

Submission date: 31 January 2020

Program/s in this review: Mathematics BA & BS

Specialized accrediting agency (if applicable): None

Campuses where the program is delivered: Anchorage

Members of the program review committee:

Mark Fitch, Chair & Professor, ANC

Sam Cook, Associate Professor, ANC

Debbie Narang, Professor, ANC

Rieken Venema, Professor, ANC

1. Centrality of Program Mission and Supporting Role (700 words or less)

Introduction

The Mathematical Association of America (MAA), in its report “The importance of Mathematical Sciences at Colleges and Universities in the 21st Century”¹ states

...mathematics plays a greater role in society than simply providing crucial workplace skills....As a core element of the traditional liberal arts, mathematics provides students opportunities to ‘foster intellectual curiosity about questions that will never be definitively settled-questions about justice, about community, about politics and culture, about difference in every sense of the word’ (American Association of Colleges and Universities, 2018). Indeed, graduates with strong liberal arts foundations are more likely...to serve in leadership roles in the workplace and at the local, state, and national level of government.

The Department of Mathematics and Statistics assists students through GER courses, service courses, a math minor, and the mathematics majors. This includes serving many ANSEP and Middle College students.

Majors

Mathematics is a part of data analysis, of environmental science, and increasingly of studies of social equity.

Producing teachers is a primary goal of the UA system. We have seen no reduction in the number of students that pursue teaching math as a result of UAA’s education programs losing accreditation. To address a possible degree weakness for these students we changed the core requirements in a way that better prepares all majors for current topics. In addition to producing teachers of secondary

¹ <https://www.maa.org/programs-and-communities/curriculum-resources/survey-and-reports/task-force-reports>

mathematics, we also produce teachers at the university level with some of our graduates serving as adjuncts, terms, and tenure track faculty in the Department of Quantitative Studies.

Service courses

The department helps students in 22 programs in 5 Schools and Colleges gain skills needed to understand and work in those fields.

In addition to producing secondary teachers of mathematics, the department offers MATH A211 and A212 to students in early childhood education and elementary education. These courses deepen student understanding of mathematics, and introduce them to modern methods of teaching mathematics which are known to increase success at all levels and reduce math anxiety and general distaste of mathematics.

Engineering, a high demand job area, is highly dependent on courses in mathematics. The majority of students enrolled in MATH A302 and A314 are engineering majors, and MATH A424 and A425 (now stacked with MATH A625) are taught exclusively for engineering majors. Most of the students in STAT A307 are computer science or computer systems engineering students. MATH A261 provides fundamental concepts for computer science and computer systems engineering majors.

GER

Although our role in the University's General Education program was suddenly changed, the department is responsible for the design or update of several courses in recent years. Many courses in the GER also serve as prerequisites for more advanced courses, and both goals were kept in mind when updating MATH A121, MATH A151, MATH A152, and MATH A155. MATH A155 (Precalculus) saw the biggest changes: it was trimmed to a one-semester 5 credit option giving appropriate students a much faster route to our traditional calculus courses.

As cryptography, Bitcoin, block chains, and analysis of big data are increasingly topics of casual conversation, people need knowledge of abstract algebra, topology, and discrete mathematics. These ideas informed our work designing the MATH A115 (Art of Mathematics) course, designed to meet UAA's mathematics GER requirement without daunting or unrealistic prerequisites and which addresses the nationally prevalent fear of mathematics by using inquiry based learning. This is a best practice in mathematics teaching as noted by the Conference Board of the Mathematical Sciences in its statement on Active Learning in Post-Secondary Mathematics Education (July 15, 2016). Although faculty members generally have the privilege of selecting their own pedagogy, MATH A115 has discovery as a student learning outcome. The course also presents a much broader range of mathematics topics, many typically taught only in upper division courses. This enables students to see mathematics as something pertinent and beautiful rather than as an arcane skill used solely by STEM geeks. Student feedback shows that this course and its pedagogy have been successful in changing attitudes.

