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.

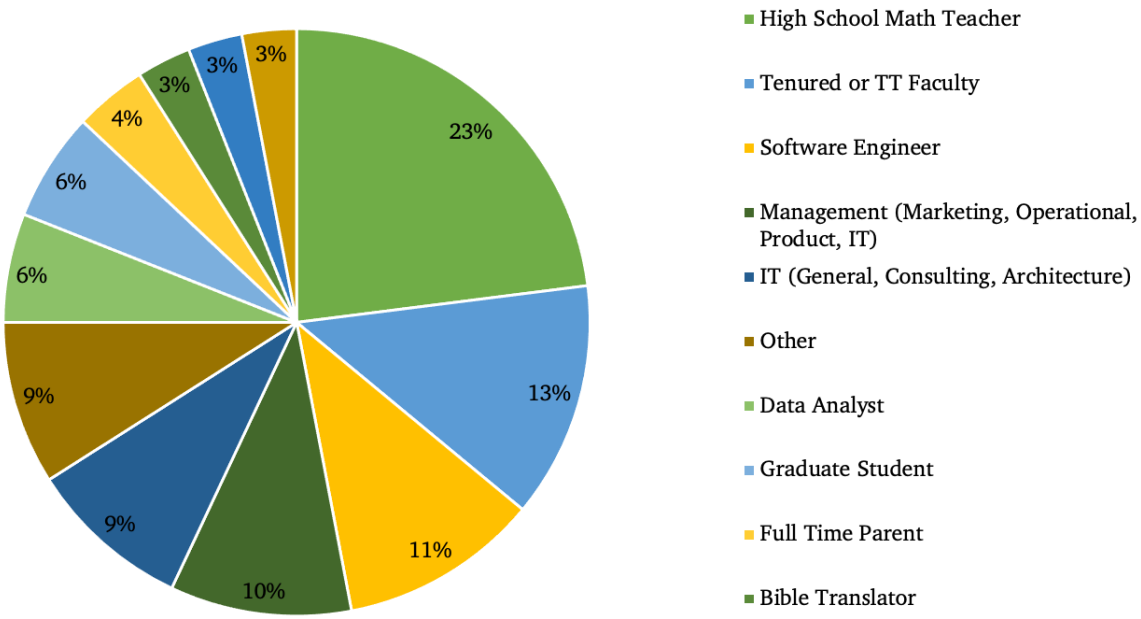

Figure 1: Alumni Occupations

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.

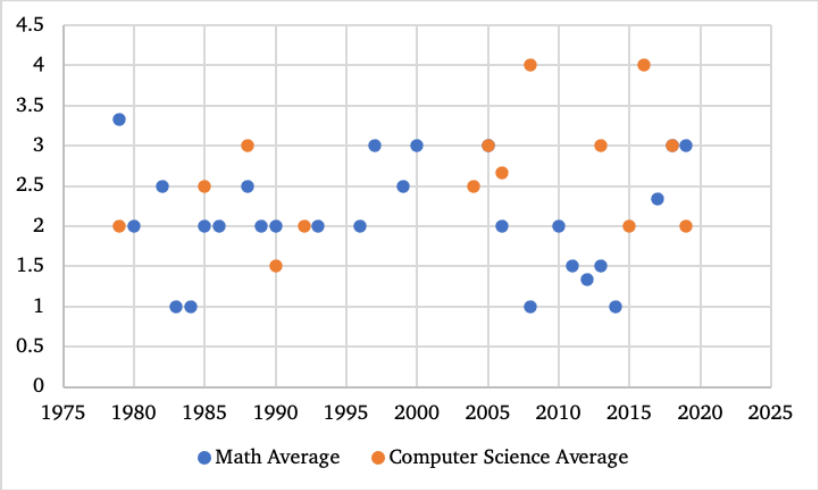

Figure 2: Mean Perception of Theoretical v. Applied Nature of Program by Year

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-

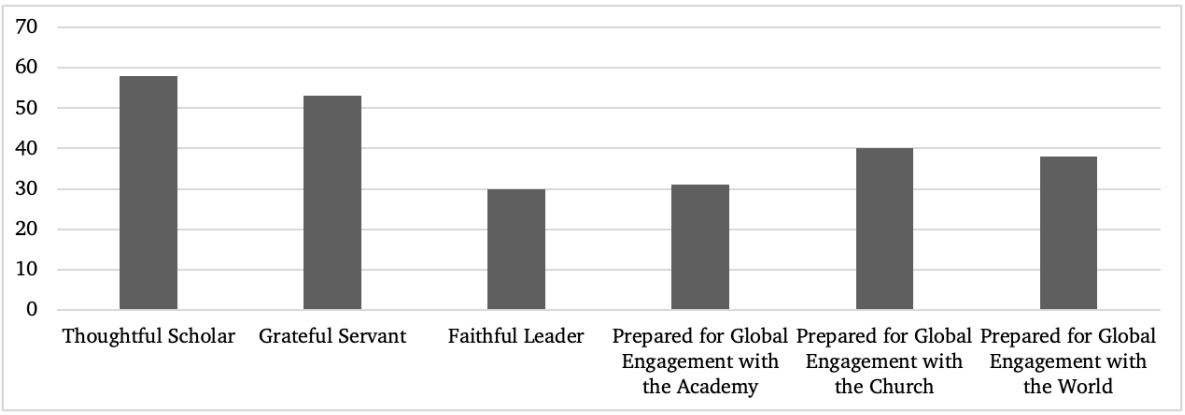

Figure 3: Descriptors at Graduation

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

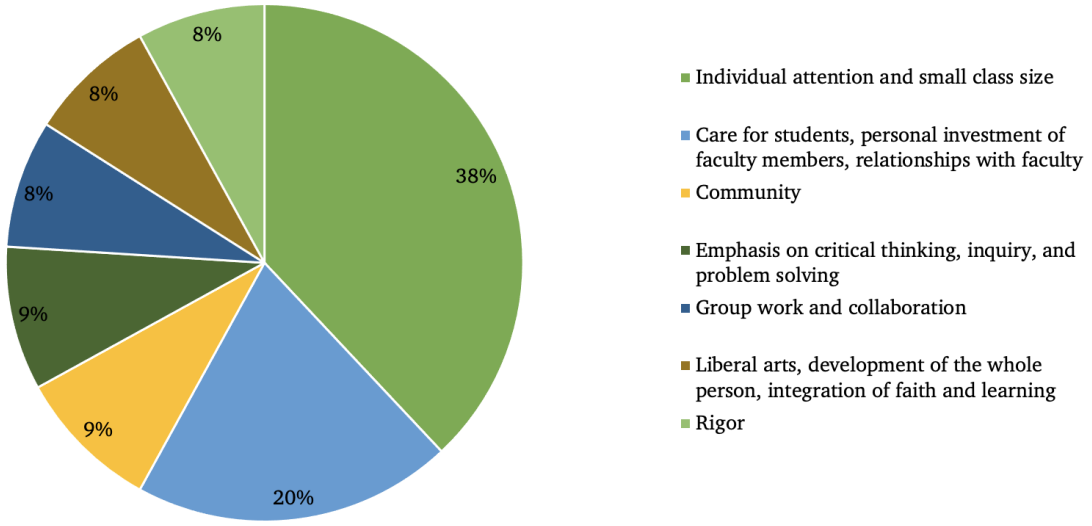

Figure 4: Best Aspects of the Departmental Program

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.

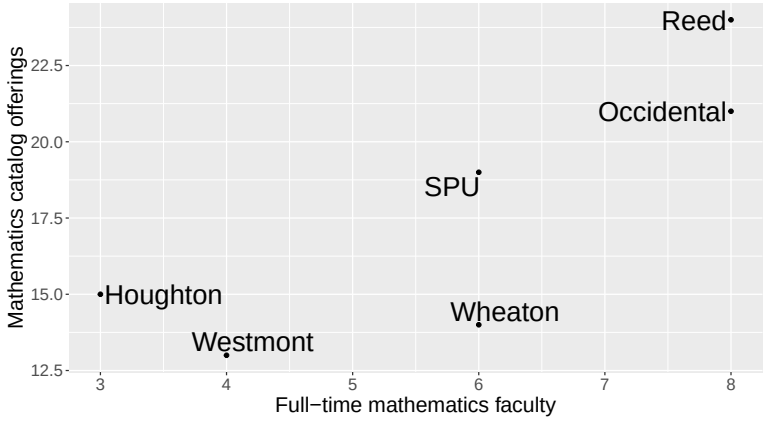

Figure 5: Catalog offerings in mathematics versus number of full-time mathematics faculty, for comparison schools.

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.

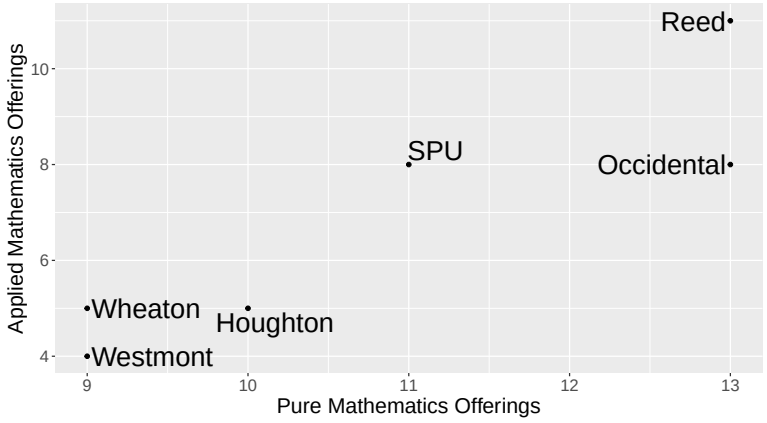

Figure 6: Number of catalog offerings in applied mathematics vs. pure mathematics, beyond the calculus sequence, for comparison schools.

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)

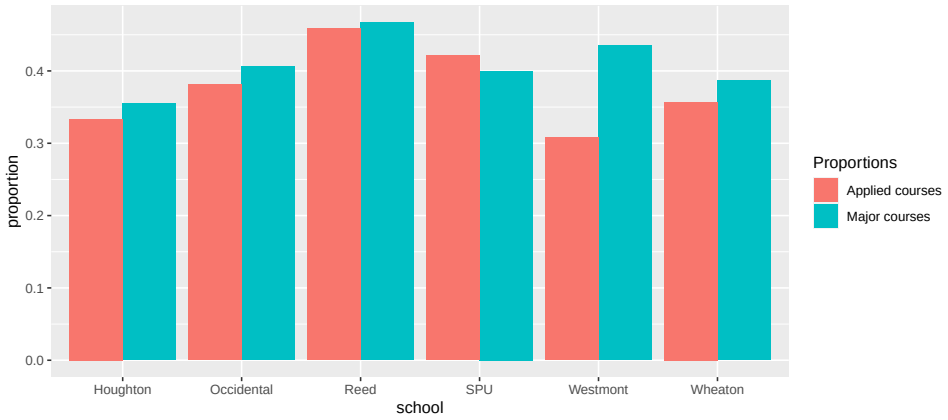

Figure 7: Courses in the major as a proportion of total courses, and proportions of course offerings that are applied, for comparison schools.

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**.

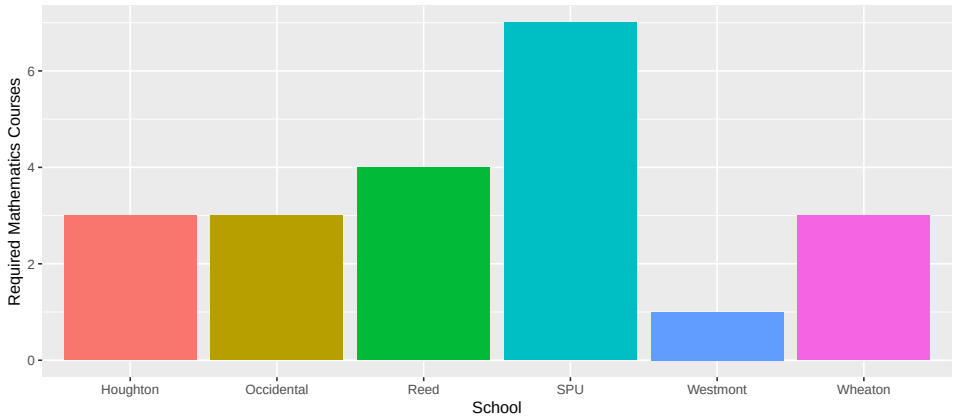

Figure 8: Number of mathematics courses that are required for the computer science major, for comparison schools.

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.

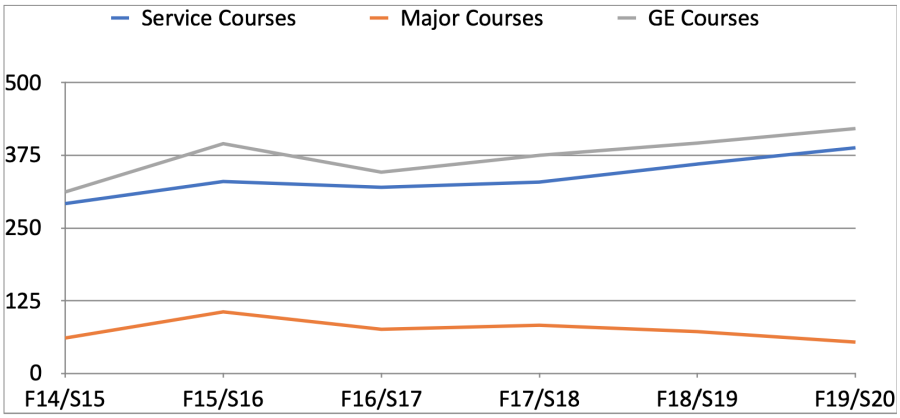

Figure 9: Enrollment numbers for courses labeled MA from Fall 2014 to Spring 2020.

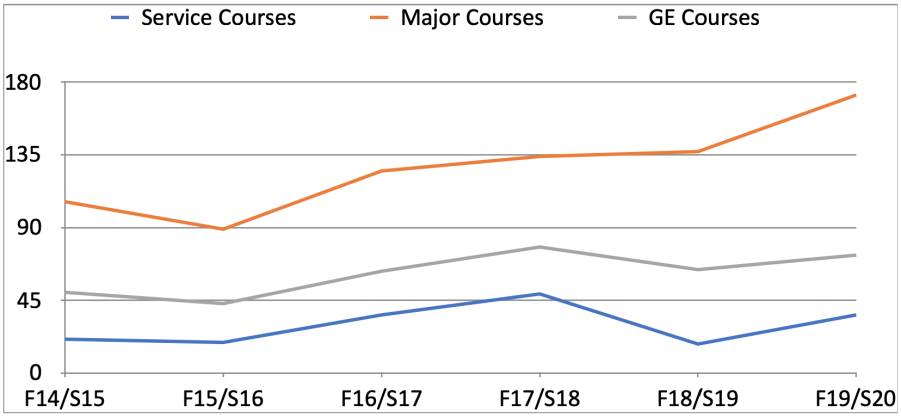

Figure 10: Enrollment numbers for courses labeled CS from Fall 2014 to Spring 2020.

