Department of Mathematics and Computer Science

Six Year Review

November 2020

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1 Introduction

The following pages summarize the assessment work of the Department of Mathematics and Computer Science from August, 2014 through May, 2020. The department currently has four FTE allocations in mathematics, and two FTE in computer science. Four faculty are in place for mathematics: Anna Aboud, Russell Howell, David Hunter, and Maria van der Walt. Whoever fills the current open position in computer science (vacated when Wayne Iba retired) will join Donald Patterson in staffing that departmental program. All faculty hold the Ph.D. degree.

1.1 Mission Statement

Our mission is to provide programs of study in mathematics and computer science, and to assist students in their general intellectual, moral, and spiritual growth as Christian thinkers. We want students to:

- acquire knowledge in mathematics and computer science, and analytical ways of thinking,
- develop the ability to communicate ideas in mathematics and computer science,
- mature as creative problem solvers, and
- ponder the connections between faith, mathematics, and computer science.

Ultimately, we seek to serve others and glorify Jesus Christ by preparing scientists, teachers, scholars, and other professionals to use their academic gifts with competence and charity.

The Program Learning Outcomes (PLOs) of the department synchronize with its mission.

1.2 Program Learning Outcomes (PLOs)

There are four components to the PLOs for our department.

Mathematics and Computer Science Program Learning Outcomes

1. *Core Knowledge*
   Students will demonstrate knowledge of the main concepts, skills, and facts of their discipline.

2. *Communication*
   Students will be able to communicate the ideas ideas of their discipline following the standard conventions of writing or speaking in the discipline.

3. *Creativity*
   Students will demonstrate the ability to formulate and make progress toward solving non-routine problems.

4. *Christian Connection*
   Students will incorporate their disciplinary skills and knowledge into their thinking about their vocations as followers of Christ.

These PLOs are posted on the departmental program review section of Westmont's website:
https://www.westmont.edu/departmental-program-reviews/program-review-mathematics.

1.3 Key Questions Explored Over the Last Review Cycle

A major recommendation growing out of our previous six-year review was to increase the applied course offerings in our mathematics curriculum. That recommendation generated key questions relating to what kinds of courses to offer, and how to staff them. The following subsections delineate what has transpired to date.

1.3.1 New Major

Thanks to the work of Ray Rosentrater (previous department chair, now retired), we packaged existing (and currently staffed) courses within our department with those from the Department of Economics and Business to create a *Data Analytics* major. Westmont's faculty approved this major during the 2018-2019 academic year. Even though just approved, three students were able complete the requirements and graduate with that major in the commencement ceremony of 2019. Four are slated to graduate in 2021. Not only has this addition increased the applied flavor of the department, but it also created a different mix of students "hanging out" in our study area. Reports from Admissions indicated that this major has been effective in recruitment.

1.3.2 New Faculty

With two retirements having taken place since 2014, the department took the opportunity to hire applied mathematicians to fill the vacated positions. Maria van der Walt (Ph.D., University of Missouri-St. Louis), who specializes in approximation theory and signal separation analysis, joined our faculty in the fall of 2017. Anna Aboud (Ph.D., Iowa State) began her service in the fall of 2019. She specializes in algorithms, and in particular the Kaczmarz Algorithm. Last summer, despite the challenges posed by the COVID-19 pandemic, Dr. Aboud pursued a research project on aspects of this algorithm with a student who plans to graduate in 2021.

1.3.3 New and Revamped Courses

Following is a synopsis of new or revised courses that relate to the recommendation from the previous review to expand our applied course offerings. Syllabi for all these courses can be found in Appendix 3.2.

- *Introduction to Subdivision Methods* (MA 150)

  Under the framework of MA-150 (Topics) Dr. van der Walt developed and offered *Introduction to Subdivision Methods* in the spring of 2018. This four-unit course focused on different subdivision schemes used in industry to generate curves and surfaces, and the mathematics underlying these tools. Prerequisites are MA 010 (Calculus 2) and MA 020 (Linear Algebra). A current task of the department is to get approval for this course as a regular offering, discuss how it will mesh with our existing curriculum, and to revise, as needed, that curriculum.

- *Human Computer Interaction* (CS 150)

  Developed by Dr. Don Patterson, *Human Computer Interaction* focuses on building interactive computer applications. It has been taught with the "150" number successfully for a few times now, so a task for our department is to get it approved as a regular course offering, and to discuss how it should fit into our curriculum.

- *Codes and Encryption* (MA 124; CS 124)

  Dr. David Hunter developed *Codes and Encription*, which fulfills elective requirements in both mathematics and computer science. Taught on an alternate year basis, the course focuses on representing data in digital form, and protecting the data from adversarial sources. Seven students are enrolled this term (fall 2020).

- *Introduction to Numerical Analysis* (MA 121)

  Dr. van der Walt revised this long-dormant four-unit course and offered it as an overseas program this past Mayterm. With MA 010 (Calculus 2) as the only prerequisite, this course has the potential to attract a significant number of students. Plans were to co-teach the course with Professor Jac (André) Weidman of Stellenboch University, South Africa. The global experience also included a three-unit course on Reconciliation in South Africa, and a one-unit PEA course in hiking. Nine students had paid deposits for this class, which required two weeks of on-campus instruction before leaving for Africa. The current COVID-19 pandemic forced cancellation of this program, but tentative plans are to resurrect it for the Mayterm 2022 offerings. More details pertaining to the specifics of this course can be found at https://www.westmont.edu/south-africa-mayterm.

- *Introduction to Statistics* (MA 005) Drs. David Hunter and Maryke van der Walt are currently using the software R and RStudio in a revised version of *Introduction to Statistics*. The structure of the course has students working in groups, and running simulations with real data. Not everyone in the department may use the text they have chosen (*Introduction to Statistical Investigations*, by Nathan Tintle, et. al.), but their approach has been well-received by students. A challenge for our department will be to offer enough sections of this class so that the class size remains reasonable (around 30 students) given that there is an increasing demand for it.

- *The Mathematics of Music* (MA 002)

  In response to requests from the Department of Music, Dr. van der Walt created MA 002, *The Mathematics of Music*. The course has been approved for credit in two GE areas: Reasoning Abstractly, and Quantitative and Analytical Reasoning. This course is now required for music majors, but is open to all students without prerequisite. Although it does not fulfill any requirements for our majors, it certainly increases the applied flavor of courses offered by the department. Current plans are to offer it on an alternate year basis with *Mathematics in Context* (MA 004).

2 Student Assessment and Program Review

2.1 Student Learning

The Program Learning Outcomes of our department (described in Section 1.2 on Page 1) have been assessed as part of our yearly review process since the previous six-year review. During thee 2015-2016 academic year the department participated in an Institutional Learning Outcome assessment. In that case an aspect of our annual report addressed that area.

Following is a summary of our findings.

- *2015–2016* (ILO Assessment: Quantitative and Analytical Reasoning)

  The department used Quantitative Literacy Reasoning Assessment (QLRA) test developed by Bowdoin College in the fall of 2014 and spring of 2015. The test was administered with a pre/post protocol to students in calculus classes. While Westmont students scored reasonably well on it, the department found that—in general—the types of topics covered in that exam were not especially relevant to the topics covered in most of our courses. The tools provided in calculus, for example, are more sophisticated than those assessed by the QLRA. The QLRA was more relevant to material presented in MA 005 (statistics) and MA 165 (Fundamentals of Mathematics II). The QAR report recommended increased use of active learning in QAR courses. While the exact formulation of such learning varies from instructor to instructor, all faculty have incorporated inquiry based learning (IBL) ideas into their QAR courses.

  One aspect of calculus courses that changed as a result of the QAR assessment was an agreement by the department to emphasize that functions can be used to capture the nature of a set of data.

- *2016–2017* (PLO Assessment: Communication)

  - Direct Assessment Methods

    Faculty teaching MA 20 (Linear Algebra), MA 108 (Real Analysis) and MA 180 (Problem Solving) collected data.

    For MA 20 comparison of work at the start and finish of the course revealed marked improvement in student writing.

    In MA 108 three writing samples were collected from each of the 11 students in the course. One set was used as an inter-rater reliability exercise; the remaining two papers from each student were evaluated by the departmental writing rubric, which is presented in Appendix 4.2. All 11 papers were acceptable in exposition and format. Three were exceptional in exposition. Seven were exceptional in format. Four were weak in analysis, which was not surprising given the nature of the course and had not yet had a chance to become proficient in creating and writing proofs.

    Faculty attended a final presentation of student work in MA 108 (Problem Solving), and assessed the work using the departmental presentation rubric, which is presented in Appendix 4.2. Of the seven presentations, two were outstanding in all areas, three were acceptable, and two were deficient. Significantly, the weak students had no prior experience in presenting material to an audience. As a result, the department decided to encourage faculty to find time for student presentations in all courses.

  - Indirect Assessment Methods

    Our students have regularly given presentations at professional meetings. Two of our recent graduates (David Kyle, 2017, and Kyle Hansen, 2019) have done so at contributed paper sessions at the Joint Mathematical Meetings of organizations including the American Mathematical Society and Mathematical Association of America (MAA), held in January. Several others have either given talks or presented posters at sectional meetings of the MAA. Positive feedback was received from those who attended the respective sessions.

In general the department is satisfied with the developed communication skills of our students, but we plan to continue to give focused attention to writing and oral presentation in selected upper and lower division classes. We will also consider giving assignments that involve writing using ideas students have already mastered so that we can determine whether any weaknesses are due to unfamiliarity with the logic involved, or with writing itself.

- *2018–2019* (PLO Assessment: Creativity)

  During the 2009-2018 academic years 53 students attempted to solve 103 problems from 5 different journals. Of these 103 attempts, 73 problems were solved and 44 of these solutions were submitted to the journals. Of these submissions, 7 were published. In terms of percentages, 73% of the problems attempted were solved, about 43% of the solutions were submitted to a journal, and about 0.07% of the solutions were published. In general, we are satisfied with this performance. For details regarding the names of students and the journals to which problem solutions were submitted, see Appendix 4.4.

- *2019–2020* (PLO Assessment: Christian Connection)

  During the 2015–2019 academic years students submitted essays as part of their requirements for MA 180. The essays were evaluated according to the rubric in Appendix 4.2, and the prompts for those essays are also in that appendix. Two essays were used for "training purposes," so that department members discussed them and came to a consensus regarding how they should be scored. As the appendices indicate, the essays are designed to see if, indeed, our students have incorporated "their disciplinary skills and knowledge into their thinking about their vocations as followers of Christ."

  In general, the department is satisfied with the results. The mean score of all these essays, per the evaluation rubric, was above 2.0 (adequate). A disappointing mean of 1.5 for the 2018–2019 academic year is partly explained by there having been only two papers to evaluate, and the students had different maturity levels.

  With respect to maturity levels, it should be noted that, during the 2015–2019 time frame, MA 180 was called *Problem Solving*, was a one-unit course, and was open to first through fourth year students. The course now serves as a capstone course, is a two- instead of a one-unit course, is offered every spring term, and is open to seniors only. This change should ensure greater maturity in future essays, as well as assisting in our evaluation process.

