Department of Mathematics
Andrews University

Program Review
Report
9 August 2016

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PRELIMINARIES

1. Definitions and Abbreviations

ACE. Andrew Core Experience (general education courses and experience). Also called "general education" in this document when referring to general education courses.

Andrews. Andrews University in Berrien Springs, Michigan.

Arizona. The University of Arizona in Tucson, Arizona.

The Department. The Department of Mathematics at Andrews University.

Eigen. Student-led mathematics and physics club. Weekly Friday "Eigentalks" comprise the colloquium series for both departments; attendance is required for majors. Monthly "Eigenvespers" occur on Friday evenings at faculty homes with a full sit-down meal, speaker, and discussion; attendance at Eigenvespers is optional.

The Faculty. Faculty of the Department of Mathematics at Andrews University.

NSF. The United States National Science Foundation.

NSF REU. National Science Foundation Research Experience for Undergraduates. These are fellowships for undergraduate research and typically occur at "REU sites" to which

undergraduates apply to do research for several weeks during the summer. REU fellowships are highly competitive.

STEM. Science, technology, engineering, and mathematics.

Tenure-eligible Faculty. Tenure-track faculty, both tenured and untenured. (Note: all current Department tenure-track faculty are tenured.)

The University. Andrews University.

Walla Walla (also WWU). Walla Walla University in College Place, Washington.

William and Mary (also W&M). The College of William and Mary in Williamsburg, Virginia.

2. Andrews at a Glance (Information for External Reviewer)

Andrews is a small, private, church-related, liberal arts and professional program university categorized as Carnegie R3: Doctoral Universities – Moderate research activity. It is classified by NSF as a Research in Undergraduate Institution (RUI). There are approximately 1750 and 1650 undergraduate and graduate students, respectively. Andrews is notably diverse; it is always in the top 5 or 6 of the most ethnically diverse and internationally diverse North American universities. Andrews is global, with affiliations around the world (about 2800 additional students). It is the flagship institution of the Seventh-day Adventist Church, a Christian denomination with 19 million baptized members in over 200 countries. Andrews is one of a network of 14 Adventist universities and colleges in North America, and houses the Seventh-day Adventist Theological Seminary. The presence of the seminary attracts students from around the world. Because Andrews serves the whole denomination, its admissions criteria are not highly selective, and there is a significant spread in the mathematical preparation of incoming students. Mathematical preparation is bimodal, with approximately 40% of incoming students needing remediation and about 30% ready for calculus and above. Among academicians, Andrews is known to be the Adventist university that promotes research (along with Loma Linda University in the health sciences). Thus Andrews attracts Adventist scholars, and the research productivity in many of the university units is higher than it is at most private liberal arts institutions of similar size.

3. The Department at a Glance

The Department of Mathematics has about 38 majors, many of whom pair mathematics with another discipline in the Humanities or STEM. The Department has 5 tenure-eligible faculty (all of whom are tenured and 3 of whom are women) and 2 non-tenure-eligible faculty with master's degrees who staff the Math and Science Center for accelerated high school students. The Department is known in the wider mathematics community for its gender and ethnic diversity, its connection to the research community, and its commitment to undergraduate research and career mentoring.

Department members have published 64 peer-reviewed research papers and given 99 research talks at conferences since 2005. Students coauthored 29 peer-reviewed research papers with faculty since 2005 and gave more than 30 talks at conferences since 2009. The Department has held continual external grant support since 2001 from 8 National Science Foundation (NSF)

grants totaling $2.5 million; 4 of these have been in collaboration with large state universities. All of these grants have had large budgets for undergraduate research stipends.

These activities have been important to our majors. 97% of our graduates from 2009-2015 are employed or enrolled in graduate or professional school. Their careers span the spectrum from actuarial science and business/finance, to STEM research fields, to law, medicine, and pharmacy, to music (conducting), to K-12 teaching and academia. They have attended top graduate and professional schools including Cal Tech, Columbia, Cornell, Georgetown, Purdue, Texas Tech, UC Davis, University of Michigan, and a long list of other well-regarded programs. While at Andrews they have participated in summer research programs at Kitt Peak Observatory, Northwestern, Yale, University of Michigan, Jet Propulsion Lab, Santa Fe Institute, and many other programs.

Our motivation for these activities is "Excellence for the Sake of Christ". The Department believes that spreading the Gospel among professional people requires *credibility, authenticity, and integrity*. Credibility means being credible scholars in our professions and eschewing mediocrity. Through our teaching, research, mentoring, and departmental vespers, we try to integrate these aspects into a holistic Christian and Adventist life as we work closely with students.

The Department has three majors.

BS Mathematics (39 credits)

This program is designed to prepare students to enter PhD programs in mathematics. Our students who go on to earn the PhD in mathematics may enter industry but typically become university professors, often spending at least part of their careers in Adventist universities. A high percentage of students who wish to enter PhD programs in physics combine this major with the physics major. The major also prepares students well for a plethora of careers in other disciplines, from economics to medicine to law.

BS Mathematics Education (36 credits plus teacher certification)

The main purpose of the BS Mathematics Education program is to prepare competent, effective middle and high school mathematics teachers (grades 6-12). This program fulfills the department's mission to support the broader mathematics education community and mentor our students for serving Christ through the teaching profession. High school teachers potentially have one of the greatest impacts on students' future life and careers. High school mathematics teachers play a crucial role, given that mathematics and English are the two greatest indicators of future career success. Out of the 15 graduates from 2008-16, 7 are currently teaching in an Adventist school, 1 is teaching in a non-Adventist private school, 4 have other employment (some in educational settings), 1 is unemployed and 2 are unknown.

Mathematical Studies Major (30 credits)

The Mathematical Studies major is a non-degree second major that must be paired with a primary major in another discipline. The required curriculum is fairly flexible. The major provides an opportunity for other STEM students to strengthen their career preparation and

portfolio by adding a second major in mathematics. The major also serves Humanities, Behavioral Science, and School of Business students, as well as others across campus who wish to strengthen their mathematical background beyond a minor but not to the point of preparing for graduate school in math (17.5% of the last 40 Math Studies graduates were from non-STEM majors).

4. Benchmark Institutions

We chose as benchmark institutions The College of William and Mary, Walla Walla University, and the University of Arizona.

The College of William and Mary is a small, selective, public research university in Williamsburg, Virginia. The undergraduate enrollment is about twice the size of Andrews' undergraduate enrollment, at approximately 3600. William and Mary is one of the eight "Public Ivy" universities, with a private university atmosphere. We chose William and Mary as a benchmark because it is a small university well known for integrating excellence in teaching with excellence in research. Its professors are known for expending a lot of energy on undergraduates, involving them in research and mentoring them for career success. Andrews is unlike William and Mary in that Andrews is private and church-related, has higher teaching loads, is not as selective, and is more diverse and global.

Walla Walla University is a small, private, church-related university in Walla Walla Washington, well known for its School of Engineering. We chose Walla Walla as a benchmark because it is affiliated with the Seventh-day Adventist Church and is a similar size as Andrews. Of the 14 North American Adventist universities, is the one that is most similar to Andrews in terms of its Engineering program and strength in STEM. Andrews is unlike Walla Walla in that Andrews places greater emphasis on research and is more diverse and global. The Walla Walla department has a long track record of successfully mentoring mathematics majors who go on to obtain PhDs in mathematics and become professional mathematicians. Given our desire to increase the number of our majors who become professional mathematicians or mathematics teachers, we want to benchmark our efforts with Walla Walla.

The University of Arizona is a large public research university in Tucson, Arizona with approximately 33,000 undergraduates. It is one of the top 20 research universities in the United States. We chose Arizona as a benchmark because we wished to compare ourselves with a well-known large department very different from our own.

5. External Reviewer

Our external reviewer, Professor Lawrence Leemis, is Professor of Mathematics and former Chair of Mathematics at The College of William and Mary. Professor Leemis is a productive researcher in the area of Operations Research, and he is a serious Christian.

CRITERION 1: MISSION, HISTORY, IMPACT, AND DEMAND

1. MISSON: How do the programs contribute to the mission of Andrews University and the Seventh-day Adventist Church?

Mission Statement for the Seventh-day Adventist Church

The mission of the Seventh-day Adventist Church is to call all people to become disciples of Jesus Christ, to proclaim the everlasting gospel embraced by the three angels' messages (Revelation 14:6-12), and to prepare the world for Christ's soon return.

Mission Statement for Andrews University

Andrews University, a distinctive Seventh-day Adventist institution, transforms its students by educating them to seek knowledge and affirm faith in order to change the world.

Vision Statement for Andrews University

Andrews University students will:

Seek Knowledge as they...

- Engage in intellectual discovery and inquiry
- Demonstrate the ability to think clearly and critically
- Communicate effectively
- Understand life, learning, and civic responsibility from a Christian point of view
- Demonstrate competence in their chosen disciplines and professions

Affirm Faith as they...

- Develop a personal relationship with Jesus Christ
- Deepen their faith commitment and practice
- Demonstrate personal and moral integrity
- Embrace a balanced lifestyle, including time for intellectual, social, spiritual, and physical development
- Apply understanding of cultural differences in diverse environments

Change the World as they go forth to...

- Engage in creative problem-solving and innovation
- Engage in generous service to meet human needs
- Apply collaborative leadership to foster growth and promote change
- Engage in activities consistent with the worldwide mission of the Seventh-day Adventist Church

Mission Statement for the Department of Mathematics

Through teaching, research, and service, the Department of Mathematics seeks to provide leadership in the mathematical sciences by:

- Preparing students with the mathematical understanding, problem-solving skills, and dispositions that enable them to excel in their chosen careers;
- Increasing mathematical and scientific knowledge through publication and presentation;
- Supporting the broader mathematics education community and mentoring others for generous service through a committed Christian life.

Vision Statement for the Department of Mathematics

(From the Strategic Plan, first drafted in 2011; see Appendix 14.) Our 10-year vision is that the Department of Mathematics, both in measureable fact and in clear reputation, will be the leading mathematics department in the Adventist system and among the best of its type in Michigan.

The Role of Teaching, Research, and Service in Carrying Out the Missions of Our Department, Andrews University, and the Adventist Church

We strive to be the best teachers possible, for two reasons. First, we are committed to helping our students gain the content mastery and critical thinking skills needed to excel in their careers. Second, we are committed to modeling excellence in work ethic, professional duty, and personal character. Furthermore, we are committed to the compassionate mentoring of students to high standards of personal responsibility and dedication to Christ so that they will be truly successful in life and career.

We strive to be exemplary scholars. When we as faculty network and are known in our discipline then we can better serve our students as mentors and recommenders. We strengthen the reputation of the department and Andrews by conducting active research programs, regularly publishing in peer-reviewed journals and presenting at conferences. Establishing a reputation for quality scholarly work opens up more career opportunities for our students and can challenge our colleagues with an example of an analytical thinker who takes the Bible seriously. To spread the gospel in the intellectual world requires credibility, which in the academic community includes credibility as good researchers. We are committed to excellence in research for the sake of Christ, for the sake of our students and the reputation of Andrews University, for the sake of the church, and for the sake of individual professional growth and career satisfaction.

Students notice when faculty members give service to the Department, to the University, to the Church, to the community, and to the discipline. By serving in these capacities and informally explaining the importance of these activities to students, we mentor students for generous service in the way of Christ.

Mentoring in any department has the potential to mirror and connect with discipleship within the church. The Department of Mathematics mentors students in faith, integrity, and analysis, thereby equipping students to make an important contribution to society in general and to the church in particular. The diversity of ethnicities and attitudes on the Andrews campus provides a

rich environment for students to learn to respect and to gain wisdom from various perspectives while holding to personal values based on Scripture. The Department of Mathematics is a vital piece of that diversity in that we have students and professors that pay careful attention to assumptions, logic, etc., analytic qualities that the world and the church needs.

The Role of our Programs in Carrying Out the Mission of the University

Our programs address the mission of the University in the following ways. Here the University mission statement bullets are slightly regrouped to facilitate explanation.

Engage in intellectual discovery and inquiry; demonstrate the ability to think clearly and critically; communicate effectively; demonstrate competence in their chosen disciplines and professions; engage in creative problem-solving and innovation:

Mathematics includes three of the seven classical liberal arts: Geometry, Arithmetic, and Logic. These pursuits foster the skills of inquiry, pattern recognition, clarity and precision of thought and logic, and the communication of logical argument. We actively encourage all of our majors to participate in undergraduate research, either through research with Andrews professors or at external NSF REU sites or internships, and each major is required to attend the Friday colloquium series. These talks, given by fellow students, faculty, and visitors, include topics on research and on career opportunity and success. In the Spring 2016 course surveys, 82% of majors agreed that the colloquium series "helped me to better understand what it is like to do research" and 73% agreed that "I learned more about potential careers in mathematics and science".

Understand life, learning, and civic responsibility from a Christian point of view; develop a personal relationship with Jesus Christ; deepen their faith commitment and practice; demonstrate personal and moral integrity; embrace a balanced lifestyle, including time for intellectual, social, spiritual, and physical development:

Our professors attempt to carry out this mission in three ways. First, we interact directly and intentionally about Christian commitment and ethics in the classroom as well as one-on-one with students through prayers, devotionals, and personal conversations. We avoid "programmed" devotionals and prayers in the classroom, but rather try to develop our abilities to share in authentic ways from the heart. We make a point to emphasize integrity, especially at the beginning of each semester as we discuss the Andrews Integrity Code in the context of each class. Second, we try to model Christian learning, ethics, commitment, and lifestyle in our own lives. Third, we team up with the Department of Physics to hold an Eigenvespers once a month for our majors. These optional vespers consists of a full sit-down dinner, a speaker, and a discussion on spiritual topics relevant to the students. The vespers talks are planned by students in conjunction with faculty mentors. The students often choose topics that relate to science and faith. In these discussions faculty try to model deep, resilient faith that is integrated with a love of learning. In a Spring 2015 survey, 60% of majors enrolled in the colloquium series indicated that "colloquium and its associated activities such as eigenvespers helped me engage in a community of Christian scholars who value questions as part of the process of deepening and owning faith". The 60% likely represents the percent that choose to attend the optional vespers.

Apply understanding of cultural differences in diverse environments; engage in generous service to meet human needs; apply collaborative leadership to foster growth and promote change; engage in activities consistent with the worldwide mission of the Seventh-day Adventist Church:

Andrews University is one of the most ethnically and internationally diverse campuses in North America. The Department majors reflect that diversity (Table 1). Recent majors come from Africa, Bermuda, the Caribbean, China, Europe, Indonesia, Korea, Mexico, Canada, and the United States. Furthermore, 60% of the department's tenure-eligible faculty are women (3 out of 5). Our majors learn and grow within a diverse and global atmosphere that prepares them to serve humanity as citizens of the world, to serve the world Church, and to excel in a global marketplace. Our BS Mathematics Education program, as part of the larger teacher certification program offered by the university and the School of Education (whose motto is "To educate is to redeem") fulfills the university's mission of educating students to affirm faith in Christ and change the world through work as professional teachers.

Table 1. Demographics of Department majors.

Term	Males	Females	Black	Hispanic	Asian	White Non-Hispanic
F 2015	44%	56%	14%	8%	19%	59%
F 2014	53%	47%	28%	6%	17%	49%
F 2013	45%	55%	18%	9%	12%	61%
F 2012	65%	35%	27%	8%	5%	60%
F 2011	72%	28%	28%	6%	6%	60%

Appendix 1 shows mappings between the Departmental student learning outcomes, the University goals, and the mathematics curriculum.

Benchmarking our Departmental Mission Statement

Table 2 compares the Department's mission statement with those of the benchmarking institutions. The full mission statements for the benchmark departments are found in Appendix 2. Our mission statement is most like that of the William and Mary department, although obviously William and Mary, as a public university, does not reference a "committed Christian life" in its service statement. Also, William and Mary states that their primary goal is to be "simultaneously an outstanding undergraduate teaching department and a nationally recognized research department, with undergraduate research as the bridge linking the two". The "bridge" of undergraduate research is not mentioned explicitly in the Andrews statement. Because of our growing commitment to undergraduate research, however, we will consider adding this to our mission statement (see Criterion 4, section 6).

Table 2. Department's mission statement compared to those of W&M, Walla Walla and Arizona.

Andrews	W&M	Walla Walla	Arizona
Impart mathematical understanding, problem-solving skills, and dispositions that enable students to excel in careers	Present	Present (divides into mission for major/service/gen ed. courses)	Present
Increase knowledge through publication and presentation	Present	Absent	Present
Support wider mathematics education community;	Present	Absent	Partially present (local schools/comm. colleges)
Mentor others for generous service through committed Christian life	Absent	Absent (mentoring of students for service is in the university mission statement)	Absent

The mentoring of students for service, especially Christian service, is absent in the other mission statements. Walla Walla does have this concept in the university's mission statement; however, the dimension of undergraduate research is missing from their statement. This highlights the unique nature of our department in terms of its emphasis on mentoring students in both research and service in the context of Christianity. Arizona's statement mentions preparing a diverse spectrum of students; the Department may consider adding this to its mission statement given that diversity is a unique strength of Andrews (see Criterion 4, section 6). The statements for both Walla Walla and Arizona mention imparting the beauty and utility of mathematics to students. This is missing in our mission statement; however, it is one of our stated general education (ACE) mathematics goals (see Appendix 1).

2. HISTORY: How does the history of the program define the contributions of the program to Andrews University?

Mathematics was listed as a separate discipline in the bulletin from about 1899 to 1920, sometimes as a heading under "School of Liberal Arts". Bulletins from 1930-31 through 1932-33 listed a "Science and Mathematics" department. In 1933-34 and 1934-35 there was a "Physical Science and Mathematics" listing, and from 1940-41 to 1949-1950 there were listings of "Physics and Mathematics" departments.

The Department of Mathematics at Andrews University as a clearly separate department appears in the 1950-51 bulletin, with faculty Edward J. Specht and Arthur D. Holmes. In 1951-52 the faculty listed were Specht and Harold Trainer Jones; these two mathematicians became the foundational pillars of the Department that has grown into what we see today.

Until the arrival of Professors Edward J. Specht and Harold T. Jones, the Department functioned primarily as a teaching department. Specht and Jones brought a vigorous research focus to the Department. When Emmanuel Missionary College became Andrews University in the early 1960s, they established a master's program. After their retirement, the Department again functioned primarily as a teaching department and the master's program closed. In 1997, the Department hired algebraist Lynelle M. Weldon, who held a doctorate from UC Davis, as the first female tenure-eligible faculty member. In 2000, the Department hired two research

mathematicians, the husband-and-wife team Yun Myung Oh (differential geometry) and Joon Hyuk Kang (partial differential equations), with doctorates from Michigan State University. In about 2001, Chair Donald H. Rhoads negotiated informally with Academic Vice President Patricia Mutch to streamline course offerings and reduce teaching loads to 20-21 semester credits per year in order to build research productivity. Also in 2001, Rhoads and Vice President Mutch hired research mathematician Shandelle M. Henson (dynamical systems), an Assistant Professor at the College of William and Mary with a doctorate from the University of Tennessee, Knoxville. Her main task was to bring further research focus to the Department, including undergraduate research. In 2006, Rhoads and Mutch hired Robert C. Moore, an expert in mathematics education with a doctorate from the University of Georgia, Athens, and Professor of Mathematics at Southern Adventist University, as Department chair to replace Rhoads, who was retiring. In 2011 the Department hired two non-tenure-eligible faculty to staff the Berrien RESA Math and Science Center, a program for accelerated high school students. This completed the current staff of 5 doctoral faculty and 2 masters faculty.

With the renewed research emphasis, the Department has become one of the most productive on campus in research and undergraduate research mentoring. Research foci are in partial differential equations, differential geometry, mathematical biology, and mathematics education and pedagogy. All five of the tenure-eligible faculty (all five are actually tenured) are active in research, and four of them have Research Faculty Status. The fifth is Chair, but is also active in ongoing research. One of the foci of the strategic plan and vision of the Department is to continue to build and secure this culture so it will continue after current faculty members have retired. The Department works with Development, alumni, future potential hires, and the administration to obtain institutional commitment and constituent support for our research program.

The Department of Mathematics is relatively unique among mathematics departments at small private liberal arts universities, including Adventist universities, because of its research productivity and inclusion of students in peer-reviewed publishing. It is relatively unique among mathematics departments in general because of its ethnic and international diversity in majors, and because 60% of its tenure-eligible faculty are female. These unique strengths greatly contribute to the success of our graduates.

Note: We thank Alice Williams and Donald Rhoads for their contributions to this section.

3. IMPACT: How does the program contribute to the academic success of Andrews University?

The Department and its programs contribute to the success of Andrews and its students in the following ways.

1. Andrews has great breadth in the preparation of incoming students. Mathematical preparation is bimodal; approximately 40% of incoming students need remediation and about 30% are calculus-ready. The Department offers a non-college-level remedial course in mathematics that is designed to help underprepared students reach a level of proficiency at which they can enroll in College Algebra or the liberal arts general education mathematics course. The remedial course is taught for mastery by an instructor in the classroom with individualized, computer-based material and with teaching assistants who also circulate to help students. Students are mentored in the study skills of goal setting, goal review, and note taking. Progress rates (passing grades

indicate completion or making good progress toward completion) in the first semester of the remedial course average 77% over the past 5 years. (National pass rates in remedial math tend to be around 50%.) Progress rates (completion or making good progress toward completion) in the second semester of the remedial course average 62%. For students who complete the remedial course material and take MATH145 there has been an average pass rate of 68% over the past two years. We continue to study into possible (especially budget-neutral) ways to increase student engagement and success in these courses.

2. The Department teaches a number of general education courses to foster quantitative literacy and critical reasoning skills. Students can take a liberal-arts general education math course (MATH145 Reasoning with Functions) or they can satisfy the general education requirement by taking a course in the STEM-preparation sequence, such as College Algebra, Precalculus, Calculus I, or higher-level courses.

3. The Department teaches mathematics courses, both lower and upper division, that are required by other STEM programs and professional programs.

4. The Mathematical Studies major, which is a 30-credit second major that can be paired with any other primary major, substantially strengthens any primary STEM major. It works particularly well for engineering majors because of the large numbers of mathematics cognates they take. It is also strengthens the preparation of business/finance, economics, and pre-law students. We are able to offer this major without teaching any additional courses, and students with substantial math requirements in their other major can add this on with just a few more courses but the payoff for them in both education and additional opportunities is significant, so this is a definite win-win scenario.

5. The BS Mathematics Education major prepares students to teach mathematics at the high school level. Many (47%) of our graduates teach in the Adventist system of secondary education. We have capacity for a substantial increase in numbers in this program so growth in the School of Education Secondary Certification program would generate revenue for the university without cost from our department.

6. The BS Mathematics major prepares students to enter PhD programs in mathematics and higher education. It also prepares students well for a plethora of careers in other disciplines. Physics majors who intend to study for a PhD in physics typically are encouraged to also take the BS Mathematics major.

7. The research productivity of the Faculty contributes to the repute of Andrews and to the value of the Andrews degree. The reputation of the Faculty, as established by publication and presentation and by networking in the wider community, contribute strongly to the success of students through letters of recommendation and person contacts as they compete for and enter into selective graduate programs and career positions. Undergraduate research that leads to papers and presentations coauthored and given by undergraduates also contributes greatly to the success of those students.

4. DEMAND: What is program enrollment and state of demand for graduates of the program?

Program Enrollment

Table 3. Approximate numbers of majors in benchmark programs. Andrews data are for Fall 2015. Benchmark institution data are approximate based on figures obtained from their departments of mathematics.

	Math Majors	Undergraduate Enrollment	Undergraduate Population
Andrews University	38	1733	2.2%
The College of William and Mary	64	6300	1.0%
Walla Walla University	30	1600	1.9%
University of Arizona	600	33000	1.8%

Andrews University has more mathematics majors, relative to its size, than our benchmark institutions (Table 3). The numbers of majors in each of our three programs has remained steady over the last 7 years, with an average total of 38 ± 1.1 (mean ± standard error). (Table 4). Over the next decade, we expect growth in the Math Studies program to parallel growth in the Engineering program.

Table 4. History of numbers of majors in each program, Fall semester.

MAJORS	F2009	F2010	F2011	F2012	F2013	F2014	F2015
BS Math	22	18	14	19	17	16	17
BS Math Ed	9	14	12	9	9	10	9
Math Studies	9	11	9	10	8	12	12
TOTAL	**40**	**43**	**35**	**38**	**34**	**38**	**38**

Employment Rate, Supply, and Demand

97% of the graduates from 2009-2015 are employed or enrolled in graduate or medical school. Graduates enter a wide variety of careers and graduate programs. The critical reasoning skills obtained through studying mathematics prepare students for success not only in STEM fields but also in business and finance, economics, education, the health professions, the insurance industry, and law. See Appendix 3 for a partial list of careers and graduate schools entered by our graduates. Those who are employed as professional mathematicians can expect robust salaries at entry-level positions. See Appendix 3, Table 17.

