development and software as a service / cloud based technologies.
• I'm not sure I know enough about how the department is set up right now to make a sensible suggestion.
• None
• Having two statistics courses. One that is purely probability and the second that is purely theoretical statistics.
• Update the computer science material to be more current. Require more of the courses that would be helpful to the work environment.
• More applied mathematics, but that may already be accomplished :)

11. What is your current role in society, and what do you consider to be your vocational calling?
• Graduate Student and TA training other Physics students
• I am transitioning from Assistant Principal (after teaching math for 25 years) to a district Coordinator for mathematics K-12.
• Software Engineer
• Software Engineer. I'm quite happy and content.
• I am currently an equity portfolio manager. Right now, I consider my calling to be a visible Christian in an industry that isn't focused on Christ.
• IT
• Professor. Teaching, mentoring, and research.
• Tax accountant/Mom.
• Lawyer
• Wife, mother, teacher of mathematics
• I am a husband and father, spiritual mentor, taxpayer, citizen of the United States of America, helper to the world's poor, and advocate for the advancement of the Gospel of Jesus Christ. Vocationally, I am a software consultant specializing in decision management systems and mathematical optimization.
• Software developer
• I am a secondary high school math teacher.
• I am a secondary educator although at the moment I am a professional substitute. I cannot imagine any other role for my service to God.
• I'm a math teacher!
• IT Professional and instructor. It appears to also be my vocational calling.
• I am currently the CEO for the company that my Grandfather started in 1985. We distribute power tools and hand tools to industrial and construction companies. I feel that God has me right where I am supposed to be. I remember fondly my time at Westmont and know that it helped to prepare me for the future.
• After teaching High School Mathematics for 10+ years, I am now a stay at home Mom working part time from home.
• Learner, teacher, and communicator. I consider communicating the synthesis of computer science and the liberal arts and connecting computer science to new problem domains to be my vocational calling.
• Mathematics Professor.
• Army Officer at U.S. Cyber Command. My vocational calling is as a cyber operations planner.
• I am currently staying in the home raising two wonderful children. I would consider my vocational calling to be teaching. I still get to practice this occasionally through volunteering in the schools.

• Instructing Students In Medical Fields Classes At The High School Level. Leadership And Encouragement. It Is Never Too Late To Follow Your Heart/Interests God May BE Calling You To Change Directions In Your Life.
• I am currently a grad student. I think my vocational calling is to teach.
• Digital Marketing and Sales Analytics at Google. Vocational calling is identifying data driven approaches and solutions to business/sales challenges and opportunities.
• I am a graduate student serving and learning. I feel my vocation is with college student affairs.
• I am teaching Junior High Math and have for the past 25 years...and YES, it was and still is my calling.
• Substitute teaching and tutoring. I consider teaching to be my vocational calling.
• Christian, Upper Middle Class office worker. Fitting in very happily with a job that balances software development and coordinating between all departments in the company.
• My current role in society is yuppie and husband. I consider my vocational calling to be one that facilitates solving human problems with technology.
• I teach Upper School Math at an International School in China to Third Culture Kids (TCKs).
• Vocationally, developer/manager
• Current role is cubicle jockey. My vocational calling is undetermined.
• I'm currently an intern with the public works dept, but I consider to travel and work abroad to be my vocation. I plan to make a photo journal documentary of a civil engineering project.
• Career: High School Mathematics Educator Main Responsibility: Wife, mother of 2, and step-mother of 2 Calling: Helping students to achieve and feel success in the area of mathematics
• Title: Enterprise Architect General description: Senior Technical Generalist for Computing Infrastructure, Fortune 150 Company Calling: Transformational Leadership
• missionary, pastor, teacher, discipler
• teacher
• Just finishing raising my 2 boys and getting them launched into their own pursuits. My vocation is as a pilot for United Airlines.
• Professionally I am a math teacher, but currently I am living on the mission field raising up the next generation of believers in India.
• High School Math Teacher, youth and women's ministry, homeschooling mom
• Currently I am employed by Special Olympics Montana doing data entry and web administration. I would say that I am leaning more and more toward teaching as a career...haven't really figured that one out yet.
• Part-time lecturer, physics, UC Irvine. Mom of 3 teenagers. Bible teacher at my church.
• High school mathematics teacher.
• Accountant
• CIO for the Superior Court of California, County of Los Angeles. I consider my role to be in alignment with my calling ("Justice", Micah 6:8)
• Role: Beginning as an retired Empty-Nester Vocation: I'll let you know next year when I discover it.
• Current role: Software Engineer (and is my calling)
• I am currently in transition
• My role is that I am an advocate for the motivations, concerns and effectiveness of the end-users of whatever software product that I am involved in helping to create. I have tried to promote empathy for our users in both my roles as a QA engineer and UX Designer.
• I am a 7th grade math teacher in Virginia. I just finished my 6th year teaching, I have taught at the high school and middle school levels.
• Sales / Marketing / Strategy
• software engineer
• Software Engineer
• Math Teacher