2.2 Alumni Reflections

2.2.1 Methods

The alumni survey was sent out via email in May 2020 to a list of 209 Mathematics and Computer Science alumni provided by the alumni office. Alumni were asked a variety of departmental and institutional questions, both multiple choice and free response. For a copy of the survey, see Appendix 4.3

Response rates and demographic trends and comparisons are discussed in Section 2.2.2. These are compared with both past alumni survey data as well as overall departmental demographics.

Highlights from the quantitative responses are represented in the first part of Section 2.2.3 using a variety of informative graphics. Results from the free response sections were coded, and extracted trends are discussed in the latter half of Section 2.2.3. Where helpful, we also analyzed responses based on major (mathematics versus computer science) and compared responses with the 2014 Alumni Survey.

Reflections on results and suggestions for departmental changes as well as changes for future surveys are listed in Section 2.2.4. We address the alumni-revealed themes of curriculum, courses, career preparation, and community. We also reflect on the departmental changes made in response to the 2014 Alumni Survey and discuss if and how these changes impacted the responses to this survey (2020).

2.2.2 Response Rates and Demographics

In Table 1 we compare the response rates and demographics with both the recent demographics of the department (using registrar data from the last five years) and the responses to the 2014 Alumni Survey. Respondents to the current survey ranged from graduation years 1979 - 2019, with particularly high responses in the 1979 - 1989 and 2004 - 2019 ranges.

	2020 Survey					**2014 Survey**					**Department**				
Response	33%					40%					N/A				
Gender	Male	Female				Male	Female				Male	Female			
	53%	41%				60%	40%				74%	26%			
Major	MA	CS	Both			MA	CS	Both			MA	CS	Both		
	66%	22%	18%			NA	NA	NA			27%	63%	10%		
Ethnic Diversity	H	NH	DTI			H	NH	DTI			H	NH	DTI		
	1.5%	82.5%	6%			NA	NA	NA			8%	87%	5%		
Racial Diversity	W	A	B	M	DTI	W	A	B	M	DTI	W	A	B	M	DTI
	90%	0%	0%	4%	6%	NA	NA	NA	NA	NA	79%	10%	3%	1%	6%

H=Hispanic, NH = Non-Hispanic, W = White, A = Asian, B = Black, M = Multiethnic, DTI = Declined to Indicate
NA, = Not Available

Table 1: Response Statistics

Although overall response trends have remained fairly consistent with the 2014 Alumni Survey, the response rate did decrease from 40% to 33%. We hypothesize that this is a result of the timing of the survey in the midst of the COVID-19 pandemic.

An interesting trend to note is the gender breakdown of the survey respondents versus the gender breakdown of the department as a whole. Although only 26% of our most recent (last five years) alumni are female, a disproportionate 40% of the survey respondents were female. The percentage of respondents who were computer science majors was also markedly different than the current department demographics (22% versus 63%). This speaks to the astounding growth of computer science as a major within recent years.

Who are our alumni? We attempt to sketch a picture. In general, our math and computer science majors spend the majority of their undergraduate time at Westmont and graduate within 4.5 years or less. Many achieve advanced degrees (12% of respondents have earned a PhD, and 56% have earned at least a master's degree), and a nontrivial subset (21%) pursue an education degree or certification. After earning their terminal degree, our graduates find professional jobs quickly, with 75% obtaining a job in their field in under 5 months. Computer science majors generally find jobs even more quickly, with 79% of respondents earning their first professional job within 2 months of graduation and 95% obtaining their first professional job within 5 months of graduation.

Although alumni jobs were varied, there were some clear trends in common occupations. A large number (39%) of our graduates go on to be either high school mathematics teachers or to work in academia. Another nontrivial segment (38%) work in some form of management, IT, or data analytics. In light of these trends, the department is discussing how we can better prepare our graduates for these occupational categories.

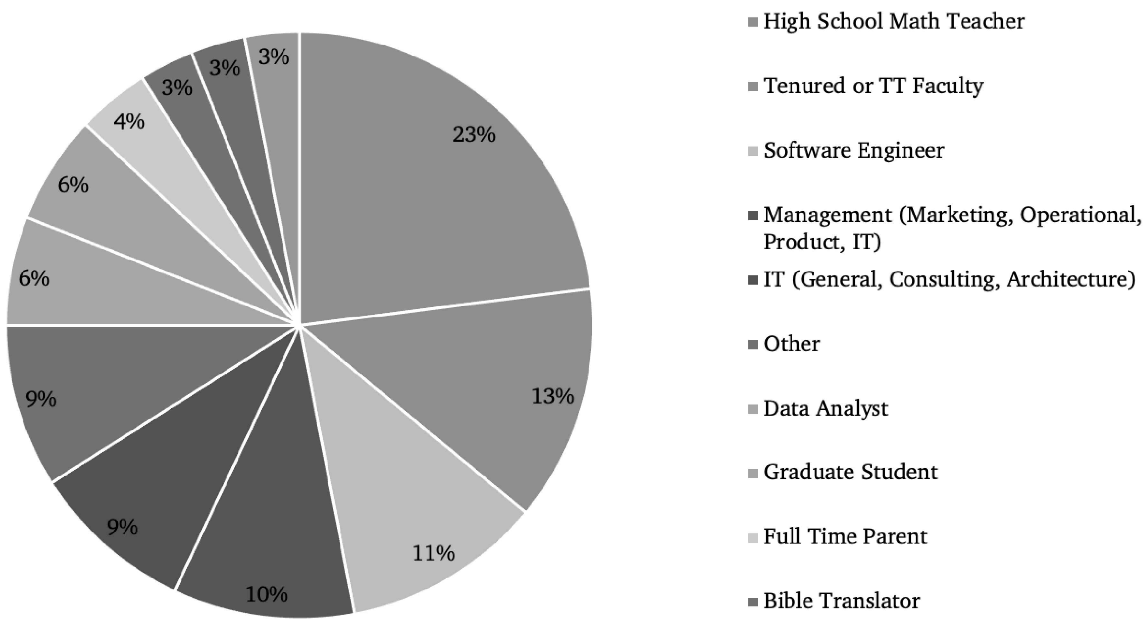

Figure 1: Alumni Occupations

2.2.3 Responses to Department and Institution

Quantitative

Overall, alumni are satisfied with Westmont as an institution, reflected by the 97% of respondents who indicated that they were extremely satisfied or satisfied with the education they received at Westmont. No respondents reported being dissatisfied. All but two alumni respondents were very likely or somewhat likely to recommend Westmont as an institution. The two who indicated that they would not recommend the school referenced cost and experience for ”nonmainstream evangelical” students, respectively. The remainder of this section shall be devoted to alumni responses and critiques concerning the Mathematics and Computer Science Department.

Alumni responses were overwhelmingly positive regarding department teaching, with 49% of the respondents rating the efficacy of the teaching in the department as superior and 44% rating it as strong. These results are consistent when viewed across both graduation year and major. When compared to the results of the 2014 Alumni Survey, there is a notable shift in responses between from the strong to superior category. In 2014, only 36% of respondents indicated that the teaching was superior and 60% indicated that it was strong. The department views this shift as encouragement that the instruction in the Mathematics and Computer Science Department is continuing to improve over time.

While all alumni report being adequately prepared by the mathematics and computer science department for their current work, 87% report being well or exceptionally well prepared compared to their peers. These responses are consistent across major and represent an improvement from the 2014 Alumni Survey in which 4% of respondents indicated that they were less than adequately prepared. Although these numbers are too small to draw strong conclusions, we hypothesize that this favorable shift may be a result of our increased effort and attention to applied course work and experiences.

For each of the four Program Learning Outcomes (See Section 1.2), alumni were asked to 1) rate the importance of the outcome for their current vocation and 2) indicate the degree to which the outcome was achieved. The results are given in Table 2. The parenthetical values are the results to the same questions from the 2014 Alumni Survey.

	Importance			**Degree Achieved**		
	Very	Somewhat	Irrelevant	Good	Average	Poor
Learning Core Content	**64%** (51%)	24% (40%)	12% (8%)	**77%** (66%)	23% (33%)	0%(0%)
Communicating Clearly	90% (90%)	10% (10%)	0% (0%)	75% (78%)	22% (21%)	3%(0%)
Creativity	78% (81%)	22% (19%)	0% (0%)	69% (72%)	26% (26%)	4%(1%)
Christian Connection	23% (29%)	43% (38%)	34% (33%)	59% (63%)	35% (35%)	7%(3%)

Table 2: Program Learning Outcomes

The reader can see that the current outcomes results are largely comparable to those from the 2014 Alumni Survey. There are a few notable differences, however (see bold entries). Specifically, alumni are now placing higher importance on Outcome 1 (learning the core content of their discipline) with a significant percentage shifting from the “somewhat” to “very” response. We are pleased to see that achievement of of Outcome 1 seems to have enjoyed a corresponding increase, with 12% more respondents reporting “Good” than in the previous survey. These results were generally consistent across major.

Alumni continue to report clear communication as vital skill for their vocation. This is evidenced by the 0% of survey respondents who considered this outcome to be irrelevant and the 90% who considered it very important. It is also interesting to note that 100% of computer science majors selected the very important option. Although reported achievement of this outcome was respectable, with 75% of the respondents indicating good, there is still significant room for growth in this area. These results affirm the importance of the department's continued commitment to intentionally developing communication skills across the curriculum.

The department was particularly intrigued about the responses to Outcome 4 (Christian Connection: Connecting your faith and major discipline) and concerned about the degree of achievement illustrated in the responses. As a department, we hypothesized that this low response is a function of the perceived disconnect of a direct link between faith and many of their more technical occupations. To explore this idea further, we separated the outcome achievement by the importance a respondent placed upon this outcome. Of those who said that Outcome 4 was very important for their discipline, 88% responded good for the degree achieved and 100% responded good or average. Of those who said Outcome 4 was somewhat important, 73% responded good for the degree achieved and 97% responded good or average. This was encouraging to the department as it shows that, for the alumni who consider it important, this integration is largely achieved. However, we do question whether there is a different way to phrase this outcome so as to better measure the connection of faith, vocation, and discipline, as we know that *all* vocation is vitally informed by faith.

In the recent past, alumni have requested that more applied coursework be integrated into the program. To track alumni perception as we implement various departmental changes, we asked alumni to rate their perception of the program on a scale of 1 to 5 with 1 being the most theoretical and 5 being the most applied. Although both computer science and mathematics majors found the program more theoretical than applied, computer science majors responses tended more to the applied side, as illustrated in Figure 2.

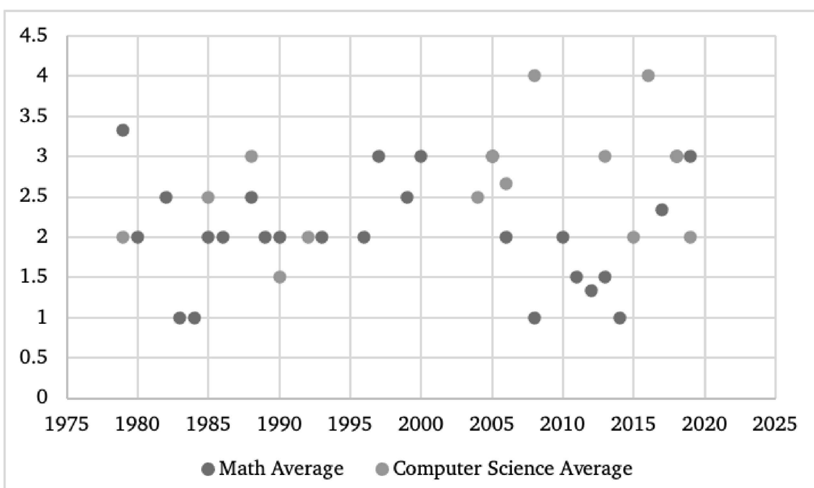

Figure 2: Mean Perception of Theoretical v. Applied Nature of Program by Year

Alumni also feel they are prepared for advanced degrees in their field with 91% reporting excellent or good preparation and all reporting at least adequate preparation. All of the computer science majors responded in the excellent or good categories.