2. Program Demand (including service to other programs), Efficiency, and Productivity (7 year trend; 1400 words or less)

We continue to see demand for our programs. This year, we have higher than average enrollment in our MATH A265 courses, which is the first class intended solely for our baccalaureate programs. We have an average of thirteen graduates per year, and after changing our program and streamlining our program

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offerings, we are able to efficiently meet the demand for our programs. In addition, we continue to offer many courses that serve the needs of students in programs and colleges throughout the University.

The data provided reflect changes that have occurred over the last several years. First, note that in AY2017-18, a sizable percentage of our curriculum, and hence our SCH, was moved from CAS Mathematics and Statistics to CTC Quantitative Studies, which of course caused many indicators to fall. Our numbers have also decreased as enrollment at UAA generally has dropped.

Our programs are poised to become even more efficient in the near term as two faculty members in our department are retiring this year. This will reduce the cost of our programs, though we will still be able to continue meeting demand for our programs and service courses while preserving capacity for the future.

B.A. and B.S. in Mathematics

Demand for the mathematics baccalaureates which include preparation for secondary education remains steady. UAA has seen an increase in dual majors with computer science through which students may prepare for data analysis. Students pursuing physics and/or astronomy have also selected mathematics as their major.

Course schedules have streamlined the number of courses solely for math majors offered each year, allowing students to graduate in four years without bottlenecks. Additional efficiencies in the department are best gained through tighter control of the number of sections of non-major courses within the university.

Math major demand is steady with a seven year graduation average of about 13. This extends at least 1.5 decades with highs and lows tracking university enrollment. The number of students active in the math major (smaller than the declared number) remains steady at about 60. We update this list each semester and meet twice per semester to discuss which students need help.

One source of recent variation is the effect of students attempting to complete a degree too rapidly (often less than four years). This is driven by highly motivated students and the middle college. Note student grade performance has suffered due to this rush.

During the review period 90 students graduated with a UAA mathematics baccalaureate degree. Of these graduates, 19 entered secondary teaching, 11 went to graduate schools in mathematics, 7 went to graduate schools in different fields including (bio-)statistics, actuarial sciences, and medicine, 41 pursued other careers, and the career paths of 12 graduates are unknown.

GER Courses

Enrollment in mathematics GER courses have trended downward along with the general enrollment trend at UAA. However the pass rate jumped up in 2016. There were three changes made about that time. First an effort was begun to advise students into the mathematics GER best suited for them. This shifted students from MATH A105 and A151, which have higher DFW rates, to STAT A200 and MATH A121 which have lower DFW rates. Second, we added MATH A115, and after coordinating technical math classes at KPC & Mat-Su we assisted Quantitative Studies in constructing MATH A104. Both enable students to avoid MATH A105, decreasing both their time to graduation and total SCH taught. MATH A155 was modified from 6 to 5 credits to make it a better choice for students.

In fall 2016 UAA also moved to ALEKS PPL as the math placement device following testing by math faculty at UAF. This placed many students in a higher initial course. All together this has resulted in a noticeable increase in GER pass rates.

In addition to offering optimal courses for the students, the Department of Mathematics and Statistics has also worked to offer pedagogical options. Online versions of MATH A115, A121, and A221 were added during the review period by coordinating with UAA's community campuses. Already the department offered courses using discovery learning, lectures, flipped classrooms, online homework, and other pedagogies.

Service Courses

The number of sections of Calculus 1, 2, and 3 have trended down along with UAA enrollment, but, especially for Calculus 3, there is unexplained noise in the trend. On the other hand MATH A261, A302, and A314 are typically full with small waitlists. There has been insufficient evidence of enough students to open another section of these courses without reducing SCH/FTEF. Rather demand can be met by reducing the retake rate.

Most likely because of the addition of MATH A212, A424, and A425 the overall SCH for service courses increased significantly over the review period. By coordinating with KPC we were able to offer MATH A211 and A212 each semester (online from KPC, face-to-face in Anchorage).