	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]

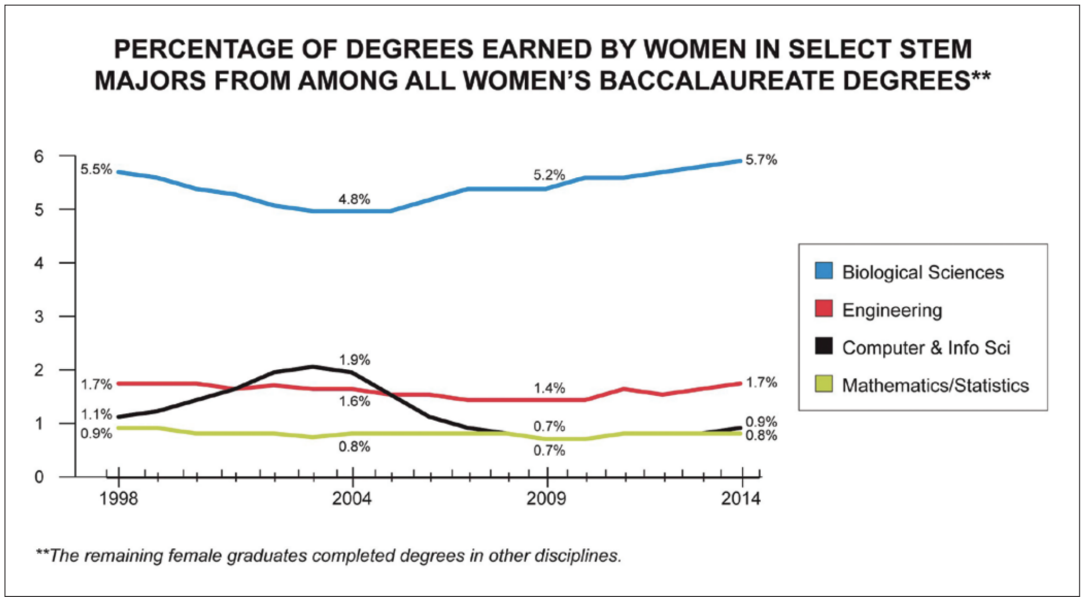

Figure 11: STEM Major distribution of women compared to all majors from [1]

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

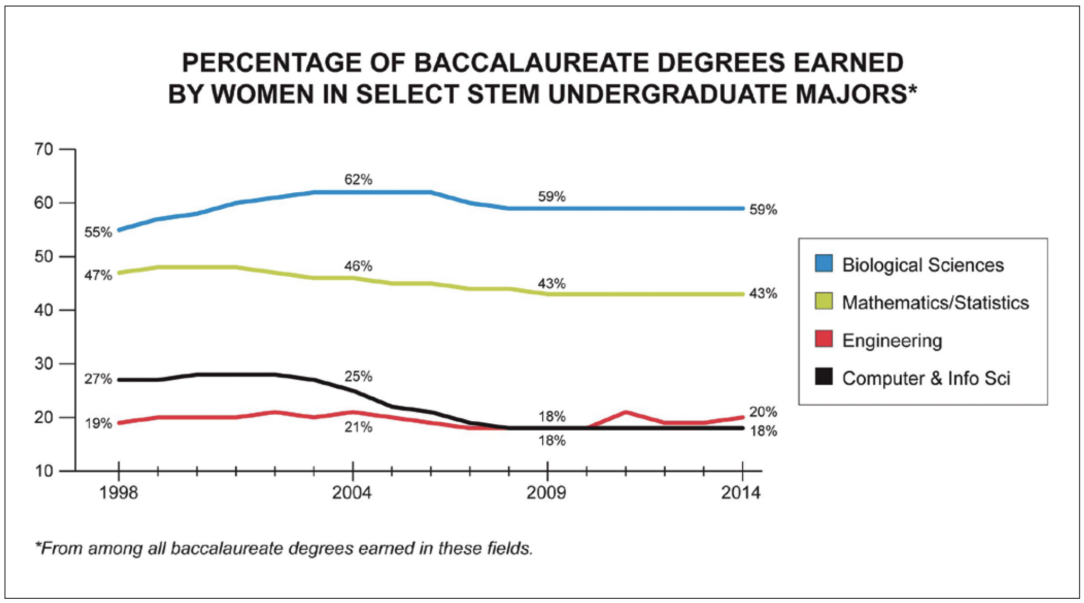

Figure 12: Distribution of gender across STEM majors from [1]

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.

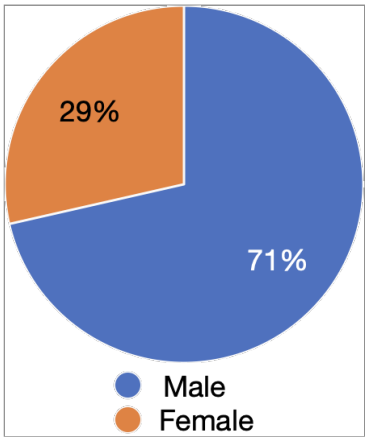

Figure 13: Gender Diversity from Fall 2014 to Spring 2020 - Math, Computer Science and Data Analytics

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.

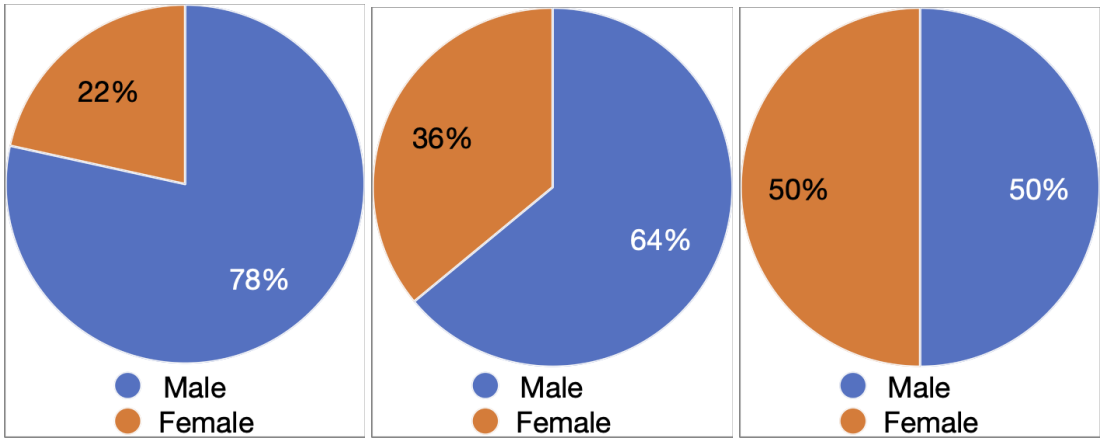

Figure 14: Gender Diversity from Fall 2014 to Spring 2020 - broken out by major. Left to right, Computer Science, Mathematics, and Data Analytics

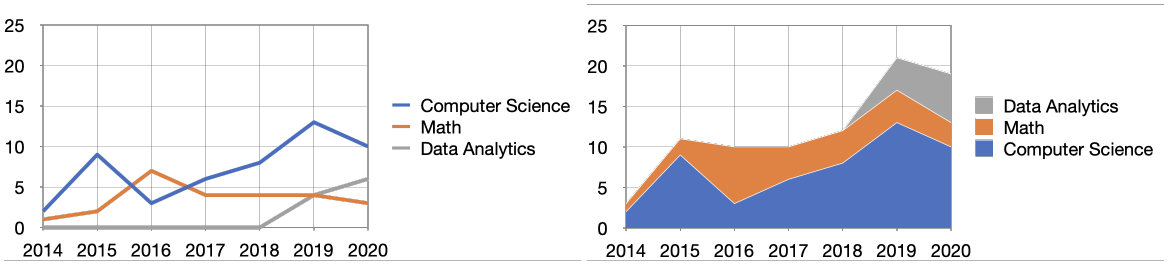

Figure 15: Major enrollment from Fall 2014 to Spring 2020. The figure shows absolute number of majors over time. The right side is stacked to show the overall growth of the department.

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.

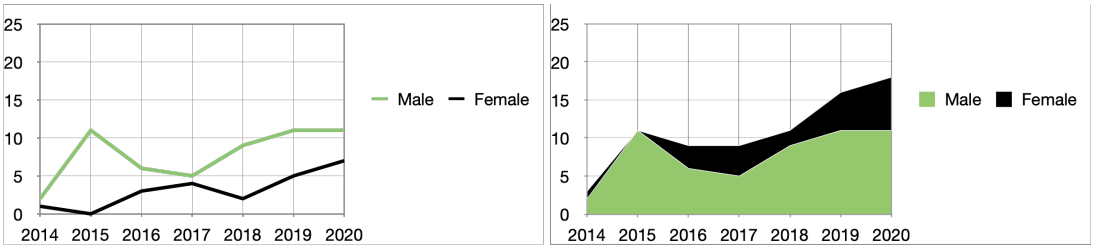

Figure 16: Gender Diversity from Fall 2014 to Spring 2020. The figure shows absolute number of individuals over time. The right side is stacked to show the overall growth of the department.

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

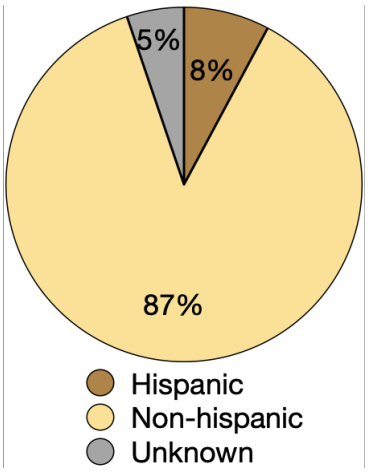

Figure 17: Ethnic Diversity from Fall 2014 to Spring 2020 - All majors

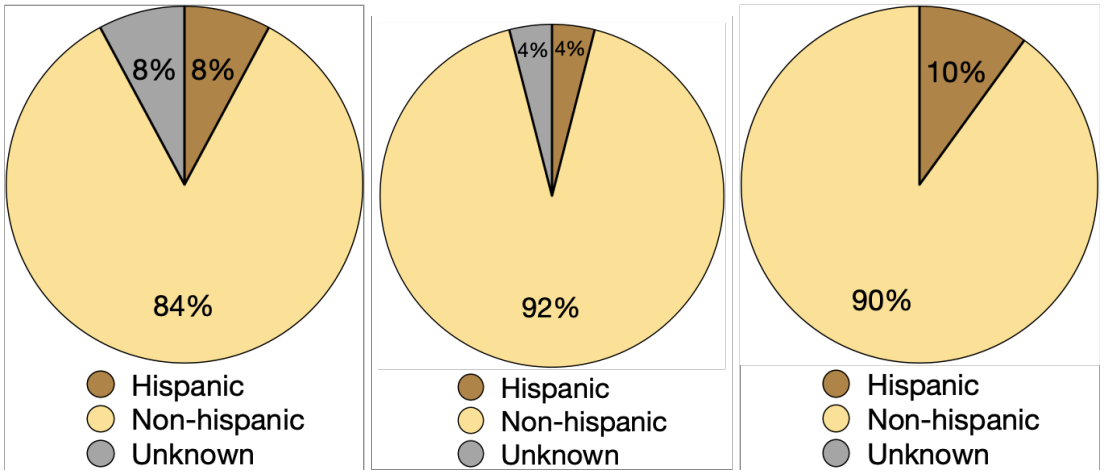

Figure 18: Ethnic Diversity from Fall 2014 to Spring 2020 - broken out by majors. Left to right, Computer Science, Mathematics, and Data Analytics

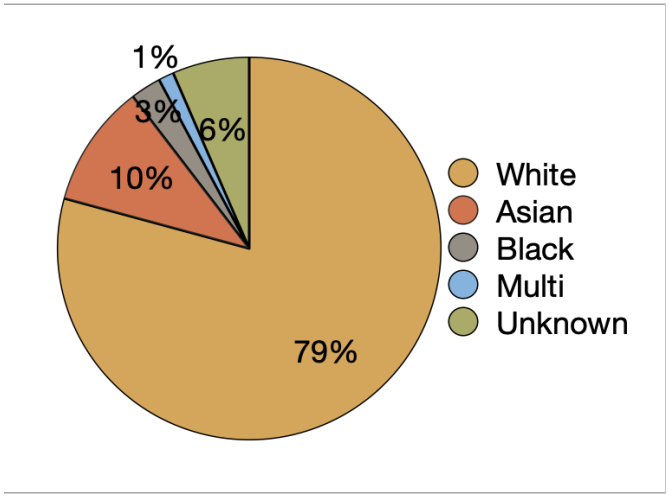

Figure 19: Racial Diversity from Fall 2014 to Spring 2020 - All majors

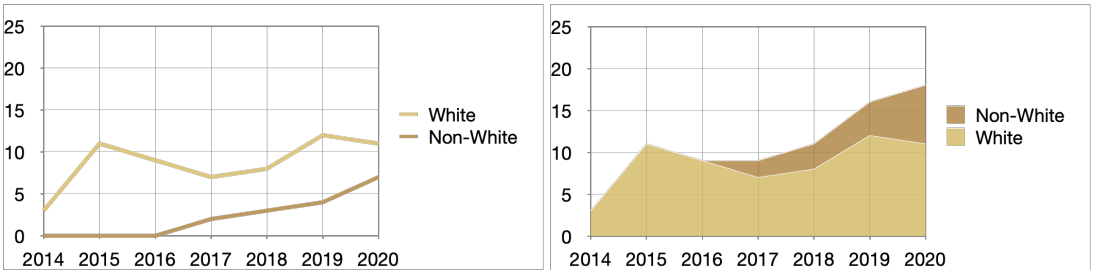

Figure 20: Racial Diversity from Fall 2014 to Spring 2020.The figure shows absolute number of individuals over time. The right side is stacked to show the overall growth of the department.

[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.

4 Appendices

4.1 New Course Syllabi

MA-150: Topics: Introduction to Subdivision Methods

Spring 2018

Meeting times: TTh 10:00 - 11:50 am, Winter Hall 110

Instructor: Dr Maryke van der Walt
email: mvanderwalt@westmont.edu
Office: Winter Hall 305
Office Phone: 805-565-6297
Office Hours: M 3 - 4:30 pm, T 2:30 - 4 pm, W 2 - 3:30 pm, Th 2 - 3:30 pm
(or just send me an email and we'll set something up)

Catalog Description: (4 credit hours) Prerequisite: MA-010 and MA-020. Programming experience is desirable but not essential. MA-150: Course content will be determined by student interest and need.