Westmont's mission statement speaks of "cultivating thoughtful scholars, grateful servants and faith-

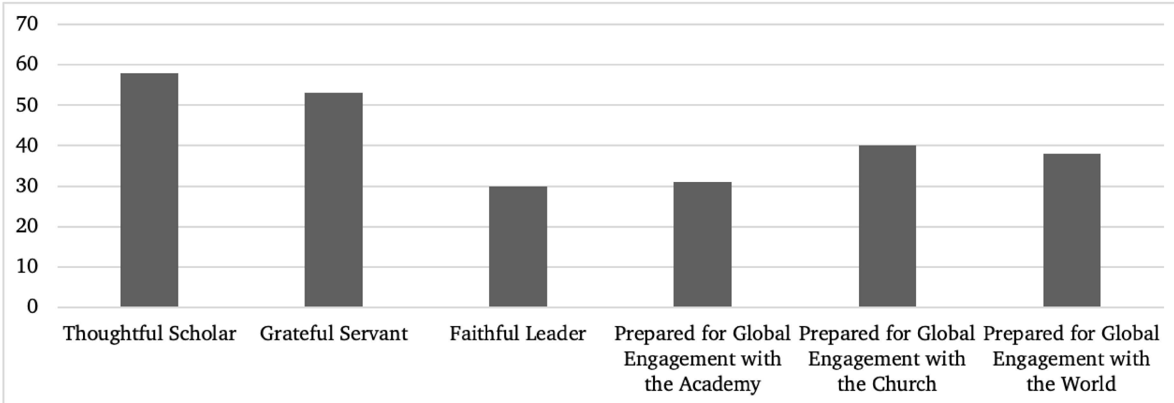

Figure 3: Descriptors at Graduation

ful leaders for global engagement with the academy, church and world." Alumni were asked to indicate which of these descriptions were accurate to them upon graduation. A histogram depicting the number of respondents who chose each descriptor is provided in Figure 3.

Our majors had particularly low responses in the categories of faithful leader, prepared for global engagement with the academy, and prepared for global engagement with the world. Indeed, only 43% of respondents who went on to earn an advanced degree responded that they were "prepared for global engagement with the academy" at the time of graduation. Although cultivating these traits is the responsibility by the entire institution—not just the Mathematics and Computer Science Department—the department desires to do its part in fostering these qualities in our students. We discussed the possibility of providing more opportunities and support for leadership within the department, e.g., teaching assistant and tutoring opportunities as well as leading math circles in the community. We also wish to be more intentional about educating students on the study abroad options which complement our majors, such as the Budapest semester in Mathematics and the South Africa Mayterm in Numerical Analysis. It is worth noting that the low responses in these categories could also be due to respondent modesty, or comparison with current levels in these areas, after many additional years of growth and development.

Qualitative

When asked to comment of the strengths and weaknesses of the department, alumni had a number of thoughtful and helpful responses. The top accolades the department earned were care and personal investment in students and also individualized student attention during instruction. A number of alumni also noted their appreciation of departmental emphasis on critical thinking and active learning, rather than just memorizing and regurgitating facts. A pie chart of the top recorded response themes is provided in Figure 4 and some alumni quotes are also included.

What were the best aspects of the department program?

"Small classes with extensive instructor interaction; focus on teaching how and why, rather than just memorization of facts."

"The professors were our learning partners. They didn't give answers but instead helped us discover the

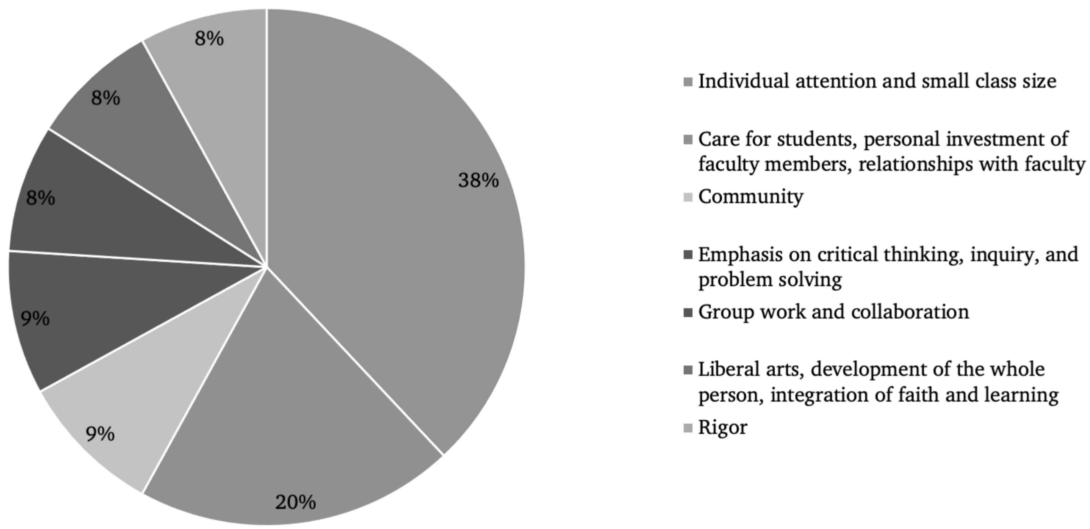

Figure 4: Best Aspects of the Departmental Program

solution ourselves."

"Professors who care about their students and take an interest in them as individuals; Learning by doing/practicing rather than lecture"

Many of the respondents (31%) declined to give suggestions for improvement. Most explained that they had been out of the department for too long to offer relevant feedback. For those who did respond, feedback on departmental improvements fell largely within the following four categories:

1. Curriculum Recommendations for Computer Science

   Alumni asked for better curriculum correlation with industry trends, specifically incorporating more long-term, project-based programs as well as implementing a greater software engineering and design focus. Alumni would like students to be learning cloud-based architecture, building github repositories, and building knowledge about cover sourse code version control. There were also suggestions for specific mathematics course requirements (Linear Algebra and Multivariable Calculus) as well as a call for greater coherency across the curriculum as a whole.

2. Course Recommendations for Mathematics

   Mathematics alumni were not as concerned with the content of the mathematics courses offered, but rather the frequency and range. They mentioned that scheduling many courses could be a challenge as a mathematics major due to the infrequency of course offerings. There were also many requests for the addition of particular courses: the philosophy of math, history of math, proofs, and a second course in linear algebra (which would be more applied in nature). Additionally, some alumni shared that encouraging majors to take differential equations and increasing the statistics requirements would help future students greatly on the job market.

3. Career and Graduate School Preparation and Career Skills

Alumni also requested an increased emphasis on graduate school and career preparation. This request assumed two different flavors. First, alumni wanted more intentional development of career skills such as presenting, communicating, and navigating challenge. Second, alumni would like to see more connections with institutions and business outside of Westmont. Alumni believe that students should be encouraged to research at different institutions, and the department should be capitalizing on connections with local industries to provide students with internships and other opportunities.

4. Community and Collaboration

   Community within the department was noted as a strength for many survey respondants. However, there was a subset of respondants who referenced this as a weakness, asking for more collaboaration and netweorking between students (we noted that all of these students were either female or from underrepresented student groups within the department). Integration of transfer students and more curriculuar and social interaction between the computer science and mathematics majors were specifically mentioned. A desire for a larger, more vibrant community was also communicated.

2.2.4 Reflections and Suggestions for Change

Suggested Changes to Survey

Although informative, there were several weakness with the current survey and survey process. We have a number of proposed concerns and changes for future years.

- As noted in Section 2.4.2, a large proportion of the students who are taught in the Mathematics and Computer Science Department are enrolled in service or GE courses. However, these students are not included in our survey respondents. In the future, we wish to consider how we can glean alumni feedback on our service classes, which play such an integral role in our impact as a department.
- Although part of our low response rates were likely due to the COVID-19 pandemic, we were still not satisfied with our numbers. In the future, we would like to bolster response rates, perhaps through either an incentive process or more extensive advertisement (reminder emails, etc.).
- The survey was quite comprehensive, which may have led respondents to be wary about revealing too much identifying information. The program is relatively small, and with only a few categories of responses (such as all majors and graduation year), alumni can be individually identified by faculty members. We suspect that this may be a particular concern for recent graduates, as one respondent entered 201X for graduation year. In the future, we hope to address this by using graduation year ranges rather than a free response option.
- Going forward, we recommend using separate response sections for the level of advanced degree and type of advanced degree. We would also recommend adding a free response "explain" category for the advanced degree preparation question.

Trends and Departmental Reflections

There are a number of trends from the survey which we wish to highlight. The first is the high value our alumni place on communication skills. This affirms the choice of our program learning outcome of communication and encourages us as a department to continue to more intentionally develop oral and written communication skills across the entire curriculum (not just the more advanced courses).

There continues to be an alumni desire for more applied course content and offerings. This is true across both the mathematics and computer science majors. This also emerged as a theme in the 2014 Alumni Survey. Although we have taken several intentional actions to address this, alumni perception of the program is still largely theoretical, as seen in the chart from the previous section. It may take more time for these changes to be felt by alumni. We have plans to further extend our department in this manner (see Section 3 for more details).

Similarly, we recognize the increased alumni desire for career preparation. Although this is not our only calling in educating students, we can do more as a department to better position our students for their future vocations. It would be particularly interesting to pursue alumni requests for more business and industry partnerships.

The department would also like to reflect on its part in fulfilling the Westmont mission of "cultivating thoughtful scholars, grateful servants, and faithful leaders for global engagement with the academy, church, and world." This survey revealed that less than half of our alumni identified as faithful leaders upon graduation. We are very interested in expanding our opportunities for leadership within the department as well emphasizing global and study abroad options which can help our students grow in both the areas of leadership as well as global engagement.

Finally, we are also invested in building intentional community within the department and making sure that every student knows that they are valued and belong. We were intrigued to see that community was identified by alumni as both a weakness and a strength, and are keen to answer the questions of "who feels in and who feels out?" and why. We have several plans to address this, such as a department email list with more robust communication and increased integration between the computer science and mathematics departments.

2.3 Curriculum Review

2.3.1 Mathematics

As a result of discussions stemming from our last six-year report, the department has streamlined its mathematics major requirements, redesigned the capstone course, added more applied offerings, and overhauled the catalog descriptions. The Curriculum Map in Table 3 illustrates where the program learning outcomes are met and assessed in the mathematics major.