The field of mathematics and fields that require mathematics (STEM fields) comprise a growing sector of the economy. In its 2012 report, The President's Council of Advisors on Science and Technology (PCAST) noted that economic forecasts predict that, over the next decade, the United States will need an extra one million college STEM graduates over the number currently expected to be produced (www.whitehouse.gov/ostp/pcast). Demand for STEM professors in academia, including mathematics professors, may increase, especially as the last of the Baby Boomer professors begin to retire in the late 2020s. These trends will also occur within the

Adventist system of universities and colleges. The demand for high school mathematics teachers will continue. According to www.bls.gov: “In addition to overall openings, many schools report having difficulty filling teaching positions for certain subjects, including math, science (especially chemistry and physics), English as a second language, and special education. As a result, teachers with education or certifications to teach these specialties should have better job prospects.” (Accessed 27 July 2015; source: http://www.bls.gov/ooh/education-training-and-library/high-school-teachers.htm#tab-6).

CRITERION 2: PROGRAM QUALITY

1. Inputs and Processes

a. HUMAN AND PHYSICAL RESOURCES: Describe how the available human and physical resources relate to what is necessary to have a strong program of high quality that mentors students to succeed.

Faculty and Staff

Expertise and Teaching

The Department has five tenure-eligible faculty, all of whom are tenured and hold doctoral degrees. We have two non-tenure-eligible faculty who teach the Berrien RESA Math and Science Center high school courses, both of whom have master’s degrees. We have one adjunct faculty member, who has a doctoral degree and teaches on a contract basis. We have one full-time office manager. We employ on average about 15 students per semester in the Department (as graders and teaching assistants) and about 5 students per semester in the Math Center (as tutors).

Nearly all of the courses are taught by full-time faculty members (excluding online general education mathematics courses offered by the School of Distance Education). Exceptions include two sections of the remedial course and MATH222 Mathematics for Elementary Teachers II, which are taught by our adjunct specialist in mathematics education. The Department sometimes needs to open an extra section of a general education class, and this also would be taught by an adjunct. The number of faculty currently is sufficient to adequately mentor students.

A faculty member holding a doctoral degree in mathematics generally is qualified to teach any course in the undergraduate mathematics curriculum. This may not apply to 1) upper division or topics courses offered exclusively due to the research specialty of another faculty member, 2) upper division statistics courses, 3) mathematics education courses, and 4) remedial courses. Courses in the latter two categories ideally should be staffed by instructors who have training in mathematical pedagogy.

BS Mathematics. The Faculty are particularly well-qualified to cover all the core courses needed to offer a BS in mathematics. The Mathematics Subject Classification of the American Mathematical Society lists the major divisions of mathematics as Foundations (the study of logical foundations), Algebra and Discrete Mathematics (the study of the structures of abstract systems), Analysis (the study of quantity and change), Geometry and Topology (the study of space), and Applied Mathematics (applications of pure mathematics; this includes statistics and

mathematics education). The training and/or research expertise of our faculty cover each of these areas (see Table 5 and also Appendix 4, Tables 16-17).

BS Mathematics Education. The Department is well-suited to offer the BS in mathematics education because of Moore's doctoral specialty in mathematics education. When he retires it will be important to try to recruit a faculty member with expertise in this area (see Criterion 4, section 4-5).

Math Studies major. The Department also has the expertise to offer the applied courses that typically are taken by Math Studies majors, in particular upper division courses in probability theory and mathematical biology, based on the expertise of Henson and Kang.

Our Faculty's areas of expertise cover all of the courses offered in our curriculum. For courses taught, see Appendix 4, Table 19.

Table 5. Core areas and faculty expertise in those areas. D indicates doctoral specialty training; M indicates master's specialty training; R indicates research expertise. Only tenure-eligible faculty are shown.

	Henson	**Kang**	**Moore**	**Oh**	**Weldon**
Foundations	M[1]		R[6]		
Algebra			M[7]		D
Analysis	D,R[2]	D,R[4]		D,R[8]	
Geometry and Topology			M[7]	D,R[8]	
Applied Mathematics	D,R[3]	M[5]	D,R[6]		R[9]

[1]*Mathematical logic*
[2]*Dynamical systems*
[3]*Mathematical ecology*
[4]*Partial differential equations*
[5]*Probability and statistics*
[6]*How students learn and teachers teach the concept of proof; mathematics education*
[7]*Quaternions*
[8]*Differential geometry, which spans Analysis and Geometry*
[9]*Statistical methods; mathematics education*

Faculty Course Evaluations

The Faculty consistently receive positive feedback from students. Evaluations from Spring 2013 – Spring 2016 are summarized in Appendix 5, broken down by Remedial, Lower Division, and Upper Division courses. Although there was little difference in results between the three categories, Upper Division results were in general a bit higher, as to be expected, except for the category "the instructor helped me to understand the course content from a Christian perspective", for which the Remedial classes scored higher than the Lower and Upper Division. Although we expected this question to receive lower scores than the others because of the course contents, we believe we can do better, and we were impressed to see that the Remedial teachers are doing a good job in this area (see Criterion 4, section 6). The Faculty got particularly high marks for being clear, prepared, well-organized, and respectful of students. The lowest marks, although still above the "neither agree nor disagree line", were from Remedial/Lower Division students in the categories of "This course helped me to express my ideas more clearly", "This course helped me to critically evaluate different sources and/or points of view", and "The instructor stimulated my interest in the subject". Teachers need to help the remedial and lower

division students understand that they are developing critical thinking skills; they should often state this objective explicitly in class (see Criterion 4, section 6).

Research

All of the tenure-eligible faculty are engaged in on-going research. Department members have published 64 peer-reviewed research papers and given 99 research talks at conferences since 2005. Students coauthored 29 peer-reviewed research papers with faculty since 2005 and gave more than 30 talks at conferences since 2009. The Department has held continual external grant support since 2001 from 8 National Science Foundation (NSF) grants totaling $2.5 million; 4 of these have been in collaboration with large state universities. All of these grants have had large budgets for undergraduate research stipends.

Appendix 4 lists the 31 publications and 43 presentations given by the Faculty since 2012. Papers and presentations coauthored with undergraduate research collaborators are shown in bold. Currently the Faculty have 14 research papers in preparation.

Faculty Awards

The Faculty are extremely dedicated to teaching, research, and service; this is reflected in a number of awards in these areas:

Daniel A. Augsburger Excellence in Teaching Award, Andrews University, 2016 (Weldon)
Siegfried H. Horn Award for Excellence in Research, Andrews University, 2011 (Henson)
Daniel A. Augsburger Excellence in Teaching Award, Andrews University, 2010 (Moore)
J. N. Andrews Medallion, Andrews University, May Graduation 2009 (Henson)
Alumnus of the Year Award, Southern Adventist University, October 25, 2007 (Henson)
Daniel A. Augsburger Excellence in Teaching Award, Andrews University, 2006 (Henson)
Distinguished Service Medallion, Southern Adventist University, 2006 (Moore)
Presidential Award for Teaching Excellence, Southern Adventist University, 2006 (Moore)
Advisor of the Year Award, Southern Adventist University, 2004 (Moore)
American Fellowship, American Association of University Women, 1996-1997 (Henson)

Facilities and Equipment

The Department is located in the Science Complex along with Biology, Chemistry, Engineering & Computer Science, and Physics. (The 6th STEM department, Agriculture, is located across campus, closer to the University Farm and Dairy.) The physical location is advantageous for our strong connections with other STEM departments, but we are spatially disconnected from other liberal arts departments, in particular, the Humanities. Thus, our location likely tends to emphasize the scientific character of applied mathematics and deemphasize the liberal arts character of pure mathematics in the minds of colleagues and administrators across campus. We discuss how to address this in Criterion 4, section 6.

The Department occupies part of the first floor of one wing of the Science Complex. There is a front office that is occupied by the administrative assistant, the chair's office, 6 faculty offices (one of which is for adjuncts), and 1 office for graders. We have a Commons Room where students study, and a Math Center that is open for afternoon tutoring and is used as an alternative classroom during other times. There are 3 traditional classrooms with capacities of 28, 44, and 50. There is an amphitheater (capacity 92) that we share with the Department of Physics. We also have a research lab for undergraduate research that contains large cabinets and hence

doubles as storage space for small items. The rest of the wing is occupied by Physics Enterprises, a business that designs and manufactures classroom/lab science teaching equipment. See Table 6.

Currently the size of our space is exactly adequate for our needs except for large-capacity classroom space. Because we share Thompson Amphitheater with the Department of Physics, and because of our need for large and high-quality chalkboards or white boards, we occasionally have difficulty scheduling large sections. As the Engineering, Computer Science, and other STEM departments continue to grow, we may face increasing difficulties with space. We address this further in Criterion 4, section 6.

The space design on the other hand is in need of improvements. Examples of improvements needed include: chairs & tables to facilitate small group learning in room 112, upgrade of AV equipment in room 111, improvement of acoustics, improvement in air circulation—especially in room 114, and new desks in rooms 111, 112, and 114.

Table 6. Space utilization.

	Capacity	**Square Feet**	**Percent of first floor HYH**
Front office	1	280.28	2.4%
Chair's office	1	203.06	1.8%
Faculty offices (6)	6	806.52	7.0%
Graders' office	3	109.44	1.0%
Research lab	5	179.71	1.6%
Math classrooms (3)	50, 28, 44	1954.04	17.0%
Math Center	10-15	467.8	4.1%
Math Commons Room	30	558.13	4.9%
Thompson Amphitheater	92	1884.42	16.4%
Physics Demo Storage	N/A	755.96	6.6%
Physics Enterprises	N/A	2368.17	20.6%
Hallway	N/A	1929.06	16.8%
Total square feet	N/A	**11,496.59**	**100%**

b. LIBRARY RESOURCES: Are library holdings adequate for the program, and to what extent are they available and utilized?

Utilization

All tenure-eligible faculty in the Department are involved in on-going research, and most have undergraduate research students. Faculty and research students regularly access or check out standard reference books, carry out comprehensive current literature searches online using Library search engines and databases, request materials through Inter-library Loan, access older journal articles in the stacks, and use the LibGuide portal, prepared specifically for the Department by the Library (http://libguides.andrews.edu/mathematics).

Class usage includes required accessing of standard books in the stacks and comprehensive literature searches for projects in classes such as MATH426.

Adequacy of Holdings

The Department's needs for books and journals significantly overlap with the needs of the other STEM departments as well as with Behavioral Sciences, the School of Business, and the School of Education. This is due to the Department's strong research foci in applied mathematics, mathematical biology, and animal behavior. For example, our research students often check out or consult the book *Applied Logistic Regression* by Hosmer and Lemeshow. The techniques in this standard book are also used by researchers from the behavioral sciences, business, finance, economics, biology, and education.

James White Library amply covers our book needs, and we can quickly fill in any gaps through our modest departmental book budget.

The Library provides excellent coverage for the Department in terms of journals. For example, in a recent comprehensive literature search, a researcher in the Department added 73 journal articles to an EndNote file, and was able to get online full texts for 67 of them (92%) through James White Library. Three of the remaining papers were in the stacks, for an overall coverage of 96%. Any journal articles not immediately available are quickly obtained through Inter-library Loan.

Databases and Other Library Resources

We use many of the databases at James White Library, including ABI Inform Global – PROQUEST, Academic OneFile, Academic Search Complete, APA PsycArticles – ProQuest, Applied Science and Technology Abstracts EBSCO, and ArticleFirst – OCLC.

The Department also frequently uses Inter-library Loan, Endnote, Digital Commons, and SelectedWorks for research purposes. Department members attend seminars provided by the Library, including seminars on Endnote, Digital Commons, and SPSS, and have found these to be extremely helpful.

As part of this Program Review, the Department worked with the Library to set up the LibGuide portal for Mathematics. See http://libguides.andrews.edu/mathematics.

The Department greatly appreciates James White Library's resources, Dean, faculty, staff, and helpfulness. Our researchers can now conduct their comprehensive literature searches through the Library. We used to make regular trips to the libraries of large universities, but in general we no longer need to do that.

Note: We thank Larry Onsager and Lauren Matacio for their contributions to this section.

c. CURRICULUM AND TECHNOLOGY: How rigorous is the curriculum for the preparation of graduates with skills necessary for a global workplace, who are able to adapt to changing environments and technology within their field? How well does the program engage students in collecting, analyzing, and communicating information, and in mastering modes of inquiry or creative work? (Please note if the program is taught online or off-campus)

Required Courses for BS in Mathematics and Benchmarking

The required courses for all three programs are shown in Appendix 6. All three programs are on-campus.

The BS Mathematics Education major is accredited by National Council for Accreditation of Teacher Education (now Council for the Accreditation of Educator Preparation), which also provides Michigan state approval of the certification program. Thus, we did not benchmark the BS Mathematics Education major. However, it is worth noting that a strength of this major is that we offer a course targeted toward math teachers, MATH 375 Secondary School Math Teaching, in contrast to both Walla Walla and William and Mary. One weakness in the program is the lack of a math history course, which is a priority when resources allow for adding a course to the curriculum.

The Mathematical Studies second major is highly flexible as a second major only, so we did not benchmark it. The program that benefits from benchmarking is the BS Mathematics major, the traditional major that prepares students to become professional mathematicians.

Appendix 7 compares the required courses to those at benchmark institutions. Andrews, Walla Walla, and Arizona are nearly identical in their required courses for the concentration that prepares students for graduate studies. William and Mary is more flexible, relying more on advisors to help students choose the correct courses for their career goals.

All three benchmark institutions offer a greater variety of topics in elective upper division mathematics courses than does Andrews. In terms of William and Mary and Arizona, this is because those two institutions have more tenure-eligible faculty than does Andrews (19 and 56, respectively). Walla Walla has the same number of tenure-eligible faculty as does Andrews (5). The Andrews department has made an intentional choice not to proliferate elective offerings in favor of an efficient, solid curriculum that both prepares students well for graduate school and also provides time for faculty research. The Department believes that the research environment and undergraduate research experience at Andrews greatly contributes to student career success.

In the recent past, the Department has discussed adding the requirements of Complex Analysis and Abstract Algebra II to the BS Mathematics degree. We decided against this, however, in order to keep the credits ≤ 40 and in order to allow flexibility for two electives, relying on advising to help graduate school-bound students choose the correct electives. Abstract Algebra II is only taught on demand at this point and is not within the regular teaching load. Based on the benchmarking with Walla Walla and Arizona, however, the Department may wish to reconsider this (see Criterion 4, sections 2 and 5). A Math History course would also be a valuable elective for this degree.

In summary, the BS Mathematics major at Andrews is strong and prepares students well for graduate school and, in particular, PhD studies in mathematics. Upper division courses have plenty of capacity for growth and in this regard an increased number of majors could be handled

at little or no cost to the university, or may allow for further strengthening the offerings. (Increasing the number of majors may increase the cost some due to mentoring resources needed.)

NCATE/CAEP Accreditation

The Mathematics Education degree (and the BS Math with additional requirements for secondary certification) is accredited by the National Council for Accreditation of Teacher Education (NCATE) until 2019 for the Preparation of Mathematics Education Teachers at the Secondary Level, as reviewed by representatives of the National Council of Teachers of Mathematics (NCTM). See Appendix 8.

Preparation for a Global Workplace

Andrews University is one of the most ethnically and internationally diverse universities in North America, and the Department majors reflect that diversity (Table 1). Our majors learn and grow within a diverse and global atmosphere that prepares them to serve humanity as citizens of the world, to serve the world Church, and to excel in a global marketplace. Mathematics can be a cultural leveler when diverse perspectives focus on the same creative and analytical approach. Doing mathematics with the "other" can break down barriers and create communities across boundaries. It is important for the Faculty to include this information about the student experience, as appropriate, in letters of recommendation for students.

2. Outputs and Outcomes

*a. **OUTPUTS:** How do the various measures of outputs demonstrate the quality of the program?*

Time to Completion

Numbers of mathematics graduates are shown in Table 7, with the numbers of graduates holding steady. Completion times are shown in Table 8. This indicates that the average terms attended for BS Mathematics majors (12) is higher than for all undergraduate students (10) and higher than the average for other STEM majors (9-11), even though the average number of credits earned by BS Mathematics majors (138) is less than for all AU students (142) and most STEM degrees. This seems to indicate more of the terms are part-time terms. Table 9 shows more detail about the number of terms that BS Mathematics majors attended Andrews. The average number of full-time terms spent at Andrews for a BS Mathematics degree is 8.56 (omitting the outlier student with 0 full-time terms). Two-thirds (12/18) of these students also attended at least one term part-time, attending an average of 2.06 terms part-time, with a quarter (3/12) of the students taking courses while in high school. These averages (8.56 full time terms and 2.06 part time terms) seems appropriate, given that close to half (8/18) of the students were double majors.

Table 10 shows similar detail for BS Mathematics Education majors. These majors earn a large number of credits (170) even though the major requires only 36 credits of math courses and 3 credits of a cognate course. This is due to the additional minor courses and/or professional education courses required for teaching certification. The average number of terms attended is 14, with an average of 10.2 full-time (omitting the outlier with 90 transfer credits) terms and 2.8 part-time terms. Almost all BS Mathematics Education majors attend multiple part-time terms.

Table 7. Numbers of graduates from each program per academic year.

GRADUATES	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
BS Math	3	3	3	4	4	5	6	2
BS Math Ed	1	1	1	1	2	0	2	2
Math Studies	1	3	5	4	1	1	6	6
TOTAL	**5**	**7**	**9**	**9**	**7**	**6**	**14**	**10**

Table 8. Undergraduate time to degree completion. Data are for Summer 2010 – Spring 2015.

		Ave Num Terms Attended	Ave Cum AU Credits	Ave All UG Credits
All BS Degrees	**Andrews University**	10	121	142
BS Degrees in STEM	**BS Mathematics**	**12**	**133**	**138**
	BS Math Education	**14**	**170**	**171**
	Animal Science	9	120	138
	Biology	10	125	141
	Chemistry	10	136	141
	Computing	11	126	143
	Biochemistry	10	119	133
	Physics	10	129	145

Table 9. Undergraduate terms attended by BS Mathematics graduates. Data are for Summer 2010 – Spring 2015.

Degree	Full-time Terms	Part-time Terms	Number of Majors	Transfer credits	Comments
Math	0	6	1		had previous BS and MS in chemistry; took courses 1/semester while working full-time
Math	6	5	1		
Math	7	3	1		always took <16 hrs/semester
Math	8	0	1		
Math	8	4	1		switched from chem major during senior year
Math	8	5	1		switched from Physics to Business to Math major
Math	8	0	1	9	
Math	8	0	1	6	
Math	8	2	2		took 1 course/semester for 1 semester as a high school student; took 3 courses over 2 summers; SM for one year; followed up with MAT
Math	8	0	2	29.5	
Math	9	0	1		
Math	9	6	2	25	took 1 course/semester for 4 semesters as a high school student
Math	9	2	2		
Math	9	2	2	40	had some bad semesters with lots of failing or dropped classes, then rebounded to do well
Math	9	2	2		started secondary certification but did not complete
Math	10	5	1		switched from Math Ed to BS Math; took 1 course/semester for 3 semesters as a high school student; SM for one year
Math	10	0	1	7	
Math	10	1	2		English & Math degrees
Math	10	0	2		switched from chem major to Physics, added Math Studies, then completed math as a double major with Physics

Table 10. Undergraduate terms attended by Math Ed graduates. Data are for Summer 2010 – Spring 2015.

Degree	Full-time Terms	Part-time Terms	Number of Majors	Transfer credits	Comments
Math Ed	7	3	2	90	Elementary certification
Math Ed	10	0	1		Secondary certification
Math Ed	10	3	1		Secondary certification
Math Ed	10	5	1	8	Secondary certification
Math Ed	10	2	2		Elementary certification

Employment Rate

97% of the graduates from 2009-2015 are employed or enrolled in graduate or medical school. Graduates enter a wide variety of careers and graduate programs. The critical reasoning skills obtained through studying mathematics prepare students for success not only in STEM fields but also in business and finance, economics, education, the health professions, the insurance industry, and law. See Appendix 3 for a partial list of careers and graduate schools entered by our graduates. Those who are employed as professional mathematicians can expect robust salaries at entry-level positions. See Appendix 3, Table 17.

Undergraduate Research

Students coauthored 29 peer-reviewed research papers with faculty since 2005 and gave more than 30 talks at conferences since 2009. The Department has held continual external grant support since 2001 from 8 National Science Foundation (NSF) grants totaling $2.5 million; 4 of these have been in collaboration with large state universities. All of these grants have had large budgets for undergraduate research stipends. Appendix 3 contains a list of the NSF REUs and other research internships obtained by majors during 2013-2015. See Appendix 4 for a list of peer-reviewed papers and presentations by students since 2012.

b. STUDENT LEARNING OUTCOMES: How well are students meeting the program's learning outcomes?

Appendix 9 compares the Department's program student learning outcomes with those of benchmark institutions Walla Walla and Arizona. (We could not locate program outcomes for William and Mary.) Our outcomes were similar to those of Walla Walla, although the latter did not specifically mention spiritual outcomes or outcomes for the teaching preparation of students pursuing secondary teaching. An outcome of Walla Walla absent in our outcomes is that students will be satisfied with the quality of the mathematics program. We do address this in our exit interviews and senior surveys. Our outcomes are quite different from those of Arizona. The first 3 of Arizona's 6 outcomes have to do with logic and proof: "Define mathematical terms precisely", "Recognize when arguments are valid, and identify logical gaps and flaws", and "Create valid proofs". These are subsumed in our first outcome. The last 3 Arizona outcomes concern modeling, computational and conceptual application, and communication to non-

specialists. These are not present in our program outcomes, (except for communication in the BS Mathematics Education major); we should consider these (see Criterion 4, section 6).

Appendix 1 maps the programs' outcomes to the curriculum, and it maps the general education (ACE) math outcomes to the curriculum. Appendix 1 also maps the program's outcomes to the University goals, and it maps the general education (ACE) math outcomes to the University goals. The student learning outcomes are well served by the curriculum and are well connected to the University goals.

In early August of each year, the Department meets at an all-day retreat. A significant part of the retreat is spent reviewing program assessment data from the previous academic year and planning data-based adjustments. However, each year the numbers are small, so trends are more difficult to detect. This year we looked back over the last six years of data collection and reviewed the summary data. Appendix 13 has the summary tables that we reviewed on August 8, 2016.

The student outcomes for participation in research or presentations (Goal 2), successful transition into graduate school or employment (Goal 3), and first-year success of graduate students (Goal 4) have been consistently met over the six years. We have not set a target for the level of spiritual commitment (Goal 5) but there have been positive indicators in the various survey responses that we have received. The involvement of undergraduate students in research is a strength of our program and we plan to build on this strength with more intentionality by annually reviewing the list of students who have reached a certain point in the program (completing MATH355) without yet participating in research or a presentation. This is to prevent capable, but quiet or low-in-confidence, students from missing an opportunity.

The student outcome of understanding and communicating mathematics at the secondary (or elementary) level (Goal 6) is unique to the Mathematics Education program. We added this goal during a review of assessment in 2013 so only have three years of data. There have been four graduates and two met the goal and two did not. In reviewing the two that did not we decided that the one score and performance was good, while the other was clearly too low and a disappointment. Recently the School of Education decided never to give the highest rating on the rubric in this evaluation so we have decided we need to adjust the goal to reflect this scoring system.

Goal 1 is a broad student outcome—depth and breadth of mathematical understanding—and has three measures. One measure is the Major Field Test. We were surprised by the proportion of our graduates that were not meeting the target we set for this test. By comparing these outcomes to the (higher) average scores of our graduates on the exam (not shown in the chart) we realized that our majors' performance tends to be bimodally distributed. We have taken the following actions in the past few years to address this finding: 1) Discontinued requirement of MFT for Math Studies majors since they are focused on the exam in their first major [but this won't show up in the data for a couple of years] 2) Are researching an appropriate target score for Mathematics Education majors since they do not take as many advanced courses 3) Increased the rigor of the BS Mathematics program [but this won't show up in the data for a couple of years] 4) Are taking steps to prepare a packet for seniors that has guidelines and resources for studying for the exam as well as an explanation of the importance of the exam.

The second measure of goal 1 was originally the overall math gpa but in 2013 we switched to looking at the final exam scores in four core courses (Calculus I, II, III, and Introduction to Linear Algebra). To reduce volatility we calculated five-year moving averages for these scores. We were again surprised by the low results. Only in Calculus I for BS Math and Intro to Linear for Math Ed did the averages consistently meet our targets. Math Studies graduates generally were not averaging above 75% on the final exams. Note that there still is bimodal behavior so some students are scoring very high on the exams but others are low and very low. We will continue to collect the data and monitor the results, but we have taken the following actions to address this finding: 1) Investigating options for a fifth-day recitation for calculus courses 2) Researching pedagogy ideas for increasing cumulative learning 3) Piloting an assessment of specific concepts with easy/medium questions on the final exam in calculus III.