Overview and Objectives: Have you ever wondered how Pixar animated Mr Potato Head in Toy Story? Or Joy in Inside Out? The short answer is that characters like these are designed using something called *subdivision schemes* – a mathematical tool that allows you to create smooth curves and surfaces on a computer through fast algorithms. The applications of subdivision schemes stretch far beyond the entertainment industry; for example, they are also used by companies like Boeing to design airplanes to satisfy certain smoothness conditions, and by engineers to model numerical solutions of partial differential equations.
So, at this point it should be clear that this course falls in the category of Applied Mathematics. Therefore, one of my objectives with this course is to introduce you to the **application** of subdivision schemes – we will study and implement different types of subdivision schemes that are used in the industry to generate curves and surfaces. However, applied mathematics is about more than the application or implementation of certain procedures – applied mathematicians need to understand why and how their implementations work! Therefore, my other objective with this course, which is just as important, is to introduce you to the amazing **mathematics** on which subdivision schemes are built and which guarantees that subdivision schemes do what they are supposed to do: generate smooth curves and surfaces.

Course Learning Outcomes: Formally, the course objectives described above can be summarized in the following course learning outcomes:
By the end of this course, students should be able to:

(i) demonstrate mastery of the fundamental concepts of subdivision schemes;

(ii) recognize, understand and implement different types of subdivision schemes;

(iii) present sound logical and mathematical arguments, both verbally and in written form;

(iv) incorporate their mathematical skills and knowledge into their thinking about the Triune God and their identities as followers of Christ.

These outcomes will be assessed through problem sets, computer homeworks and exams, to be described below.

Program Learning Outcomes: The course learning outcomes described above reflect the program learning outcomes formulated by the Mathematics department at Westmont College:

(1) Core Knowledge: Students will demonstrate knowledge of the main concepts, skills, and facts of the discipline of mathematics – reflected in (i and ii).

(2) Communication: Students will be able to communicate mathematical ideas following the standard conventions of writing or speaking in the discipline – reflected in (iii).

(3) Creativity: Students will demonstrate the ability to formulate and make progress toward solving non-routine problems – reflected in (ii) and (iii).

(4) Christian Connection: Students will incorporate their mathematical skills and knowledge into their thinking about their vocations as followers of Christ – reflected in (iv).

Text: I plan to cover Chapters 2, 3, 4, 6 and 8 of *Wavelet Subdivision Methods*, by Charles Chui and Johan de Villiers (1st edition) and Chapters 2, 3 and 4 of *Introduction to the Mathematics of Subdivision Surfaces*, by Lars-Erik Andersson and Neil F. Stewart (1st edition).

Homework: A written homework set and/or a computer programming homework set will be assigned every week.

- The written homework sets will be posted on Canvas and are designed to help you capture the mathematical theory we discuss in class.
- The computer programming homework sets are designed to help you learn more about practical considerations when implementing subdivision schemes, which in turn complements your theoretical understanding of the material. For programming, the recommended language is **Python**. The programming assignments will be posted and submitted on Canvas.

You are more than welcome to collaborate with your class mates on these assignments, as long as you write and submit your own set of solutions and list the names of your collaborators on your solutions.

Tests: We will have two written tests in class during the semester. They are tentatively scheduled for

- Thursday February 15; and
- Thursday March 22.

I will try my best not to move the test dates, but sometimes things happen and I might have to.

Final Exam: A cumulative written final exam will be taken on Monday April 30, 8 - 10 am, as scheduled by the Provost's office. Final exams will not be rescheduled to accommodate travel arrangements.

Grading: Your grade will be calculated as follows:

Written homework assignments:	30%
Computer homework assignments:	20%
Two tests:	15% each
Final exam:	20%

I will assign grades on the usual 90/80/70/60 scale; plus and minus grades will be assigned as appropriate. In borderline cases, I reserve the right to take into account consistency of attendance and

participation. Work missed (including tests) without a valid excuse will receive a zero. If you have a valid excuse for missing class or tests or for late submission of homework, please contact me as soon as possible.

Tentative Schedule:

Monday Jan 8	First day of classes
Tuesday Jan 9	**Class does not meet (Montecito mudslide)**
Thursday Jan 11	**Class does not meet (MvdW attends JMM in San Diego)**
Week 2	Refinable functions, smooth basis functions (CdV 2.1, 2.2)
Week 3	Cardinal B-splines (CdV 2.3, 2.5)
Week 4	Subdivision schemes (CdV 3.1, 3.2)
Week 5	Curve rendering (CdV 3.3, 3.4)
Week 6	Necessary conditions for subdivision convergence (CdV 4.1)
Thursday February 15	**Test 1 (CdV Chapters 2-3)**
Week 7	Subdivision operators (CdV 4.2, 4.3)
Week 8	Cascade operators (CdV 4.5, 6.1)
Week 9	Sufficient conditions for subdivision convergence (CdV 6.2, 8.1)
Monday March 12 - Friday March 16	**Spring Break**
Week 10	Interpolatory subdivision schemes (CdV 8.1)
Thursday March 22	**Test 2 (CdV Chapters 4,6,8)**
Week 11	Tensor product subdivision schemes (AS 1.2, 2.3)
Week 12	Tensor product subdivision schemes (AS 1.3, 2.4, 3.1)
Week 13	Box spline subdivision schemes (AS 3.2, 3.3, 3.4)
Week 14	Box spline subdivision schemes (AS 3.5, 3.7)
Week 15	General surface subdivision schemes (AS 4.1, 4.2)
Friday Apr 27	Last day of classes
Monday Apr 30, 8 - 10 am	**Final exam**

Other admin matters:

- Please check your Westmont email inbox regularly; I often send announcements regarding homework or office hours via email.
- Schedules and other notices will be posted on Canvas https://westmont.instructure.com/.
- During class, I expect you to be an active participant. Therefore, feel free to use your laptop, tablet, phone or calculator for note-taking or calculations, but make sure that it does not distract you or your classmates. I reserve the right to take away this privilege if it becomes a problem. ☹

Connecting with Professors: You are encouraged to take advantage of the *Take a Professor to Lunch Program* as an opportunity to get to know each of your professors over a shared meal. Feel free to contact me about this! ☺ I'm also always happy to talk over a cup of tea in my office (cookies included); you're welcome to pop in if you see me in my office or send me an email if you want to arrange something beforehand.

Attendance: If you miss a significant number of classes, you will almost certainly do poorly in this class. If you miss more than four classes without a valid excuse, I reserve the right to terminate you from the course with a grade of F – this is in line with Westmont's attendance policy, which is available at http://www.westmont.edu/_offices/registrar/academic_policies/attendance-policies.html.

Academic Integrity: Dishonesty of any kind may result in loss of credit for the work involved and the filing of a report with the Provost's Office. Major or repeated infractions may result in dismissal from the course with a grade of F. Westmont's plagiarism policy is available at https://westmont.edu/_offices/provost/Plagiarism/policydoc.pdf.

Accommodation Procedure: Students who have been diagnosed with a disability (learning, physical or psychological) are strongly encouraged to contact the Disability Services office as early as possible to discuss appropriate accommodations for this course. Formal accommodations will only be granted for students whose disabilities have been verified by the Disability Services office. These accommodations may be necessary to ensure your equal access to this course. Please contact Sheri Noble, Director of Disability Services (310A Voskuyl Library, 805-565-6186, snoble@westmont.edu) or visit http://www.westmont.edu/_offices/disability/.

Final Comments: Lastly, I really want you to succeed in this course and to enjoy mathematics as much as I do! Please don't hesitate to contact me about anything.

Pre-Course Checklist (15m)

The Canvas learning management system will be the hub of all activity for this course. In preparation for your work in this course, **please familiarize yourself with Canvas**, **familiarize yourself with the course navigation and structure**, and **personalize your settings**.

1 Familiarize Yourself with Canvas

Please view the short video introduction to the Canvas user interface below. If this is your first online course, or if you would simply like to learn more about the Canvas LMS, consider viewing some of the topics available at the **Canvas Student Support (https://community.canvaslms.com/docs/DOC-4121)** site.

2 Familiarize Yourself with the Course Navigation and Structure

MODULES

The course is organized in modules that focuses on a particular aspect of the course of study and identifies what you should be working on or thinking about during a particular week. Because we want you to pace yourself, and to develop our cohort, you cannot access subsequent modules, until the appropriate week.

3 Personalize Your Settings

Within Canvas, you can personalize your experience. We recommend the following:

- **Add a brief bio (https://canvas.instructure.com/profile)** to your Canvas Profile so that people in the course can get to know you. **Here's how. (https://community.canvaslms.com/docs/DOC-2863)**
- Adjust your **User Settings (https://canvas.instructure.com/profile/settings) (https://canvas.instructure.com/profile/settings)** to configure how you are identified and the email address used for the course. **Here's how. (https://community.canvaslms.com/docs/DOC-2888)**
- Configure your **Notifications (https://canvas.instructure.com/profile/communication) (https://canvas.instructure.com/profile/communication)** to identify the types of notifications you would like immediately, daily, weekly, or never. **Here's how. (https://community.canvaslms.com/docs/DOC-1286)**

4 Check out the calendar

If I set things up correctly the calendar tab on the far left should show you what things are due when.

Human Computer Interaction (CS 150)

Welcome Message (5m)

Greetings and welcome to the course website for CS 150. Human-Computer Interaction Technology.

This 4-unit course on building interactive applications is being offered as a hybrid course. As such, this CANVAS course page will be the hub for all course activity. To get to know your course, take a moment to read through all of the introductory materials and get started.

I'm excited to work with you this semester on doing some web application development. My name is Don Patterson and I'm the instructor for this course. As of now, there are no teaching assistants for this course. I've have taught this course several times before at UCI as part of a Master's degree program, but we are going to take it a little slower than that offering. A quick run down on my background:

- BS Degree in Computer Science from Cornell University
- MEng Degree in Electrical Engineering from Cornell University
- I spent 5 years in the Navy living in Japan and Sardinia, Italy and did two combat tours in the Persian Gulf
- Ph.D. in Computer Science from University of Washington
- I taught for ten years at UC Irvine in the Informatics Department specializing in ubiquitous computing. In 2015 I moved to Santa Barbara to join the Westmont faculty.
- When I'm not teaching Computer Science at Westmont College in Santa Barbara I might be teaching online or doing research with any number of colleagues.

For TECHNICAL Issues Throughout the Course related to the Canvas platform

Please contact the **Westmont Academic Technology page (https://www.westmont.edu/information-technology/academic-technology)** and the folks who work there.

For Questions Regarding the COURSE CONTENT, the SCHEDULE, and SYLLABUS

Please post to the slack channel **#hci-tech-fall-19 (https://westmontcs.slack.com/messages/CLTNHALQ5)**. I'm a bit of newbie to slack, so if I'm not doing it right, let me know.

For Questions that are STRICTLY PERSONAL in Nature

Please contact the **Instructor by email or direct message in slack** Please **only use** email for communication when the communication is strictly personal. Otherwise please post to the slack channel so that we can all benefit from the question and response.

OFFICE Hours

Office hours will be held jointly with Prof. Patterson's other classes.

Otherwise, please feel free to schedule an appointment to meet online to discuss any matters related to the course. I use this page to schedule my appointments: **https://www.westmont.edu/_offices/academic_advising/AdvisingAppointments.html (https://www.westmont.edu/_offices/academic_advising/AdvisingAppointments.html)**

To get started, visit the Modules view.

How the Course Works (10m)

COURSE ORGANIZATION

COURSE DESIGN

This is a **hybrid-online course**. You are expected to keep up with the weekly requirements and deadlines. The plan is to release a week's content on the Friday before the week and have the deadlines be due the Monday after the week 10 days later. In principle that means that on any given weekend you can be working ahead, or catching up as you need. On the first Monday after the material is released we will meet in person and go over the work for the week and address any educational issues that arise.

The modules are designed to be completed in order.

MODULE STRUCTURE

Modules are comprised of several repeating major components. Though some modules will have additional components, you will regularly see:

1. **Outro/Intro.** This will provide you with a summary of what happened the last week and introduce an overview of what is expected from you for the week including readings, lectures to view, quizzes, and discussions to contribute to.

2. **Lecture Videos.** These lectures are broken down into modular videos for each week's lesson. We encourage you to watch the lectures and take notes just as if you were sitting in a face-to-face lecture hall. Taking paper notes helps you to learn better and faster (**summary (https://www.scientificamerican.com/article/a-learning-secret-don-t-take-notes-with-a-laptop/)** , **actual research (http://journals.sagepub.com/doi/abs/10.1177/0956797614524581)**) Each video will be followed by an assessment that will have questions or exercises to encourage you to work with the information presented. Some videos are lecture style. Some videos are coding tutorials. For the coding tutorials I recommend watching them on high-speed to get a sense for what is going on. Then based on what the assessment is, go back to the video and follow what I am doing on your own computer, pausing and rewinding as necessary.

3. **Off-site tutorials.** We will also leverage some tutorial sites not on Canvas to help work with the technologies that we are introducing in an interactive way.

REQUIREMENTS

1. Go through each element of the module in order.

2. View the online lectures. Ensure you have a high-quality reliable computer and network connection. On most online video players it is possible to speed up, slow down and repeat playback to improve your learning experience.
3. Complete the assessments associated with the lectures.
4. Complete technical assignments that leverage the cumulative material presented up to that point.
5. Complete peer review assignments designed to expose you to alternative approaches to assignments, foster creativity and to build rapport amongst your cohort.

TECHNOLOGY REQUIREMENTS

You need access to a personal computer (Mac or Windows or Linux - iPad is not okay - check with me) for major amounts of time for this course. You need Internet access for this course. You must be able to save word processing files in a .doc or .docx (Microsoft Word) or .pdf format for sharing and submitting files to the instructor. You are expected to have working knowledge and capability with your computer before entering this class.

Class information and announcements will be communicated through Canvas, slack and through your Westmont email address.

(https://westmont.instructure.com/courses/4190/pages/need-technical-support)

Learning Outcomes (5m)

Upon the successful completion of this course, students will have **Introductory Knowledge** of the following broad learning objectives:

- Website architecture, basic networking and client server architectures
- How to write well-formed XML and JSON
- The role of HTML, CSS, and JavaScript in modern websites design
- How to write and apply well-formed HTML, CSS and JavaScript
- What the Document Object Model is and how it is manipulated by JavaScript
- How to use jQuery to prototype web applications
- How to use the Bootstrap framework to create responsive protoype web applications
- How to write server-side JavaScript using NodeJS
- How to store data for prototype web applications

The plan for the weeks is to cover roughly 10 topics over 15 weeks:

1. Basic Internetworking
2. Cloud Computing, XML
3. HTML in the Cloud
4. CSS
5. Responsive Design and Bootstrap
6. Javascript and Reversi
7. Building out a chat client
8. jQuery and building a lobby
9. Client/Server Javascript/NodeJS
10. Server/Business Logic

Substantive and Technical Goals (2m)

This course functions as a studio course in which students will be required to create a functioning web based application. These technologies are rapidly changing and external resources will be assigned to meet the learning objectives:

- This course will familiarize students with the basics of web-based applications that include presentation, content and interactivity. To accomplish this, readings, lectures, quizzes and assignments are organized as individual concepts and put into practice through exercises. By the time this course is over, you should:
  1. Be able to rapidly mock up a high-fidelity web based application
  2. Be able to create functionality for the application using client and server side technologies
  3. Be able to debug and identify where failures in the application are occurring so that they can be fixed

This course will give you:

- confidence when working with software engineering teams
- a portfolio piece
- skills to complete the senior capstone project and other future projects.