Course	BS designation	BA designation	PLO #1	PLO #2	PLO #3	PLO #4
009	required	required	I	I	I	I
010	required	required	I	I	I	I
015	required	required	D	D	D	I
019	required	required	D	D	D	I
020	required	required	D	D	D	I
108	required	required*	M	M/A	M	D
109	required	required*	M	M/A	M	D
110	required*	optional	M	M	M	D
111	required*	optional	M	M	M	D
121	optional	optional	M	M	M	D
124	optional	optional	M	M	M	D
130	optional	optional	M	M	M	D
135	optional	optional	M	M	M	D
136	optional	optional	M	M	M	D
140	optional	optional	M	M	M	D
155	optional	optional	M	M	M	D
180	required	required	M	M	M/A	M/A

Table 3: Mathematics Curriculum Map. I = Introduced, D = Developed, M = Mastered, A = Assessed. The required* designation indicates that one of a pair is required.

The Program Learning Outcome Alignment Chart for mathematics is given in Table 4. Since our last review, we have refined assessments for PLOs 2, 3, and 4. In the past we have used the "Major Field Test" to assess PLO 1, but found it unsatisfactory. A future task is to address how this program learning outcome will be assessed.

Table 5 shows our course offerings and major requirements, along with requirements for five schools of comparable size: Wheaton College (IL), Seattle Pacific University, Reed College, Occidental College, and Houghton College.

Program Learning Outcomes	PLO1	PLO2	PLO3	PLO4
Where are the learning outcomes met?	I: 009, 010 D: 015, 019, 020 M: 108, 109, 110, 111, 121, 124, 130, 135, 135, 140, 155, 180	I: 009, 010 D: 015, 019, 020 M: 108, 109, 110, 111, 121, 124, 130, 135, 135, 140, 155, 180	I: 009, 010 D: 015, 019, 020 M: 108, 109, 110, 111, 121, 124, 130, 135, 135, 140, 155, 180	I: 009, 010, 015, 019, 020 D: 108, 109, 110, 111, 121, 124, 130, 135, 135, 140, 155 M: 180
How are they assessed?	Embedded assessment	Embedded assessment	Embedded assessment	Direct assessment
Benchmark	Varies by topic	75% of lower division work will be at the acceptable level or above. 90% of upper division work will be acceptable and at least 50% will be outstanding.	We expect at least 50% of graduating seniors to have submitted a correct solution to a journal and 50% of seniors to have presented a poster of their work at a research celebration or the MAA section meetings.	At least 75% of students will be able to articulate a clear connection between their mathematical and faith lives in their second response.
Link to Institutional Learning Outcomes	2, 3, 4, 7	5, 6	3	1

Table 4: Mathematics PLO Alignment Chart.

School	Required Courses	Optional Courses
Westmont *Units/Total:* 54/124 (BS)	Calculus I, II, III;, Discrete, Linear Algebra, Analysis, Algebra, Capstone, Advanced Analysis or Advanced Algebra	Numerical Analysis, Codes and Encryption, Probability and Statistics, Formal Languages and Automata, Geometry, Complex Analysis, History of Mathematics
Wheaton	Calculus I, II, III; Linear Algebra, Intro Proofs, Differential Equations, Probability and Statistics, Capstone *Units/Total:* 48/124 (BS)	Algebra, Analysis, Complex Analysis, Geometry, Advanced Algebra, Advanced Analysis, Math Modeling, Partial Differential Equations, Probability and Statistics II, Geometry
Seattle Pacific	Calculus I, II, III; Intro Stats, Linear Algebra, Discrete, Differential Equations, Vector Calculus, Analysis, Advanced Analysis, Intro Proofs, Algebra, Advanced Algebra, Capstone *Units/Total:* 72/180 (BS)	Statistical Modeling, Data Science, Number Theory, Geometry, Applied Analysis, Complex Variables, Mathematical Statistics, Mathematical Modeling, Numerical Analysis
Reed	Calculus I, II, III; Discrete, Linear Algebra, Vector Calculus, Analysis, Algebra, Thesis *Units/Total:* 14/30 (BS)	Probability and Statistics, Data Science, Statistical Learning, Complex Analysis, Differential Equations, Geometry, Topology, Statistics Practicum, Advanced Statistical Modelling, Number Theory, Combinatorics, Algorithms, Computability, Cryptography, Probability, Mathematical Statistics, Stochastic Processes, Advanced Analysis, Advanced Algebra
Occidental	Calculus I, II, III; Discrete, Linear Algebra, Colloquium *Units/Total:* 52/128 (BS)	Analysis, Complex Analysis, Algebra, Number Theory, Probability, Mathematical Statistics, Differential Equations, Partial Differential Equations, Logic, Computability, Set Theory, Geometry, Topology, Numerical Analysis, Operations Research, Combinatorics, Graph Theory, Mathematical Modeling, Mathematical Biology
Houghton	Calculus I, II; Intro Proofs, Linear Algebra, Algebra, Analysis, Capstone *Units/Total:* 44/124 (BA)	Differential Equations, History of Mathematics, Numerical Analysis, Probability and Statistics I and II, Mathematical Modeling, Geometry, Advanced Algebra, Anvanced Analysis, Complex Analysis, Topology

Table 5: Mathematics degree requirements compared to institutions of similar size.

Westmont has the fewest mathematics courses listed in the catalog of any in our comparison group. It may be that comparison schools have more courses in the catalog than they actually offer, or it may be a reflection of our relatively small amount of staffing compared to some of these schools. Figure 5 illustrates the relationship between faculty size and the number of course offerings.

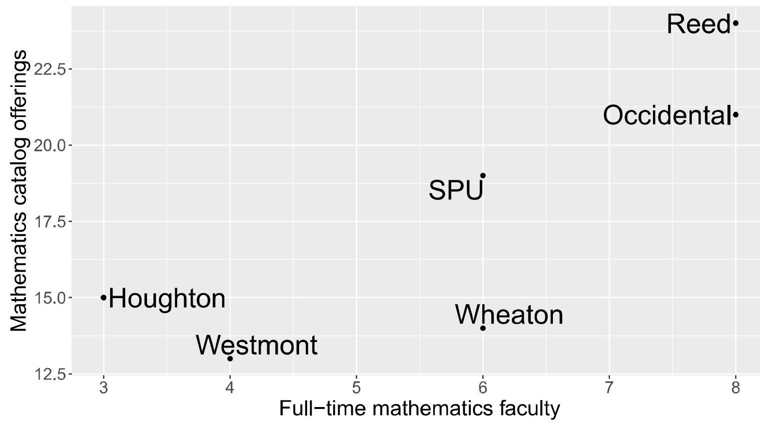

Figure 5: Catalog offerings in mathematics versus number of full-time mathematics faculty, for comparison schools.

While the department has endeavored to augment its offerings in applied mathematics, it still lags behind comparison schools in the number of catalog offerings in applied mathematics. Figure 6 illustrates the disparities.

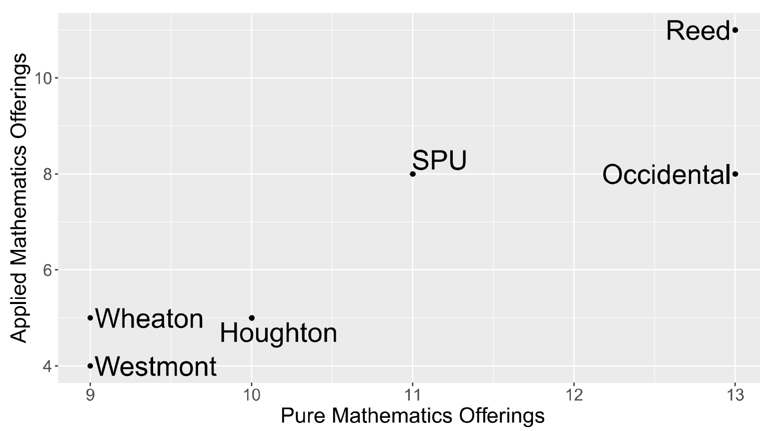

Figure 6: Number of catalog offerings in applied mathematics vs. pure mathematics, beyond the calculus sequence, for comparison schools.

Furthermore, among our comparison group, Westmont's course offerings remain skewed towards pure mathematics courses, while other schools have more of a balance between pure and applied offerings. Figure 7 illustrates that, as a proportion of total courses, Westmont offers the most pure mathematics courses and the fewest applied courses, when compared to this selection of schools.

It is also notable that some schools in our comparison group list offerings in theoretical areas of computer science as mathematics courses. Following these examples, we could increase our applied mathematics offerings by cross listing CS-120 (Algorithms) and CS-116 (Machine Learning)

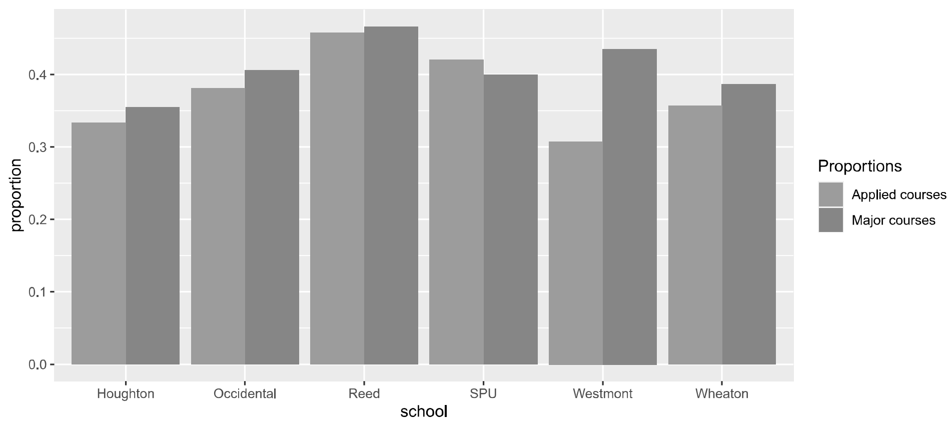

Figure 7: Courses in the major as a proportion of total courses, and proportions of course offerings that are applied, for comparison schools.

as mathematics courses. These courses might also be taught by mathematics faculty, provided there are means for supporting them in preparing to teach them. Doing so would reduce the burden on the CS faculty.

2.3.2 Computer Science

As a result of discussions stemming from our last six-year report, the department has stabilized its computer science major requirements, redesigned the senior seminar, updated some course offerings, and overhauled the catalog descriptions. The Curriculum Map in Table 6 illustrates where the program learning outcomes are met and assessed in the computer science major.

Course	BS designation	BA designation	PLO #1	PLO #2	PLO #3	PLO #4
010	required	required	I/A	I	I	I
015	required	required	D	D	D	I
030	required	required	I/A	I	I	I/A
045	required	required	D	D	D	D
105	required	required	M	M	M	D
116	optional	optional	M/A	M	M	D
120	required	required	M	M	M	D
121	optional	optional	M	M	M	D
124	optional	optional	M	M	M	D
125	optional	optional	M/A	M	M	D
128	optional	optional	M	M	M	D
130	required	required	M	M/A	M	D
135	optional	optional	M	M	M	D
140	optional	optional	M	M	M	D
145	optional	optional	M	M	M	D
190	optional	optional	M	M	M	D
192	optional	optional	M	M	M	D
195	required	required	M	M/A	M/A	M/A

Table 6: Computer Science Curriculum Map. I = Introduced, D = Developed, M = Mastered, A = Assessed.

The Program Learning Outcome Alignment Chart for computer science is given in Table 7.