The third measure of goal 1 is for Math Education students only (the Michigan State Test for Teacher Certification). The student results for this are good (100% pass rate).

c. STUDENT & EMPLOYER SATISFACTION

97% of the graduates from 2009-2015 are employed or enrolled in graduate or medical school. Although we have no objective way of measuring employer or graduate advisor satisfaction, we do receive comments from companies, K-12 institutions, graduate schools, and professional schools that our students are doing well and are well liked in their jobs and graduate programs. For example, Danielle Burton, who recently went to the mathematics PhD program at the University of Tennessee, Knoxville, was congratulated by their faculty for her excellent preparation in Real Analysis and won the following awards:

- Tennessee Louis Stokes Alliance for Minority Participation Outstanding Instructor Award, 2016
- Graduate student achievement and scholarship award for outstanding academic achievement, 2014
- Mathematics Article of the Week for *A note on the onset of synchrony in avian ovulation cycles* published in *Journal of Difference Equations and Applications*, week commencing 3 February 2014
- One of the 10 most read articles in Taylor and Francis dynamical systems journals of 2014 for *A note on the onset of synchrony in avian ovulation cycles*

Each year the graduates of the Department complete an anonymous survey assessing their view of the program by scoring positive statements about the program with a Likert scale from 1–5 with 5 denoting “strongly agree”. During the years 2010-2015 graduates, on average, agreed or strongly agreed (average scores of ≥ 4) with all statements. Eight of the sixteen statements had average scores higher than “agree” (≥ 4.5). These were:

-The program was rigorous enough to meet my educational objectives.

-I believe the research I participated in will help me in my future academic and career plans.

-One or more faculty took a personal interest in me.

-My advisor gave me sound academic advice.

-There is a team spirit of friendliness and support among the faculty and students in this program.

-I have been treated with fairness and respect by the faculty in this program.

-I have been treated with fairness and respect by other students in this program.

-My advisor was willing to meet with me when I requested advisement.

The latter three questions concerning the fairness of the program each scored an average of 4.7.

Open-ended comments from the students usually include phrases such as "I had a wonderful experience with this department" and "I loved my math classes and feel that we have a great program!" However, some students elaborate on particular aspects that they valued:

"I loved the Math Department because the faculty members really care for us. I always felt that they were there for me whether it was for academic matters or even personal ones. Of the three departments I have been a part of (math, education, and Spanish), math is my favorite."

"The teachers are phenomenal; I enjoyed the varied approach to classroom management and teaching. The teachers are wildly passionate about the classes they are teaching and give good feedback on homework and tests, and the graders seem to be on top of things."

"The greatest strengths of this program are the research opportunities that exist for those looking to work with the math professors. While math is a hard subject, there are some great math teachers in the department that do an excellent job teaching students."

"I really appreciate your care and support for the students. I will never forget the memories I had at Andrews. The greatest strength of this program is that the size of the program allows for a more personal teaching approach, i.e. more one-on-one time. I like the smaller class size, the opportunities to work within the department and to tutor, and the great professors who are willing to help students. The teachers are enthusiastic and have a deep understanding of the material, and they cover the material in-depth. I like that a wide range of subjects are taught."

"My experience with the Mathematics program here at Andrews was immensely positive. I never felt belittled or neglected by anyone in the department. The faculty helped feed my desire for knowledge and opened my mind to new mathematics and new ways of thinking. For example, learning proofs indirectly helped to develop my rhetorical critical-thinking skills. The math classes I took here at Andrews opened my eyes to a new world of things I can do or accomplish by simply using my head, and I truly feel that the sky is the limit. So as I move on to the next stages in my life, I am excited because I feel prepared, not because I feel I have accumulated sufficient knowledge for success, but because I am prepared to learn new things and solve new problems no one has faced before."

"I love this department and am sorry to be leaving it. I think it is excellent and sincerely regret my years not in the department. While I thirst for more courses and a longer list of courses in a variety of topics, I realize that there is a very limited span of time, and this dream may have to wait for graduate school to be fulfilled. I would like to thank the faculty for their patience, for their enthusiasm, support, and encouragement, and ultimately for some of the best years of my albeit-short life. Excellent department. I think the professors have done an admirable job."

From the senior surveys, our exit interviews with seniors, and our on-going interactions with graduates, we know that our students greatly appreciate our programs and their mathematics

professors. The feelings are mutual; we as faculty feel extremely privileged to serve as teachers and mentors for these students.

d. PROGRAM IMPROVEMENT

Please refer to the responses within part b (Student Learning Outcomes) of this question for some more details of departmental action taken to improve the program. In summary, we are working to improve the culture of studying for final exams as well as the Major Field Test, we are looking into options for creating a fifth-day recitation for the calculus courses, we are seeking to find other promising changes in pedagogy to improve cumulative learning, and we are piloting some more specific assessment measures to guide our improvements.

At the end of the WEAVE report are two examples of significant data-driven changes (last two pages of Appendix 10, under headings “MATH168 success rates” and “MPE/SAT/ACT score correlations”). The first change has increased success rates in MATH168 Precalculus, and the second change has allowed the University to place and register most students in mathematics classes before they arrive on campus.

In August 2014 the Department finished a study of its BS Mathematics major in which that major was benchmarked against the preparation recommended by a top mathematics PhD program (University of Michigan). As a result of the study, the Department significantly strengthened the requirements of the BS Mathematics major. The changes appeared in the 2015-2016 Bulletin. Appendix 7 demonstrates that the requirements are now equivalent to those at the benchmark institution of University of Arizona.

In the Spring of 2011 we introduced MATH375 Secondary School Mathematics Teaching as an improvement to the Mathematics Education degree and to better meet the requirements for NCATE accreditation.

CRITERION 3: FINANCIAL ANALYSIS

1. Cost & Income

The Department is relatively inexpensive and generates significant revenue for the University. In terms of cost-effectiveness, as measured by average credits generated per faculty FTE, it usually ranks in the top four departments (out of 15) in the College of Arts and Sciences.

The non-compensation annual expense budget for the Department is currently $7,748, and more than one quarter of this is due to base phone service. Unlike other STEM departments, we require little research and teaching equipment other than computers and standard AV classroom appliances. There have been no major operating or capital expenditures in recent history except for the remodeling of the Commons Room, the Front Office, and the Chair’s Office in 2013, which cost $18,000. One third of this was covered by the College of Arts and Sciences and the rest was funded by Departmental restricted funds. Other than faculty and staff wages and benefits, the Department’s largest expenditure is for student labor. Students grade papers, serve as teaching assistants, and staff the Math Center (as tutors). The Department currently budgets $15,387 for graders and teaching assistants and $3,528 for Math Center tutors. This money is

likely to come back to the university either directly as the students pay on their account or indirectly as the students can pay other expenses in order to stay in school.

The Department generates significant revenue for the University. Although it creates minimal non-credit-generated revenue (about $5,000 per year via Math Placement Exam fees and computer-maintenance fees for the remedial courses), it generates approximately 460-520 credits/FTE with an income/expense ratio of 2.89 in 2012-2013. The Department also has helped secure continual external grant support since 2001 from 8 National Science Foundation (NSF) grants totaling $2.5 million. All of these grants have included overhead funds for the University as well as large budgets for undergraduate research stipends.

Table 11 shows the total number of credits billed per year by type of course over the last 5 years. Courses are partitioned in two separate ways: Remedial + Lower Division + Upper Division, and Remedial + Gen Ed + Non Gen Ed. Credits generated by Gen Ed classes and Remedial classes have decreased 26% and 29%, respectively over that period, whereas Lower Division credits have declined only 19%, reflecting a decrease in overall university enrollment in conjunction with overall growth in STEM. Indeed, Upper Division credits grew by 138%.

Table 11. Total credits billed by type of course, broken down in two ways. Remedial (MATH091/092), Lower Division (200-300 level), and Upper Division (300-400 level) are non-overlapping categories that partition the complete set of courses. Remedial, General Education, and Non-General Education give a different partition of the complete set of courses.

TOT BILLED BY TYPE	**11-12**	**12-13**	**13-14**	**14-15**	**15-16**
Remedial	624	582	489	456	444
Lower Division	2357	2214	2111	1942	1914
Upper Division	144	276	279	254	342
Remedial	624	582	489	456	444
Gen Ed	1852	1673	1682	1486	1377
Non Gen Ed	649	817	708	710	879
All, Including Remedial	3125	3072	2879	2652	2700

Table 12. Average class size, broken down in two ways. Remedial (MATH091/092), Lower Division (200-300 level), and Upper Division (300-400 level) are non-overlapping categories that partition the complete set of courses. Remedial, General Education, and Non-General Education give a different partition of the complete set of courses.

AVE CLASS SIZE	**11-12**	**12-13**	**13-14**	**14-15**	**15-16**
Remedial	30	24	23	23	22
Lower Division	30	26	24	27	35
Upper Division	8	13	13	13	16
Remedial	30	24	23	23	22
Gen Ed	34	26	25	26	28
Non-Gen Ed	15	19	16	16	19
All, Including Remedial	25	24	23	22	24

Despite a decrease in university (and hence general education) enrollment, delivery efficiency has remained stable and the upper division credits have grown. Table 12 tracks efficiency of delivery in terms of average class sizes over the last 5 years. Average class sizes have remained relatively steady overall at 23.6 ± 0.51. Average class size declined for remedial courses due to a declining number of remedial students combined with the fact that each section is limited to 30 students by the number of computers in the lab (for example, if there are 40 remedial students, we still must open 2 sections for them). Average class sizes in Lower Division and Gen Ed have held steady or increased slightly as we have closed some sections. Average class size in Upper Division courses grew by 100%, reflecting growth in STEM.

2. Overall Financial Health

The Department plays a key role in supporting the University's mission (see Criterion 1) and forms a necessary and irreplaceable part of the success of other University programs by teaching general education and STEM service courses, and by offering the Math Studies (second) major (see Criteria 1-2). Investment in student success in remedial math courses is likely to have a direct and positive effect on retention and graduation rates. The number of majors in the Department is likely to grow along with the Engineering program or at least remain stable in the foreseeable future (see Criterion 1).

University support for all academic departments has been declining. For our department, the budget currently is bare-bones and is not quite adequate for maintaining the excellence we are committed to offering in our program. In order to make up the difference so that we can offer important social, spiritual, and career events for students, we rely on restricted funds, which come from soliciting donations from alumni through our departmental newsletters (see Appendix 12). We raise approximately $3,000 per year in this manner. Because we now find it necessary to dip into these funds for normal yearly expenses, it is difficult to increase the restricted fund long term in order to produce a large, healthy margin.

Currently our non-compensation expense budget is less than $8,000 per year. More than one quarter of this is a charge for base phone service. Because the Department needs are so basic and inexpensive, a small increase in budget can lead to high returns (see Criterion 4, section 6).

CRITERION 4: STRATEGIC ANALYSIS

1. Strengths

BS Mathematics

Our BS Mathematics program, revised in 2014 by benchmarking with the expectations of PhD programs at large state universities, and implemented in 2015-2016, is consistent with that of the University of Arizona, one of the top programs in the country. We require the same essential courses that all mathematics majors are expected to study prior to PhD studies, for example courses in Linear Algebra, Abstract Algebra, and Analysis. Students planning to attend graduate school are well prepared. Our strengthened program will recruit strong students.

BS Mathematics Education

The BS Mathematics Education program is accredited and nationally recognized by NCATE and NCTM. The demand for middle and high school mathematics teachers is high, and our graduates quickly find mathematics teaching jobs. All of our students pass the Michigan Test for Teacher Certification (MTTC) examinations, both the Professional Readiness Examination and the mathematics subject area examination, usually on the first attempt. Our students' scores for the Mathematics Education Portfolio demonstrate their achievement of the learning outcomes. Our students are successful in their student teaching experience and consistently receive high evaluations from their mentor teachers and the university professors who supervise them. Our undergraduate program cooperates with the MAT program offered by the Teaching, Learning and Curriculum Department so that graduate students can obtain secondary mathematics teacher certification.

Mathematical Studies

The Mathematical Studies program strengthens inter-departmental ties and affords students a chance to earn a second major in mathematics to augment their primary major. This provides a way for science and other students to gain a solid background in applied mathematics without taking all of the theoretical upper division theorem-proof courses. This is particularly helpful for the CVs and careers of students who plan to pursue advanced studies in engineering, computer science, chemistry, mathematical biology, economics, finance, and law. (Graduate school-bound Physics majors ideally would take the BS Mathematics major in addition to their BS Physics major, but sometimes they add the Mathematical Studies major instead.) The Mathematical Studies program recruits additional mathematics majors to our department. Some of these students eventually add the full BS Mathematics major.

2. Challenges

BS Mathematics

The newly revised BS Mathematics major is less flexible (in terms of electives) and more rigorous than it was previously. While this will not affect many PhD-bound students, who would have taken these courses anyway through faculty advising, it may pose difficulties for weaker students who choose the BS Mathematics major. It may be necessary to develop additional support for these students, and/or it may be necessary to develop an acceptance process for this program. Also, a weakness of this program is that it should require Complex Analysis and Abstract Algebra II. We decided against this in order to keep the credits ≤ 40, and in order to allow flexibility for two electives, relying on advising to help graduate school-bound students choose the correct electives. Based on the benchmarking with Walla Walla and Arizona, however, the Department may wish to reconsider this (see Criterion 2, section 1).

BS Mathematics Education

Enrollment in the BS Mathematics Education program is disappointingly low. Currently we have about 10 students enrolled in the program. MATH375 Secondary School Mathematics Teaching

is offered every other year. Five students took the course in the spring of 2015, and we expect similar enrollment in future years. Retention is also a problem; about 50% of the students who enter the program choose to change their major before graduation. One reason is that the program normally takes five years to complete, and students become disenchanted by the many requirements and become anxious to graduate. The cost of completing a long program is a common obstacle.

Mathematical Studies

We do not see any weaknesses in the Mathematical Studies program.

3. Opportunities

BS Mathematics

The revised and strengthened BS Mathematics program may attract more students to consider PhD studies and may increase the number of students prepared to do undergraduate research in pure mathematics.

BS Mathematics Education

Given the strong demand for secondary mathematics teachers, we have the opportunity to recruit more students into the program. We may be able to recruit mathematics teachers currently living in the Berrien Springs area who need to complete certification. We may be able to cooperate with other Adventist institutions so that students can begin a mathematics education program elsewhere and then transfer into our program.

Mathematical Studies

This program likely has the most potential for growth in the near future as the engineering program grows. It is important for us to educate faculty advisors about this option for their advisees, and to make sure the top students in our calculus sequence know about this opportunity. It is important for Departmental faculty to personally discuss this opportunity with each of our top non-mathematics major students.

4. Threats

BS Mathematics

We may face lowered performance with some students in this program because of its strengthened rigor, and we may lose some students. However, we may gain other students who are attracted to the rigorous curriculum and who become motivated to pursue graduate work. The new curriculum appeared in the 2015-2016 bulletin, so we have yet to see what will happen. We are watching carefully and will make corrections as necessary.

BS Mathematics Education

One threat to this program is the low enrollment. Changing accreditation standards also is an ongoing threat. We are currently seeking to obtain reaccreditation of our program, but the requirements have changed. We are confident we will obtain reaccreditation, but the new NCATE/CAEP requirements are not designed for small programs like ours, so we need to seek an alternate route to accreditation. One potential threat is the closure of Adventist academies, which reduces the demand for Adventist high school teachers. However, the public, private, and international sectors offer many job opportunities. The cost of attending this university for the number of years needed to finish this program is a challenge for many students. Also, when Moore retires it will be important to try to recruit a faculty member with expertise in mathematics education.

Mathematical Studies

There are no threats to this program.

5. Strategic Plan: Program-specific Points of Planning

BS Mathematics

The strengthened curriculum for the BS Mathematics major appeared in the 2015-2016 bulletin, so we have yet to see what will happen. We are watching carefully. It may be necessary to develop additional support for these students, and/or it may be necessary to develop an acceptance process for this program. In the recent past, the Department has discussed adding the requirements of Complex Analysis and Abstract Algebra II to the BS Mathematics degree. We decided against this, however, in order to keep the credits ≤ 40 and in order to allow flexibility for two electives, relying on advising to help graduate school-bound students choose the correct electives. Based on the benchmarking with Walla Walla and Arizona, however, the Department may wish to reconsider this (see Criterion 2, section 1).

BS Mathematics Education

We will apply for reaccreditation and seek to increase enrollment in the program. We also will talk with other Adventist institutions about potential collaboration. It is important to develop relationships with potential future faculty members with expertise mathematics education.

Mathematical Studies

It is important for us to educate faculty advisors about this option for their advisees, and to make sure the top students in our calculus sequence know about this opportunity. It is important for Departmental faculty to personally discuss this opportunity with each of our top non-mathematics major students.

6. Additional Information & Recommendations

"Year in Review" and Newsletters

The "Year in Review" articles for the Department, published in a high-quality magazine each summer by the College of Arts of Sciences, are reproduced in Appendix 11. Links to the yearly departmental newsletter (mailed to all Department alumni) are in Appendix 12. Appendix 14 gives the Department's current 10-year Strategic Plan, written in 2011 and revised in 2012. We will revise the Strategic Plan after the Program Review process is complete.

Additional Recommendations not Program-specific

The following points of discussion for the Department have been suggested by our self-study completed above. As we complete the program review process and interact with reviewers, we will pay special attention to these areas of consideration.

From Criterion 1, section 1

- William and Mary states that their primary goal is to be "simultaneously an outstanding undergraduate teaching department and a nationally recognized research department, with undergraduate research as the bridge linking the two". The "bridge" of undergraduate research is not mentioned explicitly in our departmental mission statement. Because of our growing commitment to undergraduate research, however, we could consider adding it to our mission statement.
- Arizona's mission statement mentions preparing a "diverse spectrum of students". Given that diversity is a unique strength of Andrews and given the diversity of the Department, we could consider adding diversity to our mission statement.

From Criterion 2, section 1

- The Remedial classes scored higher than the Lower and Upper Division classes on the course survey statement "The instructor helped me to understand the course content from a Christian perspective". We are impressed to see that the Remedial teachers are doing a good job in this area. We will seek to find out how they do it.
- The lowest marks on course surveys were from Remedial/Lower Division students in the categories of "This course helped me to express my ideas more clearly", "This course helped me to critically evaluate different sources and/or points of view", and "The instructor stimulated my interest in the subject". We need to help the remedial and lower division students understand that they are developing critical thinking skills by explicitly telling them that this is what they are doing. This might help stimulate some interest in the subject, as well.
- The physical location of the Department (in the Science Complex) tends to emphasize the scientific character of applied mathematics and deemphasize the liberal arts character of pure mathematics in the minds of colleagues and administrators across campus. This is a perceptual challenge that we need to be aware of and address with our colleagues in Humanities.

- Currently our physical space is almost exactly adequate for our needs except for large-capacity classroom space. Because we share Thompson Amphitheater with the Department of Physics and other departments, and because of our need for large and high-quality chalkboards or white boards, we sometimes have difficulty scheduling large sections. As the Engineering, Computer Science, and other STEM departments continue to grow, we may face increasing difficulties with space. We will continue to work with the STEM division on plans for a new STEM complex. In the meantime the students would benefit from upgrades of seating, acoustics, and A/V equipment.

From Criterion 2, section 2

- The last 3 Arizona outcomes concern modeling, computational and conceptual application, and communication of mathematics to non-specialists. These are not present in our program outcomes (except for communication in the BS Mathematics Education major). We may consider these.

From Criterion 3, section 2

- Currently our non-compensation expense budget is less than $8,000 per year. More than one quarter of this is a charge for base phone service. Because the Department needs are so basic and inexpensive, a small increase in budget can lead to high returns. An addition of even $2,000 per year to the budget would greatly help us to continue our high-quality mentoring of students in their studies, faith, and career. We are working to identify evidence-based changes that look promising to improve student success in remedial courses. These may require a modest increase in resources.

Other

- The biggest threat to our programs is that the cost of attending this university is a challenge for many students.
- The pressure for cost efficiency tends to create large sections of courses. If sections in lower division mathematics courses become too large, there may be a classroom capacity problem for the Department. Pedagogically, it is important to maintain relatively small mathematics classes. We will continue to monitor class size. In the future we may need to experiment with recitation sections and teaching assistants.
- After we receive feedback on our self-study we will update our departmental Strategic Plan (Appendix 14).

PANEL REVIEW INSTRUCTIONS

Overview

After the self-study is completed, a five-member panel of peer faculty appointed by the PDRC reviews the self-study and makes recommendations to the PDRC. The review panel consists of four Andrews University faculty members from departments not offering the program under review and one external reviewer. One of the panel members is also a member of the PDRC and appointed to serve as a liaison with the PDRC guiding the panel through the process. The external team member usually teaches in a similar program in another higher education

institution. The review panel for externally accredited programs need not include external members because external reviewers are part of the accreditation review process.

The review process usually includes meeting with the dean of the school/college, program director, and/or faculty. When the review panel is satisfied that it has a verified and accurate reading of the state of the program under review, it presents its findings in a report to the PDRC chair, who forwards a copy to the program asking for a response. The report, with the program response is considered the final report.

APPENDIX 1: PROGRAM OUTCOMES MAPPED TO CURRICULUM AND UNIVERSITY GOALS

Table 13. Program outcomes mapped to curriculum.

Program Outcomes **Students will…**	MATH 191 Calculus I	MATH 192 Calculus II	MATH 195 Calc I for Biology	MATH 215 Intro to Lin Alg	MATH 221 Math Elem Teach I	MATH 222 Math Elem Teach II	MATH 240 Calculus III	MATH 286 Diff Equations	MATH 295 Independent Study	MATH 315 Linear Algebra	MATH 355 Found Adv Math	MATH 375 Secdry Math Teach	MATH 389 Colloquium	MATH 405 Applied Math	MATH 408 Complex Analysis	MATH 426 Math Modeling	MATH 431 Real Analysis I	MATH 432 Real Analysis II	MATH 441 Abstract Alg I	MATH 442 Abstract Alg II	MATH 475 Geometry	MATH 487 Special Topics	MATH 495 Independent Study	MATH 497 Research in Math	STAT 340 Probability Theory
Demonstrate breadth and depth in their grasp of undergraduate mathematics (BS Math, BS Math Ed, Math Studies)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	X
Conduct research projects, write papers, and make presentations (BS Math, Math Studies)								x	x		x	x	x			x					x	x	x	x	
Be successful in obtaining employment or acceptance into graduate or professional programs (BS Math, BS Math Ed, Math Studies)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Be successful in completing the first year of grad school and eventually a master's or doctoral degree (those who enter graduate programs)										x	x		x	x	x	x	x	x	x	x				x	
Demonstrate a commitment to Jesus, the Seventh-day Adventist Church, and service to others (BS Math, BS Math Ed, Math Studies)													x			x									
Participate in teaching-related work experience outside of their classroom experiences (BS Math Ed)*																									
Demonstrate a good understanding of the mathematics they are teaching and the ability to communicate it clearly (BS Math Ed)					x	x					x	x									x				

*Occurs during the student teaching semester.

Table 14. General education (ACE) outcomes mapped to curriculum.

Gen Ed (ACE) Outcomes **Students will…**	MATH 091 Arith & Alg Review	MATH 092 Arith & Alg Review	MATH 145 Reason w Functions	MATH 165/166 College Alg	MATH 168 Precalculus	MATH 191 Calculus I	MATH 195 Calc I for Biology	STAT2 85 Elem Statistics
Think logically and critically	x	x	x	x	x	x	x	x
Understand mathematical concepts and identify quantitative relationships	x	x	x	x	x	x	x	x
Draw inferences from tables, graphs, and functions	x	x	x	x	x	x	x	x
Appreciate the value and application of mathematics in real world systems	x	x	x	x	x	x	x	x

Table 15. Program outcomes mapped to University goals.

	Seek Knowledge	Affirm Faith	Change the World
Program Outcomes **Students will…**	*Engage in intellectual discovery and inquiry; demonstrate the ability to think clearly and critically; communicate effectively; demonstrate competence in their chosen disciplines and professions; engage in creative problem-solving and innovation*	*Understand life, learning, and civic responsibility from a Christian point of view; develop a personal relationship with Jesus Christ; deepen their faith commitment and practice; demonstrate personal and moral integrity; embrace a balanced lifestyle, including time for intellectual, social, spiritual, and physical development*	*Apply understanding of cultural differences in diverse environments; engage in generous service to meet human needs; apply collaborative leadership to foster growth and promote change; engage in activities consistent with the worldwide mission of the Seventh-day Adventist Church*
Demonstrate breadth and depth in their grasp of undergraduate mathematics (BS Math, BS Math Ed, Math Studies)	x		
Conduct research projects, write papers, and make presentations (BS Math, Math Studies)	x		
Be successful in obtaining employment or acceptance into graduate or professional programs (BS Math, BS Math Ed, Math Studies)	x		
Be successful in completing the first year of grad school and eventually a master's or doctoral degree (those who enter graduate programs)	x		
Demonstrate a commitment to Jesus, the Seventh-day Adventist Church, and service to others (BS Math, BS Math Ed, Math Studies)		x	x
Participate in teaching-related work experience outside of their classroom experiences (BS Math Ed)			x
Demonstrate a good understanding of the mathematics they are teaching and the ability to communicate it clearly (BS Math Ed)	x		

Table 16. General education (ACE) outcomes mapped to University goals.