We have also modified the minor to encourage computer science and other majors to pursue it. There has been increased interest from students in pursuing both computer science and mathematics (minors and double majors), in addition to continued frequent double majors in mathematics and civil, mechanical, or electrical engineering.

UAS, UAA, and UAF working together have determined from past class offerings and enrollment data that more sections of GER and service courses were offered than were required to cover demand.

Each university can meet student demand and reduce costs if campuses at each university coordinate their course offerings with a focus on limiting small sections, and the departments at the three universities continue their existing coordination. If the number of sections of GER and service courses offered statewide had matched average demand over the past three years we could have reduced the number of sections by about 150 while maintaining tuition revenue.

3. Program Quality, Improvement and Student Success (1500 words or less)

The BA and BS in mathematics have been modified nearly continually as a result of assessment with a focus on providing a solid, broad foundation for a variety of careers which our graduates successfully pursue.

The major changes to the baccalaureate programs in this review period included adding a core course, removing two "options", and adding an experience requirement. The core and option changes removed a loophole allowing some students to avoid exposure to major fields of mathematics. Prompted in part by ideas from conferences, we added a requirement for students to use math outside the classroom before graduation. There are options accommodating student interests in teaching, research, and other careers.

By structuring the programs using categories we were able to add three courses (Number Theory, Topology, and Differential Geometry) without increasing the number of sections offered per year (courses in a category alternate).

Changes resulting from the removal of the CAS requirements address the large percent of mathematics majors with interests in various sciences, non-science applications, and pure mathematics. The BA is maintained for the large group of mathematics majors who have little interest in any sciences.

Faculty have added assignments to their classes that provide students with evidence to include in their required program portfolios. There has been a particular emphasis on communications skills, for instance by requiring student presentations in some classes.

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Faculty have had some success at recruiting students to engage in undergraduate research. One student completed a project that resulted in a grant from the Office of Undergraduate Research, a presentation at a national mathematics conference, and a publication in a peer-reviewed journal. However, with only four research faculty members and three of those untenured during most of the review period, we were limited in resources. The program experience requirement should increase the number requesting research. The work with dual computer science/mathematics interests has already generated more requests for one faculty member.

External evidence of the quality of our students and the value of our program include the exam for the Putnam Competition and the ETS Major Field Test. The William Lowell Putnam Competition is put on annually by the Mathematical Association of America. The exam is notoriously difficult; the median score is usually 0 or 1 out of 120, with about 5000 students taking the exam each year. It is notable that we have regularly been able to recruit 4-8 students each year interested in taking the exam, and we generally have more than one positive score each year! Each year, the MAA reports the highest 150 team scores, and our team has been named twice during the review period! This is supported by faculty. Each fall, two or three faculty members volunteer to serve as coaches for our interested students, leading weekly sessions in preparation for the exam, which is given in early December each year.

We require each math major to complete the ETS Major Field Test in mathematics. Our students score around the national average each year on the ETS Mathematics Test of Knowledge. During the review period two math students earned perfect scores (score of 200 with the national average around 150). We have had many students go on to graduate study in mathematics at prestigious schools. Our graduates have gone on to graduate studies in other disciplines as well, such as medicine, actuarial science, statistics, biostatistics, and meteorology.

Advising of our students is done by our faculty to increase their connections and provide advice tailored to their planned careers. We have worked to find ways to increase our advising related contact with students. These efforts have included requiring students in our MATH A265 (Fundamentals of Mathematics) course to introduce themselves to their advisor, and engage in a discussion of their interests and likely goals. Each semester this assignment leads to some students meeting their advisor for the first time.

This desire to better get to know and advise our students has also resulted in the creation of a one credit course, MATH A264 (Introduction to the Mathematics Major) that introduces majors to each faculty member, to general skills (like mathematical typesetting), to different fields of mathematics, and to opportunities such as summer research. Feedback gathered each semester indicates effectiveness of the course and has led to refinements.

Effectiveness of the assessment is noted in each section of this review.

GER Courses

Updates to GER courses are described in Section 2.