Suggestions for Success (2m)

Suggestions: You are encouraged to do the following in an effort to enhance your experience in this course:

1. Leverage online documentation for the various technologies presented in this course. These technologies are extensive and changing and learning how to stay abreast of the changes is an important skill to learn and take with you.
2. Contact and consult with Professor Patterson as often as is necessary to do well in this course. Do not wait until problems are irreparable or concerns are outdated to seek assistance. If you need assistance, ask for it. If you ask for it, you'll get it. We are here and we want to provide assistance; it is your responsibility to ask us for it as you need it.

Accommodations:

Any student who feels he/she may need an accommodation based on the impact of a disability should contact the instructor privately to discuss his/her specific needs. Also, contact **Disability Services (https://www.westmont.edu/disability-services-welcome)** as soon as possible to better ensure that such accommodations are implemented in a timely fashion. We are more than happy to ensure appropriate accommodations if/when the Disability Services staff directs us to do so.

Counseling Center:

If you find that personal problems, career indecision, study and time management difficulties, etc. are adversely impacting your successful progress at Westmont, please check out the **Counseling Center online (https://www.westmont.edu/counseling-and-psychological-services)**.

Expectations and Conduct (4m)

Expectations:

You are adult students at Westmont College, a top private institution of higher education in both the U.S. and the world. I expect much greater levels of responsibility than many of you may have experienced as high school students or internships, whether at Westmont or elsewhere. Expectations of Math/CS faculty are considerably high regarding both academic performance and personal initiative. You piloting a new “hybrid course” (amongst others you are probably taking). I expect that you will fulfill all obligations as adult students during this time, just as you would in other aspects of your life or careers. All perspectives are allowed and, indeed, welcomed but expressing them in a respectful way is required. Reasonable people can disagree but disagreement needs to be expressed in ways that are conducive to the free exchange of ideas and attendant productive dialogue.

Conduct

Students are expected to conduct themselves in a professional manner. Students are expected to follow Westmont's standards of academic conduct. Cases of suspected academic misconduct will be immediately forwarded to Student Affairs, and will be pursued to resolution. This is an unpleasant process for all involved, so please do not put yourself in this situation.

Plagiarism & Cheating:

The primary source of cheating in this class is through copying HTML, CSS and JavaScript. I expect you to acknowledge anyone else’s code that you have leveraged or used. Looking for answers in online resources is perfectly reasonable and expected. Copying and pasting from online resources and not acknowledging it is considered cheating. If you use someone else’s creation and don’t acknowledge it you are liable to receive a 0 for the assignment and **a 0 for the course**. Additionally when you turn in work I expect that it accurately reflect your understanding of a topic. Don't turn in something that you don't understand and can't produce on your own.

Otherwise this course will follow the same procedures and expectations as other CS classes that I teach.

Participation (1m)

By actively participating in class you can develop your professional skills for design. Here are some examples of how you can participate:

1. Treat all with respect – be constructive in your reviews
2. Plan time to accomplish the online tasks. Do not wait until the last minute.
3. Comment, build on, or clarify others' contributions
4. Post useful or interesting information to the #general or class specific slack channels.

Quality of Assignments (1m)

As technical students in a field that requires excellent communication skills, this course has high expectations on the quality and presentation of completed assignments and reports. Assignments should be well organized, thoroughly proofread, and free from grammatical errors. The use of appropriate, clear titles, figure captions, and headings is also important.

In this course we also expect any code submitted to be well-formatted and appropriately commented with citations as necessary.

Contacting the Instructors (1m)

Contacting the Instructor

You are welcome to give me feedback about the course, to ask a question about an assignment, to share an interesting article or resource, to request additional time for an assignment (because of significant health, personal, or educational matter), or similar communication. Please note the following guidelines:

- Slack is the preferred mode of contact
  - For public comments about the course use: **https://westmontcs.slack.com/messages/CLTNHALQ5 (https://mhcid.slack.com/messages/CC5BT83BJ)**
  - **(https://mhcid.slack.com/messages/CC5BT83BJ)** For slack direct messages to Prof. Patterson use: **https://westmontcs.slack.com/messages/D2KBX7S1K (https://westmontcs.slack.com/messages/D2KBX7S1K)**
  - For email to Professor Patterson use: **dpatterson@westmont.edu (mailto:djp3@ics.uci.edu)**
- Whenever appropriate, please use a public forum to ask questions so that other can benefit from our conversation
- If you don't receive a reply in a timely manner (<24 hours), please resend your message without guilt.

Grading Policies (2m)

Late Assignments

Online courses inevitably involve glitches and outages. The best way to avoid being adversely affected by them is to start early and have buffer time in your schedule in case something goes wrong. In the case of Westmont system outages late assignments will be managed on a case-by-case basis. Generally, late assignments will be accepted at a penalty of 1% point per hour late. Assignments that are submitted on-time or late by email will be penalized an additional 10% because we have online systems in place to improve feedback and educational outcomes that email does not easily support. Assignments that can't be emailed, for example, online quizzes must be completed on time.

Re-grading Policy

To have work re-graded, you must submit a Re-grade Request within one week of when your work was returned (later requests may be addressed in exceptional circumstances). The request must be a single pdf page and sent by e-mail. It should contain the following information:

- Name
- Statement that you are requesting a regrade
- Which assignment you are communicating about
- The circumstances for the request
- Your desired outcome

The instructor will consider your request. If the instructor is convinced by your argument, your work will be re-graded. If not, the instructor will send you e-mail explaining why. No re-grades will be considered for late work.

BE AWESOME (∞)

Honestly I really don't like syllabi because they sound like you are about to enter a prison full of rules and punishments. We have to say these things because clear policies help to keep things fair, help to keep expectations appropriately high, and help to protect students, faculty and the institution against bias and injustices (small and large).

But step back for a second and remember to BE AWESOME.

You should encourage and help each other because some of you will continue to be each other's professional support network for the rest of your career. Some of you may even end up friends for life.

Be positive. Sometimes it's hard, but we've got so much negativity in our world already why add to it? Be gentle in your criticisms and enthusiastic in your praise. Don't shy away from giving both kinds of feedback.

But that doesn't mean you need to be soft. I love the motto "**High Road, Hard Ball (https://diplopundit.net/2017/02/02/tom-countrymans-farewell-a-diplomats-love-letter-to-america/)** " Put on your game face. Take it seriously. Help everyone to keep their dignity.

Let's go!

Codes and Encryption (MA 124; CS 124)

Math/CS 124 — Codes and Encryption

Time and place: 10:05–11:55am, TTh, Adams 217

Professor: David J. Hunter, Ph.D.

e-mail:	`dhunter@westmont.edu`
Office Phone:	x6075
Office:	Winter Hall 303
Student Hours:	M–Th 3:30–5:00pm, or by appointment.

Catalog Description: (Four credit hours) Prerequisites: MA/CS-015 or MA-020. Modern applications of computing demand that the storage and transmission of data be secure and reliable. Cryptography is the study of techniques for protecting data from adversaries, while coding theory deals with representing data robustly in digital form. This course provides an introduction to these related fields. Topics include basic number theory and modern algebra, classical and modern cryptosystems, discrete logarithms, hash functions, digital signatures, elliptic curves, and error-correcting codes.

Prerequisites: MA-015 and/or MA-020. Programming experience is desirable but not essential.

Overview: This course will give a general introduction to cryptography and coding theory. The point of view will be mathematical, yet applied. We will focus on the general mathematical principles that govern the ways that information is stored and transmitted securely. We will not dwell too heavily on the technicalities of specific protocols and implementations. Rather, we strive to understand the concepts that underlie the technology, so that you will be prepared to view current and future implementations as scientists and engineers, not as technicians.

Textbook: *Introduction to Cryptography with Coding Theory*, by Trappe and Washington, 2nd Edition. If you have your own computer, install R and RStudio on it (`https://www.rstudio.com`).

Grading: Grades are weighted as follows.

Written Assignments:	25%
R Course Package:	25%
Midterms:	2 @ 15% each
Final Exam:	20%

The final exam will be on Wednesday, December 16, from 8:00–10:00am. Finals will not be rescheduled to accommodate travel arrangements.

You should expect a written assignment due the night before every class meeting. You will submit them on Canvas (`https://westmont.instructure.com`) as PDFs, which you can create by scanning your written work using a scanning app. If you prefer, you can typeset these assignments using LaTeX or a word processor.

Over the course of the semester, you will develop an R package containing a library of functions for solving problems in cryptography and coding theory. Typically, I will give you a template including function prototypes, ROxygen comments, and test cases that your functions should satisfy. You will submit successive versions of this package as `tar.gz` files on Canvas.

Attendance: Please show up to class on time; it is rude and distracting to your classmates if you come to class late. Significant tardies count as absences. If you miss an excessive number of classes, you will almost definitely do poorly in this class. I consider it excessive to miss more than two classes during the course of the semester. If you miss more than four classes without a valid excuse, I reserve the right to terminate you from the course with a grade of F. Work missed (including tests) without a valid excuse will receive a zero.

Other Policies: Learning communities function best when students have academic integrity. Cheating is primarily an offense against your classmates because it undermines our learning community. Therefore, dishonesty of any kind may result in loss of credit for the work involved and the filing of a report with the Provost's Office. Major or repeated infractions may result in dismissal from the course with a grade of F. Be familiar with the College's plagiarism policy, found at: `https://www.westmont.edu/office-provost/academic-program/academic-integrity-policy`.

Codes and Encryption (MA 124; CS 124)

In particular, providing someone, actively or passively, with an electronic copy of your work is a breach of the academic integrity policy. Do not email, post online, or otherwise disseminate any of the work that you do in this class. If you keep your work on a repository, make sure it is private. You may work with others on the assignments, but make sure that you type up your own answers yourself. You are on your honor that the work you hand in represents your own understanding.

Tentative Schedule: The following schedule is a rough first approximation of the topics in *Trappe* that we plan to cover; it is subject to revision at the instructor's discretion. Chapter 3 (Basic Number Theory) will be covered throughout the course when the relevant topics arise.

- Chapter 2: Classical Cryptosystems
- Chapters 4–5: DES and AES
- Chapter 6: The RSA Algorithm

  Midterm #1 (through Chapter 6)
- Chapter 7: Discrete Logarithms
- Chapter 8: Hash Functions
- Chapter 9: Digital Signatures
- Chapter 16: Elliptic Curves

  Midterm #2 (through Chapter 16)
- Chapter 18: Error Correcting Codes

  Final Exam (cumulative, with an emphasis on Chapter 18)

Program and Institutional Learning Outcomes: The mathematics and computer science department at Westmont College has formulated the following learning outcomes for all of its classes. (PLO's)

1. Core Knowledge: Students will demonstrate knowledge of the main concepts, skills, and facts of the discipline of mathematics.
2. Communication: Students will be able to communicate mathematical ideas 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 mathematical skills and knowledge into their thinking about their vocations as followers of Christ.

In addition, the faculty of Westmont College have established common learning outcomes for all courses at the institution (ILO's). These outcomes are summarized as follows: (1) Christian Understanding, Practices, and Affections, (2) Global Awareness and Diversity, (3) Critical Thinking, (4) Quantitative Literacy, (5) Written Communication, (6) Oral Communication, and (7) Information Literacy.

Course Learning Outcomes: The above outcomes are reflected in the particular learning outcomes for this course. After taking this course, you should be able to:

- Demonstrate understanding of the theoretical basis for cryptography and coding theory. (PLO 1, ILOs 3,4)
- Write and evaluate mathematical arguments according to the standards of the discipline. (PLO 2, ILOs 3,5)
- Construct solutions to novel problems, demonstrating perseverance in the face of open-ended or partially-defined contexts. (PLO 3, ILO 3)
- Consider the ethical implications of the subject matter. (PLO 4, ILO 1)

These outcomes will be assessed by written assignments, programming assignments, and written exams, as described above.

Codes and Encryption (MA 124; CS 124)

Accommodations for Students with Disabilities: Students who have been diagnosed with a disability (learning, physical or psychological) are strongly encouraged to contact the Disability Services office as early as possible to discuss appropriate accommodations for this course. Formal accommodations will only be granted for students whose disabilities have been verified by the Disability Services office. These accommodations may be necessary to ensure your equal access to this course. Please contact Sheri Noble, Director of Disability Services (310A Voskuyl Library, 565-6186, `snoble@westmont.edu`) or visit `https://www.westmont.edu/disability-services` for more information.

Numerical Analysis (MA 121)

MA 121: Introduction to Numerical Analysis

May 4 - June 5

Instructors: Dr Maryke van der Walt
Meeting times: 2 hours per weekday

Catalog Description: (4 credit hours) Prerequisite: MA 010 or 10H, Recommended: CS 010. Numerical methods in the solution of equations; polynomial approximations; integration, and the solution of differential equations. Use of computer where applicable.

Required resources:

- Timothy Sauer, Numerical Analysis, 2nd Edition, Pearson, 2012.
- MATLAB student license.

Overview and Objectives: The purpose of this course is to study a number of computer methods for solving mathematical problems that would be difficult (or even impossible) to solve analytically.

The topics covered include: finite precision arithmetic, rounding error and stability, solving nonlinear equations numerically, interpolation using polynomials and cubic splines, numerical differentiation and integration and numerical solution of differential equations. Students will use MATLAB (one of the standard languages used by applied mathematicians) to implement these methods.

Course Learning Outcomes: Formally, the course objectives described above can be summarized in the following course learning outcomes: By the end of this course, students should be able to:

(i) demonstrate mastery of the fundamental concepts as listed in the Overview and Objectives above;

(ii) use their mathematical knowledge to describe phenomena and solve problems encountered in the world around them;

(iii) display logical reasoning when faced with non-routine problems;

(iv) present sound mathematical arguments, both verbally and in written form;

(v) incorporate their mathematical skills and knowledge into their thinking about the Triune God and their identities as followers of Christ.

These outcomes will be assessed through written and computer assignments and exams.

Program Learning Outcomes: The course learning outcomes described above reflect the program learning outcomes formulated by the Mathematics department at Westmont College:

(1) Core Knowledge: Students will demonstrate knowledge of the main concepts, skills, and facts of the discipline of mathematics – reflected in (i).

(2) Communication: Students will be able to communicate mathematical ideas following the standard conventions of writing or speaking in the discipline – reflected in (iv).

Numerical Analysis (MA 121)

(3) Creativity: Students will demonstrate the ability to formulate and make progress toward solving non-routine problems – reflected in (ii) and (iii).

(4) Christian Connection: Students will incorporate their mathematical skills and knowledge into their thinking about their vocations as followers of Christ – reflected in (v).

Tentative Schedule:

Week 1	Introduction to MATLAB
	Finite precision arithmetic, rounding error and stability
Week 2	Solving equations numerically
	Interpolation
Week 3	Interpolation
	Test 1
	Numerical differentiation and integration
Week 4	Numerical differentiation and integration
	Numerical solution of differential equations
Week 5	Numerical solution of differential equations
	Test 2

Assignments: Every week, you will complete an assignment consisting of exercises in hand-calculation, problem-solving and computer implementation. You are more than welcome to collaborate with your class mates on these assignments, as long as you write and turn in your own set of solutions and list the names of your collaborators on your solutions.