• Professor of Physics, which I consider to be my calling
• I teach high school. I believe that this job is also a calling.
• Director (Dean-level) of the STEM Division (includes natural and computational sciences with degrees in biology, chemistry, physics, mathematics and computer science) at a public university
• Part Time Math Teacher and full time mother and wife
• Software engineer.
• high school mathematics teacher; teaching, mentoring, discipling, and training students from multiple cultures and diverse backgrounds
• husband, father and a senior software engineer at a fast-growing company.. so hopefully I can impart not only good technical and programming skills, but pass on wisdom and Truth where possible.
• Senior Manager for the US Government
• Colleague inspiration, through calling others to challenging creativity; peer encouragement, support, resource provider.
• My role is to be a good model of Christ to my community. I am to be a role model and mentor to those around me. I fell my vocational calling is to serve people any way possible but especially in the area of mathematical appreciation and accounting/financial services.
• Current role is student and a job in STEM is my vocational calling.
• Father, Speaker, Programmer
• Epidemiologist
• Missionary in the field of Bible Translation
• software engineer for both
• Husband, Father, Church, Volunteer Youth Leader. Strategic Missile Defense

APPENDIX 4 SURVEY OF OTHER MATHEMATICS PROGRAMS

The following lists give examples of the set of courses one could take to get a degree in mathematics from the given school **Bold** courses are required; *italicized* courses are a choice among several; plain text are elective

WHEATON (34 of 124 hours)
Calc II
Vector calculus
Linear algebra
Discrete
Algebra
Analysis
Geometry
Math Modeling
History and Foundations (capstone)

GEORGE FOX (44 of 126 hours)
Intro to CS
Calc I
Calc II
Calc III
Intro to proofs
DEs with Linear Algebra
Probability
Real Analysis
Discrete
Mathematical Statistics
Number theory
Advanced Linear Algebra
Algebraic Structures
Senior Seminar

ST OLAF (10 of 35 credits)
Calc I
Calc II
Linear algebra
Computational Math
Algebra
Multivariable
Intro to DEs
Discrete
Complex Analysis
Geometry

POINT LOMA BA (46 of 128 hours)
Calc I
Calc II
Calc III
Linear algebra
Number theory with proofs
Intro to Computer Programming
Fundamentals of CS
History
Mathematical Statistics
Algebra
Discrete
Service Learning
Diff EQ
Mathematical modeling
Secondary School Math
Senior Seminar

POINT LOMA BS (63 of 128 hours)
Calc I
Calc II
Calc III
Linear algebra
Number theory with proofs
Intro to Computer Programming
Fundamentals of CS
Data Structures and algorithms
University Physics
History
Mathematical Statistics
Algebra
Analysis
Discrete
Service Learning
Diff EQ
Mathematical modeling
Complex Analysis
Secondary School Math
Senior Seminar

SEATTLE PACIFIC BA (60 of 180 credits)
Calc I
Calc II
Calc III
Linear algebra
DEs
Vector calculus
Prob and Stats
Axiomatic geometry
Analysis
Algebra
Algebra II
Evolution of mathematical thought [history]
Practicum (educational setting)
Internship
Senior Seminar

SEATTLE PACIFIC BS (67 of 180 credits)
Calc I
Calc II
Calc III
Linear algebra
DEs
Vector calculus
Prob and Stats
Axiomatic geometry
Analysis
Algebra
Algebra II
Evolution of mathematical thought [history]
Practicum (educational setting)
Internship
Complex
Mathematical modeling
Number Theory
Senior Seminar

The table below gives some information about requirements for degrees in math from Wheaton, Point Loma, Seattle Pacific, George Fox, St. Olaf, and Westmont.

	Wheaton	PL BA	PL BS	SPU BA	SPU BS	Fox	St Olaf	W BA	W BS
Require both algebra and analysis	Y		Y	Y	Y			Y	Y
Require a second course in alg. or analy				Y	Y***				Y
Require history	Y*	Y	Y	Y					
Require computer science		Y	Y						
CS an elective option								Y	Y
Require geometry				Y					
Require number theory		Y							
Require a proofs course		Y**	Y**			Y			
Require an applied course#		Y	Y					Y^^	Y^^
Have an applied course as an option or elect.#	Y	Y	Y	Y	Y	Y	Y		
Senior Seminar (# of units if less than standard course)	Y	1	1	Y	Y	2			
Separate prob and stats courses		Y	Y			Y			
% of units that can be earned with research or practicum or service		20%	20%	33%	33%		20%		
% of units specified/dictated	82%	61%	78%	86%	73%	62%	30%	65%	63%
% of units choice among several	0%	22%	14%	0%	0%	0%	20%	18%	22%
% of units elective	18%	17%	8%	14%	27%	38%	50%	17%	15%

#Applied courses include Math Modeling, DE, math'l stats, numerical analy, applied analy.
*Part of the senior seminar.
**Part of numer theory.
***SPU requires both second courses for the BS.
^^Course in a science dept.