Service Courses

We modernized MATH A302 (Ordinary Differential Equations) by shifting emphasis from solving methods to study of geometrical ideas and higher dimensional systems. In consultation with faculty in computer science and engineering, we updated MATH A261 (Introduction to Discrete Mathematics) which is a requirement in their programs. This was both a curriculum update and a change of prerequisites to remove a bottleneck for computer science and computer systems engineering majors and a duplication of material for dual

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math/computer science majors. We replaced MATH A423 (Advanced Engineering Mathematics) with a pair of courses, MATH A424 and A425, covering the same topics at much greater depth.

We replaced MATH A211 (Mathematics for Elementary School Teachers) with a pair of courses, MATH A211 and A212, to increase the coverage of this material and to match the structures at UAS and UAF.

Most recently we completed a review of the Calculus (MATH A251-253) sequence. A trial of an alternate sequence addressing the most frequent student and faculty concerns is under way.

Multiple instructors are taking advantage of recent available funding to add Peer Learning Instruction to their calculus courses to enhance student success.

Of the faculty members teaching online courses three completed the Online Learning Consortium's certificate program. Four courses have obtained Quality Matters recognition. More faculty have completed classes on online teaching. Two of the faculty members teaching online have PhD's involving online technology and learning.

- I. Outcome 1
 - a. Demonstrate knowledge of the techniques of modern mathematical subjects including all of algebra, analysis, discrete mathematics, and probability and statistics.
 - b. Methods used
 - i. ETS Major Field Test (direct)
 - ii. Student mathematics program portfolios (indirect with some direct)
 - c. Key findings: Graduates of the mathematics baccalaureates continue to perform well on the ETS Major Field Test indicating that they are well prepared. Anecdotal evidence indicates sufficient preparation for graduate study. The portfolios have often contained an insufficient breadth of examples; the department is working to increase the number of artifacts each student submits.
 - d. Major actions: The department has changed portfolio instructions and the frequency of feedback to improve student documentation of learning.
- II. Outcome 2
 - a. Demonstrate an ability to solve problems using skills such as deductive logic, data analysis, computation, modeling, connections, and other mathematical techniques.
 - b. Methods used
 - i. ETS Major Field Test (direct)
 - ii. Student mathematics program portfolios (indirect with some direct)
 - c. Key findings: Performances on the ETS MFT as noted above indicate sufficient preparation in this area. Student portfolios indicate that students are recognizing multiple ways to solve problems and are succeeding in using them.
 - d. Major actions: none
- III. Outcome 3
 - a. Demonstrate an ability to create mathematical proofs
 - b. Methods used

- i. Student mathematics program portfolios
 - c. Key findings: Feedback each year ensures examples are present in the portfolios.
 - d. Major actions: Faculty have begun meetings twice per semester to discuss student progress so longitudinal assistance can be provided.
- IV. Outcome 4
 - a. Demonstrate an ability to read, write, and speak about mathematics.
 - b. Methods used
 - i. Student mathematics program portfolios (indirect with some direct)
 - c. Key findings: Artifacts and reflections in the portfolios have been increasing due to emphasis by faculty.
 - d. Major actions: none
- V. Outcome 5
 - a. Demonstrate cognizance of their mathematical knowledge, of mathematics around them, and of the benefit of continued study of mathematics.
 - b. Methods used
 - i. Student mathematics program portfolios (indirect with some direct)
 - ii. Mathematics graduate exit survey (indirect)
 - c. Key findings: Student reflections indicate they are well aware of what they learned, when they learned it, and what its value is
 - d. Major actions: none

4. Program Duplication / Distinctiveness (300 words or less)

Demand for Baccalaureates in Mathematics exists across the state of Alaska. Many students are place restricted and demonstrate a preference for local courses. UAA provides a very strong and current mathematics program which is efficiently offered.

Baccalaureates in Mathematics are available at UAS, UAA, and UAF. UAA's program requires the greatest breadth of its students, but offers few electives and does not offer a statistics option or degree. UAF has more electives in the catalog, and offers a statistics option. UAS's mathematics program is in the intersection of UAA and UAF's programs. Due to long standing coordination, transfer of courses or between programs is seamless for students from service courses to courses for math majors. Where it is advantageous to our students, courses are shared across campuses and universities (e.g., 400-level statistics).