Tests: We will have two written tests in class.

Grading: Your grade will be calculated as follows:

Assignments:	34%
Two tests:	33% each

I will assign grades on the usual 90/80/70/60 scale; plus and minus grades will be assigned as appropriate. In borderline cases, I reserve the right to take into account consistency of attendance and participation.

Attendance: If you miss a significant number of classes, you will almost certainly do poorly in this class. If you miss more than six classes without a valid excuse, I reserve the right to terminate you from the course with a grade of F – this is in line with Westmont's attendance policy, which is available at http://www.westmont.edu/_offices/registrar/academic_policies/attendance-policies.html. Students are responsible for obtaining information and assignments distributed during missed classes. Class notes for missed days should be obtained from a fellow student and not the instructor.

Academic Integrity: Dishonesty of any kind may result in loss of credit for the work involved and the filing of a report with the Provost's Office. Major or repeated infractions may result in dismissal from the course with a grade of F. Westmont's plagiarism policy is available at https://westmont.edu/_offices/provost/Plagiarism/policydoc.pdf.

Numerical Analysis (MA 121)

Accommodation Procedure: Students who have been diagnosed with a disability (learning, physical or psychological) are strongly encouraged to contact the Disability Services office as early as possible to discuss appropriate accommodations for this course. Formal accommodations will only be granted for students whose disabilities have been verified by the Disability Services office. These accommodations may be necessary to ensure your equal access to this course. Please contact Sheri Noble, Director of Disability Services (310A Voskuyl Library, 805-565-6186, snoble@westmont.edu) or visit http://www.westmont.edu/_offices/disability/.

Introduction to Statistics (MA 005)

Math 5 — Introduction to Statistics

Time and place:

Section 3: 2:00–3:05pm, MWF, Winter 206

Professor: David J. Hunter, Ph.D.

e-mail:	`dhunter@westmont.edu`
Office Phone:	x6075
Office:	Winter Hall 303
Student Hours:	TTh 2:00–4:30pm, or by appointment.

Overview and Purpose: In your future vocation, you will be better equipped to be a faithful presence in our modern culture if you know how to analyze data and use it to make decisions. This course will introduce you to the practice of statistics in a wide variety of contexts. You will learn the fundamental techniques for making inferences from data. By the end of the course, you should be able to describe data with graphs and numbers, produce data and simulate chance models using randomization, estimate parameters with confidence intervals, assess evidence for a claim with significance tests, and explore correlations using regression.

Textbook: We will cover Chapters 1–10 of *Introduction to Statistical Investigations*, by Nathan Tintle, et. al.

Technology: You are welcome to use phones, tablets, and laptops in class, as long as you stay on-task and do not distract yourself or others. In fact, it will be helpful to have access to the applets at `http://www.isi-stats.com/isi/applets.html` for class activities. Since we will be working in groups, it won't be necessary for everyone to have access to these applets, but you will probably want to have at least a smartphone so you can try these simulations yourself. Educational research has shown that students who take hand-written notes retain material better than those who take notes on a laptop, so I encourage you to have a notebook and a pen or pencil as well. However, most of the work for this course, aside from exams, will be submitted online.

We will be using R and RStudio for some of the assignments in this class. This software is freely available for Windows, Mac, and Linux. If you would like to install it on your own computer, go to `https://cran.rstudio.com/` to get R, and then go to `https://www.rstudio.com/` to get RStudio. These programs are also installed in the computers in the library.

Grading: Your grade will be calculated as follows:

Daily Assignments (WeBWorK):	15%
Exploration Participation (daily log sheets):	5%
Investigations (uploaded to Canvas):	15%
Hour Exams (written):	3 @ 15% each
Final Exam (written):	20%

I will assign grades based on a 90/80/70/60 scale, with +/—'s within 2.5 percent of each letter-grade cutoff. You can keep track of your progress on Canvas. In borderline cases, I reserve the right to take into account consistency of attendance and participation.

Assignments: There will be three types of recurring assignments: Explorations, Daily Assignments, and Investigations. Be in the habit of checking Canvas each day to see what has been assigned.

During each class meeting, you will complete an *Exploration* working cooperatively with your group. At the end of each class, I will collect a single log sheet from each group to record your participation in the Exploration. These group activities are designed to be the central focus of the course, and they will consume the majority of class time, aside from whole-class discussions and short mini-lectures.

On the evening before each class, you will need to complete an online *Daily Assignment* that will review the previous Exploration and help you prepare for the upcoming Exploration. Daily Assignments will be completed on WeBWorK, a web-based homework delivery system for mathematics. Most WeBWorK problems allow multiple attempts, so as long as you persist and complete the assignments on time, your WeBWorK grade should be respectable. You can get to the WeBWorK assignments through Canvas.

At the end of each chapter, I will assign an *Investigation* that will review and assess the concepts from the chapter. These ten longer assignments will require you to synthesize the material from each chapter and explain your reasoning. Investigations will be completed using RStudio, and you will upload your completed `.html` file to Canvas.

Introduction to Statistics (MA 005)

In addition to these graded assignments, I will provide a list of review problems from the textbook that you should complete to help you prepare for the exams.

Exams: We will have three written exams in class during the semester, and a cumulative written final exam. I will announce the dates and scope of these exams in advance. The final exam will be on Friday, December 13, from noon–2pm. Final exams will not be rescheduled to accommodate travel arrangements.

Other Policies: If you miss a significant number of classes, you will almost definitely do poorly in this class. I consider it excessive to miss more than three classes during the course of the semester. If you miss more than six classes without a valid excuse, I reserve the right to terminate you from the course with a grade of F. Work missed (including tests) without a valid excuse will receive a zero.

If you miss an Exploration because of an excused absence, you can submit a written summary of the answers at the beginning of the following class. WeBWorK assignments and Investigations will be accepted up to 48 hours late for 75% credit, and no credit will be given for submissions beyond 48 hours late.

I expect you to check your email on a regular basis. If you use a non-Westmont email account, please forward your Westmont email to your preferred account. I'll send out notices on Canvas, so make sure you receive Canvas notifications in your email.

Academic Integrity: Learning communities function best when students have academic integrity. Cheating is primarily an offense against your classmates because it undermines our learning community. Therefore, dishonesty of any kind may result in loss of credit for the work involved and the filing of a report with the Provost's Office. Major or repeated infractions may result in dismissal from the course with a grade of F. Be familiar with the College's plagiarism policy, found at `https://www.westmont.edu/office-provost/academic-program/academic-integrity-policy`.

In particular, providing someone with an electronic copy of your work is a breach of the academic integrity policy. Do not email, post online, or otherwise disseminate any of the work that you do in this class. You may work with others on the assignments, but make sure that you type up your own answers yourself. You are on your honor that the work you hand in represents your own understanding.

Tentative Schedule: We will try to conform to the following schedule, although it is subject to revision at the instructor's discretion. Exam dates will be announced at least one week in advance.

Sections	**Topics**
P3–1.1	Simulation and chance models
1.2–1.4	Strength of evidence
1.5–2.1	Inference for one proportion; Sampling
2.2–2.3	Inference for one quantitative variable; Errors and significance
	Hour Exam #1, Chapters 1–2
3.1–3.5	Confidence intervals for single proportions and means
4.1–5.2	Comparing two groups: proportions
5.3	Comparing two groups: means
	Hour Exam #2, Chapters 3–5
6.1–7.2	Paired designs; Paired data
7.3–8.2	Comparing multiple proportions
9.1–9.2	Comparing multiple means
	Hour Exam #3, Chapters 6–9
10.1–10.5	Correlation and least squares regression
	Final Exam (cumulative)

Accommodations for Students with Disabilities: Students who have been diagnosed with a disability (learning, physical or psychological) are strongly encouraged to contact the Disability Services office as early as possible to discuss appropriate accommodations for this course. Formal accommodations will only be granted for students whose disabilities have been verified by the Disability Services office. These accommodations may be necessary to ensure your equal access to this course. Please contact Sheri Noble, Director of Disability Services (310A Voskuyl Library, 565-6186, `snoble@westmont.edu`) or visit `https://www.westmont.edu/disability-services` for more information.

Introduction to Statistics (MA 005)

General Education: This course fulfills the Quantitative and Analytical Reasoning (QAR) requirement because it emphasizes understanding and communication of numeric data including the computation and interpretation of summative statistics and the presentation and interpretation of graphical representations of data. A core focus of the course is the explicit study of quantitative and analytic methods. This course also fulfills Reasoning Abstractly (RA) because it focuses on critical and analytical reasoning about non-empirical, abstract concepts, objects and structures. You will learn to understand and evaluate abstract arguments and explanations, analyze abstract concepts and solve abstract problems. Students completing this course will be able to:

- interpret numeric data, summative statistics and graphical representations (QAR);
- reflect on the strengths and weaknesses of particular quantitative models or methods as tools in the natural and social sciences (QAR);
- be able to interpret, reflect on, and use quantitative models and data in public, vocational, and/or private decision making (QAR);
- identify instances of abstract reasoning about abstract objects or concepts (in the form of arguments, explanations, proofs, analyses, modeling, or processes of problem solving) (RA);
- construct an instance of valid reasoning about abstract objects or concepts (in the form of arguments, explanations, proofs, analyses, modeling, or processes of problem solving) (RA);
- distinguish valid forms of reasoning about abstract objects or concepts (in the form of arguments, explanations, proofs, analyses, modeling, or processes of problem solving) from invalid and/or fallacious forms of reasoning (RA).

Program and Institutional Learning Outcomes: The mathematics department at Westmont College has formulated the following learning outcomes for all of its classes. (PLO's)

1. Core Knowledge: Students will demonstrate knowledge of the main concepts, skills, and facts of the discipline of mathematics.
2. Communication: Students will be able to communicate mathematical ideas 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 mathematical skills and knowledge into their thinking about their vocations as followers of Christ.

In addition, the faculty of Westmont College have established common learning outcomes for all courses at the institution (ILO's). These outcomes are summarized as follows: (1) Christian Understanding, Practices, and Affections, (2) Global Awareness and Diversity, (3) Critical Thinking, (4) Quantitative Literacy, (5) Written Communication, (6) Oral Communication, and (7) Information Literacy.

Course Learning Outcomes: The above outcomes are reflected in the particular learning outcomes for this course. After taking this course, you should be able to:

- Demonstrate mastery of fundamental concepts of statistics. (PLO 1, ILOs 3,4)
- Describe mathematical models and structures according to the standards of the discipline. (PLO 2, ILOs 3,5)
- Present mathematical constructions, computations, and arguments orally, with clarity and accuracy. (PLO 2, ILO 6)
- Construct solutions to novel mathematical problems, demonstrating perseverance in the face of open-ended or partially-defined contexts. (PLO 3, ILO 3)
- Explain the connection between your personal mathematical development and your professional calling. (PLO 4, ILO 1)

These outcomes will be assessed by preview activities, group explorations, activity write-ups, practice problems, and tests, as described above.

The Mathematics of Music (MA 002)

Mathematics of Music

Spring 2021

Instructor: Dr Maryke van der Walt
email: mvanderwalt@westmont.edu
Office: Winter Hall 305
Office Phone: 805-565-6297
Office Hours: TBA

Overview and objectives: In this interdisciplinary course, we will explore some of the connections between mathematics and music. We will do this on different levels. First, we will see how fundamental concepts in music (for example, rhythm, time signature, scales, keys, intervals, intonation, tuning and symmetry) are based on mathematical principles (geometric series, least common multiples, sine functions, rational numbers, irrational numbers and group theory, to name but a few). On a physical level, we will study the science of sound and the mathematics underlying sound waves and pitch. Lastly, we will investigate how some composers have based their creations on mathematical concepts. Examples include Schoenberg and his twelve-tone music and modern composer Xenakis, who has used computers and probability theory to create "stochastic music".

Apart from studying these connections in class, you will also get to explore them in practice. As part of the course, you will attend at least two local music productions or recitals and report on the mathematical connections you observed. You will also get to incorporate some of these mathematical connections in your own composition, which will serve as your final project in this course.

Required resources:

1. *From Music to Mathematics: Exploring the Connections*, by Gareth E. Roberts.
2. *Music and Mathematics: From Pythagoras to Fractals*, edited by John Fauvel, Raymond Flood and Robin Wilson.
3. *Music: A Mathematical Offering*, by Dave Benson.
   Published online by the author at https://homepages.abdn.ac.uk/d.j.benson/pages/html/maths-music.html.
4. Staff paper.

Course learning outcomes: Formally, the course objectives described above can be summarized in the following course learning outcomes (CLO's):

The Mathematics of Music (MA 002)

	CLO	Instructional Activity	Assessment
(i)	demonstrate an understanding of the multiple connections between mathematics and music;	lecture group activities listening activities reading	class participation homework assignments tests final project
(ii)	develop an understanding of music theory and a deeper appreciation for music;	lecture group activities listening activities reading concert attendances	class participation homework assignments tests final project concert reports
(iii)	develop skills in analytical thinking, critical thinking and abstract reasoning;	lecture group activities reading concert attendances	class participation homework assignments tests concert reports
(iv)	integrate their artistic and analytical skills;	group activities listening activities	class participation homework assignments final project
(v)	reflect upon the Triune God, the Creator of music and mathematics, and their identities as followers of Christ.	lecture group activities	class participation

Program learning outcomes: The course learning outcomes described above reflect the program learning outcomes formulated by the Mathematics department at Westmont College:

(1) Core Knowledge: Students will demonstrate knowledge of the main concepts, skills, and facts of the discipline of mathematics – reflected in CLO (i).

(2) Communication: Students will be able to communicate mathematical ideas following the standard conventions of writing or speaking in the discipline – reflected in CLO (iii).

(3) Creativity: Students will demonstrate the ability to formulate and make progress toward solving non-routine problems – reflected in CLO (iv).

(4) Christian Connection: Students will incorporate their mathematical skills and knowledge into their thinking about their vocations as followers of Christ – reflected in CLO (v).

General education: This course fulfills the *Common Skills: Quantitative and Analytical Reasoning* (QAR) requirement because it emphasizes the ability to interpret, evaluate and communicate quantitative ideas present in musical structures (CLO (i), (iii) and (iv), with the broader description, including specific mathematical topics that will be studied, under **Overview and Objectives**.). Students will apply relevant mathematical and logical methods to analyze sound and concepts in music theory effectively and be able to utilize the results appropriately when making decisions in this field.

This course also fulfills *Reasoning Abstractly* (RA) because it focuses on critical and analytical reasoning about non-empirical, abstract concepts and objects, specifically as it applies to musical structures. Students will learn to understand and evaluate abstract arguments and explanations, analyze abstract concepts and solve abstract problems in music theory and composition (CLO (iii) and (ii) and the broader

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description under **Overview and Objectives**).