	Seek Knowledge	Affirm Faith	Change the World
Gen Ed (ACE) Outcomes **Students will…**	*Engage in intellectual discovery and inquiry; demonstrate the ability to think clearly and critically; communicate effectively; demonstrate competence in their chosen disciplines and professions; engage in creative problem-solving and innovation*	*Understand life, learning, and civic responsibility from a Christian point of view; develop a personal relationship with Jesus Christ; deepen their faith commitment and practice; demonstrate personal and moral integrity; embrace a balanced lifestyle, including time for intellectual, social, spiritual, and physical development*	*Apply understanding of cultural differences in diverse environments; engage in generous service to meet human needs; apply collaborative leadership to foster growth and promote change; engage in activities consistent with the worldwide mission of the Seventh-day Adventist Church*
Think logically and critically	x	x	x
Understand mathematical concepts and identify quantitative relationships	x		x
Draw inferences from tables, graphs, and functions	x		x
Appreciate the value and application of mathematics in real world systems	x	x	x

APPENDIX 2: MISSION STATEMENT BENCHMARKING

Mission Statement
College of William and Mary Department of Mathematics
(Revised 22 September 2008; source: David Lutzer, former Chair)

Our primary departmental goal is to be simultaneously an outstanding undergraduate teaching department and a nationally recognized research department, with undergraduate research as the bridge linking the two. Our secondary goals are: to provide the academic core of the Computational Operations Research graduate program; to participate in doctoral supervision through the Applied Science department when appropriate students and resources can be found; to participate in various interdisciplinary programs linked to undergraduate mathematics; and to cooperate with the School of Education in mathematics education programs of various kinds. Our tertiary mission is to hold leadership positions in our various national professional organizations and in on-campus faculty governance activities.

Mission Statement
Walla Walla University Department of Mathematics
(Revised 01 June 2015; source: Jonathan Duncan, Chair)

The mission of the Department of Mathematics is

- to provide an excellent undergraduate mathematics program for mathematics majors whose future plans include graduate school, professional school, teaching in secondary schools, or other employment immediately after graduation.
- to provide strong and relevant support courses for students majoring in engineering, the physical sciences, education, and other areas with special mathematics requirements.
- to provide general studies courses that will help students develop problem-solving skills and gain an appreciation for the beauty and utility of mathematics.

Mission Statement
University of Arizona Department of Mathematics
(Accessed 22 June 2016; source: http://math.arizona.edu/about/department)

Specifically our goals are:

- to communicate the beauty, utility, and excitement of mathematics and to be at the frontiers of new discoveries;
- to prime the pipeline pump and prepare a broad and ethnically diverse spectrum of entering students, enabling them to meet the challenges of University programs whose quality will continue to climb;
- to build a first-rate, enthusiastic and vigorous faculty blending youth and maturity in a variety of overlapping fields across the broad spectrum of mathematical sciences with the dual aims that each individual is internationally recognized for the depth and originality

of his or her contributions and that the collaborations lead to an environment in which the whole is greater than the sum of the parts;

- not to do all things, but to do well those things we do;
- to provide flexible yet solid undergraduate and graduate programs which challenge the intellect, cater to the diverse interests of our majors and which complement, particularly at the graduate level, our internationally recognized Interdisciplinary Program in Applied Mathematics;
- to encourage and foster creativity and scholarship in their broadest possible interpretations;
- to encourage students in the belief that they gain most from the university experience by developing self-discipline, self-reliance and, under appropriately supervised conditions, by giving full rein to their own creativity;
- to embrace the notion that change such as is manifested in computer technology and educational reform can be beneficial, enhance learning and enrich the intellectual environment;
- to be a resource in the mathematical sciences for other disciplines whose own activities have an ever-increasing need for the power of mathematics;
- to work closely, not only with colleagues from other disciplines within the University, but also with colleagues from the local schools and community colleges who share the responsibility of ensuring the flow of a mathematically literate and confident generation of new Students;
- to be part of a University which aspires to be the best and which pursues policies compatible with this goal.

APPENDIX 3: INTERNSHIPS AND CAREERS OF ANDREWS' MATH MAJORS

National Science Foundation (NSF)-funded Research Experience for Undergraduate (REU) Fellowships Obtained 2013-2015

Andrews University, Seabird Ecology Team
Boston University, NHLBI Institute for Training in Biostatistics
Brooklyn College, Computational Molecular Biophysics Lab
Kitt Peak National Observatory, Arizona
North Carolina State University
University of Central Florida, College of Optics and Photonics, Nanophotonic Material Group
University of Guadalajara, Mexico
University of Michigan
University of Nebraska, Lincoln
Yale University, Center for Research on Interface Structures & Phenomena

Partial List of Careers of graduates from 2006-2016

Actuarial Science
Accounting
Assessment
Business
Computer Programming
Elementary Education
EMT
Engineering
Finance
Higher Education
ITS
Law
Medicine
Music (conducting)
Pharmacy
Risk Management
Secondary Education
Software Engineering

Partial List of Graduate Schools Attended 1961-2016

American Univ, Washington College of Law
Andrews University
Australian National University in Canberra
Benjamin N. Cardozo School of Law
California Institute of Technology
Central Michigan University
Colorado State University
Columbia University Law School
Cornell University
Florida State University
George Mason University
Georgetown University
Indiana University, Bloomington
Loma Linda Medical School
Miami University, Oxford, Ohio
New Jersey Institute of Technology
Notre Dame University
Oklahoma State University
Pennsylvania State University
Purdue University
Roosevelt University, Schaumburg, IL
Stanford University
Texas Tech University
University of Illinois Urbana-Champaign
University of Arizona
University of Buffalo
University of California, Davis
University of California, Santa Barbara
University of Illinois, Chicago
University of Iowa
University of Michigan School of Law
University of Minnesota
University of Massachusetts
University of North Texas, Denton
University of Tennessee, Knoxville
University of Texas, Dallas
West Virginia University, Morgantown
Western Michigan University

Table 17. Occupations for mathematicians.

Occupation	Job Summary	Entry-level Education	2015 Median Pay
Actuaries	Analyze the financial costs of risk and uncertainty using mathematics, statistics, and financial theory to help business develop policies to minimize risk	Bachelor's Degree	$97,070
Mathematicians	Conduct research to develop and understand mathematical principles; analyze data; apply mathematical techniques to real-world problems	Master's Degree	$111,110
Operations Research Analysts	Use advanced mathematical and analytical methods to help organizations investigate complex issues, identify and solve problems, and make better decisions	Bachelor's Degree	$78,630
Statisticians	Use statistical methods to collect and analyze data to address problems in business, engineering, health care, and other fields.	Master's Degree	$80,110
Projected growth from 2014-2024 is 28% or about 42,900 new jobs Median annual wage $81,360 (May 2015)			

Data courtesy of the *Bureau of Labor Statistics Occupational Outlook Handbook*, published Dec. 17, 2015
http://www.bls.gov/ooh/math/home.htm

APPENDIX 4: QUALITY OF FACULTY: EDUCATION AND SCHOLARSHIP

Table 18. Faculty degrees and research foci. Umlauf and Vence, who teach primarily at the high school level, are not shown. They both hold master's degrees.

	Henson	**Kang**	**Moore**	**Oh**	**Weldon**
Doctoral Degree	PhD Mathematics	PhD Mathematics	EdD Math Education	PhD Mathematics	PhD Mathematics
Doctoral Degree Institution	University of Tennessee, Knoxville	Michigan State University	University of Georgia, Athens	Michigan State University	University of California, Davis
Doctoral Degree Foci	Mathematical Ecology	Partial Differential Equations	Undergraduate Mathematics Education	Differential Geometry	Abstract Algebra
Master's Degree Foci	Mathematical Logic	Statistics	Abstract Algebra	Differential Geometry	
Current Research Foci	Dynamical Systems, Animal behavior	Nonlinear elliptic and parabolic PDEs	Learning and teaching of mathematical proof	Riemannian geometry, submanifold theory	Mathematics education, statistical methods
Research Faculty Status	Yes	Yes	Yes	Yes	No (chair)
ResearchGate website	Yes	Yes	Yes	Yes	Yes
Professional memberships	AMS RMA Phi Kappa Phi Pi Mu Epsilon Sigma Xi	MAA Phi Kappa Phi Sigma Xi Pi Mu Epsilon	MAA MASAL MCTM NCTM Pi Mu Epsilon	AMS Pi Mu Epsilon Sigma Xi MAA	MAA Pi Mu Epsilon

Note:
AMS = American Mathematical Society
MAA = Mathematical Association of America
MASAL = Michigan Academy of Sciences, Arts & Letters
MCTM = Michigan Council of Teachers of Mathematics
NCTM = National Council of Teachers of Mathematics
RMA = Resource Modeling Association

Table 19. Courses taught. An "X" indicates a particular pedagogical focus (the faculty member often teaches the course or oversees it). An "s" indicates a particular research specialty. An "h" indicates that the faculty member has taught the course at least once. "SED" indicates that the School of Ed teaches the course. Independent Study and Topics courses are not shown. Faculty members Umlauf and Vence, who teach primarily at the high school level, are not shown.

	Course	**Henson**	**Kang**	**Moore**	**Oh**	**Weldon**
Remedial	MATH091 Arith and Algebra Review I			h	h	X
	MATH092 Arith and Algebra Review II			h	h	X
Gen Ed	MATH145 Reasoning with Functions	h		X	h	X
	MATH165(166) College Algebra (Bus)	h		h	X	h
	STAT285 Elementary Statistics	X				X
	MATH168 Precalculus	h	X	h	h	
	MATH191 Calculus I	h	h	X	h	X
	MATH195 Calculus I for Biology	X,s				
Other Lower Division	MATH192 Calculus II	h	h	h	X	h
	MATH215 Intro to Linear Algebra		X	h	X	h
	MATH221 Math for Elem Teachers I			X,SED		
	MATH222 Math for Elem Teachers II			X		
	MATH240 Calculus III	h		h	X	
	MATH286 Differential Equations	s	s	h	X,s	
Upper Division	MATH315 Linear Algebra			h		X,s
	MATH355 Foundations Advanced Math	h		X,s		
	MATH375 Secondary Sch Math Teach			X		
	MATH389 Colloquium	X		h		
	MATH405 Applied Mathematics		X,s			
	MATH408 Complex Analysis		X		h	
	MATH426 Math Modeling in Biology	X,s				
	MATH431 Real Analysis I		X			
	MATH432 Real Analysis II		X			
	MATH441 Abstract Algebra I			h		X,s
	MATH442 Abstract Algebra II					X,s
	MATH475 Geometry			X		
	MATH497 Research in Mathematics	X,s	X,s		X,s	X,s
	STAT340 Probability Theory w/ Stat App		X,s			

Peer-reviewed Research Papers Since 2012
(Student coauthors in bold)

To Appear

Kang, J. H., and **Robertson, T.** A general elliptic nonlinear system of two functions with application. To appear in International Electronic Journal of Pure and Applied Mathematics.

Kang, J. H., and **Robertson, T.** A general elliptic nonlinear system of multiple functions with application. To appear in American Review of Mathematics and Statistics.

Moore, R. C., Byrne, M., Hanusch, S., and Fukawa-Connelly, T. When we grade students' proofs, do they understand our feedback? To appear in Proceedings of the 19th Annual Conference on Research in Undergraduate Mathematics Education.

Moore, R. C., Byrne, M., Fukawa-Connelly, T., and Hanusch, S. Interpreting proof feedback: Do our students know what we're saying? To appear in Proceedings of the 19th Annual Conference on Research in Undergraduate Mathematics Education.

Sandler, A. G., Megna, L. C., Hayward, J. L., Henson, S. M., Tkachuck, C. M., and Tkachuck, R. D. Every-other-day clutch-initiation synchrony in ring-billed gulls (*Larus delawarensis*). To appear in Wilson Journal of Ornithology.

Suceava, B., Carriazo, A., Oh, Y. M., and Van der Veken, J. Recent Advances in the Geometry of Submanifolds, Dedicated to the Memory of Franki Dillen (1963-2013). To appear in Contemporary Mathematics, Vol. 674.

2016

Moore, R. C. 2016. Mathematics professors' evaluation of students' proofs: A complex teaching practice. International Journal of Research in Undergraduate Mathematics Education 2:246-278.

2015

Atkins, G. J., **Sandler, A. G., McLarty, M.**, Henson, S. M., and Hayward, J. L. 2015. Oviposition behavior in Glaucous-winged Gulls (*Larus glaucescens*). Wilson Journal of Ornithology 127:486-493.

Cushing, J. M., Henson, S. M., and Hayward, J. L. 2015. An evolutionary game theoretic model of cannibalism. Natural Resource Modeling 28:497–521.

Hayward, J. L., Atkins, G. J., **Reichert, A. A.**, and Henson, S. M. 2015. Common Ravens (*Corvus corax*) Prey on Rhinoceros Auklet (*Cerorhinca monocerata*) Eggs, Chicks, and Possibly Adults. Wilson Journal of Ornithology 127:336-339.

Kang, J. H. 2015. Smooth positive solutions to an elliptic model with C2 functions. International Journal of Pure and Applied Mathematics 105:653-667.

Kang, J. H., and **Tritch, W.** 2015. Conditions for existence or nonexistence of positive solutions to elliptic general model. British Journal of Mathematics and Computer Science 8:447-457.

Navia, B., **Burden, C., Steely, T., Hasegawa, H., Cha, E.**, Henson, S. M., Stout, J., and Atkins, G. 2015. Parallel effects of temperature on the male cricket calling song, phonotaxis of the female and the auditory responses of the L3 neurone. Physiological Entomology 40:113–122.

Oh, Y. M., and **Seo, Y. L.** 2015. A curve satisfying $\tau / \kappa = s$ with constant $\kappa > 0$. American Journal of Undergraduate Research 12:57-62.

Payne, B. G., Henson, S. M., Hayward, J. L., **Megna, L. C.**, and Velastegui Chavez, S. R. 2015. Environmental constraints on haul-out and foraging dynamics in Galápagos marine iguanas. Journal of Coupled Systems and Multiscale Dynamics 3:208-218.

2014

Burton, D., and Henson, S. M. 2014. A note on the onset of synchrony in avian ovulation cycles. Journal of Difference Equations and Applications 20:664–668.

Hayward, J. L., Weldon, L. M., Henson, S. M., **Megna, L. C., Payne, B. G., and Moncrieff, A. E.** 2014. Egg cannibalism in a gull colony increases with sea surface temperature. The Condor: Ornithological Applications 116:62-73.

Megna, L. C., Moncrieff, A. E., Hayward, J. L, and Henson, S. M. 2014. Equal reproductive success of phenotypes in the *Larus glaucescens-occidentalis* complex. Journal of Avian Biology 45:410–416.

Moore, R. C. 2014. What constitutes a well-written proof? In T. Fukawa-Connelly, G. Karakok, K. Keene, and M. Zandieh (Eds.), Proceedings of the 17th Annual Conference on Research in Undergraduate Mathematics Education, Denver, Colorado.

Savic, M., Moore, R. C., and Mills, M. 2014. Mathematicians' views on transition-to-proof and advanced mathematics courses. In T. Fukawa-Connelly, G. Karakok, K. Keene, and M. Zandieh (Eds.), Proceedings of the 17th Annual Conference on Research in Undergraduate Mathematics Education, Denver, Colorado.

2013

Cowles, J. D., Henson, S. M., Hayward, J. L., and **Chacko, M. W.** 2013. A method for predicting harbor seal (*Phoca vitulina*) haulout and monitoring long-term population trends without telemetry. Natural Resource Modeling 26:605-627.

Hayward, J. L., **Megna, L. C., Payne, B. G.**, Velastegui Chavez, S. R., and Henson, S. M. 2013. Temporal and environmental effects on the behavior of flightless cormorants. Wilson Journal of Ornithology 125:790–799.

Kang, J. H. 2013. Steady state solutions to general competition and cooperation models. Communications in Mathematics and Applications 4:201-212.

Kang, J. H. 2013. Positive equilibrium solutions to general population model. International Journal of Pure and Applied Mathematics 85:1009-1019.

McCormick, M. A., Hayward, J. L., and Henson, S. M. 2013. Egg mass in Glaucous-winged Gulls (*Larus glaucescens*) as a function of length and width. Northwestern Naturalist 94:147-150.

Moncrieff, A. E., Megna, L. C., Hayward, J. L., and Henson, S. M. 2013. Mating patterns and breeding success in gulls of the *Larus glaucescens-occidentalis* complex, Protection Island, Washington, USA. Northwestern Naturalist 94:67-75.

Moore, R. C. 2013. Measuring a circle: A math lesson for grades 5-10. Journal of Adventist Education 75:30-33.

Oh, Y. M. 2013. Riemannian submersions and Lagrangian isometric immersion I. International Electronic Journal of Geometry 6:14-18.

2012

Cushing, J. M., and Henson, S. M. 2012. Stable bifurcations in semelparous Leslie models. Journal of Biological Dynamics 6:80-102.

Henson, S. M., Weldon, L. M., Hayward, J. L., **Greene, D. J., Megna, L. C., and Serem, M. C.** 2012. Coping behaviour as an adaptation to stress: Post-disturbance preening in colonial seabirds. Journal of Biological Dynamics 6:17-37.

Oral Presentations at Conferences Since 2012
(*Presenter in italics*; **student coauthors in bold**)
*Plenary address

2016

**Cushing, J. M.*, Henson, S. M., and Hayward, J. L. The effects of climate change on marine birds: rising sea surface temperature, cannibalism, and reproductive synchrony, Part II. 2016, World Conference on Natural Resource Modeling, Resource Modeling Association, Flagstaff, AZ, June 14, 2016.

**Henson, S. M.*, Cushing, J. M., and Hayward, J. L. The effects of climate change on marine birds: rising sea surface temperature, cannibalism, and reproductive synchrony, Part I. 2016, World Conference on Natural Resource Modeling, Resource Modeling Association, Flagstaff, AZ, June 14, 2016.

Moore, R. C., Byrne, M., Hanusch, S., & Fukawa-Connelly, T. Is grading papers an effective teaching practice? 14th Annual Teaching and Learning Conference, Andrews University, Berrien Springs, MI, April 2016.

Kang, J. H. A general elliptic nonlinear system of two functions with application. Mathematical Association of America, Hillsdale College, Hillsdale, MI, April 1, 2016.

Oh, Y. M. On the Riemannian submersion invariant and Lagrangian submanifolds. Mathematical Association of America, Hillsdale College, Hillsdale, MI, April 1, 2016.

Atkins, G., **Reichert, A.**, Henson, S. M., and Hayward, J. L. The effects of the copulation song and other disturbances on the frequency and synchronization of reproductive behaviors in gulls (*Larus glaucescens*). Michigan Academy of Science, Arts & Letters Annual Conference, Zoology Section, Saginaw Valley State University, University Center, MI, March 4, 2016.

Dass, S., Henson, S. M., and Hayward, J. L. A mathematical model of animal behavior. Michigan Academy of Science, Arts & Letters Annual Conference, Mathematics Section, Saginaw Valley State University, University Center, MI, March 4, 2016.

Henson, S. M., Cushing, J. M., and Hayward, J. L. Effects of warming seas: cannibalism and reproductive synchrony in a seabird colony. Michigan Academy of Science, Arts & Letters Annual Conference, Mathematics Section, Saginaw Valley State University, University Center, MI, March 4, 2016.

Oh, Y. M. Riemannian submersion invariant and geodesics. Michigan Academy of Sciences, Arts & Letters, Mathematics Section, Saginaw Valley State University, Saginaw, MI, March 4, 2016.

Robertson, T., and Kang, J. H. A general elliptic nonlinear system of two functions with application. Michigan Academy of Sciences, Arts & Letters Annual Conference, Mathematics Section, Saginaw Valley State University, Saginaw, MI, March 4, 2016.

Kolpacoff, V. L., and Henson, S. M. The effect of gross domestic product on HIV infection rate. Michigan Academy of Science, Arts & Letters Annual Conference, Mathematics Section, Saginaw Valley State University, University Center, MI, March 4, 2016.

Moore, R. C., Byrne, M., Hanusch, S., and Fukawa-Connelly, T. Proof grading: Is it worth your time and effort? Michigan Academy of Science, Arts and Letters Annual Conference, Mathematics Section, Saginaw Valley State University, University Center, MI, March 4, 2016.

Moore, R. C., Byrne, M., Fukawa-Connelly, T., and Hanusch, S. Interpreting proof feedback: Do our students know what we're saying? 19th Annual Conference on Research in Undergraduate Mathematics Education, Pittsburgh, PA, February, 2016.

Moore, R. C., Byrne, M., Fukawa-Connelly, T., and Hanusch, S. Interpreting proof feedback: Do our students know what we're saying? Joint Mathematics Meetings, Seattle, WA, January 2016.

Robertson, T., and Kang, J. H. Conditions for positive solutions of the general elliptic model. Joint Mathematics Meetings, Seattle, WA, January 14, 2016.

2015

Henson, S. M., Cushing, J. M., and Hayward, J. L. Effects of warming seas: Cannibalism and reproductive synchrony in a seabird colony. 5th International Conference on Mathematical Modeling and Analysis of Populations in Biological Systems, University of Western Ontario, London, Ontario, Canada, October 4, 2015.

Cushing, J. M., **Veprauskas, A.**, Henson, S. M., and Hayward, J. L. Environmental change and life history strategies: cannibalism and reproductive synchrony II. American Mathematical Society, Spring Southeastern Sectional Meeting, special session on New Developments in Population Dynamics and Epidemiology, Huntsville, AL, March 27, 2015.

Hayward, J. L., Henson, S. M., and Cushing, J. M. Environmental change and life history strategies: cannibalism and reproductive synchrony I. American Mathematical Society, Spring Southeastern Sectional Meeting, special session on New Developments in Population Dynamics and Epidemiology, Huntsville, AL, March 27, 2015.

Henson, S. M., Cushing, J. M., and Hayward, J. L. Environmental change and life history strategies: cannibalism and reproductive synchrony III. American Mathematical Society, Spring Southeastern Sectional Meeting, special session on New Developments in Population Dynamics and Epidemiology, Huntsville, AL, March 27, 2015.

Atkins, G., **Sandler, A., Reichert, A.**, Henson, S. M., and Hayward, J. L. The effects of the copulation song and other disturbances on the frequency and synchronization of reproductive behaviors in gulls (*Larus glaucescens*), Michigan Academic of Sciences, Arts & Letters Annual Conference, Andrews University, Berrien Springs, MI, March 13, 2015.

**Hayward, J. L*, and **Henson, S. M.* Effects of climate change on animal behavior, Michigan Academy of Science, Arts & Letters Annual Conference, Andrews University, Berrien Springs, MI, March 13, 2015.

Kang, J. H. Equivalent mathematical conditions for survival of species of animals for the most general population models. Michigan Academy of Sciences, Arts & Letters, Andrews University, Berrien Springs, MI, March 13, 2015.

Moore, R. C. When mathematicians grade students' proofs, why don't the scores agree? Michigan Academy of Science, Arts & Letters Annual Conference, Mathematics Section, Andrews University, Berrien Springs, MI, March 13, 2015.

Oh, Y. M. Riemannian submersion invariant and theta-slant submanifolds II, Michigan Academy of Sciences, Arts & Letters Annual Conference, Andrews University, Berrien Springs, MI, March 13, 2015.

Reichert, A., Hayward, J. L., and Henson, S. M. The behavior of Glaucous-winged gull egg cannibals, Michigan Academic of Sciences, Arts & Letters Annual Conference, Andrews University, Berrien Springs, MI, March 13, 2015.

Sandler, A. G., **Megna, L. C.**, Henson, S. M., and Hayward, J. L. Every-other-day ovulation synchrony, high nesting density, and egg loss in a colony of ring-billed gulls (*Larus delawarensis*), Michigan Academic of Sciences, Arts & Letters Annual Conference, Andrews University, Berrien Springs, MI, March 13, 2015.

Weir, S., Henson, S. M., Hayward, J. L., and **Reichert, A.** Egg-laying synchrony as an adaptive response to egg cannibalism in a seabird colony, Michigan Academic of Sciences, Arts & Letters Annual Conference, Andrews University, Berrien Springs, MI, March 13, 2015.

Weldon, L. M. Academic mindsets. Michigan Academy of Sciences, Arts & Letters Annual Conference, Andrews University, Berrien Springs, MI, March 13, 2015.

Burton, D., and Henson, S. M. A note on the onset of synchrony in avian ovulation cycles, Joint Mathematics Meetings, MAA General Contributed Paper Session on Modeling or Applications, San Antonio, TX, January, 2015.

Cushing, J. M., **Veprauskas, A.**, Henson, S. M. Environmental change and life history strategies: cannibalism and reproductive synchrony, Joint Mathematics Meetings, MAA Invited Paper Session on Recent Advances in Mathematical Modeling of the Environment and Infectious Diseases, San Antonio, TX, January, 2015.

2014

Jensen, R. E., Cushman, R., Hayward, J. L., Henson, S. M., and Zippi. P. A. Late Pleistocene stratigraphy and sedimentology of Protection Island, Washington. Geological Society of America Annual Meeting, Vancouver, British Columbia, Canada, October 19-22, 2014.

Hayward, J. L., and Henson, S. M. Hot and bothered: Climate change, ovulation synchrony, and cannibalism in gulls. Joint Meeting of the American Ornithologists' Union, Cooper Ornithological Society, and Society of Canadian Ornithologists, Estes Park, CO, September 25, 2014.