Program Learning Outcomes	PLO1	PLO2	PLO3	PLO4
Where are the learning outcomes met?	I: 010, 030 D: 015, 045 M: 105, 116, 120, 121, 124, 125, 128, 130, 135, 140, 145, 190, 192, 195	I: 010, 030 D: 015, 045 M: 105, 116, 120, 121, 124, 125, 128, 130, 135, 140, 145, 190, 192, 195	I: 010, 030 D: 015, 045 M: 105, 116, 120, 121, 124, 125, 128, 130, 135, 140, 145, 190, 192, 195	I: 010, 015, 030 D: 015, 045, 105, 116, 120, 121, 124, 125, 128, 130, 135, 140, 145, 190, 192 M: 195
How are they assessed?	Embedded assessment	Embedded assessment	Embedded assessment	Direct assessment
Benchmark	Assessed cohorts should score greater than 7 (satisfactory) on a 10-point rubric that is individually tailored to each assessment. Longitudinal comparison should show improvement.	Assessed cohorts should score greater than 7 (satisfactory) on a 10-point rubric that is individually tailored to each assessment. Longitudinal comparison should show improvement.	Assessed cohorts should score greater than 7 (satisfactory) on a 10-point rubric that is individually tailored to each assessment. Longitudinal comparison should show improvement.	At least 75% of students will be able to articulate a clear connection between their technical and faith lives in their second response.
Link to Institutional Learning Outcomes	2, 3, 4, 7	5, 6	3	1

Table 7: Computer Science PLO Alignment Chart.

Table 8 shows our computer science course offerings and major requirements, along with requirements for five schools of comparable size: Wheaton College (IL), Seattle Pacific University, Reed College, Occidental College, and Houghton College.

School	Required Courses	Optional Courses
Westmont *Units/Total:* 56/124 (BS)	**Discrete**, CS I, II; Organization and Architecture, Programming Languages, Algorithms, Software Development, Seminar	Artificial Intelligence, Numerical Analysis, Cryptography, Databases, Big Data, Formal Languages and Automata, Networks, Operating Systems
Wheaton *Units/Total:* 50/124 (BS)	**Calculus I, Discrete, Linear Algebra**, CS I, II; Software Development, Algorithms, Systems, Ethics	Networking, Machine Learning, Progamming Languages, Databases, Computational Linguistics, Analysis of Algorithms, Operating Systems, Seminar
Seattle Pacific *Units/Total:* 106/180 (BS)	**Calculus I, II, III; Discrete, Linear Algebra, Differential Equations, Statistics**, Data Structures, Systems, Applications, Networks, Programming Languages, Operating Systems, Algorithms, Organization, Logic System Design, Microcontroller System Design	Theory of Computation, Compilers, Advanced Operating Systems, Databases, Advanced Programming, Networks, Advanced Architecture, Topics
Reed *Units/Total:* 14/30 (BS)	**Calculus I, II; Discrete, Linear Algebra**, CS I, II; Algorithms, Computability and Complexity, Computer Systems, Thesis	Ethics, Parellelism, Artificial Intelligence, Deep Learning, Natural Language Processing, Algorithms Programming, Advanced Programming, Graphics, Cryptography, Operating Systems, Advanced Architecture, Networks
Occidental *Units/Total:* 48/128 (BS)	CS I, II; **Calculus I, Mathematical Foundations or Discrete and Linear Algebra**, Organization, Seminar (2)	Data Science, Haptic Media, Game Design, Algorithms, Graphics, Algorithms Analysis, Information Theory, Artificial Intelligence, Natural Language Processing, Programming Languages, Human Computer Interaction, Machine Learning, Robotics, Computability and Complexity, Web Development, Networking, Mobile Apps, Databases, Operating Systems, Security, Cryptography
Houghton *Units/Total:* 57/124 (BS)	**Calculus I; Intro Proofs, Discrete**, CS I, II; Architecture, Algorithms, Databases, Machine Learning, Research, Networking	Software Engineering, Topics, Computational Statistics, Big Data, Operating Systems, Foundations, Databases, Machine Learning, Data Science I, II

Table 8: Computer Science degree requirements compared to institutions of similar size. Required mathematics courses in **bold**.

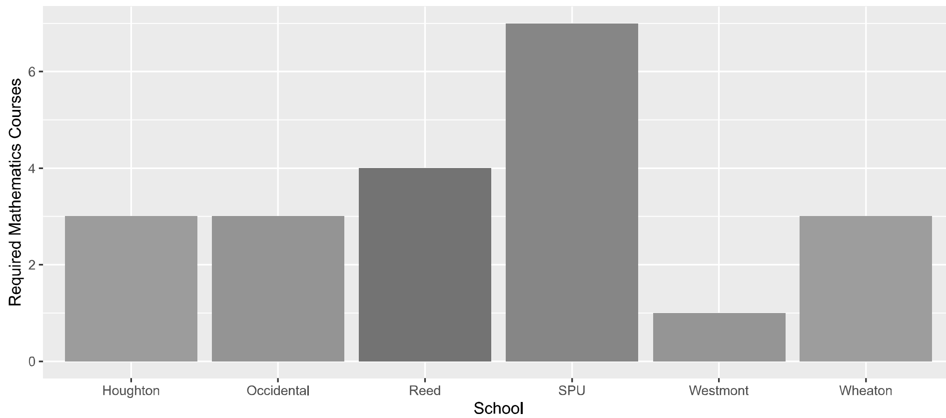

Figure 8: Number of mathematics courses that are required for the computer science major, for comparison schools.

One discrepancy that is quite striking is the relative dearth of mathematics courses required in support of the computer science major. Figure 8 shows that Westmont stands out as requiring the fewest mathematics courses in support of a BS degree in computer science. In fact, Westmont is the only school not to require at least a semester of calculus for its computer science students.

2.3.3 Curriculum changes to consider

During the next assessment cycle, the department plans to discuss the following modifications to our curriculum.

- Consider a transition to teaching Differential Equations in the Mathematics department. (It is currently taught in the Physics department.)
- Consider adding a second course in partial differential equations.
- Consider adding a second upper-division statistics course.
- Consider adding an applied track in the major (which would require the differential equations courses).
- Evaluate whether our current mathematics requirements for the computer science major are sufficient.
- Explore the possibility of requiring senior mathematics majors to take the GRE subject exam as a form of core knowledge assessment.
- Adjust the applied/theoretical balance of our linear algebra course.

2.4 Program Sustainability and Adaptability

2.4.1 Serving Society

As discussed in Section 2.2, our alumni feel at minimum adequately prepared and at most exceptionally well prepared for their work relative to their peers. 87% feel well prepared or extremely well prepared relative to their peers. This is encouraging! In our previous review cycle, 87% of alumni felt the preparation they received were above average or stronger as compared to their peers.

Based on the alumni survey, 36% of our graduates have occupations in education (secondary teachers and tenure-track / tenured faculty), while 41% of our graduates have occupations in an area of applied science or business (Figure 1. For comparison, in our previous review cycle, 43% of alumni listed an occupation in education and 39% of alumni listed an occupation in applied science or business. Strategies to broaden our applied course offerings, while upholding the rigor of our program, were therefore part of our discussion during our previous six-year review, and our department has implemented specific ideas that emerged from these discussions:

- A Data Analytics major was instituted in 2017. This interdisciplinary program brings together foundational courses from Mathematics, Computer Science and Economics and Business to provide our students with the necessary skills to analyze data effectively.
- To better equip Mathematics graduates to meet employer expectations, we have made CS-010 and CS-030 required courses for BS Mathematics since 2014.
- We have started to broaden our applied course offerings; examples are Codes and Encryption (CS/MA-124), Human Computer Interaction (CS-150) and Introduction to Subdivision Methods (MA-150).

With more alumni in applied occupations and an overwhelming majority still feeling well prepared for their work, we feel encouraged that these strategies are hitting the mark. One respondent in our alumni survey specifically commented on appreciating the Data Analytics major in this regard. However, both Computer Science and Mathematics graduates still view the program as very theoretical as opposed to applied (Figure 2. Computer Science graduates specifically asked for a more applied, long-term project curriculum. One Math major asked for more applied courses. This is a theme that our department is still actively pursuing, since we believe offering more applied courses can only benefit our major enrollment numbers. More about this follows in the next section (Serving Westmont).

From the alumni reflections, we see the program learning outcomes that seem to be the most relevant to our graduates are *Communicating Clearly* and *Creativity*: Table 2 shows that 90% of alumni feel that communicating clearly is "very important", and 78% of them feel creativity is "very important". When asked about the degree to which the outcome *Communicating Clearly* was achieved, 75% responded "good", 22% responded "average", and 3% responded "poor". For the outcome *Creativity*, 69% responded "good", 27% responded "average", and 4% responded "poor". Our department is having discussions about how to make sure we're serving our students well in this areas; things to consider are focusing more on written and oral communication in introductory classes and adding a proof-writing class to our curriculum.

2.4.2 Serving Westmont

Our department offers a significant number of courses that serve other departments. Classes that are either required or recommended for graduates in Biology, Chemistry, Economics and Business, Engineering, Kinesiology, Physics, Psychology and Sociology include MA-005, MA-008, MA-009, MA-010, MA-015, MA-019, MA-020 and CS-010. MA-160 and MA-165 serve students in Liberal Studies. MA-002 is a new course planned for Spring 2021 that will be required for Music majors.

In Table 9 and Figures 9 and 10, we show the enrollment numbers for courses labeled MA and CS from Fall 2014 to Spring 2020, and Table 10 shows the number of graduates in Mathematics, Computer Science and Data Analytics between 2015 and 2020.

As a percentage of total Mathematics enrollment over the last six years, service course enrollment form 81.7%, major courses form 18.3%, and GE courses form 90.9%. We are encouraged by a steady increase in enrollment in service courses and GE courses. This is mainly due to increased interest in Introduction to Statistics with more programs in the Natural Science division requiring or recommending this class. We anticipate that enrollment in our Calculus sequence will also increase in the coming years as the newly added Engineering program grows.

On the other hand, we have capacity for growth in our major course enrollment and number of Mathematics graduates. Our department is continuing to investigate ways to attract more Mathematics majors; specifically, as mentioned earlier, we are actively exploring offering more applied courses. More applied courses could make a Mathematics degree more attractive and marketable, especially since Applied Mathematics is a fast growing career field. Moreover, it would better support our students who are entering applied occupations, and it could also speak to the interests Data Analytics and Engineering majors (both fast-growing programs). Ideas for more applied courses that fit with our department faculty interests include a Numerical Analysis class, an upper-division Statistics class, a more applied Linear Algebra class and a Differential Equations / Modeling class. We could also increase our Applied Mathematics offerings by cross listing CS-120 (Algorithms) and CS-116 (Machine Learning) as Mathematics courses. These courses might also be taught by Mathematics faculty, provided there are means for supporting them in preparing to teach them. Doing so would reduce the burden on the CS faculty. Broadening our Applied Mathematics offerings could even lead to an Applied Mathematics track inside the Mathematics major, as proposed in our Curriculum Review (Section 2.3).

On the Computer Science side, service courses enrollment form 19%, major courses form 81%, and GE courses form 39.4% as a percentage of total Computer Science enrollment over the last six years. We are pleased to report that major course enrollment and graduation numbers in Computer Science have increased significantly over the last five years. This is partly due to the new Data Analytics major since Computer Science classes form a significant part of this program.

We are hopeful that we'll fill our open Computer Science faculty position soon to meet this increased interest in our CS program.