Students completing this course will be able to:

- make use of mathematical models for studying sound and music theory (QAR) (CLO (i), (iii));
- reflect on the strengths and weaknesses of particular quantitative models or methods as tools in the study of sound and music theory (QAR) (CLO (i), (iii));
- be able to interpret, reflect on, and use quantitative models and data in music composition (QAR) (CLO (i), (iii), (iv));
- identify instances of abstract reasoning about abstract concepts in music theory (in the form of arguments, explanations, proofs, analyses, modeling, or processes of problem solving) (RA) (CLO (iii));
- construct an instance of valid reasoning about abstract concepts in music theory (in the form of arguments, explanations, proofs, analyses, modeling, or processes of problem solving) (RA) (CLO (iii));
- distinguish valid forms of reasoning about abstract concepts in music theory (in the form of arguments, explanations, proofs, analyses, modeling, or processes of problem solving) from invalid and/or fallacious forms of reasoning (RA) (CLO (iii)).

Homework: Homework assignments will be assigned on a regular basis (7-8 assignments during the couse of the semester). The work sheet will be posted on Canvas, typically one week before the due date. You are expected to write your solutions clearly, with logical arguments and proper notation (CLO (iii)). You are more than welcome to collaborate with your class mates on these assignments, as long as you write and turn in your own set of solutions and list the names of your collaborators on your solutions. Late homework will not be accepted without warning – if you cannot make it to class to submit your homework, please contact me before hand so that we can make alternative arrangements.

Concert reports: You are required to attend two musical performances during the semester and turn in a typed 1-2 page report. The purpose of these reports is to observe connections to the course material, to enhance your musical appreciation, and to support your fellow students and the arts (CLO (ii) and (v)). Each review is due within two weeks of the concert.

Tests: We will have two written tests in class during the semester (CLO (i)-(iii)). If you miss a test without a valid excuse, a grade of zero will be recorded. If you need to miss a test and you have a valid excuse (for example, an illness or participating in Westmont sports events), please contact me as soon as possible to arrange a make-up. Test solutions will be posted on Canvas after all students have completed the exam.

Final project: As a conclusion of the course, you will complete a final project consisting of a musical composition and performance demonstrating some of the mathematical concepts you have learned in the course (CLO (i), (iv) and (v)). You will also write a short report to explain the mathematical connections and rationale in your work. Performances of the final project will take place during the scheduled final exam period. The last couple of class periods will be allocated for you to work on your project and to receive constructive criticism.

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Grading: Your grade will be calculated as follows:

Class participation:	10%
Homework assignments:	20%
Two concert reports:	5% each
Two tests:	20% each
Final project:	20%

I will assign grades on the usual 90/80/70/60 scale; plus and minus grades will be assigned as appropriate. In borderline cases, I reserve the right to take into account consistency of attendance and participation.

Tentative schedule:

Week 1	Introduction
	Rhythm (Roberts Chapter 1)
Week 2	Rhythm (Roberts Chapter 1)
	Basic Music Theory (Roberts Chapter 2)
Week 3	Basic Music Theory (Roberts Chapter 2)
Week 4	The Science of Sound (Roberts Chapter 3, Benson Chapters 1, 3)
Week 5	The Science of Sound (Chapter 3, Benson Chapters 1, 3)
	Test 1
Week 6	Tuning and Temperament (Roberts Chapter 4)
Week 7	Tuning and Temperament (Roberts Chapter 4)
Week 8	Musical Group Theory (Roberts Chapter 5)
Week 9	Musical Group Theory (Roberts Chapter 5)
Week 10	Change (Bell) Ringing (Roberts Chapter 6, Fauvel Chapter 7)
Week 11	Test 2
	Twelve-Tone Music and Serialism (Roberts Chapter 7)
Week 12	Twelve-Tone Music and Serialism (Roberts Chapter 7)
	Mathematical Modern Music (Roberts Chapter 8, Fauvel Chapter 8)
Week 13	Mathematical Modern Music (Roberts Chapter 8, Fauvel Chapter 8)
Week 14	Final Project: Mathematical Composition
Week 15	Final Project: Mathematical Composition

Technology:

- Schedules and other notices will be posted on Canvas https://westmont.instructure.com/.
- I will be using Canvas to post announcements, so please make sure that you receive Canvas notifications about announcements right away.
- During class, I expect you to be an active participant. Therefore, feel free to use your laptop, tablet, phone or calculator for note-taking or calculations, but make sure that it does not distract you or your classmates. I reserve the right to take away this privilege if it becomes a problem. ☹
- No electronic technology of any kind will be required or allowed during the exams.

Office hours: As listed above, my scheduled office hours are .... Office hours are times that I have reserved to be in my office, available to help you. You do not have to check with me beforehand; just drop in! To get the most out of a visit, I encourage you to come prepared – the clearer you are about what you understand and what you don't understand, the better I can try to help you. Also, never feel stupid for asking questions; that's how you learn and make progress!

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Contacting me: If you cannot reach me in person, the best way to contact me is via email (as listed above, my email address is mvanderwalt@westmont.edu). I typically respond quickly during working hours.

Connecting with professors: You are encouraged to take advantage of the *Take a Professor to Lunch Program* as an opportunity to get to know each of your professors over a shared meal. Feel free to contact me about this! ☺ I'm also always happy to talk over a cup of tea in my office (cookies included); you're welcome to pop in if you see me in my office or send me an email if you want to arrange something beforehand.

Attendance: If you miss a significant number of classes, you will almost certainly do poorly in this class. If you miss more than six classes without a valid excuse, I reserve the right to terminate you from the course with a grade of F – this is in line with Westmont's attendance policy, which is available at http://www.westmont.edu/_offices/registrar/academic_policies/attendance-policies.html. Students are responsible for obtaining information and assignments distributed during missed classes. Class notes for missed days should be obtained from a fellow student and not the instructor.

Academic integrity: Dishonesty of any kind may result in loss of credit for the work involved and the filing of a report with the Provost's Office. Major or repeated infractions may result in dismissal from the course with a grade of F. Westmont's plagiarism policy is available at https://westmont.edu/_offices/provost/Plagiarism/policydoc.pdf.

Accommodation procedure: Students who have been diagnosed with a disability (learning, physical or psychological) are strongly encouraged to contact the Disability Services office as early as possible to discuss appropriate accommodations for this course. Formal accommodations will only be granted for students whose disabilities have been verified by the Disability Services office. These accommodations may be necessary to ensure your equal access to this course. Please contact Sheri Noble, Director of Disability Services (310A Voskuyl Library, 805-565-6186, snoble@westmont.edu) or visit http://www.westmont.edu/_offices/disability/.

Final comments: Lastly, I really want you to succeed in this course and to enjoy mathematics and music as much as I do! Please don't hesitate to contact me about anything.

> *There is geometry in the humming of the strings, there is music in the spacing of the spheres.*
> *– Pythagoras*

4.2 Rubrics

Rubric for scoring mathematical writing at program level (revised 1/2016)

I. Logic	*Deficient*	*Emerging*	*Outstanding*	*Score*
Deductions are sound and adequately justified.	Serious logical errors or the question is not adequately addressed.	Only minor logical errors or missing steps/explanations.	Complete justification free of logical errors.	
Appropriate use of definitions, terminology, and axioms.	Many improper applications.	Generally applies definitions and axioms correctly.	Consistently uses definitions and axioms correctly.	
.	*0* *1* *2* *3* *4* *5* .			
II. Exposition	*Deficient*	*Emerging*	*Outstanding*	*Score*
Writing is complete and economical.	Incomplete thoughts. Excessive wordiness. Irrelevant digressions. Confusing sentences or phrases.	Generally complete, clear, and concise. Few unneeded sentences or phrases. Mostly on point.	Always complete and concise. Clearly addresses the heart of the problem.	
Well organized with appropriate variation in sentence structure.	Disorganized, awkward, and/or repetitious.	Globally organized with only occasional awkward, misplaced, or repetitious sentences.	Well organized at all levels with clear sentences of varying structure.	
Proper use of prose.	Poor word choice. No connecting prose.	Generally adequate word choice. Missing some connecting prose.	Consistently good word choice. Good transitions.	
Spelling, grammar and punctuation.	Many errors.	Few errors.	No grammatical, punctuation, or spelling errors.	
Appropriate use of variable names and symbols.	Poor or inconsistent choices. Undefined variables.	Notation sometimes ambiguous or misleading.	Consistently good choices.	
.	*0* *1* *2* *3* .			
III. Formatting and Typesetting	*Deficient*	*Emerging*	*Outstanding*	*Score*
General layout.	Poor or inconsistent choices.	Generally appropriate choices.	Consistently good choices.	
Alignment and spacing.	No discernible alignment protocol.	Occasionally inconsistent or non-standard alignment or spacing errors.	Standard alignment and spacing used throughout.	
Formatting as mathematics.	No special formatting or poor or inconsistent choices.	Generally appropriate choices.	Consistently good choices.	
	0 *1* *2* .			

COMMENTS:

Mathematics Communication Rubric

Presenter: **Date:**

Criteria					Points
	1	**2**	**3**	**4**	
Content	The presentation contains serious logical errors. 0 1 2 3	Demonstrates lack of understanding of some of the mathematical concepts of the presentation. 4 5 6 7	The presentation has some missing steps or minor errors. 8 9 10 11	Demonstrates a complete and comprehensive understanding of the mathematical concepts. The work is justified and without error 12 13 14 15	
Organization	Audience cannot understand presentation because there is no sequence of information. 0	Audience has difficulty following the presentation because student jumps around. 1 2	Information is presented in a logical sequence that audience can follow. 3 4	Information is presented in a logical and interesting sequence with motivation. 5	
Visuals/ Examples	No visuals/examples 0	Visuals/examples are largely irrelevant or distracting. 1 2	Visuals/examples are related to the presentation but do not contribute significantly to audience understanding 3 4	Visuals/examples used supported audience understanding 5	
Delivery	Presenter mumbles, incorrectly pronounces terms, or speaks too quietly. Student is ill prepared. 0	Presenter incorrectly pronounces terms. Audience members have difficulty hearing. Back to class. Often too fast or too slow. 1 2	Presenter's voice is clear. Pronounces most words correctly. Generally, faces the class. Few pauses to check understanding. Sometimes too fast or slow. 3 4	Student engages the class with a clear voice and precise pronunciation of terms. Pauses appropriately. Well prepared. Good pace. 5	
Questions	Presenter is unable to respond to questions. 0	Presenter responds to questions, but the response is incorrect or off track. 1 2	The responses are correct but circuitous or confusing. 3 4	Responses are correct, clear, and to the point. 5	
				Total	

Comments:

PLO 3 Rubric: Creativity			
Apply mathematical theory, problem solve, and use math-related technology in real-world contexts			
	Competent *Evidence demonstrates that the student has mastered this objective at a high level.*	**Acceptable** *Evidence shows that the student has generally attained this objective.*	**Unacceptable** *Evidence that the student has mastered this objective is not provided, unconvincing or very incomplete.*
1. Translation of real world context into mathematical context	• Math problem matches the real world scenario with aptness and completeness	• Math problem matches the real world scenario	• Mismatch between real world scenario and math problem
2. Application of theory to problem	• Appropriate math theory is generally applied to the problem with aptness and completeness	• Appropriate math theory is generally applied to the problem	• Significant math theory is missing from the solution
3. Use of technology	• Technology use, where appropriate, is correct and effective	• Technology use, where appropriate, is generally correct with room for improvement	• Technology use, where appropriate, has notable flaws or omissions
4. Translation of mathematical solution to real world context	• Real world scenario matches the math problem with aptness and completeness	• Real world scenario matches math solution	• Mismatch between math solution and real world scenario
5. Solution quality	• Solution is apt and fully accomplishes the purpose	• Solution to given problem is at least mostly valid and generally accomplishes the purpose	• Solution has one or more important flaws and does not accomplish purpose

Christian Connection Rubric

Mature perspective on the discipline	**Lacking (D or F range)**	**Adequate (C or B range)**	**Superior (A range)**
	Essay contains none of the following characteristics.	Essay contains one or more of the following characteristics, but fails to develop any of these ideas in depth.	Essay contains one or more of the following characteristics, and develops at least one of these ideas in depth.
	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.		

Connections between faith and discipline	**Lacking (D or F range)**	**Adequate (C or B range)**	**Superior (A range)**
	Essay does not identify any substantive connections between faith and mathematics.	Essay identifies one or more substantive connections of the type listed below, but these connections are not developed completely.	Essay contains well-developed, substantive connections of one or more of the types listed below.
	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.		

Assessment Guidelines

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.

4.3 Survey Questions: 2020

Departmental Questions

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?
    - Exceptionally well
    - Well
    - Adequately
    - Poorly
    - Exceptionally poorly
3. What were the best aspects of the departmental program?
4. What improvements would you suggest for the departmental program? And why?
5. Please indicate how theoretical or applied you found the Mathematics and Computer Science Department at Westmont. Remember that the program includes courses, research, internships, extra-curricular lectures, etc.
    - 1 (Most Theoretical)
    - 2
    - 3
    - 4
    - 5 (Most Applied)
6. What is your current role in society, and/or what do you consider to be your vocational calling? (e.g., your job, "full-time parent," "part-time volunteer with this organization," etc.)
7. If a family member, friend, or business acquaintance asked you to recommend an educational institution, how likely is it that would you recommend Westmont?
    - Very likely
    - Somewhat likely
    - Not very likely

8. (Follow-up question for those who responded *not very likely*:) Why you would you not recommend Westmont?

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.

9. Outcome 1: Learning the Core Content of the Discipline:
How important is this outcome for your current vocation?

   - Very
   - Somewhat
   - Irrelevant

   To what degree would you say you have achieved this outcome as a result of your Westmont experience?

   - Good
   - Average
   - Poor

10. Outcome 2: Communicating Clearly (written and oral forms)
How important is this outcome for your current vocation?

    - Very
    - Somewhat
    - Irrelevant

    To what degree would you say you have achieved this outcome as a result of your Westmont experience?

    - Good
    - Average
    - Poor

11. Outcome 3: Creativity (the ability to deal with non-standard problems or situations)
How important is this outcome for your current occupation?

    - Very
    - Somewhat
    - Irrelevant

    To what degree would you say you have achieved this outcome as a result of your Westmont experience?

    - Good
    - Average
    - Poor

12. Outcome 4: Connecting your Faith and Major Discipline
How important is this outcome for your current vocation?

    - Very
    - Somewhat
    - Irrelevant

    To what degree would you say you have achieved this outcome as a result of your Westmont experience?