In order to enable students at other campuses to participate more in the math major, UAA is trying to offer video conference sections stacked with face-to-face courses, initially MATH A302. Our goal is to increase retention of students who drop when faced with the necessity of moving to Anchorage.

Principles shared by the universities, campuses, and departments teaching mathematics and statistics are that face-to-face courses be available to students and faculty be available locally to assist even when a course is taught from another campus. This can extend a quality opportunity to all campuses.

To achieve savings, the departments of Mathematics and Statistics desire support from upper level administrators for coordination in distributing GER and service courses so that we do not have excess capacity. This should allow for face-to-face classes at each campus where demand dictates.

Locally, there is some administrative duplication caused by splitting the instruction of mathematics and statistics service and general education courses across two departments. Faculty in both departments teach courses in both departments. This overlap is vital for keeping the curriculum in sync (many service/GER courses are part of sequences that span the departments). Constructing schedules, arranging for textbooks, cataloging syllabi, and other annual tasks are unnecessarily complicated. Further, students are frequently unaware of whom to contact.

5. Summary Analysis (500 words or less)

Faculty of the Department of Mathematics and Statistics value student success and constantly consider how to improve the programs in light of national movements, course offerings, and curriculum changes to aid students. They have demonstrated an ability to work together across campuses and universities to coordinate curriculum, offer maximum schedule flexibility, and increase options available to students. The department has high quality faculty with a variety of mathematical and statistical backgrounds in both pure and applied mathematics and statistics, which allows us to work well with a broad range of departments and offer topical breadth to our students.

The department will continue pursuing an increase in double majors by continuing to offer a strong program of interest to students in the engineering fields as well as finding ways to attract more students with underserved interests, e.g., in data analysis and astrophysics. Further, interest in biostatistics could be addressed jointly with faculty at UAA and UAF. The department will maintain a robust major with strong enrollment by continuing to update the programs to prepare students for current workforce opportunities as listed previously and by increasing the collaboration with local institutions, organizations, and companies by creating appropriate internships. Through increased engagement with the ANSEP and Middle College programs, we will be able to recruit additional majors. We can increase the number of students engaging in undergraduate research and scholarship to the extent we retain research faculty.

We will continue our efforts to reduce costs for students through the use of publisher payment options and the use and development of open educational resources including textbooks, homework systems, and interactive demonstrations.

It is a goal of the UAA Mathematics and Statistics department to continue strong communication and coordination with our sister departments on the community campuses. Efforts to serve place-based students at more campuses efficiently is complicated by student preference for face-to-face classes. Many students will delay taking a class by a semester rather than take a section that is offered asynchronously online or face-to-face at another, accessible campus. To optimize the number of sections offered to cover student demand, the faculty teaching mathematics and statistics courses at UAA need: 1) facilities for video conferencing or other means of shared synchronous classes, 2) qualified mathematics and statistics faculty to be available at each campus to assist students with courses taken synchronously from another campus, 3) tutoring or similar assistance available at each campus, and 4) time to demonstrate to students that these methods are as effective and enjoyable as current offerings.

In addition, it will be important to continue working closely with our colleagues in the Quantitative Studies Department. Improved synergy, including increased consistency of sections, and increased continuity of course sequences can be achieved through reduced administrative barriers between departments teaching mathematics and statistics. Decreased student confusion and, likely, improved distribution of staff work are

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also possible. Student tutoring, both paid and for credit, would likewise be easier to manage and possibly more cost effective.

The programs and offerings of the Department of Mathematics and Statistics have evolved, and continue to evolve, to meet the needs of a modern education. The mathematics programs at UAA offer students an education which leads to high-paying, desirable jobs. They further offer the opportunity for interdisciplinary study to analyze complex data which can support the Alaskan economy. Mathematics majors and alumni contribute through tutoring, teaching, and a unique perspective of the world around us.