The gender and racial make-up of Mathematics, Computer Science and Data Analytics majors are considered in detail in Section 2.5.

	F14/S15	F15/S16	F16/S17	F17/S18	F18/S19	F19/S20	Total
MA:							
Service Courses	292	330	320	329	360	388	2019
Major Courses	61	106	76	83	72	54	452
GE Courses	312	395	346	375	396	421	2245
Math Total	353	436	396	412	432	442	2471
CS:							
Service Courses	21	19	36	49	18	36	179
Major Courses	106	89	125	134	137	172	763
GE Courses	50	43	63	78	64	73	371
CS Total	127	108	161	183	155	208	942
Dept Total	480	544	557	595	587	650	3413

Table 9: Enrollment numbers for courses labeled MA and CS.

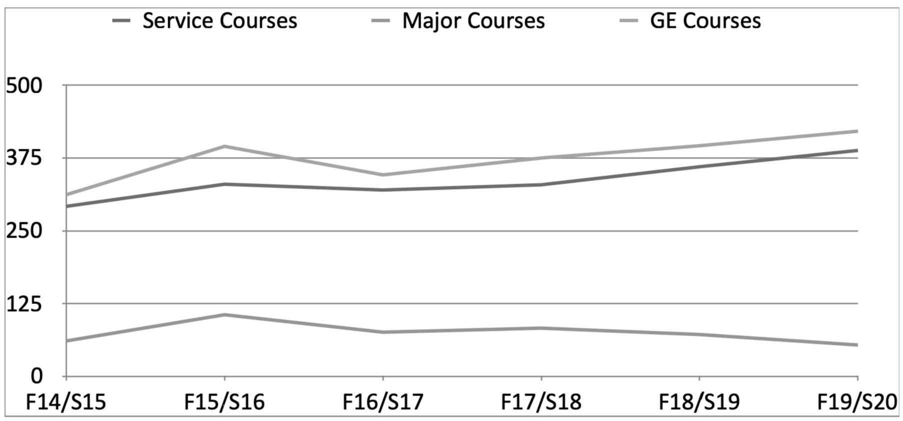

Figure 9: Enrollment numbers for courses labeled MA from Fall 2014 to Spring 2020.

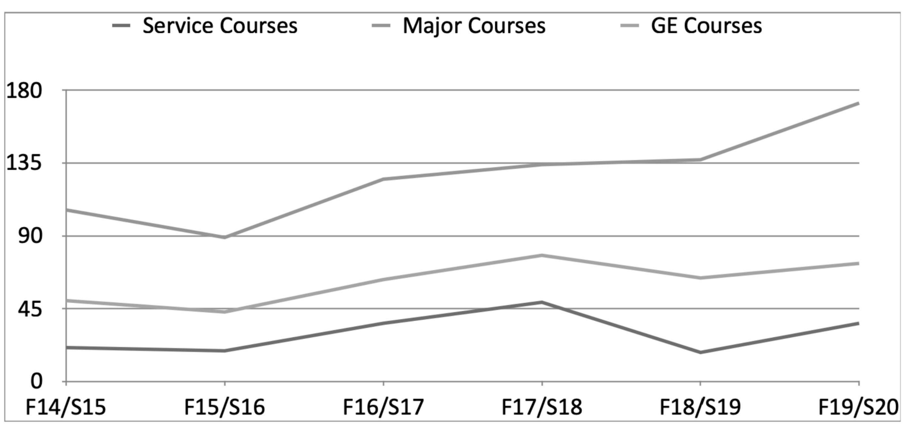

Figure 10: Enrollment numbers for courses labeled CS from Fall 2014 to Spring 2020.

	2015	2016	2017	2018	2019	2020
Math	2	6	3	6	4	3
CS	8	5	4	10	10	12
DA	-	-	-	-	4	6

Table 10: Number of graduates in Mathematics, Computer Science and Data Analytics between 2015 and 2020.

2.4.3 Comparison with Similar Programs

In Table 11, we compare Westmont with other departments of similar sizes with respect to sustainability and adaptability issues. As discussed in detail in our Curriculum Review in Section 2.3, we have broadened our applied course offerings in recent years, but we are still a little behind peer institutions on this front. As mentioned earlier, we are actively pursuing increasing our applied course offerings even further.

Our Data Analytics major certainly sets Westmont apart from peer institutions and is a key component to the sustainability and adaptability of our program. It is encouraging that the program is already graduating good sized classes.

From a marketing standpoint, our department might investigate adding a few features to our website, like highlighting student research and student employment opportunities in the department. We might also include profiles about current majors and what they find attractive about the department and our programs, and we might highlight more feedback from our alumni survey, specifically concerning career possibilities for graduates (this will also be helpful for advising).

2.4.4 Summarizing Strengths and Challenges

Based on the above, we summarize the strengths and challenges of our department with respect to sustainability, as well as discussion points for our department in the next assessment cycle:

- Our alumni report that they feel adequately prepared to enter the workforce.
- The Mathematics side of our department continues to play an important role in teaching service classes for other departments.
- Enrollment and graduation numbers for Computer Science courses have increased significantly over the last review cycle. The Data Analytics major is also continuing to grow and sets Westmont apart from peer institutions.
- Filling the open position in Computer Science remains a challenge, particularly with the increased interest in our Computer Science courses.
- We will actively pursue broadening Applied Mathematics course offerings. It could attract more Mathematics majors and also serve the interests of our Data Analytics (and even Engineering) majors better.

School	Faculty	Notes
Westmont	Math: 4 full-time, 1 adjunct CS: 1 full-time, 1 open	Offers BS / BA in Math and CS, BS in DA. No special tracks inside these majors. Website features career paths, alumni profiles, current events and Mathematics Field Day.
Wheaton	Math/Stat: 6 full-time CS: 3 full-time	Offers BS / BA in Math and CS. Four areas of concentration within Math major: Pure Mathematics, Applied Mathematics, Statistics, Secondary Education. Website features **research opportunities, student employment opportunities**, competitions, Math club and CS Lab.
Seattle Pacific	Math: 6 full-time, 1 instructor CS: 2 full-time (part of CS/Engineering dept)	Offers BS / BA in Math and CS, BS in Applied Math, minor in DA. Website features alumni profiles and career possibilities.
Reed	Math/Stat: 8 full-time, 3 adjunct CS: 3 full-time, 2 adjunct, 1 open	Offers BS in Math and CS as well as hybrid majors: Math/Stats, Math/Physics, Math/Econ, Math/CS. Requires qualifying exam and written theses for Math and CS programs. Website features colloquiua events and student publications.
Occidental	Math: 8 full-time, 3 adjunct CS: 4 full-time, 4 adjunct	Offers BS in Math and CS. Three areas of concentration within CS major: Computer Science, Computational Mathematics and CS+X (technology-focused). Website features alumni career profiles, **current majors profiles** and diversity statement.
Houghton	Math: 3 full-time CS: 2 full-time	Offers BA in Math, BS in CS, BA in Data Science (but does not integrate with Econ&Business dept). Website features Summer Research Institute for Science/Math **undergraduate research**.

Table 11: Comparison of our program with programs at institutions of similar sizes.

- We will consider featuring student research, student employment opportunities, major profiles and alumni survey feedback (specifically relating to career possibilities) on our department website. These items should be of interest to prospective students.
- We will discuss how to effectively teach our PLO's Communicating Clearly and Creativity, starting even in introductory courses (not only in upper-division classes).

2.5 Contribution to Diversity

2.5.1 Gender

In a variety of different contexts, the Computer Science profession does not have gender equity: the representation of genders is significantly different than the general population and less equitable than other STEM disciplines. For example, While 56% of percent of professional occupations in the 2019 U.S. workforce were held by women. Only 26% percent of professional computing occupations in the 2019 U.S. workforce were held by women. 18% percent of Chief Information Officer (CIO) positions in Top 1000 Companies are held by women.[3]

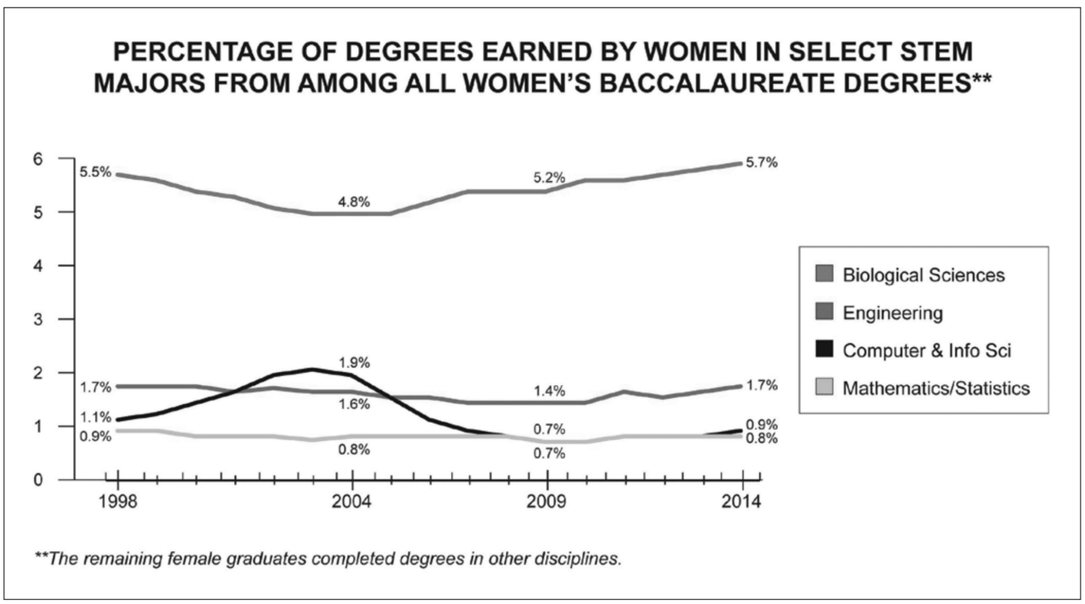

Figure 11: STEM Major distribution of women compared to all majors from [1]

Figure 11 is nation-wide data that shows that among all majors, less than 2% of women choose to major in Math, Statistics, and Computer and Information Sciences.

Figure 12 (also nation-wide data) shows that even when restricted to STEM majors, the gender distribution is heavily biased against women in Computer and Information Sciences. When viewed through this lens, Mathematics and Statistics tends to fare better.