    - Good
    - Average
    - Poor

Demographic and Institutional Questions

13. What is your ethnicity/race?

    - American/Alaskan Native
    - Asian
    - Black
    - Hawaiian/Pacific Islander
    - Hispanic
    - White
    - Multiethnic
    - Other

14. What major(s) did you complete at Westmont?

15. What minor(s) (if any) did you complete at Westmont?

    Regarding the time you spent in earning your undergraduate degree:

16. How many years elapsed between starting your undergraduate degree and completing it?

17. How many of those years were spent at Westmont?

18. What degrees have you earned (and with what institution) since leaving Westmont?

19. If you pursued an advanced degree, how well did Westmont prepare you?

    - Excellent preparation
    - Good preparation
    - Adequate preparation
    - Poor preparation
    - N/A

20. How long did it take you after graduation (or graduate school) to find your first professional job?

    - 0–2 months
    - 3–5 months
    - 6–9 months
    - 10–12 months
    - 13 or more months
    - N/A

21. Westmont's mission statement reads as follows. *Westmont College is an undergraduate, residential, Christian, liberal arts community serving God's kingdom by cultivating thoughtful scholars, grateful servants and faithful leaders for global engagement with the academy, church and world.*

    When you graduated from Westmont, would you have described yourself as (mark all that apply):

    - A thoughtful scholar
    - A grateful servant
    - A faithful leader
    - Prepared for global engagement with the academy
    - Prepared for global engagement with the world
    - Prepared for global engagement with the church

22. Overall, how satisfied wee you with the education you received at Westmont?

    - Extremely satisfied
    - Satisfied
    - Neither satisfied nor dissatisfied
    - Dissatisfied
    - Extremely dissatisfied

4.4 Alumni Free Responses

"What were the best aspects of the departmental program?"

- The people. I felt cared for for the first time in college after attending three other schools before Westmont.
- The professors, specifically their concern for the students and their Christian witness.
- Small classes
- The small class sizes and hack nights.

- Software development (taught by Jon Walker) gave me an appreciation of many challenges of building software that I ended up seeing even large companies (like Citrix) struggle with. I think it was in that class that I read the amazing (and simple) book by Steve Krug 'Don't make me think'.The small classes and group work in all of the classes were amazing. Learning data structures was very useful... and helped my firs rounds of interviews at Google for a Product Management role there.
- small classes
- Critical thinking skills
- Small class sizes. Compassionate teachers.
- The small class sizes combined with the personal investment of all the professors into each student's success.
- The teachers.
- the amount of personal attention
- Contact with professors- great relationships and individual help
- Accessible faculty
- Academic rigor, strong relationships with the faculty.
- The professors' availability for questions and assistance both inside and outside of the classroom
- How much time the faculty could dedicate to individual students
- The small class sizes and the availability of professors during office hours.
- Community. I always had access to professors and other students. We would work together to help each other understand.
- Small classes with extensive instructor interaction; focus on teaching how and why, rather than just memorization of facts.
- The sense of community among the students in the department, between students and faculty, and among the faculty as well. Studying with other students and the availability and willingness of professors to work with students and help students. Community events such as the weekly department dinners, and other times spent at professor's houses are memorable. I also enjoyed the content of many of the courses and the learning process in the classroom.
- The times we explored possible career paths for mathematicians after graduation.
- The faculty knew each of us as individuals
- "I was so blessed that Westmont began offering the Computer Science degree during my time at Westmont. The class size and interaction with faculty and classmates made all the difference! I was very prepared as I went out into the job market."
- Community

- Integration of faith and math, summer research and TA opportunities, personalized instruction and direction
- My favorite aspects of the Mathematics department were the small class sizes and close relationships that came from this.
- I loved working on assigments in my professor's offices. Getting to sit at a table with my friends while working through problems and walking into the offices when we got stuck was so helpful.
- Small class size, access to profs
- Personal interaction with the professors
- Small classes
- Small class sizes, passionate professors, broad range of topics and an emphasis on critical thinking
- small class size; variability in courses
- The professors' dedication to the intellectual, spiritual and personal growth of the students.
- 1. The workbook "How to read and write proofs" was an extra assignment given to me since I hadn't learned proofs in high school. 2. Being a statistics math lab supervisor on campus using the TI-83 was great prep for my job as a math teacher. 3. A Physics prof invited students home for the Super Bowl. 4. Student teaching in Costa Rica. 5. Graduating with a teaching credential in 4 years.
- My experience was that the courses were taught with a high level of rigor. When compared to other colleges and universities, it seemed that we were challenged more. I also found the community of students was instrumental in my personal growth as a Christian and a young man.
- Small class sizes and faculty were always helpful.
- Solid theoretical foundation, close interactions with professors
- Professors' investment in students
- Professors were respectful and always willing to help students who asked for help. I benefited from office hours as well as.
- Personal nature of professors made them very approachable. Really achieved a sense of community with the faculty and students in the department.
- The best part for sure is how personal the professors and instruction were, they really helped me individually when I was stuck and developed relationships with me. I was truly cared about and they wanted to help me succeed.
- We had intelligent, capable professors. What we focused on, we learned. I think Dr. Mrs. Kihlstrom's approach of open book but problem solving focus was very strong and much more realistic than any of my other test taking. I HIGHLY ENCOURAGE the department to continue (and encourage individual grown in this area of the teaching craft) I think encouraging and

training /how/ to think, stretching those muscles, is probably one of the most vital skills in understanding a subject and being prepared to tackle unknowns. Westmont's students are bright and should be getting into top companies. All of them want kids and people that show a strong ability to knock down barriers and tackle unknowns.

- The rigor of the academics, the academic freedom I experienced, and the caring professors
- The small class sizes helped build professor/student relationships and allows for more in depth conversations both in and out of the classroom.
- Small classes combined with group work and faculty availability. I definitely didn't take advantage of all the benefits that came with having faculty always so willing to answer questions and encourage curiosity.
- The professors were our learning partners. They didn't give answers but instead helped us discover the solution ourselves. There was a great sense of community in Winter Hall, my favorite place to study.
- As a computer science major, the two most useful aspects of my education were group projects and large, long-term coding assignments.
- Professors who care about their students and take an interest in them as individuals; Learning by doing/practicing rather than lecture
- it was small and we got a lot of attention from our professors on a regular basis.
- The caring teachers, the small class sizes, the academic rigor, concern for students as a whole person, encouragement to pursue higher learning, supportive environment. And so much more!
- I really liked the application of theory that I found in many classes (graphics in particular). In addition I really enjoyed comprehensively covering the theory and practice that leads to the solutions of big problems in mathematics— here I'm thinking about the modern algebra curriculum. That was an excellent class that prepared me well for the things I'm currently studying.
- Great professors and their availability and office hours; small class sizes;
- The small class sizes and personal approach Dr. Howell and Dr. Rosentrater gave to each student. The courses were rigorous and the instructors caring.
- The interactions with the professors.
- I loved the small class sizes and the availability of the professors to work with you outside of class.
- Close attention and care from professors, who sought to enrich my education beyond the classroom. This included problem-solving seminars, research projects, suggested summer readings, and so forth.
- The broad liberal arts approach, incorporating many other aspects of science, culture and religion into the curriculum.
- Opportunity to be a TA led me into math teaching

- The caring professors who taught us to love God, love others, and love mathematics!
- Amazing community!! which felt like family. The community events with students and faculty throughout the entire year were invaluable. And the casual hangouts in the department with students and faculty also contributed significantly to my education and growth as a person. scaffolding of the curriculum across the math major (especially with the sequence courses giving two different people's perspectives on a discipline). This was clearly well thought out, even if people took classes in different places in their math education...intentional development of writing across the math curriculum. This was scaffolded amazingly well both within each course and across the courses!! I have gone back and looked at my papers starting in multi and ending in analysis... Writing was probably the most valuable thing I learned from my math professors as well as the most challenging part of the curriculum. You all always gave individualized feedback that held high standards that pushed me to actually grow as much as I possibly could. liberal arts emphasized within math classes (with history sprinkled throughout each course with History of Math capstoning everything nicely) incredibly helpful office hours (even if it took me a long time to figure out what those were and how to use them) organic collaboration among math majors on weekly assignments really helped me learn the material better. This was especially nice since it included everyone's contributions and not just the ""strong"" students leading the others. the new building's study area helped the organic collaboration outside speakers (which the math majors continued to talk about the presentations for a week afterwards). The wide course selection on various topics. This was amazing! especially for such a small school. I took literally everything I could. great advising! from both my official advisor and everyone else in the department. Problem Solving Seminar... I was terrified of this class! Now, I know it's because I struggled significantly with imposter syndrome and thought this class would reveal that I know literally zero mathematics. All these negative feelings about this class made me dread it every week and I think I actually did a terrible job in this class every time I took it. But!! This made me learn how to actually be a mathematician. And I loved working on my challenging problem even if I made no progress on it. I just hated how... visible my struggles were. It was great to actually learn how to cope with that in the safety of the Westmont mathematics program before faceplanting on this in grad school. Yes, I didn't fully get over this until the end of grad school... but Problem Solving Seminar equipped me well for that terrible journey."
- Knowledge and love of the Lord. I loved singing and learning about the hymns.
- The faculty's teaching ability and availability to answer student questions.
- The relational and compassionate professors
- The theoretical approach complemented my practical personal activities.

"What improvements would you suggest for the departmental program?"

- For computer science, keep curriculum current on industry trends
- Opportunities to write/have guidance on presenting technical subjects for technical or non technical audiences.

- "At the time we didn't ship work we did... They were all C++ programs... It would have been good to experience more of the whole software dev journey... even if that was just with 1 platform. I remember struggling with turing machines and lisp... While those helped broaden my understanding of C.S. in general, they provided no real long run value. Technology and tools have changed so much since I was there (2000, 2001, 2002, 2003, and early 2004)... however design was much more important than I realized at the time. Having an art/design/psychology course focused on the craft of Interactive Design (using Sketch or Adobe XD and then running through user tests) could have helped immensely. "
- stay in contact with alumni
- To treat all students the same, whether they are geniuses or regular C students. They are all equal before the Lord.
- For computer science, emphasis on practical (career beneficial) skills
- In the computer science realm, it might be nice to do a project involving a software application that has a more complex directory structure, build process, etc (if this isn't being done already). Maybe something like examining a "simple" open source project already on GitHub so that students can get a feel of what a "real life" software application looks like.
- i graduated many years ago and this may have changed, but more advising/coaching about graduate school for those interested would have been good
- More statistics offerings, statistics is my bread and butter
- Coherent course content throughout the curriculum. For instance, starting with a base set of knowledge that can be built on in subsequent courses, e.g. use of Linux, git, remote repositories and collaborative software early on so that they can be leveraged later.
- I don't know about the current program in detail. However it was of the utmost importance to me to maintain a wide network of next steps after graduation from Westmont. For many this includes career opportunities or post graduate studies.
- Perhaps more collaboration and networking between the students
- Honestly, I graduated from Westmont in 1988, so I couldn't even begin to offer suggestions as mathematics education has changed with the advancement of technology.
- More focus on software engineering and large, continuous projects in industry for Computer Science majors.
- As a math major I would have benefited greatly from a class dedicated to teaching proof methods and strategies before taking courses such as Modern Algebra and Real Analysis. From what I remember, teaching of proof methods was embedded into the Linear Algebra course but were not taught directly during class time. It didn't seem to go along well with the Linear Algebra course, and in some future classes I had difficulty learning new concepts while at the same time trying to follow along and learn proof methods I had only learned in a cursory fashion beforehand.
- It would have been interesting to meet local business leaders that use mathematics in their jobs.

- One hitch was that certain classes were only offered every other year in a particular season. This precluded some other programs that I would have liked to take. I don't know if anything can be done about that due to the size of the student body.
- I'm probably too dated to offer much constructive feedback.
- This is more of a personal desire, but I would have loved more classes on the philosophy of Mathematics.
- It's been a long time, I'm sure things are so different from when I went.
- Have a better approach to integrate transfer students. I came in as a transfer student and struggled for the first semester with how the math classes functioned.
- Incorporating some more modern, web based & cloud based architecture classes – writing software has changed a lot in the last decade, and there is a large part of the industry that is writing cloud-based software as a service where it is important to have some foundation of everything involved there.
- better support for those struggling
- It's hard to say since I have been out of the program for 24 years now!
- My first week of classes I was expected to hand in a homework assignment, but it was incomplete because I had questions & wanted to check my solutions. I remember that I needed to leave the classroom to cry around the corner. I suggest letting students ask questions before they are required to hand in an assignment.
- I don't know what the program is like today. So, I can't give a valid response.
- At the time, more 'learning by doing' would have been good - since rectified, I believe.
- none
- I really appreciated the course - I forgot the name of it now sorry - it was a 1 or 2 unit class where you worked to solve problems from a magazine and get published. While this was extremely difficult, I feel that it was a wonderful opportunity that really showed where you could go with mathematics if you wanted to continue to the graduate level.
- I really like the addition of the Data Analytics major. This is a very relevant and useful track of study in today's marketplace.
- To bring back history of math. That was a class that I was really looking forward to, but I was not able to take it since it was not offered for the few years when I was able to take it
- "Stronger connections in various industries, education on, advocacy for internships. Practical preparation for things like job interviews. Some more project classes. I was wholly unprepared in this sense and it was never communicated to me how critical it was for me to land an internship so that I could continue my career smoothly and have basic success. Independent study project would also be great for a senior project semester course. There's a lot of research and problem solving that students will have to manage once they get into a professional environment, but because all of the assignments but the team semester project are time boxed and broken down already, students aren't learning these skills. This is hard on everyone, but it

is especially difficult on those who will be challenged by these directly (ADHD, etc). I basically got zero support for severe challenges (outside of emotional support, and, when I sought it, tutoring, but understanding was never my problem), and, to our credit, we just didn't pursue it or have any ideas on how. Now that I've been in the industry, I've seen how it's impacted my ability to do things such as keep a job long enough to get faster. The skills necessary to nurture have become clearer. I think some training for professors on how to approach explaining things in different ways with the specific aim to target different thinkers would be helpful in helping them develop reasonable, practical implementation in their classrooms. A lot of things in my upper division heavy math classes, I've had to go back and relearn. I had more success learning and remembering on my own than when I was in class, mostly because I found materials that took this kind of thing into account, and was oriented around tracing a concept from inception to completion. This allowed me to solve more varied problems and come up with creative solutions. Encouragement and opportunity to work on compelling open source projects would help transition into the workplace to build up a portfolio as well as give back. Exposure to estimation, even if it's just a soft exercise worked into each assignment. Building up an understanding of one's own velocity is difficult and enlightening. I think it's good to start this early. It's weird hopping straight into this in an internship or first job."

- Find a way to partner with and offer mathematical internships at other (maybe secular) universities for students so that when they apply to grad school, all their work isn't done at Westmont only.

- "First, I think I would split Math and CS from being grouped together like they are. There's very little crossover between the knowledge gained/needed post graduation, and it seems the only reason why the 2 are grouped together is because there's not enough students majoring in the 2 majors. Secondly I would have 3 full time CS professors rather than 2, and the occasional adjunct. During my time at Westmont, the program felt cobbled together by a handful of individuals rather than a smooth learning experience. Granted I was there at the time when Wayne was the only CS professor for a number of years, only having Don for my final year, but now that Wayne has retired, it's back to that situation again. 1 professor, and perhaps even 2, is not enough for this program if it is to be great. "

- In the math department, encourage taking some sort of differential equations class, or perhaps sneak it in to the linear algebra course somehow. I feel like that's a fairly standard course that's taught elsewhere, and I didn't really have much exposure to the ideas there. As for computer science, maybe find ways to encourage projects outside of class, or help students build a portfolio throughout their time at Westmont.