Henson, S. M., **St. Martin, W.**, and Hayward, J. L. Tradeoff between daily and yearly reproductive synchrony in colonial seabirds. American Ornithologists' Union, Joint Meeting, Estes Park, CO, September 25, 2014.

Reichert, A., Hayward, J. L., and Henson, S. M. The behavior of Glaucous-winged Gull egg cannibals. Joint Meeting of the American Ornithologists' Union, Cooper Ornithological Society, and Society of Canadian Ornithologists, Estes Park, CO, September 25, 2014.

***Sandler, A.*, Megna, L. C.,** Henson, S. M., and Hayward, J. L. Every-other-day ovulation synchrony, high nesting density, and egg loss in a colony of Ring-billed Gulls (*Larus delawarensis*). Joint Meeting of the American Ornithologists' Union, Cooper Ornithological Society, and Society of Canadian Ornithologists, Estes Park, CO, September 25, 2014.

Henson, S. M., and *Hayward, J. L.* Hot and bothered: climate change, cannibalism, and ovulation synchrony. Andrews Research Conference, Early Career Researchers in STEM, Andrews University, Berrien Springs, MI, May 8, 2014.

Atkins, G., Henson, S. M., and Hayward, J. L. Evaluating the effect of broadcasting a model copulation song on the head-toss and mounting behavior of Glaucous-winged Gulls on Protection Island. Michigan Academy of Science, Arts, and Letters Annual Conference, Zoology Section, Oakland University, Rochester, MI, February 28, 2014.

Hayward, J. L., *Henson, S. M.*, and Atkins, G. Egg cannibalism in marine gulls increases with sea surface temperature. Michigan Academy of Science, Arts, and Letters Annual Conference, Zoology Section, Oakland University, Rochester, MI, February 28, 2014.

Henson, S. M., Cushing, J. M., and Hayward, J. L. Reproductive synchrony in populations can ameliorate the effects of adult-on-juvenile cannibalism. Michigan Academy of Science, Arts & Letters Annual Conference, Mathematics Section, Oakland University, Rochester, MI, February 28, 2014.

Kang, J. H. Conditions to existence of positive solutions to general elliptic model. Michigan Academy of Sciences, Arts & Letters Annual Conference, Mathematics Section, Oakland University, Rochester, MI, February 28, 2014.

Oh, Y. M. Riemannian submersion invariant and theta-slant submanifolds. Michigan Academy of Sciences, Arts & Letters, Oakland University, Rochester, MI, February 28, 2014.

Sandler, A., Atkins, G., Hayward, J. L., Henson, S. M., **McLarty, M.**, and **McCormick, M**. Features of copulation and the copulation call in Glaucous-winged Gulls (*Larus glaucescens*). Michigan Academy of Science, Arts, and Letters Annual Conference, Zoology Section, Oakland University, Rochester, MI, February 28, 2014.

Weldon, L. Remedial math journeys. Michigan Academy of Sciences, Arts and Letters, Oakland University, Rochester, MI, February 28, 2014.

Moore, R. C. What constitutes a well-written proof? 17th Annual Conference on Research in Undergraduate Mathematics Education, Denver, CO, February 2014.

Savic, M., Moore, R. C., and Mills, M. Mathematicians' views on transition-to-proof and advanced mathematics courses. 17th Annual Conference on Research in Undergraduate Mathematics Education, Denver, CO, February 2014.

Cushing, J. M., Henson, S. M., and Hayward, J. L. Cannibalism can allow survival of a population endangered by decreased environmental resource availability. Special Session on Mathematics in Natural Resource Modeling, 2014 Joint Mathematics Meetings, Baltimore, MD, January 17, 2014.

Henson, S. M., Cushing, J. M., and Hayward, J. L. Reproductive synchrony in populations can ameliorate the effects of adult-on-juvenile cannibalism. Joint Mathematics Meetings, AMS Special Session on Mathematics in Natural Resource Modeling, Baltimore, MD, January 17, 2014.

Kang, J. H. Coexistence condition of two species of animals residing in an environment. Joint Mathematics Meetings, Baltimore, MD, January 17, 2014.

Moore, R. C. Mathematics professors' evaluation of students' proofs. MAA Session on Assessment of Proof Writing throughout the Mathematics Major, Joint Mathematics Meetings, Baltimore, MD, January 2014.

Oh, Y. M., Some inequalities on Riemannian submersion and isometric immersions. Joint Mathematics Meetings, General contributed paper session: Research in Geometry and Linear Algebra, Baltimore, MD, January 16, 2014.

Savic, M., Moore, R. C., and Mills, M. Mathematicians' views on transition-to-proof and advanced mathematics courses. Joint Mathematics Meetings, Baltimore, MD, January 2014.

2013

Oh, Y. M. An inequality on Riemannian submersion invariant and theta-slant submanifold. American Mathematical Society, Fall Western Sectional Meeting, UC Riverside, CA, November 2-3, 2013.

Burton, D., and *Henson, S. M.* Bifurcation of synchronous ovulation cycles in colonial birds. American Mathematical Society, Fall Southeastern Sectional meeting, special session on Mathematical Models in Biology and Physiology, Louisville, KY, October 6, 2013.

Atkins, G., **Sandler, A., McLarty, M.**, **McCormick, M.**, Henson, S. M., and Hayward, J. L. Egg laying behavior in glaucous-winged gulls. Michigan Academy of Science, Arts & Letters Annual Conference, Zoology Section, Hope College, Holland, MI, March 22, 2013.

Burton, D, Henson, S. M., Hayward, J. L. Onset of synchrony in avian ovulation cycles. Michigan Academy of Science, Arts & Letters Annual Conference, Mathematics Section, Hope College, Holland, MI, March 22, 2013.

Hayward, J. L, *Weldon, L. M.*, Henson, S. M., **Megna, L. C., Moncrief, A. E., and Payne, B. G.** The effect of sea surface temperature on egg cannibalism in gulls. Michigan Academy of Science, Arts & Letters Annual Conference, Mathematics Section, Hope College, Holland, MI, March 22, 2013.

Henson, S. M., Hayward, J. L, and Cushing, J. M. Coevolutionary dynamics of cannibalism and ovulation synchrony: a discrete-time mathematical model. Michigan Academy of Science, Arts & Letters Annual Conference, Mathematics Section, Hope College, Holland, MI, March 22, 2013.

Kang, J. H. Steady state solutions to general population model. Michigan Academy of Sciences, Arts & Letters Annual Conference, Hope College, Holland, MI, March 22, 2013.

Moore, R. C. What constitutes a well-written proof? Michigan Academy of Science, Arts & Letters Annual Conference, Mathematics Section, Hope College, Holland, MI, March 22, 2013.

Oh, Y. M. An inequality of Riemannian submersion invariant and Lagrangian isometric immersion. Michigan Academy of Sciences, Arts & Letters, Hope College, Holland, MI, March 22, 2013.

Sandler, A., Atkins, G., **McLarty, M., McCormick, M.**, Henson, S. M., and Hayward, J. L. Copulation call and behavior of Glaucous-winged Gulls (*Larus glaucescens*). Michigan Academy of Science, Arts & Letters Annual Conference, Zoology Section, Hope College, Holland, MI, March 22, 2013.

Atkins, G., **Sandler, A., McLarty, M., McCormick, M.**, Henson, S. M., and Hayward, J. L. Egg-laying behavior in glaucous-winged gulls. Pacific Seabird Group, Annual Meeting, Portland, OR, February 22, 2013.

Hayward, J. L., **Megna, L. C.**, **Payne, B. G.**, Velastegui Chávez, S. R., and *Henson, S. M.* Temporal and environmental effects on the behavior of flightless cormorants, Pacific Seabird Group, Annual Meeting, Portland, OR, February 22, 2013.

Hayward, J. L, Weldon, L. M., Henson, S. M., **Megna, L. C., Moncrief, A. E., and Payne, B. G.** Egg cannibalism in gulls increases with sea surface temperature. Pacific Seabird Group, Annual Meeting, Portland, OR, February 22, 2013.

Kang, J. H. Coexistence steady state solutions to general population model. Joint Mathematics Meetings, San Diego, CA, January 10, 2013.

Oh, Y. M. Riemannian submersion and Lagrangian isometric immersion. Joint Mathematics Meetings, General contributed paper session: Research in Geometry and Linear Algebra, San Diego, CA, January 10, 2013.

Payne, B. G., Henson, S. M., Hayward, J. L., **Megna, L. C.**, Velastegui Chavez, S. R. Temporal dynamics of Galapagos marine iguana (*Amblyrhynchus cristatus*) haulout. Joint Mathematics Meetings, special session on Mathematics of Natural Resource Modeling, San Diego, CA, January 10, 2013.

2012

Burton, D., Henson, S. M., and Hayward, J. L. Oscillator synchrony in avian ovulation cycles. Michigan Academy of Science, Arts & Letters Annual Conference, Zoology Section, Alma College, Alma, MI, March 2, 2012.

Henson, S. M., Hayward, J. L., **Cowles, J. D., Chacko, M. W.** Dynamics of harbor seal haulout, Michigan Academy of Science, Arts & Letters Annual Conference, Environmental Science and Ecology Section, Alma College, Alma, MI, March 2, 2012.

McCormick, M., Henson, S. M., and Hayward, J. L. Gull egg mass as a function of length and width. Michigan Academy of Science, Arts & Letters Annual Conference, Zoology Section, Alma College, Alma, MI, March 2, 2012.

Megna, L. C., **Moncrieff, A. E.**, Hayward, J. L., and Henson, S. M. Hybridization and reproductive success of gulls in the *Larus glaucescens-occidentalis* Complex at an Inland Colony. Michigan Academy of Science, Arts & Letters Annual Conference, Zoology Section, Alma College, Alma, MI, March 2, 2012.

Payne, B. G., Hayward, J. L, Henson, S. M., and **Megna, L. C.,** and Velastegui Chavez, S. R. Dynamics of Galápagos marine iguana haul-out. Michigan Academy of Science, Arts & Letters Annual Conference, Environmental Science & Ecology Section, Alma College, Alma, MI, March 2, 2012.

Weldon, L. M., Hayward, J. L., Henson, S. M., **Megna, L. C., Payne, B. G., and Moncrieff, A. E.** Effects of nest location, timing, clutch size, and other factors on hatching success in Glaucous-winged Gulls. Michigan Academy of Science, Arts & Letters Annual Conference, Zoology Section, Alma College, Alma, MI, March 2, 2012.

Cowles, J. D., *Henson, S. M.*, Hayward, J. L. A mathematical model of harbor seal haulout. Joint Mathematics Meetings, AMS Special Session on Mathematics in Natural Resource Modeling, Boston, MA, January 5, 2012.

Payne, B. G., Hayward, J. L, Henson, S. M., **Megna, L. C.,** and Velastegui Chavez, S. R. Dynamics of Galápagos marine iguana haul-out. Joint Mathematics Meetings, AMS Special Session on Mathematics in Natural Resource Modeling, Boston, MA, January 5, 2012.

Presentations at Universities and Public Lectures Since 2012
(*Presenter in italics*)

Henson, S. M., and Hayward, J. L. Distinguished Research Lecture, "Effects of climate change on animal behavior", La Sierra University, Riverside, CA, May 27, 2015.

Hayward, J. L., and *Henson, S. M.* Phi Kappa Phi lecture, "Effects of climate change on animal behavior", Andrews University, Berrien Springs, MI, April 1, 2015.

Henson, S. M., and *Hayward, J. L.* Colloquium, Rosario Beach Marine Laboratory, “Co-adaptive dynamics of cannibalism and ovulation synchrony”, Anacortes, WA, July 24, 2013.

Hayward, J. L., and *Henson, S. M.* Public lecture, "Cape George University" lecture series, Cape George, Port Townsend, WA, May 22, 2013.

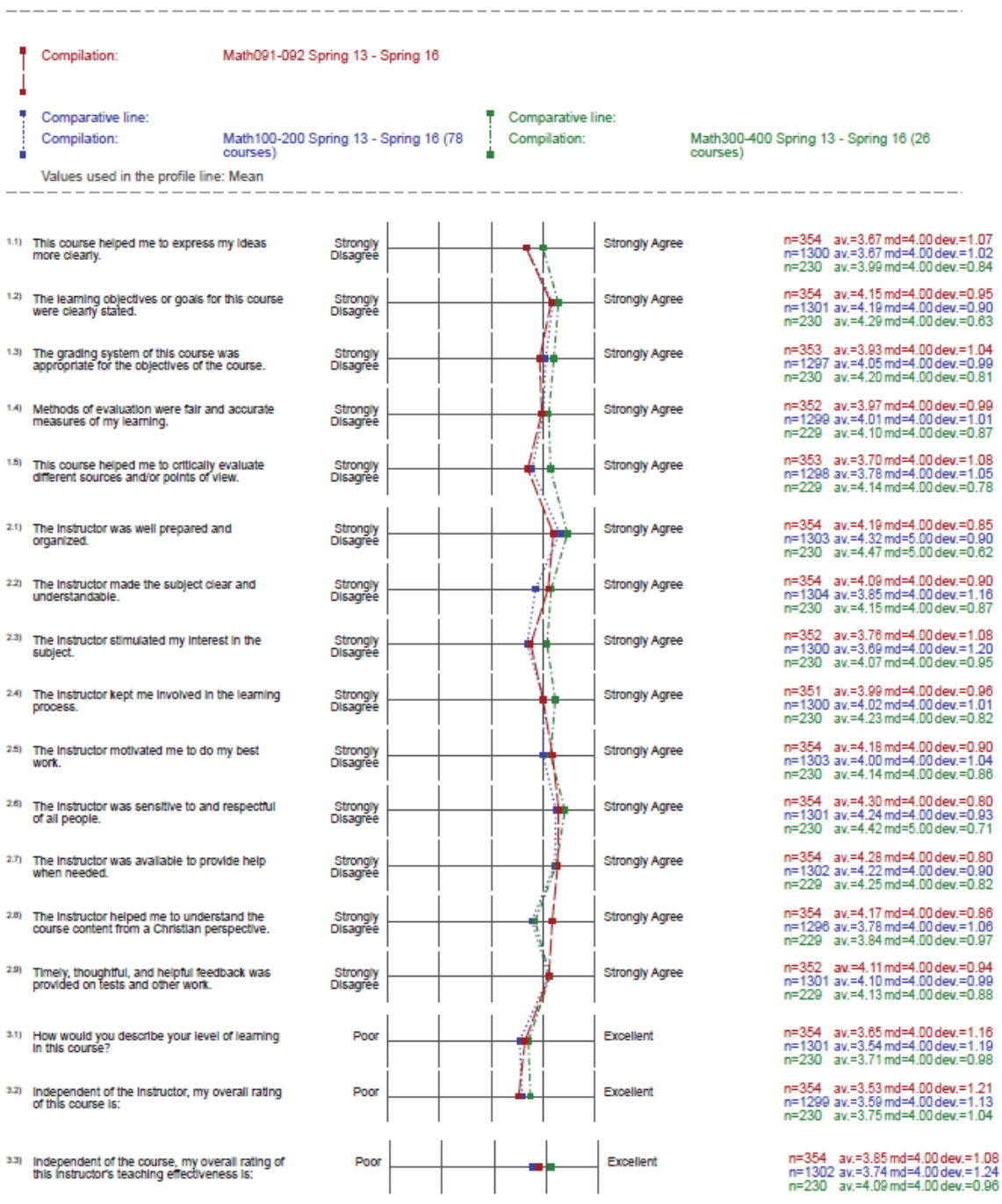
Henson, S. M., Hayward, J. L., and Cushing, J. M. Conference to Honor Tom Thompson and Ken Wiggins, "Coadaptive dynamics of cannibalism and ovulation synchrony: a discrete-time mathematical model," Walla Walla University, Walla Walla, WA, May 17, 2013.

Henson, S. M. Colloquium, Departments of Mathematics and Biology, "Chaotic dynamics and lattice effects documented in experimental insect populations," Albion College, Albion, MI, May 2, 2013.

Henson, S. M. Colloquium, Departments of Mathematics and Biology, "Chaotic dynamics and lattice effects in experimental insect populations," Hope College, Holland, MI, March 8, 2013.

APPENDIX 5: COURSE SURVEYS

Mathematics Course Surveys
Spring 2013 – Spring 2016



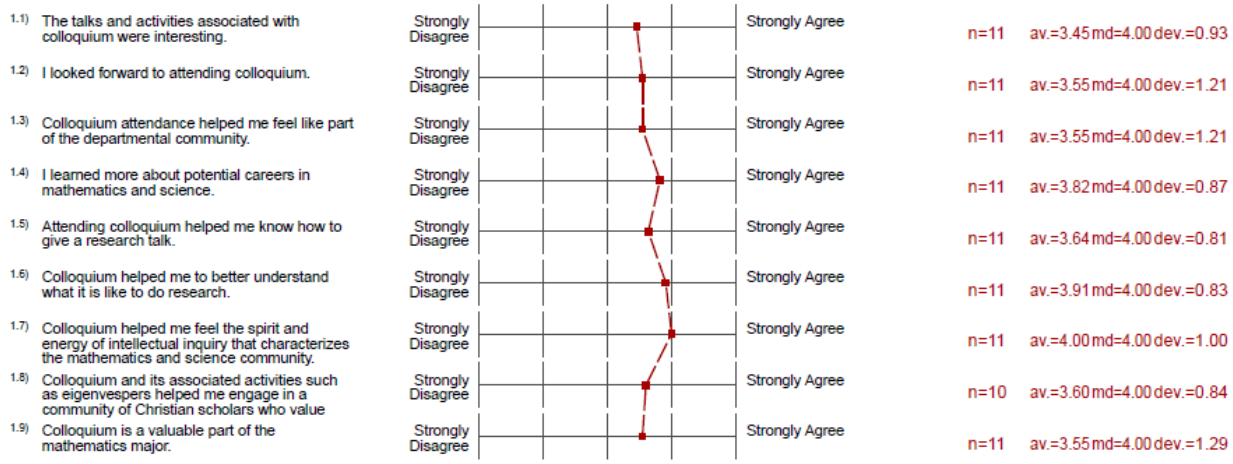
MATH389 Colloquium (Eigentalks on Fridays)
Spring 2015 Course Survey

Henson,ShandelleMATH389-001-201521

Profile

Subunit: College of Arts and Sciences
Name of the instructor: Professor Shandelle Henson
Name of the course: (Name of the survey) Mathematics Colloquium (MATH389-001-201521)

Values used in the profile line: Mean



APPENDIX 6: PROGRAM REQUIREMENTS AND SEQUENCING

Program Requirements

BS Mathematics (39 credits)

Required courses

MATH 191 - Calculus I Credits: 4 or MATH 195 - Calculus I for Biology Credits 4

MATH 192 - Calculus II Credits: 4

MATH 215 - Introduction to Linear Algebra Credits: 3

MATH 240 - Calculus III Credits: 4

MATH 286 - Differential Equations Credits: 3

MATH 315 - Linear Algebra Credits: 3

MATH 355 - Foundations of Advanced Mathematics Credits: 3

MATH 389 - Mathematics Colloquium Credits: 0 or PHYS 277 - Physics Colloquium Credits 0 (4 semesters)

MATH 431 - Real Analysis I Credits: 3

MATH 432 - Real Analysis II Credits: 3

MATH 441 - Abstract Algebra I Credits: 3

In consultation with a Department of Mathematics advisor, students should choose at least 6 credits from the following courses:

MATH 405 - Applied Mathematics Credits: 3

MATH 408 - Complex Analysis Credits: 3

MATH 426 - Mathematical Modeling in Biology Credits: 3

MATH 442 - Abstract Algebra II Credits: 3

MATH 475 - Geometry Credits: 3

MATH 487 - Special Topics in _____ Credits: 1–3

MATH 495 - Independent Study Credits: 1–3

MATH 497 - Research in Mathematics Credits: 0–3

STAT 340 - Probability Theory with Statistical Applications Credits: 3

Cognate Course—3

CPTR 151 - Computer Science I Credits: 3 or PHYS 235 - MATLAB Credits: 3

For Secondary Certification additional required courses are:

MATH 375 – Secondary School Mathematics Teaching Credits: 3

MATH 475 – Geometry Credits: 3

STAT 285 – Elementary Statistics Credits: 3

BS Mathematics Education (36 credits + teaching certification)

Required courses

MATH 191 - Calculus I Credits: 4 or MATH 195 - Calculus I for Biology Credits: 4

MATH 192 - Calculus II Credits: 4

MATH 215 - Introduction to Linear Algebra Credits: 3

MATH 240 - Calculus III Credits: 4

MATH 355 - Foundations of Advanced Mathematics Credits: 3

MATH 375 - Secondary School Mathematics Teaching Credits: 3

MATH 475 - Geometry Credits: 3

MATH 315 - Linear Algebra Credits: 3 or MATH 441 - Abstract Algebra I Credits: 3

MATH 286 - Differential Equations Credits: 3 or MATH 426 - Mathematical Modeling in Biology Credits: 3

MATH 389 - Mathematics Colloquium Credits: 0 or PHYS 277 - Physics Colloquium Credits: 0 (4 semesters)

STAT 285 - Elementary Statistics Credits: 3

STAT 340 - Probability Theory with Statistical Applications Credits: 3

Cognate Course—3 credits

CPTR 151 - Computer Science I Credits: 3 or PHYS 235 - MATLAB Credits: 3

Mathematical Studies Major (30 credits; non-degree major; must be taken as a second major)

Required courses:

MATH 191 - Calculus I Credits: 4 or MATH 195 - Calculus I for Biology Credits: 4

MATH 192 - Calculus II Credits: 4

MATH 215 - Introduction to Linear Algebra Credits: 3

MATH 240 - Calculus III Credits: 4

MATH 389 - Mathematics Colloquium Credits: 0 or PHYS 277 - Physics Colloquium Credits: 0 (4 semesters)

In consultation with a Department of Mathematics advisor, students will take at least 15 additional credits from the following courses:

MATH 286 - Differential Equations Credits: 3

MATH 315 - Linear Algebra Credits: 3

MATH 355 - Foundations of Advanced Mathematics Credits: 3

MATH 405 - Applied Mathematics Credits: 3

MATH 408 - Complex Analysis Credits: 3

MATH 426 - Mathematical Modeling in Biology Credits: 3

MATH 431 - Real Analysis I Credits: 3

MATH 432 - Real Analysis II Credits: 3

MATH 441 - Abstract Algebra I Credits: 3

MATH 442 - Abstract Algebra II Credits: 3

MATH 475 - Geometry Credits: 3

MATH 487 - Special Topics in _____ Credits: 1–3

MATH 495 - Independent Study Credits: 1–3

MATH 497 - Research in Mathematics Credits: 0–3

STAT 340 - Probability Theory with Statistical Applications Credits: 3

Cognate Course—3 credits

CPTR 151 - Computer Science I Credits: 3 or PHYS 235 - MATLAB Credits: 3

Course Sequencing

MATH MAJOR CLASS CYCLE*

Any semester: **STAT 285**

Prereq	EVEN Fall		
	MATH 191	Calculus I	12:30-13:20 MTWR
191	MATH 215	Intro to Linear Alg	14:00-15:15 MW
192	MATH 240	Calculus III	12:30-13:20 MTWR
286, 240	MATH 405	Applied Math	14:00-15:15 TR
355	MATH 475	Geometry	11:30-12:20 MWF
	ODD Spring		
	MATH 191	Calculus I	12:30-13:20 MTWR
191	MATH 192	Calculus II	12:30-13:20 MTWR
	MATH 195	Calculus I for Biology	10:30-11:20 MTWR
192	MATH 286	Differential Eqns	14:00-15:15 TR
191	MATH 355	Found of Adv Math	14:00-15:15 MW
355	MATH 375	Sec Sch Math Tch	16:15-17:30 TR
240, 355	MATH 408	Complex Analysis	15:30-16:45 MW
240, 355	MATH 441	Abstract Algebra I	10:30-11:20 MWF
191	STAT 340	Prob Theory/Stat	12:30-13:45 MW
	ODD Fall		
	MATH 191	Calculus I	12:30-13:20 MTWR
191	MATH 215	Intro to Linear Alg	14:00-15:15 MW
192	MATH 240	Calculus III	12:30-13:20 MTWR
	MATH 220	Geometry & Num	11:30-12:20 MWF
191	MATH 426	Math Model in Bio	14:00-15:15 TR
240, 355	MATH 431	Advanced Calc I	12:30-13:45 TR
	EVEN Spring		
	MATH 191	Calculus I	12:30-13:20 MTWR
191	MATH 192	Calculus II	12:30-13:20 MTWR
	MATH 195	Calculus I for Biology	10:30-11:20 MTWR
192	MATH 286	Differential Eqns	14:00-15:15 TR
191	MATH 355	Found of Adv Math	14:00-15:15 MW
215, 355	MATH 315	Linear Algebra	10:30-11:20 MWF
431	MATH 432	Advanced Calc II	12:30-13:45 TR
191	STAT 340	Prob Theory/Stat	12:30-13:45 MW

*This is not a guarantee but a courtesy summary.

Please refer to the bulletin and class schedule for updated information.