Within the 2019 nation-wide cohort of baccalaureate degrees, 21% of Computer Science degrees

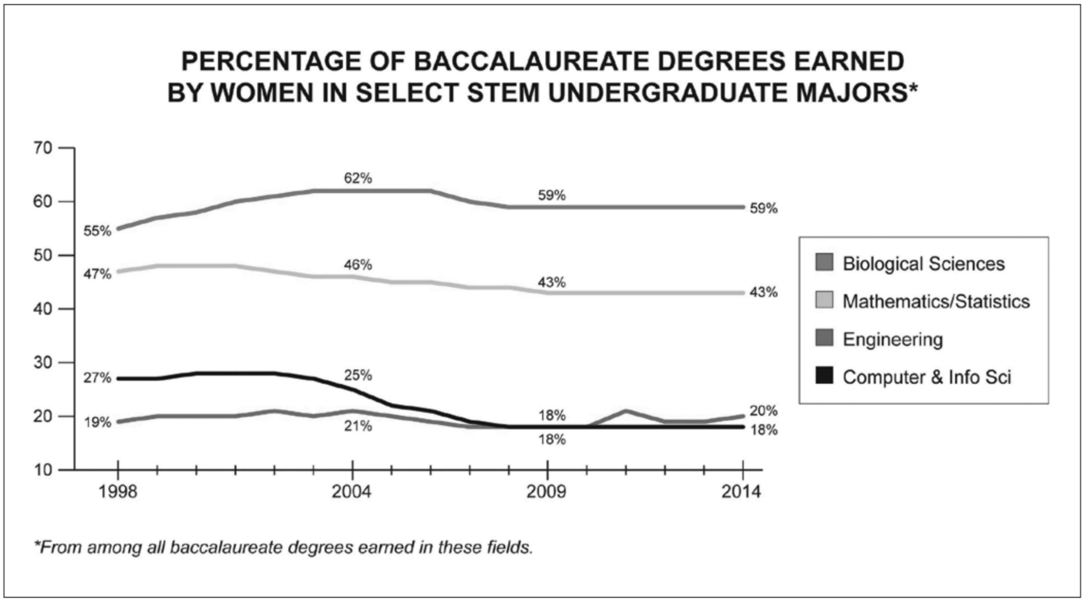

Figure 12: Distribution of gender across STEM majors from [1]

were awarded to women [3]. While this and the aforementioned trends are industry-wide, Westmont's programs do not escape the same systemic patterns. Fortunately as shown in figure 13 over the review period Westmont has been trending higher than national averages at 29% (across department majors). Unfortunately, there is room to improve as this is considerably less than gender distribution of the population from which it is drawing.

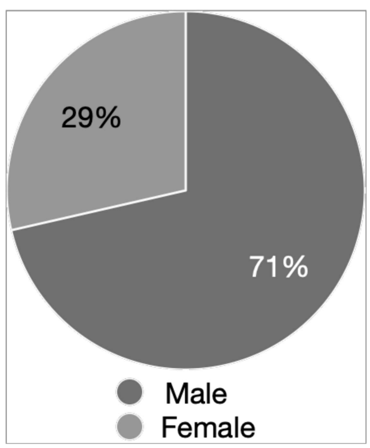

Figure 13: Gender Diversity from Fall 2014 to Spring 2020 - Math, Computer Science and Data Analytics

When analyzed by major, as show in figure 14 the data is a little more clear that our Computer Science major is trending almost exactly according to national trends and our department gender equity is being greatly improved by the Data Analytics major which has a 50% male/female distribution.

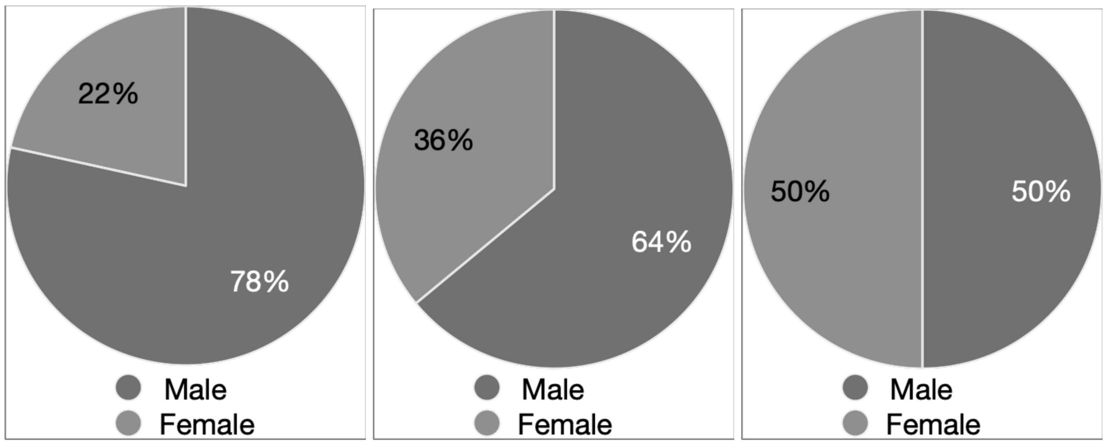

Figure 14: Gender Diversity from Fall 2014 to Spring 2020 - broken out by major. Left to right, Computer Science, Mathematics, and Data Analytics

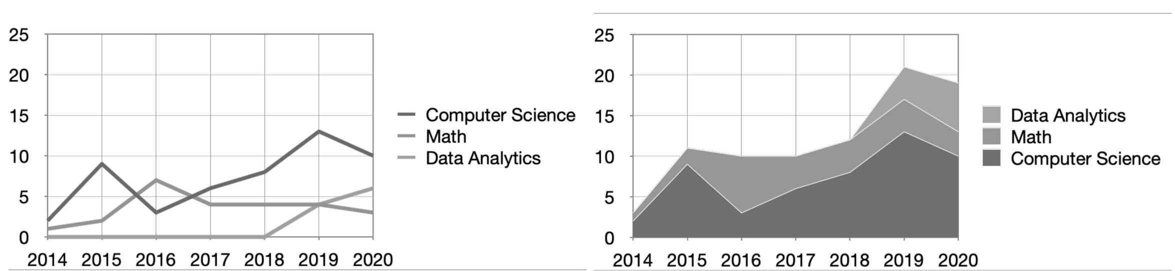

Figure 15: Major enrollment from Fall 2014 to Spring 2020. The figure shows absolute number of majors over time. The right side is stacked to show the overall growth of the department.

Temporal trends in our department, as shown in figure 15, point to growth generally as the Computer Science and Data Analytics majors have clearly increased in size over the last six-years. The graph suggests that the Data Analytics major is slightly cannibalizing the Computer Science and Mathematics majors but overall is increasing the number of majors in our department. With respect to gender equity we can infer that the overall growth in the Data Analytics major is improving our gender representation. It should also be noted that at the same time as the Data Analytics major was introduced, we hired two additional women as faculty members, confounding the analysis a bit. Regardless, we hope that the overall effect is to move toward an environment in which gender is not notable in the decision to study in the department. Figure 16 shows that there has been a modest growth in both male and female majors with females major growth slightly outpacing male majors.

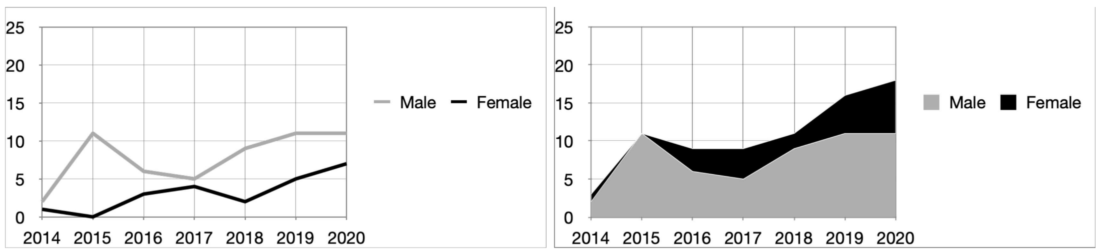

Figure 16: Gender Diversity from Fall 2014 to Spring 2020. The figure shows absolute number of individuals over time. The right side is stacked to show the overall growth of the department.

2.5.2 Race and Ethnicity

Our department's racial and ethnic profile is primarily white and non-Hispanic. With respect to ethnicity, figure 17 shows that a small percentage of our department population is Hispanic ($<$ 8%). This is not consistent with the California population which is approximately 39% [4], for a similar but different category of "Latinos". Strategically this demographic is growing in size and influence in higher-education and will be a significant percentage of the higher-education population in California by 2026 [2].[1]

As we look in individual majors, as show in figure 18 we see that there is little difference across majors in reported ethnicity.

A racial breakdown of the department is show in figure 19. This graph demonstrates that our department is 79% white which is much higher the college in general which reports a 54% white population for 2020 [2].

However, there is some reason for optimism as the temporal trends show in figure 20 show a clear increase in non-white participation in the department. In this regard, we believe our ability achieve racial equity is closely tied to the college at large which is making efforts to improve the environment for non-white students on campus and which, at least statistically, is showing similar modest success

[1] A manual analysis of the unknown race and ethnicity suggests that it is evenly distributed across categories and not the result of a systematic trend of non-reporting by one category

[2] https://www.westmont.edu/sites/default/files/2020-09/Fall2020_10yrsethnicity.pdf

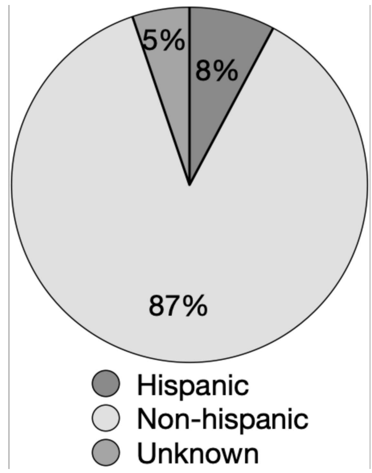

Figure 17: Ethnic Diversity from Fall 2014 to Spring 2020 - All majors

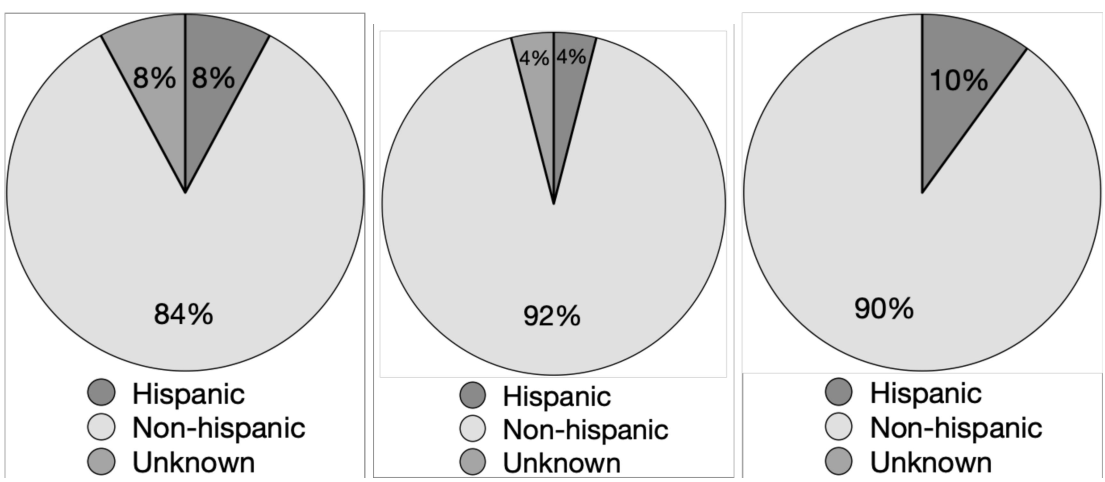

Figure 18: Ethnic Diversity from Fall 2014 to Spring 2020 - broken out by majors. Left to right, Computer Science, Mathematics, and Data Analytics