- It's been almost twenty years since I started at Westmont, I imagine the program looks fairly different now than when I was a student, but when I came through there wasn't much I would have changed.

- Perhaps more long-term project based work as that could prepare students for project timelines/experience in a work environment

- Could we have some sort of database of alumni to better connect with others?

- I would make linear algebra and MVC a requirement or at least strongly encouraged for the CS major. Linear algebra/MVC is foundational to understanding many of the most relevant algorithms these days.

- Course offering can be narrow during certain semesters. Hiring more faculty or adjuncts would alleviate this but this is obviously a challenging request
- I graduated 38 years ago so I don't know what the department evolved into so I don't think I am qualified to offer changes.
- When I was a student in the department, there was a very small community of majors at the time. While this is largely outside of the department's control, it would have been nice to have felt part of a vibrant community of students
- I graduated in 1979 - not sure what I have applies.
- I can't think of any improvements at this time.
- More challenging assignments, especially in the lower level courses. Now, there is a fine line here and you need to scaffold things since you cannot overwhelm students, but overall, I felt pretty complacent in courses since the expectations for A level work were lower than needing to put in a lot of effort. Any time a class actually had some hard assignments, I probably looked like a much different student (not quite confident, but extremely eager and wanting to learn things more deeply). More inquiry based/discovery based learning to help students learn more deeply and remember longer. More long term, in-depth projects. History of Math did this well, for example, with several mini-projects and a large research paper. These projects would help both my first and second point as well as offer students license to explore areas of interest like different applications. A second course in linear algebra (which could jive well with a data analytics program if you take a more numerical approach to it). Linear algebra underpins a lot more mathematics than I ever suspected. I completely missed ""the point"" of linear algebra when I took the course. So, maybe also reworking that course to be less about row reducing matrices and more about the theory and applications. But I think a second course could also help with depth. Every topic I was confused about in other Westmont courses (and beyond) became overwhelmingly clear once I actually learned vector spaces and bases and linear transformations... Literally every topic I was confused about was because I had a very weak linear algebra background. Partially my fault for not knowing how to learn when I took the course. Partially the fault of the course for emphasizing the row reduction and not how to interpret the problems/results to understand what the row reduction tells you. More cross-over with the CS side of the department both in terms of courses and community. I couldn't tell you a single CS major's name my year except for the double major. More integration of content (especially if project driven) could attract more underrepresented students to both subjects. More explicit student skills development, especially for learning mathematics. How to read a math textbook even at different levels; how to solve problems and then reflect on both what went wrong and right to use as tools later; how to develop metacognition for deeper learning; how to ask yourself questions–e.g. where was this assumption used in a proof? what if we tweaked the problem this way? how does this connect to other concepts in this course and beyond? I'm stuck, so what haven't I used yet? ..This would help all students but especially underrepresented students and first gen students. No one learns this stuff in high school, so no one is really college prepared (including the students earning A's). I really didn't learn this stuff until second semester analysis and then not fully until I started teaching. I don't know how I missed the memo on how to learn... but I definitely did. Teaching these things is really hard and time consuming in the classroom, but it will still help those students who cannot even begin to ask for this help. Minor point: the Probability and Statistics course was really just a Probability course so maybe transparency about that. And... I just realized I could do

paragraphs here... So let me do a quick edit to help out the poor reader digesting my stream of consciousness.

- It would be beneficial for students in the computer science department to learn more about source code version control, specifically through Git. Proficiency with Git is super useful as a software engineer, and understanding version control ties in closely with being able to effectively collaborate with other developers.
- I liked what we did...I am not sure if (or what) changes might have been made.
- None.
- I'm not sure, it's been many years since I've been in it.

4.5 Miscellaneous Data

Journals

VI. Appendix: Problem Solving Data

	Student	Journal	Prob. Number	Solved	Submitted	Solution Published
	Fall 2009					
	David Montgomery	Math Horizons	234	X	X	x
	Daniel Mathis	Math Horizons	235	X	X	x
x	Aaron Panchal	Math Mag.	1821	X	X	
	Phil Davis	Math Mag.	1821			
	Phil Davis	Math Mag.	1822			
	Steve Bergen	Math Mag.	1822			
	William Hodge	Math Mag.	1824	X	X	
x	Brad Pearson	Math Mag.	1830	X	X	
x	Sabrina Dangc	Math Monthly	11435	X	X	
x	David Montgomery	Math Monthly	11449			
	Spring 2010					
x	Sabrina Dangc	Math Horizons	233	X	X	X
x	Steve Bergen	Math Horizons	238	X		
x	Rebecca Akaka	Math Horizons	239	X		
x	Kent Stormans	Math Horizons	244	X		
x	Kaitlin Bagby	Math Monthly	11470			
S	Kent Stormans	Math Monthly	11480			
S	Phil Davis	Math Monthly	11480			
	Fall 2010					
x	Jackson Roberts	Math Horizons	241	X		
x	Brad Pearson	Math Monthly	11508	x		
	Richard Lopez	Math Monthly	11511	X		
	Spring 2011					
X	Kaitlin Bagby	College Math J.	936	X		
X	Carol Downes	College Math J.	937	X		
X	Amelia Hobart	Math Horizons	255	X	X	X
X	Richard Lopez	Math Horizons	255	X	X	X
x	Richard Lopez	Math Mag.	1857	X	X	
x	Greg Wallen	Math Mag.	1858			
	Amy Cooper	Math Monthly	11543	X	X	

Journals

Benn Smith	Math Monthly	11543		
Fall 2011				
Amy Cooper	Math Monthly	11582		
Katie Elliot	Math Mag.	Q1011	X	NA
Katie Elliot	Math Monthly	11581	X	
Ally Fredrickson	Math Mag.	1873	X	
Daniel Mathis	Math Monthly	11587		
Daniel Mathis				
Spring 2012				
Carol Downes	Math Mag.	1881	X	X
Carol Downes	Math Mag.	Q1015	X	NA
Katie Elliot	Math Monthly	11613	X	X
Katie Elliot	Math Monthly	11611		
Amelia Hobart	Math Monthly	11604	X	X
Amelia Hobart	Math Horizons	271	X	
Jackson Roberts	Math Horizons	273	X	
DJ Stout	Math Mag.	Q1016	X	NA
DJ Stout	Math Monthly	11615	X	X
Fall 2013				
Tyler Brannan	CMJ	1007	x	x
Riley Hall				
Rachael Huo	CMJ	1002		
Daniel Ray	Monthly	11712	X	X
Spring 2014				
Amy Hamilton	Math Horizons	298	X	X
Amy Hamilton	Monthly	11751		
Riley Hall	Monthly	11737	X	X
Riley Hall	Math Horizons	304	X	X
Riley Hall	CMJ	1016	X	X
Russell Harmening	CMJ	1019	X	X
Sarai Mitchel	Math Horizons		X	X
Daniel Ray	Monthly	11744	X	X
Daniel Ray	Monthly	11733		

Journals

Ashley Ward	Math Horizons	302	X	X	
Fall 2014					
Austin Woods	Math Horizons	313	X	X	X
Austin Woods	Math Horizons	314	X		
Austin Woods	Math Horizons	310	X	X	X
Austin Woods			X		
Fall 2015					
Olivia Hughes	Math Monthly	11857	X	X	
Olivia Hughes	Math Horizons	333			
Dillon Montag			X	X	
Dillon Montag					
Jonah Kock	Math Mag	1971			
Miranda Witrock	CMJ	1052			
Miranda Witrock	Math Horizons	327			
Abby DeYoung	Math Horizons	330	x		
Abby DeYoung	Math Monthly	11860			
Austin Zuidama	CMJ	1055	\		
Austin Zuidama	Math Mag	1973			
Spring 2016					
Katie Morhoff	Math Mag	Q1053	X		
Katie Morhoff	Math Mag	1976	X	X	
Amy Hamilton	Math Monthly	11867			
Amy Hamilton	Horizon	334	X		
Dillon Montag					
Kyle Fredrickson	CMJ	1059			
Abby DeYonge	Math Monthly	11860			
Abby DeYonge	Math Monthly	11876	X		
Miranda Wittrock	Math Mag	1979	X	X	
Miranda Wittrock	Monthly	11881	X	X	
James Solum	CMJ	1059			
James Solum	Horizon	340	X		

Journals

David Kyle	CMJ	1056	X	X
David Kyle	Math Monthly	11870		
David Kyle	Horizon	339	X	
Julian Danc	Math Mag	1979		
Julian Danc	Math Horizon	337		
Fall 2016				
Emma Donnelson	Math Monthly	11922	X	X
Katie Morhoff	Math Mag	1996	X	
David Spindler	Horizon	342	x	
Austin Zuidama	Horizon	343	X	
Spring 2017				
Kyle Fredrickson	Math Mag	2001	X	X
Kyle Hansen	Math Monthly	11944	X	X
David Kyle	Math Monthly	11947	X	X
David Kyle	Math Mag	2006	X	X
Samuel Muthiah	Math Monthly	11949	X	X
Cameron Parker	Horizons	357	X	
Heather Totten	Horizons	352	X	X
Fall 2017				
Matt Coffman	Math Monthly	11985		
Natelli Cripe	Math Monthly	11994	x	x
Kevin Gao	Math Monthly	11998	x	
Leal Makaroff	Math Monthly	11986		
David Spindler	Math Monthly	11996		
Spring 2018				
Emma Donnelson	Math Monthly	12018	x	x
Emma Donnelson	CMJ	1120	x	x
Hannah Fisk	Coll. Math J.	1106	x	x
Samuel Muthiah	Math Monthly	12008		
Samuel Muthiah	Math Magazine	2037		

4.6 Library Journal/Book Expenditures and Database Usage

Library Expenditures for Journals and Books

	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020
Print & individual ebook expenditures	$1,268.06	$1,466.53	$1,434.83 Includes books added from Don Patterson's Provost fund, $457.17	$452.67 Includes books added from Don Patterson's Provost fund $1,085.67	$1,113.79	$877.57
Book Standing Orders			***Reflective and collaborative processes to improve mathematics teaching*** $60.72			
Individual Journal Expenditures	$1,688.54	$1,323.55	$1,327.6	$462.95	$829.23	$833
Journals	**American Mathematical Monthly** ($388) **College Mathematics Journal** ($235) **Fibonacci Association Membership** - Includes **Fibonacci Quarterly** ($82) **Historia Mathematica** ($406) **Math Horizons** ($51) **Mathematical Gazette** ($183.54) **Mathematics Magazine** ($235) **Mathematics Teacher** ($190)	**Historia Mathematica** now part of Elsevier package Fibonacci Association Membership (Includes Fibonacci Quarterly) ($82) **Mathematical Association of America Package** ($863.55) **American Mathematical Monthly, College Mathematics Journal, Math Horizons, Mathematics Magazine** now come from JSTOR Mathematical Association of America Package **Mathematical Gazette** ($174) **Mathematics Teacher** ($204)	**Fibonacci association membership** ($85) **Mathematical Association of America Package** (includes Math horizons, Mathematics magazine, American mathematical monthly, College mathematics journal) $849.60 **Mathematical gazette** $182 **Mathematics teacher** $211	**American mathematical monthly** (part of Mathematical Association of America Package)$475 **Fibonacci association membership** $85 **Mathematical gazette** $199	**American mathematical monthly** ($522.45) **Fibonacci quarterly** ($89) **Mathematical gazette** ($217.78)	**American mathematical monthly** ($529) **Fibonacci association membership (**$85) **Mathematical Gazette** ($219)
Eresources expenditures	$6,958.57	$6,958.58	$6,912	$7,499.1	$7,545.85	$7,323.45

Eresources (databases, ebook packages)	ACM Digital Library	ACM Digital Library	ACM Digital Library	ACM Digital Library	ACM Digital Library	ACM Digital Library
Journal and Article Database Usage Statistics						
Math/Computer Science						
Journals/# of Full-Text Articles Accessed (JR1)	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**
ACM Computing Surveys (ACM)	4	0	0	1	2	0
ACM Transactions on Algorithms (TALG)	2	0	0	0	15	0
ACM Transactions on Computation Theory (TOCT)	0	0	0	0	1	0
ACM Transactions on Computer-Human Interaction (TOCHI)	0	0	0	0	0	1
ACM Transactions on Computer Systems (TOCS)	0	0	1	0	5	0
ACM Transactions on Computing Education (TOCE)	0	0	1	0		0
ACM Transactions on Database Systems (TODS)	0	0	0	0	1	0
ACM Transactions on Embedded Computing Systems (TECS)	0	0	3	0	0	0
ACM Transactions on Graphics (TOG)	0	0	0	0	0	1

ACM Transactions on Information and System Security (TISSEC)	1	0	0	0	0	0
ACM Transactions on Internet Technology (TOIT)	0	0	0	0	1	0
ACM Transactions on Applied Perception (TAP)	1	0	0	0	0	0
ACM Transactions on Information Systems (TOIS)	0	1	0	0	1	0
ACM Transactions on Interactive Intelligent Systems (TiiS)	1	0	0	0	1	0
ACM Transactions on Mathematical Software (TOMS)	0	0	1	0	1	0
American mathematical monthly (part of Mathematical Association of America package)	20	22	1	25	44	2
College mathematics journal (part of Mathematical Association of America Package)	0	0	0	0	cancelled	
Fibonacci Quarterly	-	-	-	-	-	-
IEEE/ACM Transactions on Networking (TON) (ACM)	1				9	
Journal of Computational and Graphical Statistics	0	0	2	0	2	0

Journal on Educational Resources in Computing (JERIC)	0	0	0	0	1	0
Journal of Experimental Algorithmics (JEA)	0	0	0	0	1	0
Journal of the ACM (ACM)	2			1	12	0
Mathematical gazette	16	17	0	5	6	0
Mathematics magazine (part of Mathematical Association of America Package)					cancelled	
Mathematics teacher	6	44	2	1	cancelled	
Math horizons (part of Mathematical Association of America Package)	1	0	1	10	cancelled	
The Two-Year College Mathematics Journal (part of the Mathematical Association of America package)	0	0	0	0	cancelled	
Databases/# of Searches (DB1)						
ACM Digital Library	105	65	42	53	220	21

4.7 Library Instruction for Mathematics and Computer Science

Journal on Educational Resources in Computing (JERIC)	0	0	0	0	1	0
Journal of Experimental Algorithmics (JEA)	0	0	0	0	1	0
Journal of the ACM (ACM)	2			1	12	0
Mathematical gazette	16	17	0	5	6	0
Mathematics magazine (part of Mathematical Association of America Package)					cancelled	
Mathematics teacher	6	44	2	1	cancelled	
Math horizons (part of Mathematical Association of America Package)	1	0	1	10	cancelled	
The Two-Year College Mathematics Journal (part of the Mathematical Association of America package)	0	0	0	0	cancelled	
Databases/# of Searches (DB1)						
ACM Digital Library	105	65	42	53	220	21

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