BS MATH MAJOR--start in Even Fall*

Required: 191, 192, 215, 240, 286, 315, 355, 431, 432, 441, 2 electives
Certification: 375, 475, **STAT 285** (any semester)
Any semester: **CPTR 151**
4 semesters: **MATH 389**

Prereq	even Fall			App Math	Sec Cert	Grad Sch	Custom
	MATH 191	Calculus I	12:30-13:20 MTWR	**191**	**191**	**191**	
	odd Spring						
191	MATH 192	Calculus II	12:30-13:20 MTWR	**192**	**192**	**192**	
191	MATH 355	Found of Adv Math	14:00-15:15 MW				
191	STAT 340	Prob Theory/Stat	12:30-13:45 MW	**340**			
	odd Fall						
191	MATH 215	Intro to Linear Alg	14:00-15:15 MW	**215**	**215**	**215**	
192	MATH 240	Calculus III	12:30-13:20 MTWR	**240**	**240**	**240**	
191	MATH 426	Math Model in Bio	14:00-15:15 TR				
	even Spring						
192	MATH 286	Differential Eqns	14:00-15:15 TR	**286**	**286**	**286**	
191	MATH 355	Found of Adv Math	14:00-15:15 MW	**355**	**355**	**355**	
215, 355	MATH 315	Linear Algebra	10:30-11:20 MWF				
191	STAT 340	Prob Theory/Stat	12:30-13:45 MW		**340**		
	even Fall						
191	MATH 215	Intro to Linear Alg	14:00-15:15 MW				
286, 240	MATH 405	Applied Math	14:00-15:15 TR	**405**	405	405	
355	MATH 475	Geometry	11:30-12:20 MWF	475	**475**	475	
	odd Spring						
192	MATH 286	Differential Eqns	14:00-15:15 TR				
355	MATH 375	Sec Sch Math Tch	15:30-16:45 TR		**375**		
191	STAT 340	Prob Theory/Stat	12:30-13:45 MW			340	
240, 355	MATH 408	Complex Analysis	14:00-15:15 MW	408	408	**408**	
240, 355	MATH 441	Abstract Algebra	10:30-11:20 MWF	**441**	**441**	**441**	
	odd Fall						
191	MATH 215	Intro to Linear Alg	14:00-15:15 MW				
191	MATH 426	Math Model in Bio	14:00-15:15 TR	426	426	426	
240, 355	MATH 431	Advanced Calc	15:30-16:45 TR	**431**	**431**	**431**	
	even Spring						
215, 355	MATH 315	Linear Algebra	10:30-11:20 MWF	**315**	**315**	**315**	
431	MATH 432	Advanced Calc	15:30-16:45 TR	**432**	**432**	**432**	
191	STAT 340	Prob Theory/Stat	12:30-13:45 MW				

*Note: This is not a guarantee but a courtesy summary. Please refer to the bulletin and class schedule for updated information.

BS MATH MAJOR--start in odd Fall*

Required: 191, 192, 215, 240, 286, 315, 355, 431, 432, 441, 2 electives
Certification: 375, 475, **STAT 285** (any semester)
Any semester: **CPTR 151**
4 semesters: **MATH 389**

Prereq	odd Fall			App Math	Sec Cert	Grad Sch	Custom
	MATH 191	Calculus I	12:30-13:20 MTWR	**191**	**191**	**191**	
	even Spring						
191	MATH 192	Calculus II	12:30-13:20 MTWR	**192**	**192**	**192**	
191	MATH 355	Found of Adv Math	14:00-15:15 MW				
191	STAT 340	Prob Theory/Stat	12:30-13:45 MW	**340**			
	even Fall						
191	MATH 215	Intro to Linear Alg	14:00-15:15 MW	**215**	**215**	**215**	
192	MATH 240	Calculus III	12:30-13:20 MTWR	**240**	**240**	**240**	
355	MATH 475	Geometry	11:30-12:20 MWF				
	odd Spring						
192	MATH 286	Differential Eqns	14:00-15:15 TR	**286**	**286**	**286**	
191	MATH 355	Found of Adv Math	14:00-15:15 MW	**355**	**355**	**355**	
191	STAT 340	Prob Theory/Stat	12:30-13:45 MW		**340**	340	
	odd Fall						
191	MATH 215	Intro to Linear Alg	14:00-15:15 MW				
355	MATH 426	Math Model in Bio	14:00-15:15 TR	426	426	426	
240, 355	MATH 431	Advanced Calc	15:30-16:45 TR	**431**	**431**	**431**	
	even Spring						
192	MATH 286	Differential Eqns	14:00-15:15 TR				
215, 355	MATH 315	Linear Algebra	10:30-11:20 MWF	**315**	**315**	**315**	
431	MATH 432	Advanced Calc	15:30-16:45 TR	**432**	**432**	**432**	
191	STAT 340	Prob Theory/Stat	12:30-13:45 MW				
	even Fall						
191	MATH 215	Intro to Linear Alg	14:00-15:15 MW				
286, 240	MATH 405	Applied Math	14:00-15:15 TR	**405**	405	405	
355	MATH 475	Geometry	11:30-12:20 MWF	475	**475**	475	
	odd Spring						
355	MATH 375	Sec Sch Math Tch	15:30-16:45 TR		**375**		
240, 355	MATH 408	Complex Analysis	14:00-15:15 MW	408	408	**408**	
240, 355	MATH 441	Abstract Algebra	10:30-11:20 MWF			**441**	
191	STAT 340	Prob Theory/Stat	12:30-13:45 MW				

*Note: This is not a guarantee but a courtesy summary. Please refer to the Bulletin and class schedule for updated information.

BS MATH EDUCATION--Start in EVEN Fall*

Required:	191, 192, 215, 240, 355, 375, 475, S285, S340; 315 or 441; 286 or 426;	
Any semester:	**CPTR 151**	
Any semester:	**STAT 285**	
Four semesters:	**MATH 389**	

Prereq	even Fall			Sec
	MATH 191	Calculus I	12:30-13:20 MTWR	**191**
	odd Spring			
191	MATH 192	Calculus II	12:30-13:20 MTWR	**192**
191	STAT 340	Prob Theory/Stat	12:30-13:45 MW	
	odd Fall			
191	MATH 215	Intro to Linear Alg	14:00-15:15 MW	**215**
192	MATH 240	Calculus III	12:30-13:20 MTWR	**240**
	even Spring			
192	MATH 286	Differential Eqns	14:00-15:15 TR	**286**
191	MATH 355	Found of Adv Math	14:00-15:15 MW	**355**
191	STAT 340	Prob Theory/Stat	12:30-13:45 MW	
	even Fall			
191	MATH 215	Intro to Linear Alg	14:00-15:15 MW	
355	MATH 475	Geometry	11:30-12:20 MWF	**475**
	odd Spring			
192	MATH 286	Differential Eqns	14:00-15:15 TR	
355	MATH 375	Sec Sch Math Tch	15:30-16:45 TR	**375**
240, 355	MATH 441	Abstract Algebra	10:30-11:20 MWF	**441**
191	STAT 340	Prob Theory/Stat	12:30-13:45 MW	
	odd Fall			
191	MATH 215	Intro to Linear Alg	14:00-15:15 MW	
192	MATH 240	Calculus III	12:30-13:20 MTWR	
	MATH 220	Geometry & Num	11:30-12:20 MWF	
355	MATH 426	Math Model in Bio	14:00-15:15 TR	
	even Spring			
192	MATH 286	Differential Eqns	14:00-15:15 TR	
215, 355	MATH 315	Linear Algebra	10:30-11:20 MWF	
191	STAT 340	Prob Theory/Stat	12:30-13:45 MW	**340**

*Note: This is not a guarantee but a courtesy summary.
Please refer to the bulletin and class schedule for updated information.

BS MATH EDUCATION--Start in odd Fall*

Required:
Any semester: **CPTR 151**
Any semester: **STAT 285**
4 semesters: **MATH 389**

Prereq	odd Fall			Courses
	MATH 191	Calculus I	12:30-13:20 MTWR	**191**
	even Spring			
191	MATH 192	Calculus II	12:30-13:20 MTWR	**192**
191	STAT 340	Prob Theory/Stat	12:30-13:45 MW	
	even Fall			
191	MATH 215	Intro to Linear Algebra	14:00-15:15 MW	
192	MATH 240	Calculus III	12:30-13:20 MTWR	**240**
	odd Spring			
192	MATH 286	Differential Eqns	14:00-15:15 TR	**286**
191	MATH 355	Found of Adv Math	14:00-15:15 MW	**355**
191	STAT 340	Prob Theory/Stat	12:30-13:45 MW	
	odd Fall			
191	MATH 215	Intro to Linear Algebra	14:00-15:15 MW	**215**
192	MATH 240	Calculus III	12:30-13:20 MTWR	
	MATH 220	Geometry & Numbers	11:30-12:20 MWF	
191	MATH 426	Math Model in Biology	14:00-15:15 TR	
	even Spring			
192	MATH 286	Differential Eqns	14:00-15:15 TR	
215, 355	MATH 315	Linear Algebra	10:30-11:20 MWF	**315**
191	STAT 340	Prob Theory/Stat	12:30-13:45 MW	**340**
	even Fall			
192	MATH 240	Calculus III	12:30-13:20 MTWR	
355	MATH 475	Geometry	11:30-12:20 MWF	**475**
	odd Spring			
192	MATH 286	Differential Eqns	14:00-15:15 TR	
355	MATH 375	Sec Sch Math Tch	15:30-16:45 TR	**375**
240, 355	MATH 441	Abstract Algebra	10:30-11:20 MWF	
191	STAT 340	Prob Theory/Stat	12:30-13:45 MW	

*Note: This is not a guarantee but a courtesy summary.

BS Mathematics major with Physics minor
A sample schedule of classes (starting in an even Fall)

First-year:

	Fall		Spring
MATH191 Calculus I	4	MATH192 Calculus II	4
RELT100 God and Human Life	3	Life Science general	4
ENGL115 English Comp I	3	ENGL215 English Comp II	3
HIST117 Civ and Ideas	3	INFS120 Foundations of Info.	3
Fine Arts/Humanities general	3	BHSC100 Philosophy of Service	2
MATH389 Colloquium	0	MATH389 Colloquium	0
	16		**16**

Second-year:

	Fall		Spring
MATH240 Calculus III	4	MATH286 Differential Equations	3
MATH389 Colloquium	0	MATH355 Found of Adv Math	3
PHYS241 Physics for Scientists	4	MATH389 Colloquium	0
PHYS271 Physics Lab	1	PHYS242 Physics for Scientists	4
PHYS235 MATLAB	3	PHYS272 Physics Lab	1
COMM104 Communication	3	Religion general	3
HLED120 Fit for Life	1	Fitness general	1
	16		**15**

Third year:

	Fall		Spring
MATH405 Applied Math	3	STAT340 Probability Theory	3
MATH475 Geometry	3	MATH408 Complex Analysis	3
MATH389 Colloquium	0	MATH441 Abstract Algebra	3
PHYS411 Theoretical Mechanics	2.5	MATH389 Colloquium	0
PHYS412 Theoretical Mechanics	2.5	Physics minor elective	2.5
Religion general	3	HIST118 Civ and Ideas	3
BHSC300 Service Fieldwork	2	Fitness general	1
	16		**15.5**

Fourth year:

	Fall		Spring
MATH215 Intro to Linear	3	MATH315 Linear Algebra	3
MATH431 Adv. Calc I	3	MATH432 Adv. Calc II	3
MATH426 Math Modeling	3	MATH389 Colloquium	0
MATH389 Colloquium	0	Fine Arts/Humanities general	3
Physics minor elective	2.5	Social Science general	3
Social Science general	3	Religion general	3
Fitness general	1		
	15.5		**15**

BS Mathematics Education major with Physics minor for secondary certification

A sample schedule of classes (starting in an even Fall)

First-year:	Fall
MATH191 Calculus I	4
RELT100 God and Human Life	3
INFS120 Found. of Info. Tech.	3
ENGL115 College Writing I	3
Social Science general	3
	16

	Spring
MATH192 Calculus II	4
CPTR151 Intro. to Cptr. Prog.	3
EDTE165 Phil. & Soc. Fnd. of Ed.	4
ENGL215 College Writing II	3
HLED120 Fit for Life	1
	15

Second-year:	Fall
MATH240 Calculus III	4
MATH215 Intro. To Linear Alg.	3
MATH389 Colloquium	0
PHYS241 Physics for Scientists	4
PHYS271 Physics Lab	1
EDTE228 Except. & Div. Learners	3
	15

	Spring
MATH286 Differential Equations	3
MATH355 Found of Adv Math	3
MATH389 Colloquium	0
PHYS242 Physics for Scientists	4
PHYS272 Physics Lab	1
EDPC302 Educ. Psychology	3
Fitness Education general	1
	15

Third year:	Fall
MATH475 Geometry	3
MATH389 Colloquium	0
PHYS411 Theoretical Mechanics	2.5
PHYS412 Theoretical Mechanics	2.5
Life Science general	4
HIST117 Civilizations & Ideas I	3
	15

	Spring
MATH375 Sec. School Math Tch.	3
MATH441 Abstract Algebra	3
MATH389 Colloquium	0
PHYS430 Thermodynamics	2.5
EDTE408 Prin. of Tch. & Learn.	3
HIST118 Civilizations & Ideas II	3
Fitness Education general	1
	15.5

Fourth year:	Fall
STAT285 Elementary Statistics	3
MATH389 Colloquium	0
EDTE424 Clsrm. Testing & Eval.	2
EDTE459 Methods (Sec. Area)	3
EDTE476 Integrating Inst. Tech.	2
COMM450 Comm. in the Clsrm	3
RELT225 Doctr. of Adv. Faith	3
	16

	Spring
STAT340 Probability Theory	3
MATH389 Colloquium	0
Physics minor elective	2.5
EDTE417 Teaching Reading…	3
Religion general	3
Fine Arts/Humanities general	3
	14.5

Summer:

HIST400 SDA History & Proph…	3

Fifth year:	Fall
EDTE480 First Days of School	2
EDTE487 Student Teaching Sem.	1
EDTE488 Student Teaching--Sec.	13
	16

(completed in the summer)

For all: Don't forget to schedule in CPTR151 and STAT285 if needed.

Under-prepared: A major who is not calculus-ready needs an extra year. Catch-up is theoretically possible but not advisable unless the student is strong. In particular, unless a student takes Calculus II in the summer then he/she would be advised to wait until Second-year Fall to take Calc I so the class can be in sequence and from the same textbook as Calc II and III. ← Recommended: MATH168 in the fall and CPTR151 in the spring.

Strong: It is not recommended for students to try to complete a major in less than four years (unless they come in with a full year of calculus credit). This will result in missing 1 or more classes that a strong student should definitely take. ← Recommended: take additional classes, math or otherwise

APPENDIX 7: CURRICULUM BENCHMARKING

Table 20. Courses required for BS Mathematics compared to those of benchmark institutions. Based on 2015-2016 bulletins.

Andrews (required)	**W&M BS standard concentration**	**WWU BS grad school prep concentration**	**Arizona BS comprehensive concentration**
MATH191 (or MATH195) Calc I (bio)	x	x	x
MATH192 Calculus II	x	x	x
MATH215 Intro to Linear Algebra	x	x	x
MATH240 Calculus III	x	x	x
MATH286 Differential Equations		x	x
MATH315 Linear Algebra	[1]	x	x
MATH355 Foundations Advanced Math	x	x	x
MATH389 Colloquium		x	
MATH431 Real Analysis I	x	x	x
MATH432 Real Analysis II		x	x
MATH441 Abstract Algebra I	x	x	x[2]
Cognate: Comp programming language	x	x	x
Students bound for math PhD programs are advised by Andrews faculty mentors to take the follow courses:			
MATH408 Complex Analysis	[1]		x
MATH442 Abstract Algebra II	[1]	x	x[3]
MATH405 Applied Mathematics	[1]		
MATH426 Mathematical Modeling[4]	[1]		
MATH497 Research in Mathematics	Honors (req)		

[1]From 2015-2016 W&M Catalog: "Students wishing to obtain a deeper understanding of mathematics (e.g., in preparation for graduate school) should take additional upper-division courses. Second courses to make year-long sequences in linear algebra, analysis, abstract algebra, numerical analysis, statistics, or operations research are particularly recommended."
[2]From 2015-2016 Arizona Catalog: or 400-level ODE course
[3]From 2015-2016 Arizona Catalog: or 400-level PDE course
[4]Taught as a research methods capstone course preparing students for PhD studies in math and science

APPENDIX 8: NCATE ACCREDITATION

NATIONAL RECOGNITION REPORT
Initial Preparation of Mathematics Education Teachers at the Secondary Level (2003 Standards)

NCATE recognition of this program is dependent on the review of the program by representatives of the National Council of Teachers of Mathematics (NCTM).

COVER PAGE

Name of institution

Andrews University School of Education, MI

Date of review

MM	DD	YYYY
08	01	2013

PART G - DECISIONS

Please select final decision:

◉ **National Recognition**. The program is recognized through the semester and year of the institution's next NCATE accreditation decision in 5-7 years. **To retain recognition, another program report must be submitted mid-cycle (2 years in advance for a 5-year cycle and 3 years in advance for a 7-year cycle) before the next scheduled accreditation visit.** The program will be listed as nationally recognized through the semester of the next NCATE accreditation decision on websites and/or other publications of the SPA and NCATE. The institution may designate its program as nationally recognized by NCATE, through the semester of the next NCATE accreditation decision, in its published materials. National recognition is dependent upon NCATE accreditation. *Please note that once a program has been nationally recognized, it may not submit another report addressing any unmet standards or other concerns cited in the recognition report.*

APPENDIX 9: PROGRAM OUTCOMES BENCHMARKING

Table 21. Program outcomes compared to those of benchmarks. We were not able to obtain student learning outcomes for William and Mary.

Andrews Program Outcomes	William & Mary	Walla Walla	Arizona
Demonstrate breadth and depth in their grasp of undergraduate mathematics (BS Math, BS Math Ed, Math Studies)		x	x
Conduct research projects, write papers, and make presentations (BS Math, Math Studies)		x	
Be successful in obtaining employment or acceptance into graduate or professional programs (BS Math, BS Math Ed, Math Studies)		x	
Be successful in completing the first year of grad school and eventually a master's or doctoral degree (those who enter graduate programs)		x	
Demonstrate a commitment to Jesus, the Seventh-day Adventist Church, and service to others (BS Math, BS Math Ed, Math Studies)			
Participate in teaching-related work experience outside of their classroom experiences (BS Math Ed)*			
Demonstrate a good understanding of the mathematics they are teaching and the ability to communicate it clearly (BS Math Ed)			x

*Occurs during the student teaching semester.

Program Outcomes
Walla Walla University Department of Mathematics
(Revised 1 June 2015; source: Jonathan Duncan, Chair)

Upon completion of the Mathematics Major at Walla Walla University, students will:

- understand mathematical principles in the areas of Calculus, Algebra, and Applied Mathematics.
- carry out an independent research project and produce high-quality oral and written reports.
- successfully transition to the next step in their career or education. In particular:
    - students who obtain secondary certification in mathematics will secure a secondary teaching position.
    - students who apply to graduate and professional programs will be accepted and receive financial support, where available.

    - students who wish to work in applied mathematics or actuarial science will successfully obtain positions related to their field.

- be satisfied with the quality of the mathematics program.

Program Outcomes
University of Arizona Department of Mathematics
(Accessed 22 June 2016; source: http://assessment.arizona.edu/sci/Mathematics%20Undergrad)

- Define mathematical terms precisely.
- Recognize when arguments are valid, and identify logical gaps and flaws.
- Create valid proofs.
- Critically evaluate and extend selected mathematical models in the current scientific literature.
- Apply computational methods and mathematical concepts from to analyze scientific problems
- Effectively communicate results to non-specialized audiences in written and verbal form

APPENDIX 10: ASSESSMENT REPORT FOR 2014-2015

Andrews University

Detailed Assessment Report

2014-2015 Mathematics and Mathematics Education, BS

As of: 8/09/2016 04:01 PM EST

Mission

Mission / Purpose

The Andrews University Department of Mathematics' statement of mission:

Through teaching, research, and service, the Department of Mathematics seeks to provide leadership in the mathematical sciences by:

preparing students with the mathematical understanding, problem-solving skills, and dispositions that enable them to excel in their chosen careers;

increasing mathematical and scientific knowledge through publication and presentation;

supporting the broader mathematics education community and mentoring others for generous service through a committed Christian life.

Objective Sort

Goals SLOs

Student Learning Outcomes/Objectives, with Any Associations and Related Measures, Targets, Findings, and Action Plans

SLO 1: Demonstrate Knowledge of Mathematics

Math majors will demonstrate breadth and depth in their grasp of undergraduate mathematics.

Relevant Associations:

Andrews Mission/Goal Associations

1.2 Demonstrate the ability to think clearly and critically

1.5 Demonstrate competence in their chosen disciplines and professions

Related Measures

M 2: Major Field Test Scores

Major Field Test scores

(As of the 2013-14 bulletin, we will no longer require Mathematics Studies majors to take the MFT, but BS Math and BS Math Ed majors will still be required to take the test.)

Source of Evidence: Standardized test of subject matter knowledge

Target:

50th Percentile (about 155/200) or higher on the Major Field Test

Finding (2014-2015) - Target: Partially Met

Ten students took the MFT during the 2014-15 school year. Scores ranged from a high of 170/200 to a low of 133/200. Only two of the students did not reach the goal of attaining 150 or higher on the test. The mean for the scores was 156.1.

Connected Documents

Assessment Table 2014-15
Major Field Test 2014-15

M 3: ETS Proficiency Profile

Standardized test given to all seniors at AU. The test gives the results for the majors from the different departments and ranks them to other departments and national norms.

Source of Evidence: Standardized test of subject matter knowledge

Target:

The main use of this measure is to see how our students' preformances match those of other AU departments and national norms.

Finding (2014-2015) - Target: Met

The mean total score was 451.1/500 for the entire student group taking the test at Andrews, **472.33** for mathematics majors (21.23 **higher**), with Skills subscores of 114.57 for Critical Thinking, **115** for mathematics majors (~**same**); 120.21 for Reading, **124** for mathematics majors (3.79 **higher**); 115.37 for writing, **120** for mathematics majors (4.63 **higher**); and 115.39 for mathematics,**125** for mathematics majors (9.61 **higher**). For the Context-based subscores the mean for the entire student group is 117.23 for Humanities, **121** for mathematics majors (3.77 **higher**); 115.34 for Social Sciences, **121.**67 for mathematics majors (6.33 **higher**); and 117.73 for Natural Sciences, **121** for mathematics majors (3.27 **higher**). The overall mean for mathematics was higher than any other major's mean.

Connected Document

Assessment Table 2014-15

M 4: Student Teaching (Math Ed)

Student teacher internship

Source of Evidence: Field work, internship, or teaching evaluation

Target:

Students should attain 3 or higher on a 5-point scale for items 3 and 4 on the Andrews University/Mathematics Department Student Teaching Evaluation Form. 1=Unsatisfactory 2=Emerging 3=Satisfactory 4= Proficient 5= Exceptional.

Finding (2014-2015) - Target: Met

Our two Math Ed student teachers had averages of 81.5 and 81 on the questions (with scores ranging from 1 (unsatisfactory) to 5 (exceptional) The mentor teacher and university supervisors were very pleased. and all scores were 4 or higher for both students.

Connected Document

Assessment Table 2014-15

M 5: MTTC (Math Ed)

Michigan Test for Teacher Certification in Mathematics

Source of Evidence: Certification or licensure exam, national or state

Target:

100% of students will pass the MTTC Basic Skills Test and or Content area Test with a 220 minimum score or higher. 85% of students will pass with a 260 or higher.

Finding (2014-2015) - Target: Not Reported This Cycle

No data is yet available from the School of Education. Both teachers passed the test, but exact score are unknown at this time.

Connected Document

Assessment Table 2014-15

M 9: Alumni Survey

This survey looks at graduates and tracks the number of students entering a graduate program, those completing the first year, and those seeking to pursue a master's or doctorial program.

Source of Evidence: Graduate/professional school acceptance rate

Target:

3 or higher on a 5 point scale (3 = neutral, 4 = agree, and 5= strongly agree).

Finding (2014-2015) - Target: Not Reported This Cycle

Survey results are not yet available.

M 10: Cohort Data for Core Courses

Looking at final test scores for majors in four core courses (Calculus I, Calculus II, Calculus II, and Introduction to Linear Algebra), we will determine the success of our program in having at least 75% of the students achieve a 75% or higher in each of these courses.

Source of Evidence: Faculty pre-test / post-test of knowledge mastery

Target:

On the final test scores for majors in four core courses (Calculus I, Calculus II, Calculus

II, and Introduction to Linear Algebra), at least 75% of math majors will achieve a 75% or higher in each of these courses.

Finding (2014-2015) - Target: Partially Met

BS Math majors--only in Calc I did 75% have 75% or higher, although the class averages in all the classes were higher than 75%. BS Math Ed majors--only in Intro to Linear Algebra did the students meet the goal. Math Studies majors--the goal was not met in any subject.