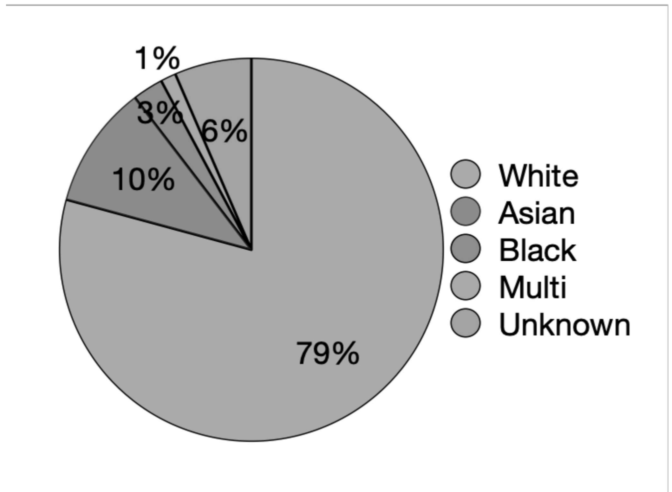

Figure 19: Racial Diversity from Fall 2014 to Spring 2020 - All majors

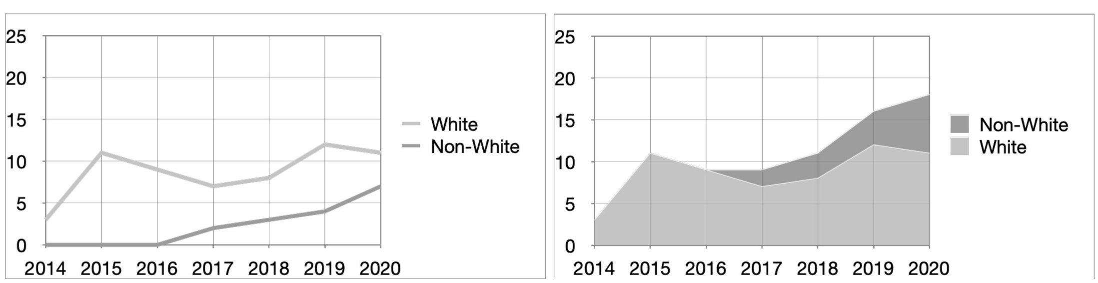

Figure 20: Racial Diversity from Fall 2014 to Spring 2020.The figure shows absolute number of individuals over time. The right side is stacked to show the overall growth of the department.

[3].

We did not do a separate analysis of race by major as the numbers were too small to give confidence in the observed trends.

2.5.3 Going forward

As we look toward the future of diversity in the department we should investigate why the Data Analytics major is effectively attracting women. We should increase our effort to hire racially diverse Computer Science faculty to our open position. We should continue to work toward creating community across all our majors so that we can see the diversity in our midst and remove the reasons to notice the participation of any particular category of individual in the department.

We should analyze our Women In TECH lunches to ensure they are meeting the needs of our students and consider similar ways to normalize the participation of different races and ethnicities in our community life.

[3] https://www.westmont.edu/sites/default/files/2020-09/Fall2020_10yrsethnicity.pdf

2.6 Additional Analysis

2.6.1 Faculty

The increasing demand to offer appropriately-taught statistics courses has potential budget implications for adjunct hiring. In addition, the expanding interest in computer science and data analytics will likely require an additional FTE position in computer science. It is anticipated that Russell Howell will retire before the next six-year review (scheduled for 2026). It is not too early to begin looking a viable candidates.

Further, with such a limited FTE (especially compared with other institutions), the scheduling of courses is becoming problematic. For example, because MA-010 only has one section in the Spring, finding a time slot that does not conflict with courses required for other majors is difficult. It is also very difficult to have required upper-division classes offered only on an alternate year basis. This situation limits student choice for off-campus programs (to the point of possibly preventing their participation), and creates scheduling challenges given the limited classroom space on campus (courses that only meet on alternate years must be scheduled so as not to be offered at the same as other required courses likewise offered on an alternate year basis).

2.6.2 Interaction with Other Departments

Our department cooperates well with other departments in the institution for which it provides service courses. The emergence of the Data Analytics major is an example of cooperation with the Department of Economics and Business.

2.6.3 Facilities

Current facilities (classroom, office space) are adequate, though as with all departments, finding acceptable classrooms at any given time is a growing problem. Office facilities may become a problem as other departments are increasingly using offices originally designated for our department. With the anticipated continuing use of adjuncts, and possibly increasing the number of faculty in our department, office space may become an issue of other departments continue request the use of these offices.

2.6.4 Faith-Learning Integration

Our department is fully-committed to this task, and evidence of that commitment can be seen even in our course syllabi: the collateral reading of *Flatland* in Multivariable Calculus (MA 19) demands analysis of higher dimensions from a Christian perspective; our Advanced Real Analysis Course (MA 109) has *Mathematics for Human Flourishing* as a required text; and Our Capstone Problem Solving Course (MA 180) for Spring 2021 will be using *Mathematics in a Postmodern Age: A Christian Perspective* as a prime resource.

2.6.5 Collaboration with the Departmental Library Liaison

Library Mathematics and Computer Science Scholarly Literature Collections

- The library's policy for how we select and deselect scholarly literature in subject areas is implemented by a liaison librarian, who works with faculty, consults scholarly book reviews, and assesses student needs as they conduct research consultations and information literacy instruction.

- Over the past six years, the Department of Mathematics and Computer Science has worked with the library liaisons Mary Logue and Theresa Covich.

- Over this period, $1,500 was allocated annually for print books, individual ebooks, and videos (including steaming). This is the same for each academic department. The total budget line for these materials has varied slightly between $40,000-$45,000. Our eresource expenditures continue to rise; not only because we purchase more titles electronically now than in the past, but because subscription and one-time purchase costs continue to rise as well.

- In 2020-2021 we are evaluating our current collection development policies and procedures, with the goal of making our collections even more accessible and cost-effective. We will be creating new ways to evaluate and communicate with the Math/Computer Science faculty through our liaison, Theresa Covich, letting faculty know about the results of our collection analyses, usage statistics for both print and online resources. We also hope to invite Math/CS faculty into the library to see our print collections and participate in making decisions about deselection of existing print books.

- For details of expenditures, scholarly print and electronic books and journals, and usage statistics, see Appendix 4.6

Library Instruction for Mathematics and Computer Science

- The Math and Computer Science faculty have rarely, if ever, requested that a librarian provide either research consultations or in-class instruction in how to find, evaluate, or integrate sources into their research projects.

- In the summer of 2017, Mark Sargent asked the library to take a step in the direction of becoming "a hub of student learning," by providing leadership in picking up the disparate threads of tutoring being done on campus. One partnership that developed was the loaning of the library's Instruction Lab and reporting of student attendance at weekly tutoring sessions combining students from MA 009/010, Calculus I/II. The tutor was hired based on referrals from Math faculty, and paid through library funds. Attendance was reported to the Provost's office.

- Theresa Covich was hired in the summer of 2018 to coordinate and manage the recruitment, training, and supervision of library tutors to support the General Educaiton program. She was also actively involved in developing student success initiatives and connecting struggling students with tutoring services. Theresa is also the mathematics and computer science library liaison. She consults with department faculty throughout the recruitment, hiring, and training process. She is working particularly closely with Anna Aboud.

- This year we will be beginning another cycle of Information Literacy ILO assessment. Jana Mayfield Mullen, Library Director and formerly Information Literacy Librarian, will be the

Lead Assessment Specialist. The hope is to expand our definition of Information Literacy to include and reflect all disciplinary habits of mind, with special emphasis on gathering wisdom from a broad range of departments, especially those in the Behavioral and Natural Sciences.

- See Appendix 4.7 for instruction statistics.

2.6.6 Student Participation in Off-Campus Programs

With sequenced courses offered sparingly (e.g., upper-division requirements are only offered on an alternate-year basis), the participation in off-campus programs is difficult to schedule unless those programs offer some kind of class in mathematics or computer science. The South African Mayterm offers hope that such offerings might occur on a regular basis. Additionally, the department will be having discussions on how to increase the participation in the Budapest Semester in Mathematics, managed by St. Olaf College.

2.6.7 Student/Faculty Research Opportunities

The field of mathematics poses special problems for undergraduate research, as most research topics in mathematics require graduate-level training. Nevertheless, our faculty have recently been successful in engaging students in meaningful research activities. As was mentioned earlier in this report, Anna Aboud pursued a research program on aspects of the Kaczmarz Algorithm. David Hunter has worked with a variety of students on summer projects. Russell Howell likewise has had research students in the field of complex analysis. A recent student and he published their results in the journal *Involve*.

3 Conclusions and Vision for the Future

3.1 What was learned

- We should consider more applied course offerings such as: a more regular offering of numerical analysis, creating two different versions of linear algebra (possibly on alternate years), adding a sequel lower-division statistics course to MA 005, and creating a partial differential equations class. Discussions should take place with the Physics department regarding the ownership of the current MA/PH 040 differential equations class.

- It is important to think about the shifting dynamics with the increasing numbers of data analytics majors. How can we both support and capitalize on this trend? Should DA majors be required to take linear algebra? As mentioned in the previous bullet point, should we make an applied version of linear algebra that is more relevant for them? Also, how can we best support the emerging Engineering Program?

- We should continue building community among *all* majors by ensuring we have an accurate email list, continuing with our annual barbecue/awards ceremony, regular prayer for students, and informing majors of tutoring and TA positions. This last item can help with future teacher training as well.

- Identifying leadership opportunities for students is an important task. The tutoring and TA opportunities mentioned in the previous bullet point implies that we should start and maintain a tutoring list within the mathematics department. “Math Circle” volunteers can complement on a more regular basis the annual service many of our majors render by participating in Westmont’s annual *Mathematics Field Day* for high school students. Details of this event can be found at `https://westmont.edu/_academics/departments/mathematics/mathematics-field-day/`.

- Periodic coordination with other departments relying on classes we teach for their majors is important, as well as obtaining student input from these classes. Students in these classes comprise the majority of those served by our teaching.

- We should discuss possibly better ways of measuring the achievement of Outcome 4 (Christian connection), or possibly discuss the way this outcome is articulated.

- As already alluded to, it is important to focus on “marketing ideas,” such as student research, student employment opportunities, major profiles, and alumni survey feedback concerning career possibilities.

- The focus on our communication and creativity PLO should start from the “ground up,” and not be only emphasized in more advanced courses.

- Finally, we should discuss ways to support prospective secondary teachers. For example might it be possible to have some co-teaching between the mathematics and education departments?

3.2 Changes Implemented, in Progress, or Planned

- Since the last six-year report, two applied mathematicians were hired as replacement positions for faculty who retired. The department now has a good balance, in terms of training, between the pure and applied aspects of the discipline.

- With the balance of pure and applied mathematicians in place, preliminary discussions have already taken place regarding how to take advantage of this balance. One concrete change has been the decision to offer Numerical Analysis (MA 121) on a more regular basis. Other possibilities are the creation of an applied version of Linear Algebra (MA 020), and the creation of a course in partial differential equations.

- The implementation of many of the changes already discussed has staffing implications, and of course is contingent on student enrollment. If enrollment in the computer science and data analytics majors continues to increase, additional faculty will surely be required.

- Hiring in computer science is a national challenge. We hope to develop a strategy for finding and recruiting viable candidates in the long term. For example, if our current open position in computer science is fulfilled, might be begin an advertised search for a third position? The grooming of current selected students to consider a teaching ministry is an important task.

- Our recent hires have brought with them many good ideas and energy to our program, and the department should continue to build on this positive momentum.