Connected Documents

5-year Cohort Results 2010-2015
Assessment Table 2014-15

SLO 2: Conduct Research Projects (BS Math and Math Studies)

BS Math and Math Studies majors will conduct math-related research projects, write papers, and make presentations during their college years at Andrews

Relevant Associations:

Andrews Mission/Goal Associations

1.1 Engage in intellectual discovery and inquiry

1.2 Demonstrate the ability to think clearly and critically

1.3 Communicate effectively

1.5 Demonstrate competence in their chosen disciplines and professions

2.3 Demonstrate personal and moral integrity

3.1 Engage in creative problem solving and innovation

Related Measures

M 1: Research Project

Number of BS Math and Math Studies graduates who participated in research projects or REUs and/or gave presentations during their college years at Andrews.

Source of Evidence: Senior thesis or culminating major project

Target:

At least 75% of BS Math and Math Studies majors will have conducted research and/or made a presentation on that research during their college career at Andrews.

Finding (2014-2015) - Target: Met

Nine of twelve graduates conducted research or gave presentations during their college years at Andrews.

Connected Documents

Assessment Table 2014-15
Presentations and Research 2014-15

SLO 3: Teach Clearly (Math Ed)

Math education majors will demonstrate a good understanding of the mathematics they are teaching and the ability to communicate it clearly.

Relevant Associations:

Andrews Mission/Goal Associations

1.3 Communicate effectively

1.5 Demonstrate competence in their chosen disciplines and professions

Related Measures

M 4: Student Teaching (Math Ed)

Student teacher internship

Source of Evidence: Field work, internship, or teaching evaluation

Target:

Students should attain 3 or higher on a 5-point scale for items 5-8 on the Andrews University/Mathematics Department Student Teaching Evaluation Form. 1=Unsatisfactory 2=Emerging 3=Satisfactory 4= Proficient 5= Exceptional.

Finding (2014-2015) - Target: Met

All scores were 4 or higher for both students.

Connected Document

Assessment Table 2014-15

M 5: MTTC (Math Ed)

Michigan Test for Teacher Certification in Mathematics

Source of Evidence: Certification or licensure exam, national or state

Target:

All math education majors will pass MTTC exam.

Finding (2014-2015) - Target: Met

Both students passed the MTTC exam.

Connected Document

Assessment Table 2014-15

SLO 4: Complete First Year in Post-undergraduate Education

Mathematics graduates will be successful in completing the first year of their graduate or professional program.

Other Objectives

Other Outcomes/Objectives, with Any Associations and Related Measures, Targets, Findings, and Action Plans

O/O 4: Job or Graduate Placement

Math majors will be successful in obtaining employment or acceptance into graduate or professional programs.

Connected Document

BLS Outlook on Selected Jobs for Mathematicians

Relevant Associations:

Andrews Mission/Goal Associations

1.5 Demonstrate competence in their chosen disciplines and professions

4 Job Placement Information

Related Measures

M 6: Department Exit Interview

All graduating senior math majors answer questions in an oral interview with a professor. Of note are Senior Exit Interview questions:

#5 Would you like to comment on how your time at Andrews affected your spiritual growth.

#7 What are your plans for the future?

Source of Evidence: Exit interviews with grads/program completers

Target:

All mathematics and mathemtical studies majors will achieve this goal.

Finding (2014-2015) - Target: Partially Met

Four of the twelve graduates are headed graduate school. Another is teaching school for the summer and will then return to Andrews to work while waiting for her fiancé to finish so that the two of them can attend graduate school. So 5 of 12 are heading to graduate school. Of the other 7, 5 are looking for jobs (two have a summer internship), and two have no definite plans.

Connected Documents

Assessment Table 2014-15
Department Exit Questionnaire 2014-15
Department Exit Questionnaire 2014-15 (online)

O/O 5: Commitment to Jesus & SDA Church

The faculty of the Department of Mathematics will model and support math majors in demonstrating commitment to Jesus, the Seventh-day Adventist Church, and service to others in their personal lives, classrooms, and walk with Christ.

Connected Document

Department Exit Questionnaire 2009-2011

Relevant Associations:

Andrews Mission/Goal Associations

1.1 Engage in intellectual discovery and inquiry

1.2 Demonstrate the ability to think clearly and critically

1.3 Communicate effectively

1.4 Understand life, learning, and civic responsibility from a Christian point of view

2.1 Develop a personal relationship with Jesus Christ

2.2 Deepen their faith commitment and practice

2.3 Demonstrate personal and moral integrity

2.4 Embrace a balanced lifestyle, including time for intellectual, social, spiritual, and physical development

2.5 Apply understanding of cultural differences in diverse environments

3.1 Engage in creative problem solving and innovation

3.2 Engage in generous service to meet human needs

3.4 Engage in activities consistent with the worldwide mission of the Seventh-day Adventist church

Related Measures

M 6: Department Exit Interview

All graduating senior math majors answer questions in an oral interview with a professor. Of note are Senior Exit Interview questions:

#5 Would you like to comment on how your time at Andrews affected your spiritual growth.

#7 What are your plans for the future?

Source of Evidence: Exit interviews with grads/program completers

Target:

We have chosen not to set measurable criteria for this goal.

Finding (2014-2015) - Target: Met

Student answered positively in most cases. Some sample responses are

Being in the department has impacted my spiritual life positively.

I was able to grow and develop spiritually in many different ways. The main thing was discovering my own spirituality and what I believe for myself.

I not a particularly spiritual individual. However, the physics and math students at Andrews provided me with many great conversations about philosophy and theology that were very interesting. There should be more classes like “Physics and Faith” for other disciplines.

My time at Andrews has taught me how to have an open mind to those whose beliefs differ from mine.

Though I now have more questions than when I began, my time at Andrews has taught me what it means to be a Christian, to live as a stranger in the world, choosing to reflect the values of a better kingdom until it comes by following Jesus' example, even if that means great suffering and feeling powerless in the face of evil and violence.

I think a more accurate statement would be that being at Andrews is what made my spiritual growth possible.

Connected Documents

Assessment Table 2014-15
Department Exit Questionnaire 2014-15
Department Exit Questionnaire 2014-15 (online)

M 7: Department Exit Questionnaire

Graduating seniors anonymously fill out an exit questionnaire with 16 questions covering different areas of the mathematics program, including how being a part of the department affected their academic and spiritual lives. Of note are questions:

7 I understand how the Christian faith and ethics relate to my professional area.

9 The faculty in this program were a positive influence on my spirtual growth.

Students rate the aspects on a scale of 1 to 5:

1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly agree

Source of Evidence: Exit interviews with grads/program completers

Target:

We have chosen not to set specific numerical targets.

Finding (2014-2015) - Target: Met

Of the eleven respondents, on question 7, the mean was 4.47. On Question 9, the mean score for eleven respondents was 4.31.

Connected Documents

Assessment Table 2014-15
Department Exit Questionnaire 2014-15
Department Exit Questionnaire 2014-15 (online)

M 8: AU Senior Survey

This survey is given to all AU graduating seniors to evaluate the impact that the university has had on various aspects of the academic, personal, and spiritual life. This

survey will give us a comparison for answers students give us on our department exit questionnaire.

Responses are given with the following scales:

Mean is on a 1-5 point scale.

Mission: 1 very little, 3 moderately, and 5 very much.

Major: 1 strongly disagree, 3 neutral, and 5 strongly agree.

Spiritual Commitment: 1 do not keep, 3 keep when convenient, and 5 Keep.

Source of Evidence: Evaluations

Connected Document

BLS Outlook on Selected Jobs for Mathematicians

Target:

Students will place a 3 or higher rating on the 5-point scale.

Finding (2014-2015) - Target: Met

Again, the mean scores were lower than for the department survey but with only four respondents instead of ten. Mean scores on the Mission section ranged from 3.00 to 3.75 and 3.00 to 4.50 on Spiritual Commitment, the highest being To observe the seventh-day Sabbath and live a lifestyle that promotes physical health, the lowest being to support world evangelism through personal participation or financial contribution.

Connected Documents

Assessment Table 2014-15
Senior Survey 2014-15

O/O 6: Program Quality

The program quality of the department of mathematics will be determined by how students perform in classes, on standardized tests, in outside research projects, in attaining jobs and/or graduate school enrollment, and in their ability to live a Christian life of service in diverse cultures.

Connected Documents

Department Exit Questionnaire 2009-2011
Math data driven changes fall 2012
Math Graduation rates
Math Road Map (2013-14)
Senior Exit Exam 2010-11
Senior Survey 3-year Comparison 2008-2011

Relevant Associations:

Andrews Mission/Goal Associations

1.1 Engage in intellectual discovery and inquiry

1.2 Demonstrate the ability to think clearly and critically

1.3 Communicate effectively

1.4 Understand life, learning, and civic responsibility from a Christian point of view

1.5 Demonstrate competence in their chosen disciplines and professions

2.1 Develop a personal relationship with Jesus Christ

2.2 Deepen their faith commitment and practice

2.3 Demonstrate personal and moral integrity

2.4 Embrace a balanced lifestyle, including time for intellectual, social, spiritual, and physical development

2.5 Apply understanding of cultural differences in diverse environments

3.1 Engage in creative problem solving and innovation

3.2 Engage in generous service to meet human needs

3.3 Apply collaborative leadership to foster growth and promote change

3.4 Engage in activities consistent with the worldwide mission of the Seventh-day Adventist church

4 Job Placement Information

Related Measures

M 7: Department Exit Questionnaire

Graduating seniors anonymously fill out an exit questionnaire with 16 questions covering different areas of the mathematics program, including how being a part of the department affected their academic and spiritual lives. Of note are questions:

7 I understand how the Christian faith and ethics relate to my professional area.

9 The faculty in this program were a positive influence on my spirtual growth.

Students rate the aspects on a scale of 1 to 5:

1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly agree

Source of Evidence: Exit interviews with grads/program completers

Target:

3 or higher on a 5 point scale (3 = neutral, 4 = agree, and 5= strongly agree).

Finding (2014-2015) - Target: Partially Met

All responses were 3 or higher except one student who, on question 3, gave a response

of 2 for the program being broad enough in scope; one student gave the department a 1 on question 6 ("As I face the job market or graduate school, I believe that I am as well prepared academically as similar graduates from other schools"); one response to question 10 was a 2 ("One or more faculty took a personal interest in me"); two responses were a 2 on question 13 about course scheduling; and one response was a 2 on question 16 ("There is a team spirit of friendliness and support among the faculty and students in this program").

Connected Documents

Assessment Table 2014-15
Department Exit Questionnaire 2014-15
Department Exit Questionnaire 2014-15 (online)

M 8: AU Senior Survey

This survey is given to all AU graduating seniors to evaluate the impact that the university has had on various aspects of the academic, personal, and spiritual life. This survey will give us a comparison for answers students give us on our department exit questionnaire.

Responses are given with the following scales:

Mean is on a 1-5 point scale.

Mission: 1 very little, 3 moderately, and 5 very much.

Major: 1 strongly disagree, 3 neutral, and 5 strongly agree.

Spiritual Commitment: 1 do not keep, 3 keep when convenient, and 5 Keep.

Source of Evidence: Evaluations

Connected Document

BLS Outlook on Selected Jobs for Mathematicians

Target:

The overall responses will be 3 or higher on the 5-point scale.

Finding (2014-2015) - Target: Met

The mean responses were all above a 3, with the lowest being 3.25 (I would recommend this program to a friend) and the highest being 4.67 (Faculty were aware of new developments in their field or discipline).

Connected Documents

Assessment Table 2014-15
Senior Survey 2014-15

Goal Sort Action Plan Details //YB 06/05/2014 original Analysis Questions //YB

Details of Action Plans for This Cycle (by Established cycle, then alpha)

Admission screening and support system

1. We will discuss the possibility of an admission screening process.
2. Develop a support system and identify weak students early.

Established in Cycle: 2009-2010
Implementation Status: In-Progress
Priority: High

Projected Completion Date: 04/27/2011

Require Eigen attendance

Require all math majors to attend Eigen

Established in Cycle: 2009-2010
Implementation Status: Finished
Priority: High
Implementation Description: We voted to require four semesters eigen attendance.
Projected Completion Date: 10/17/2010

Revise targets

We need to revise the current measurement goals.

Established in Cycle: 2009-2010
Implementation Status: In-Progress
Priority: High

Relationships (Measure | Outcome/Objective):
Measure: Research Project | **Outcome/Objective:** Conduct Research Projects

Projected Completion Date: 04/28/2011

Revise targets, require presentations and Eigen

1. We need to revise our current measurement goals.
2. Require students to do presentations in their classes(e.g., Math 355, 375 or Math 475) or for Eigen.
In particular, consider how to encourage Pi Mu Epsilon members to give a talk.
3. In Oct 18th meeting, we required math majors and math ed majors to attend Eigen for four semesters.

Established in Cycle: 2009-2010
Implementation Status: In-Progress
Priority: High

Projected Completion Date: 04/28/2011

Ways to foster spiritual growth

Discuss ways to foster spiritual growth in department. Look at Senior Exit Interview question #5 and assess how it applies to demonstrating commitment to Jesus & the SDA church.

Established in Cycle: 2009-2010
Implementation Status: Planned
Priority: Medium

Relationships (Measure | Outcome/Objective):
Measure: Department Exit Questionnaire | **Outcome/Objective:** Commitment to Jesus & SDA Church

Revamping of several areas of the department assessment

In the next few months we will be looking at a better way to assess the department's and students' success.

Established in Cycle: 2011-2012
Implementation Status: Planned
Priority: High

Projected Completion Date: 04/27/2013

MATH168 success rates

After several semesters in which a higher than expected number of students underperformed or failed MATH 168 (Precalculus), we collected data from six semesters (Fall 2009 to Spring 2012) to find out 1) if the class size or room type had an effect on student performance, 2) if MPE scores were good indicators of potential success, 3) if success or failure correlated somehow to specific majors, and 4) if repeatedly taking the class yielded success.

The data collected from the six semesters included majors, class grade, MPE scores, gender, year in school, SAT/ACT scores, and number of times they'd taken the course.

Established in Cycle: 2012-2013
Implementation Status: In-Progress

Priority: High
Implementation Description: We split the class into two sections (24 and 30 students) and moved the venue from the Chemistry amphitheatre back to the Math classrooms. Both teachers use problem sessions (Dr. Kang for an hour once a week on Fridays and Mr. Vence every day for 1/2 hour before class). Both professors urge their students to utilize the Math Center. Also, after this semester students will need a P3 to take the class.

MPE/SAT/ACT score correlations

Because advisers wanted to be able to register students for classes before fall when the department offered the Mathematics Placement Exam (MPE) to new students, we looked into the possibility of assigning MPE scores based on the students SAT/ACT scores. Another factor was that Griggs University joined with Andrews University and needed a way to administer the MPE to students taking their AU distance learning courses. To that end, we ran data comparing SAT, ACT, and MPE scores to each other and found a good correlation. Now Banner automatically converts ACT math and SAT math scores to MPE scores, with the following conversion:

E0 = 200-470, <20

P2 = 480-500; 20-21

P3 = 510-530; 22-23

P4 = 540-570; 24-25

P5 =580-800; >=26

Students with E0 scores can retake the MPE at one of the preset dates, and students wishing to raise their scores can do the same.

Established in Cycle: 2012-2013
Implementation Status: Finished
Priority: High

DEPARTMENT OF MATHEMATICS

Text by Shandelle Henson, department chair / Photos by Karen Johnson-McWilliams

◀Dr. Joon Hyuk Kang, Dr. Yun Myung Oh, Dr. Lynelle Weldon, Dr. Shandelle Henson, and Dr. Robert Moore enjoy celebrating the graduation of Belinda Cheesboro, Physics and Mathematics Studies major.

WHAT DOES IT mean for an academic to follow the way of Jesus in the twenty-first century? What does it mean for an academic mathematician or scientist to love God with the whole mind? Our department pondered these questions in our August 2014 departmental retreat and throughout the 2014-2015 school year. These are deep questions requiring lifelong reflection. I do not know the whole answer, but I have been thinking about the following points:

First, loving God with the mind means that Christian academics must decide intentionally to behave as Christians in our dealings with students, staff, colleagues, and administrators. This may seem obvious, but it is completely nontrivial to anyone who takes the Sermon on the Mount seriously. There is much to consider here, especially regarding the role of boundaries, discipline, and accountability in the compassionate mentoring of students.

Second, loving God with the mind means being the best teachers and mentors possible as we challenge students to appreciate the world of ideas and nature and as we prepare them for future success. While leading students to the current limits of human knowledge, we are pastors who affirm not only the joy and freedom of learning but also the deep, resilient faith that gives meaning to scholarship and creativity. We ourselves must understand thoroughly and then help students to understand the scope and limits of mathematical and scientific methods, the integrity with which the Christian approaches ideas and data, and the deep value that the Incarnation affords nature and observation.

Third, loving God with the mind means being the best scholars possible, doing the best mathematics and science possible, for God's honor. This involves conducting first-rate research with utmost integrity and building credibility within the discipline. It involves mentoring students to do the same. Every research paper and presentation comes from both the mind and the heart, *Soli Deo Gloria*. For the Christian scholar, mediocrity is not an option.

▲Brandon Baptist (BS Math Ed), Keddy Emmanuel (BSE Mechanical Engineering, Math Studies), and Danielle Martin (BS Math) on graduation day.

Clearly the life of the teacher-scholar is a calling, a vocation, and not simply a career. We conduct every part of that life for the sake of Christ.

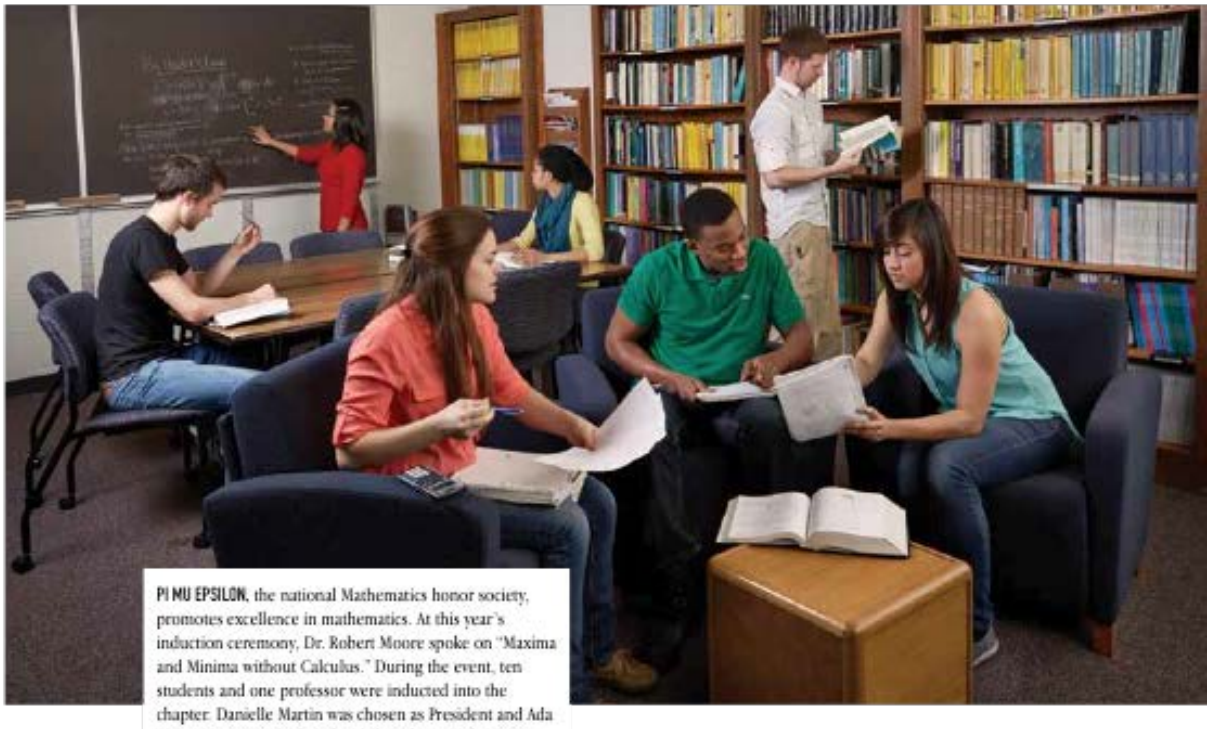
May our passion for learning and creativity and our astonishment at the deep structure of nature inspire awe and worship in us and in our students. May our commitment to Christ lead us to the best of thinking and doing.

WEBPAGE: andrews.edu/math
FACEBOOK: Andrews University Department of Mathematics

2013-14 *Year in Review* article

DEPARTMENT OF MATHEMATICS

Text by Rachel Boothby / Photo by Dave Sherwin



▲ Mathematics students enjoy using their newly renovated student lounge.

PI MU EPSILON, the national Mathematics honor society, promotes excellence in mathematics. At this year's induction ceremony, Dr. Robert Moore spoke on "Maxima and Minima without Calculus." During the event, ten students and one professor were inducted into the chapter. Danielle Martin was chosen as President and Ada Alvarez as Vice President for the 2014-2015 school year.

This spring, the Seabird Ecology Team was granted a 5-year renewal of their funding by the National Science Foundation (NSF). The project, led by Mathematics chair Shandelle Henson and Biology professor Jim Hayward of Andrews University, is in collaboration with Jim Cushing at the University of Arizona. It focuses on the effects of climate change in marine organisms with respect to foraging and the timing of reproduction. Students will continue to gain experience in mathematical ecology as they prepare for careers in STEM fields.

Danielle Burton (BA English, French, Mathematical Studies 2008, MS Mathematics and Science 2013) has realized success in the early stages of her Mathematics PhD program at the University of Tennessee, Knoxville. Her paper, "A note on the onset of synchrony in avian ovulation cycles," was accepted and published in the Taylor & Francis research journal, *The Journal of Difference Equations and Applications*. It was also chosen as the Mathematics Article of the Week from all Taylor & Francis journals. Furthermore, she received the Graduate Student Achievement and Scholarship Award for 2014 for outstanding academic achievement at the University of Tennessee. Danielle speaks highly of her Andrews professors in preparing her for her current program, saying, "Your support and mentorship is one of the things that makes Andrews exceptional."

MATHEMATICS STUDENT HIGHLIGHT

William Tritch is a 2014 graduate from Andrews University with BS degrees in Mathematics and Physics. While at Andrews, he participated in many research projects, including some interdisciplinary studies. In 2013, William enjoyed a summer research experience for undergraduates (REU) at the University of Nebraska–Lincoln where he studied partial differential equations. In the fall, he is headed to Texas Tech University to work on a PhD in Mathematics. He has a full fellowship and plans to work with the well-known mathematician Linda Allen in the field of mathematical epidemiology. Of his time at Andrews, William notes, "Arriving at Andrews, I planned to pursue medicine; however, the faculty helped me see that this was not the right fit for me. Through their support and encouragement, they helped me discover a field that combines my love for mathematics and medicine—mathematical epidemiology."

2012-13 *Year in Review* article

Department of Mathematics

Text by Christian Bacchiocchi
Photo by Karen Johnson-McWilliams

For years, people have stereotyped mathematics and those who choose to study it. Many people assume that math-lovers are predominantly "left-brained" or encounter difficulty when trying to engage in artistic activities. But that's not really the case! And the desire of our department chair, Dr. Shandelle Henson, is to lay these myths to rest.

When asked about the liberal arts, people usually think of writing, painting, photography, or graphic design. But of the seven original liberal arts, three are related to the very backbone of mathematics—arithmetic, geometry, and logic. The separation between the worlds of mathematics and English is not nearly as vast of an expanse as people may believe. Many students combine both English and mathematics in their academic career; for example, Matthew Chacko, an English major, recently completed his senior Honors' thesis in the field of mathematics.

In order to do well in math, a person must be able to write well. Though equations appear to be a grouping of numbers, they are actually a logical sentence that must adhere to many of the rules a writer follows when drafting an essay or research paper. Just as critiquing grammar in a sentence to ensure proper meaning follows a logical progression, ensuring that a mathematical equation is set up properly and will render a true solution follows a parallel process.

Dr. Henson is a firm believer in the shared relationship between mathematics and English. She studied English for a time, and her interest in it continues to this day. She affirms that these fields are different sides of the same coin, and people cannot disregard one while attempting to maintain the other. Her goal is to help change the world's perspective on mathematics and to help others embrace its multifaceted nature.

ALUMNUS SPOTLIGHT

Danielle Burton graduated from Andrews University with her undergraduate degree in both English and mathematics. She traveled abroad, teaching English in China before returning to Andrews to earn her Master's Degree in Mathematics & Science. In the fall of 2013 she will be attending the University of Tennessee, where she has been offered the very prestigious PEER Fellowship and will be pursuing her Ph.D. in mathematics.

This year's inductees into Pi Mu Epsilon, the Math Honor Society.

APPENDIX 12: DEPARTMENTAL NEWSLETTERS

https://www.andrews.edu/cas/math/newsletter/2015-newsletter.pdf

https://www.andrews.edu/cas/math/newsletter/newsletter-chair-letter-2015.pdf

https://www.andrews.edu/cas/math/newsletter/2014_newsletter.pdf

https://www.andrews.edu/cas/math/newsletter/2013_newsletter_final_submitted_for_publishing.pdf

https://www.andrews.edu/cas/math/newsletter/newsletter_2012_and_letter.pdf

https://www.andrews.edu/cas/math/newsletter/newsletter_2011_and_letter.pdf

APPENDIX 13: ASSESSMENT SUMMARY TABLES FOR 2009-16

Summary of Assessment Results 2009-16, BS Math and Math Studies

B.S. Math & Math Studies Student Outcomes	**2009-10**	**2010-11**	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**Summary**
Goal 1: Breadth and Depth Measure 1: Major Field Test Target: **50th percentile** minimum for all	Yes: 6 (86%) No: 1	Yes: 6 (86%) No: 1	Yes: 2 (25%) No: 6	Yes: 2 (33%) No: 4	Yes: 5 (71%) No: 2	Yes: 7 (64%) No: 4	Yes: 6 (75%) No: 2	Cumulative: **68%** Yes: 34 No: 20 Total: 54 **Goal of 100% is not being met.**
Goal 1: Breadth and Depth Measure 2. *[was Average Math GPA of 3.0 or higher]* Five-year average of final test scores Target: at least **75%** of the graduates **score 75% or higher** in each of four core courses (Calculus I, II, III, Intro to Lin)	Math GPA: 3.47	Math GPA: 3.48	Math GPA 3.11	Math GPA 3.12	BS math **C1: 77%** C2: 53% C3: 58% LA: 64% ---------- Math studies C1: 30% C2: 55% C3: 43% LA: 71%	BS math **C1: 79%** C2: 53% C3: 56% LA: 59% ---------- Math studies C1: 70% **C2: 75%** C3: 70% LA: 69%	BS math **C1: 88%** C2: 62% C3: 55% LA: 71% ---------- Math studies C1: 58% C2: 64% C3: 53% LA: 65%	Met GPA goals, but averages hid bimodal behavior BS math **meeting goal in C1** Math studies **not meeting goal**
Goal 2: Research/Papers/Talk Measure: participation in math research project or presentation Target: At least [50%] **75%** of graduates	[50%] Yes: 3 (50%) No: 3	[50%] Yes: 7 (88%) No: 1	Yes: 7 (78%) No: 2	Yes: 4 (80%) No: 1	Yes: 7 (88%) No: 1	Yes: 9 (75%) No: 3	Yes: 7 (88%) No: 1	Cumulative: **78%** Yes: 43 No: 12 Total: 55 **MET Goal of 75%**
Goal 3: Successful transition after graduation Measure: Employment/Grad school admission Target: **100%**	Yes: 7 (70%) No: 3	Yes: 4 (57%) No: 3	Yes: 7 (88%) No: 1	Yes: 5 (83%) No: 1	Yes: 6 (86%) No: 1	Yes: 6 (60%) No: 4	Yes: 4 (50%) No: 4	Cumulative: **71%** Yes: 41 No: 17 Total: 58 **Goal of 100% is not being met**
Goal 4: First-year success of graduate school students Measure: Successful completion of first year of graduate school Target: **100%**	Yes: 5 No: 0	NA	NA	Yes: 6 No: 0	Yes: 3 No: 0	Yes: 4 No: 0	Yes: 2 No: 0	Cumulative: **100%** Yes: 20 No: 0 Total: 20 **MET Goal of 100%**

Discussion: Change goal? Provide support? Collect data to determine support needed?

B.S. Math & Math Studies Student Outcomes	**Comments:**
Goal 1: Breadth and Depth Math majors will demonstrate breadth and depth in their grasp of undergraduate mathematics. Measure 1. Major Field Test: at least 50th percentile (about 155/200)	(review math ed results also) *Note: Math Studies starting in 2014 will not take MFT *Question: Check only Math BS averages in past? *Note: Added requirements to BS Math in 2015-16 bulletin *Suggest: Prepare sheet explaining importance of exam for advisor to give to Seniors in Fall *Idea: Award recognition (plaque) for scores above __%ile
Goal 1: Breadth and Depth 2. [Average Math GPA of 3.0 or higher] Average of five-year final test scores (at least 75% of the students score 75% or higher in each of four core courses)	(review math ed results also) *Professors are talking about preparing for finals *Plan for Karen to prepare email with tips on preparing for finals—send to professors 3 weeks before finals and professors send to students: ideas?? *Is this a class issue or a major issue? Collect data to compare majors scores to class scores? Monitor this data to see effects of changes? *Change goal for math studies majors? OR Provide more support—what? *Suggest start specific concept checking in courses
Goal 2: Research/Papers/Presentations Math majors will conduct research projects, write papers, and make presentations. At least [50%] 75% participation in math research project and/or presentation by the end of their senior year	*Question: Should we include posters? *Suggest: each fall review list of majors (Sophomores on up) who have not yet done research or presentation
Goal 3: Employment/Grad school Math majors will be successful in obtaining employment or acceptance into graduate or professional programs. All.	*Note: The data is only within 4 months of graduation. *Change goal? *Change cohort? (allow one year to find out) *Note: Karen emails job opportunities out to Mathematician listserv and posts on Facebook where last year's graduates can see it *Idea: Solicit relevant job advertisements from department alumni
Goal 4: First-year of graduate school, successful completion All mathematics graduates who enter graduate programs will be successful in completing the first year and eventually a master's or doctoral degree.	*Goal is being met. *Suggest solicit feedback from graduate students regarding their preparation

Summary of Assessment Results 2009-16, BS Math Education

B.S. Math EDUCATION Student Outcomes	Summary	Comments
Goal 1: Breadth and Depth Math Education majors will demonstrate breadth and depth in their knowledge of undergraduate mathematics. 1. Major Field Test: at least 50th percentile	Cumulative: **50%** Yes: 5 No: 5 Total: 10 **Goal of 100% is not being met.**	*Lynelle did not find an exam to replace this one *Suggest continue to search for replacement *Change goal for Math Ed?
Goal 1: Breadth and Depth 2. [Average Math GPA of 3.0 or higher] Average of five-year final test scores (at least 75% of the students score 75% or higher in each of four core courses)	2013-14 2014-15 2015-16 C1: 71% 71% **75%** C2: 71% 71% 63% C3: 40% 50% 57% **LA: 83% 75% 78% MET goal in Intro to Linear**	*Similar questions as for BS Math *Note Math Ed did better in Linear than BS Math
Goal 1: Breadth and Depth 3. MTTC math exam scores: all pass	Cumulative: **100%** Yes: 10 No: 0 Total: 10 **MET goal of 100% passing**	
Goal 2: Teaching-related experience All Math Education majors will have teaching-related work experience during their college years.	Cumulative: **100%** Yes: 10 No: 0 Total: 10 **MET goal of 100% having experiences**	
Goal 3: Employment/Grad school All Math Education majors will be successful in obtaining employment or acceptance into graduate or professional programs.	Cumulative: **100%** Yes: 10 No: 0 Total: 10 **MET goal of 100% employment/grad school**	*2 never got teaching jobs: 1 location/confidence; 1 international obstacle
Goal 4: First-year teaching or grad school, successful completion Mathematics Education graduates who accept teaching jobs or enter graduate programs will be successful in completing the first year. Those who enter graduate programs eventually complete a master's or doctoral degree.	Cumulative: **unknown (75-100%)** Yes: 6 No: 0 Unknown: 2 Total: 8	
Goal 6: Understanding and communication of high school (or elementary) math Math Education majors will demonstrate a good understanding of the mathematics they are teaching and the ability to communicate it clearly. All score at least 80 on student teaching.	Cumulative: **50%** Yes: 2 No: 2 (one 70.5 one 40) **Goal of 100% not being met**	*80 is proficient; 70 is satisfactory *recommend changing goal to 70 or above

APPENDIX 14: STRATEGIC PLAN DRAFT 2012

STRATEGIC PLAN 2011-2021

Department of Mathematics

Last updated
02 May 2012

Executive Summary

Vision: Our 10-year vision is that the Department of Mathematics, both in measureable fact and in clear reputation, will be the leading mathematics department in the Adventist system and among the best of its type in Michigan.

Current state: We have approximately 40 majors (an increase of over 444% in nine years), with high teaching and research productivity. Since 2001 we have published 60 peer-reviewed research papers and have helped attract over 1 million dollars in National Science Foundation (NSF) funding, most of which supports student research.

Capacity: Currently, our maximum capacity is 40 majors. With one extra PhD faculty member, the estimated capacity is 70. With two extra PhD faculty, the estimated capacity is 100, the bulk of these being Mathematical Studies majors. Our true capacity will be a complicated function of the growth of Engineering due to filling sections of the calculus sequence and due to double majoring.

Goals in brief: We will strengthen our two BS programs, support the growing Science, Technology, Engineering, and Mathematics (STEM) programs with more sections and smaller class sizes, strengthen remedial and general education offerings, and provide more academic support for students. We will continue to foster diversity in majors, especially underrepresented groups, including women. We will continue to strengthen our faculty and student research, and we will provide service and leadership to the university through strong participation in university-level committees. We will create a departmental culture of personal responsibility and excellence and mentor students in Christian development in the Adventist context of a healthful lifestyle and holistic belief.

Greatest needs in brief: Two faculty (PhD tenure-track; one endowed chair); space (Science Complex research addition to house Center for Interdisciplinary Science); One full time STEM promoter/recruiter for all STEM areas and for Center for Interdisciplinary Science.

Resource timeline summary:

Years 1-2:
One FTE: PhD research mathematician to teach the following added sections:
- MATH191, MATH192, MATH168, STAT285 (14 credits/year)
- "Bridge" course to advanced mathematics (3 credits/year)
- Honors logic course (3 credits/year)
- (University solicitation of support for our endowed chair fund)

Funds for two outside colloquium (EigenTalk) speakers per year
Funds to send two student researchers per year to present at Joint Mathematics Meetings
Significantly increased budgets for Math Center and developmental program:
- One FTE for a Math Center/Developmental coordinator position
- Increased budget for student labor (Math Center tutors)

Increased budget for graders and TAs to run recitation sections
College of Arts and Sciences (CAS) STEM promoter/recruiter

Years 3-5:
Three contracts to teach the following added sections:
- Two alternate-year upper division courses (3 credits/year)
- One math ed course (3 credits/year)
- One new section MATH091/092

Travel funds for conferences so that each faculty who presents is fully funded
Travel funds for meeting with academy teachers
Office/research/grader space, faculty/student interaction area
Research & Development addition to Science Complex: Center for Interdisciplinary Science

Years 5-10:
One FTE: PhD research mathematician to teach the following added sections:
- MATH191, MATH192 MATH168, MATH145 (14 credits/year)

One contract for MATH091/092, new section if needed; subtract 2 contracts added in Years 3-5

Mission Statement

Through teaching, research, and service, the Department of Mathematics seeks to provide leadership in the mathematical sciences by:

- Preparing students with the mathematical understanding, problem-solving skills, and dispositions that enable them to excel in their chosen careers;
- Increasing mathematical and scientific knowledge through publication and presentation;
- Supporting the broader mathematics education community and mentoring others for generous service through a committed Christian life.

Vision for Future

Our 10-year vision is that the Department of Mathematics, both in measureable fact and in clear reputation, will be the leading mathematics department in the Adventist system and among the best of its type in Michigan.

Current Department at a Glance

- *Faculty and staff on Department budget*: 5 full-time associate/full professors of mathematics cover college-level courses. One half-time instructor and contract teachers cover most of the remedial courses. We have one full-time administrative assistant.
  Faculty on Math and Science Center Budget: One assistant professor of mathematics instruction teaches full time at the Math and Science Center, as does one half-time instructor.
- *Programs*: Majors: BS Mathematics, BS Mathematics Education, Mathematical Studies. Minors: Mathematics, Mathematics Education, Mathematics of Economics and Finance. We participate with the Departments of Biology and Behavioral Science in the Behavioral Neuroscience program, and we participate with the Departments of Biology, Chemistry, and Physics in the Interdisciplinary Masters in Mathematics and Science. We collaborate with the Department of Biology via two mathematical biology courses, mathematical modeling labs in BIOL348 General Ecology, and a National Science Foundation (NSF)-funded research group.
- *Growth in majors*: We have approximately 40 majors. From 2000-2001 to 2001-2002 the number of math majors grew from 9 to 20, and in 2009-2010 the number of majors reached 40—a dramatic increase of over 444% in nine years.
- *Women in mathematics / high ethnic diversity*: Andrews University is one of the most diverse university campuses in North America. Recent statistics show that it is *the* most internationally diverse campus and the 6th most ethnically diverse campus. The Department of Mathematics well-reflects this diversity. Furthermore, four of its seven faculty are female, and three of its five tenured / tenure-track faculty are female.
- *High teaching productivity*: For FY09, we had
  - Productivity = 3.47 (4th highest in CAS)
  - UG Student:Teacher = 15.9 (5th highest in CAS)
  - UG Credits = 2813 (6th highest in CAS)

- Total Credits = 2825 (7th highest in CAS)

  U.S. four-year colleges and universities: Enrollment rose by 13% from 2000 to 2005; enrollment in mathematics and statistics courses was essentially flat (grew by only 0.43%)[i].

  Andrews: Undergraduate enrollment at Andrews rose by 11.6% between 2003-2004 and 2008-2009 (as measured in the Fall semesters); enrollment in mathematics and statistics courses grew by 15.7% during the same time period.

- *High research productivity*: For FY08 (FY09 report omitted these numbers) we had
  - FAR/FTE = 3.4 (1st in CAS)
  - Since 2001 the department faculty has published 60 peer-reviewed research papers.
  - Since 2001 the department has helped attract over 1 million dollars in National Science Foundation (NSF) funding, most of which supports student research.
- We administer pre-college-level remedial math program (MATH091/092) for students who are accepted with severe math deficiencies (enrollment = 236 last year).
- We administer Mathematics Placement Exam (MPE) to all incoming students (465 last year) and offer it at 6 academies.
- We administer the Math Center and staff it with tutors.
- We administer large NSF grants.

Specific Goals

Our goals are designed to address current specific institutional, denominational, and societal needs in the context of our Mission Statement by building on our current strengths. We list the goals in four categories. The needs addressed by each goal are documented in endnotes. The implementation and resources required are detailed in a later section.

I. Programs and Teaching
   A. BS Mathematics: Produce 5 graduates per year who will go on to earn PhDs in mathematics.[ii]
   B. BS Mathematics Education: Produce 5-10 strong graduates per year who will become certified K-12 mathematics teachers.[iii]
   C. Mathematical Studies Major: Continue to prepare students for careers that require cross-disciplinary skills.[iv] Through the Mathematical Studies major and the BS Mathematics major, produce 5-10 graduates per year who will go on to graduate studies or professional studies in mathematically-related fields.
   D. Support growing STEM programs with more sections and smaller class sizes ($\leq$ 35).[v]
   E. Promote critical thinking for general education[vi], and create a positive campus attitude toward mathematics as a liberal arts discipline.[vii]
   F. Strengthen support systems for at-risk mathematics students.
   G. Continue to attract underrepresented groups in Mathematics and STEM fields, including women.

II. Research

A. Continue and strengthen faculty peer-reviewed research, application for funding, and networking in the wider research community.[viii]
B. Create strong culture of undergraduate research networked into the wider research community.[ix]

III. Service
A. Serve the University through strong academic leadership and substantive committee work.
B. Continue and strengthen service to wider research community through peer review, editorships, national committees, and service on panels for granting agencies such as NSF.
C. Support Lake Union academies.

IV. Modeling lifestyle and life skills for students
A. Create a departmental culture of personal responsibility and excellence; mentor students away from entitlement and mediocrity.
B. Facilitate spiritual growth and integration of faith and learning.
C. Model and promote the benefits unique to Adventist lifestyle and holistic belief.
D. Integrate graduates into network of Adventist conversation and community.

Implementation

IA. We will review, strengthen, and grow the BS Mathematics major by

- Benchmarking: To identify any weaknesses in our program, we will compare our curriculum to the University of Michigan's BS curriculum and to their expectations for incoming mathematics PhD students. We also will interview our alumni currently in graduate school. We will revise our curriculum accordingly.
- Adding three courses: We will add two upper division alternate-year courses (for example, a second semester of Abstract Algebra (already listed but not taught), and a course in Real Analysis or Topology). We also will add a "bridge" course to advanced mathematics. This adds 6 credits per year to our teaching.[x]
- Recruiting: We will recruit and encourage talented students to pursue a PhD in mathematics. We will consider instituting a "gateway" exam at the end of the sophomore year that will serve as a "qualifying exam" for PhD-bound students. We will create a departmental culture that values the professorial life by means of the gateway exam, colloquium speakers, personal interactions and advising, and a STEM promoter/recruiter who will recruit SDA public high school students as well as academy students.

IB. We will review and grow the quality and number of BS Mathematics Education majors by

- Benchmarking: To identify any weaknesses in our program, we will compare our curriculum to the University of Georgia's and the University of Arizona's curricula. We will revise our curriculum accordingly.
- Adding one 3-credit course in mathematics education.
- Recruiting: We will recruit and encourage talented students to pursue K-12 mathematics teaching. We will create a departmental culture that values high school teaching by

means of colloquium speakers, personal interactions and advising, and a STEM promoter/recruiter who will recruit SDA public high school students as well as academy students.

IC. We expect the Mathematical Studies major (a "second major") to grow naturally as other STEM departments, in particular the Department of Engineering and Computer Science, grows. We will continue to grow the two mathematical biology courses and the research collaboration with Biology.

ID. To accommodate the needs and growth of the Departments of Engineering and Computer Science and Physics, as well as the growing number of students from other departments, we must open more sections of certain courses. Some sections of high-demand courses will be taught in summer.

- Next two years: We must open an extra section each of MATH191 and MATH192 each year. We must open one extra section of MATH168 each year. We must open one extra section of STAT285 each year. This is a total of 14 credits per year.
- Next 5-10 years: Given the projected growth of Engineering and the growing number of students needing remediation, we may need to add another section of MATH191, MATH192, MATH168, MATH091/092, and MATH145 per year. This is a total of 17 credits per year, 3 of which are contract.

IE. We want to convince the faculty at large of the value of traditional liberal arts mathematics for critical thinking. The Chair will work with the Provost, Deans, Director of Advising, Director of Honors, and the appropriate committees to find the best venue to present this message to the wider faculty in order to encourage advisors to pass on a positive attitude to their advisees. We also will add Honors mathematics course by request of the Honors Council. A proposed Honors course is Logic. This will add 3 credits per year.

IF. We will hire a full time developmental mathematics specialist (probably with a doctorate in mathematics education) to coordinate the developmental program and the Math Center tutoring program. The coordinator will oversee a tutor training program and a lab assistant training program, recruit Math Center tutors and MATH091/092 lab assistants, analyze Math Center usage to adjust services to needs, teach MATH091/092, oversee contract teachers, manage website content on math help, work closely with Student Success to improve the effectiveness of math tutoring, and work with Griggs University to make MATH091/092 available by distance learning. The goal is create an environment in which students are encouraged to think through ideas and master concepts for themselves, but also one that is welcoming and where they experience success to motivate them to continue. We will require more support for student labor in order to hire more graders, TAs to run recitation sections, and more tutors for the Math Center. We need to increase our wages for the Math Center. At present, some students can make significantly more by tutoring for Student Success, so it is difficult for us to find tutors.

IG. Most graduating mathematics majors declared the major sometime during their enrollment in the Calculus sequence. Calculus is one of the most important factors in attracting majors. We identify outstanding students in the Calculus sequence and invite them to consider adding

mathematics majors. In this process, we are able to recruit majors who reflect the diversity of Andrews University.

IIA. All five of our current doctoral faculty are involved in ongoing research or are restarting research programs. We have one of the highest research productivity records in the university. However, there are two areas in which we need to strengthen our research.

- We will increase our number of presentations at research conferences. The Chair will encourage each faculty member to attend at least one research meeting per year and will ensure travel funding for one meeting per year if the faculty member gives an oral presentation.
- We will increase the number of applications for internal and external grants. The Chair will encourage and mentor each faculty member to submit grant proposals.

IIB. Faculty engaged in research will involve at least one undergraduate per year. We will continue to encourage each major to participate in summer REU (NSF-sponsored Research Experience for Undergraduates) programs or internships. Faculty will take their research students to conferences to observe and present in student sessions, and to network them into the wider research communities. Students will present their research at Eigen*Talks.

IIIA. The Department will find its voice on campus by improving leadership and service in university-level committees.

- Faculty will serve on committees that fit their strengths and interests. Full professors with research loads normally will serve on 2-3 university-level committees per year, at least one of which is substantial. Associate professors with research loads normally will serve on 1-2, and assistant professors (after the first year) will serve on at least one. Doctoral faculty without research loads will serve on more committees, and faculty who are starting or restarting research programs will serve on fewer committees.

IIIB. We will continue and strengthen our record of service to the wider profession through peer review, editorships, and service on panels for granting agencies.

IIIC. Create a statement of support for academy mathematics programs and recommendations for college preparatory curricula. Open dialogue with academy teachers.

IVA. Plans in progress

IVB. We already are integrating all new majors into the Eigen*Club by requiring attendance at Eigen*Talks. Faculty will become more involved in Eigen*Club and Eigen*Vespers. Plans in progress.

IVC. Participate in and promote campus health initiatives. In 2011 approximately 10 faculty and students from the Department of Mathematics followed a fitness plan that centered on exercise, proper diet, and quiet time for reflection and prayer.

IVD. Continue to develop departmental Facebook page (see Facebook: Andrews University Department of Mathematics); track and communicate with alumni. Construct alumni database in collaboration with Alumni Services. Create bulletin board featuring alumni and their careers.

Timeline

Years 1-2:
Add one budget for one young PhD research mathematician to teach the following sections:
MATH191, MATH192, MATH168, STAT285: add one new section/year (14 credits/year)
Add one "bridge" course per year (3 credits/year)
Add one Honors course (3 credits/year)
(University solicitation of support for our endowed chair fund)

Funds for two colloquium speakers per year
Significantly increased budget for Math Center
    One FTE for a Math Center/Developmental coordinator position
    Increased budget for student labor (Math Center tutors)
Increased budget for graders and TAs to run recitation sections
CAS STEM promoter/recruiter

Chair works to improve departmental image and secure advisor support
Review BS programs
Make MATH091/092 available through Griggs University
Increase representation on committees
Increase involvement in Eigen*Club
Departmental Facebook page
Alum Careers bulletin board

Years 3-5:
Add two alternate-year upper division courses (3 credits/year; add one contract until Year 5)
Add one math ed course (3 credits/year; add one contract until Year 5)
MATH091/092: add one new section if needed (3 credits/year, contract)

Funds for travel to conferences
Funds for travel to meet with academy teachers or bring them to campus

Add office/research/grader space, faculty/student interaction area
Research & Development addition to Science Complex

Implement support for academy mathematics programs

Years 5-10:
Add one budget for young PhD research mathematician
Add MATH191, MATH192 MATH168, MATH145, one new section /year (14 credits/year)
Subtract 2 contracts added in Years 3-5

Add one contract for MATH091/092, new section if needed (3 credits/year, contract)

Suggestions for University Strategic Plan

- Base merit scholarships on ACT/SAT and GPA, contingent on completion of a college preparatory curriculum in high school. The current practice (of basing scholarships on GPA) discourages academy students from pursuing college preparatory courses.
- Through promotion and resource allocation, create a strong niche for Andrews University as a small research university that emphasizes undergraduate research.
- Do not create new schools that require new deans, office support, etc. The Department of Biology in CAS has more students than three of the schools on campus.
- Hire a STEM promoter/recruiter—not someone who will travel to speak to small groups, but rather someone who can build a coherent promotional media strategy and also recruit SDA public high school students.
- Raise money for Research & Development extension to Science Complex.

Endnotes

[i] D. J. Lutzer et al. 2005, Statistical Abstract of Undergraduate Programs in the Mathematical Sciences in the United States, American Mathematical Society, http://www.ams.org/cbms/cbms2005.html.
[ii] The mass retirement of the Sputnik generation will leave gaps in academia. Universities, in particular Adventist universities, will need new PhDs who are passionate about the teacher/scholar vocation.
[iii] There is a tremendous need, in our church and in wider society, for talented high school mathematics teachers. The profession is under-valued; the most talented students often are advised to "aim higher" than high school teaching. This career, however, is fundamentally important to society.
[iv] Cross-disciplinary skills are extremely valuable and become more so. Our Mathematical Studies major is our most successful program. This is a secondary, non-degree, major for students with a primary major in some other field.
[v] Growing STEM departments, in particular Engineering and Computer Science and Physics, currently are experiencing a growth bottleneck because of our inability to open more sections of calculus and precalculus. The disciplinary standard for class sizes in mathematics is < 35.
[vi] Mathematics, in the long tradition of liberal arts studies, teaches critical thinking. Learning to solve mathematical problems trains the mind for precise and logical thought, whether or not those particular problems arise in the student's later career.
[vii] It is important to "sell" the importance of the liberal arts mathematics requirement to advisors, who can then sell it to students
[viii] See "Current Department at a Glance" for current research productivity.
[ix] A unique niche of Andrews University in the Adventist system is its growing culture of undergraduate research.
[x] Currently our MATH355 serves both as the "bridge" course for our majors and as a Discrete Mathematics course for Computer Science majors. It does not serve the "bridge" purpose very well because of the multiple goals.