

Millikin University
Annual Assessment of Student Learning in Mathematics
By Dr. Joe Stickles, Chair
July 1, 2018

Executive Summary

The Department of Mathematics supports Millikin's Mission in that the Department works to prepare students for:

- professional success by providing all of our majors with core mathematical experiences and a range of application areas, and through the various emphases, readying them to enter the work force or pursue graduate study,
- democratic citizenship in a diverse and dynamic global environment by providing fundamental tools to analyze dynamic events that will inform public policy, and
- a personal life of meaning and value by helping our students develop the intellectual framework through thinking rigorously and rationally, and instilling in them the mindset that will enable them to remain life-long learners.

The assessment results for data collected from the 2017-18 academic year constitute the department's ongoing systemic attempt to quantify student achievement within the department. The results suggest that goals of the Mathematics, Actuarial Science, Mathematics Education, and Data Science programs are being met. Further, the Mathematics Education program maintained its Illinois State Board of Education (ISBE) accreditation. No additional assessment data is necessary for the mathematics education major beyond what is collected for the yearly ISBE report completed by Dr. Paula R. Stickles.

Report

Goals

The mission of the department is to produce graduates, regardless of emphasis, who are able to:

1. integrate and differentiate functions,
2. express and interpret mathematical relationships from numerical, graphical, and symbolic points of view,
3. read and construct mathematical proofs,
4. analyze various discrete and continuous probability models,
5. apply mathematics to other disciplines, and
6. present mathematical results and arguments orally and in writing.

In addition to the above core learning goals, mathematics graduates will achieve the following emphasis-specific goals.

1. Mathematics

A mathematics major will:

- a. read and construct mathematical proofs in two advanced subject areas,
- b. apply appropriate mathematical techniques to solve problems within mathematics and in extra-disciplinary contexts, and
- c. complete a research project, including dissemination of the project's findings.

2. Actuarial Science

An actuarial science major will:

- a. prepare for two Society of Actuaries' exams,
- b. satisfy two of the Validation by Educational Experience (VEE) requirements of the Society of Actuaries, and
- c. complete a research project, including dissemination of the project's findings.

3. Mathematics Education

A mathematics education major will:

- a. prepare for the Illinois Licensure Exam in mathematics,
- b. apply appropriate pedagogical techniques to teach mathematics through exploration and problem solving consistent with best practices in the field, and
- c. compile a portfolio of materials demonstrating the following in the field of mathematics: content knowledge, pedagogical content knowledge, an ability to plan instruction, and analyze and document one's impact on student learning.

4. Data Science

A data science major will:

- a. learn foundational material in mathematics and statistics necessary for the study of data science,
- b. apply this foundational material using techniques from computer science and information systems, and
- c. complete a research project, including dissemination of the project's findings.

Snapshot

The Department of Mathematics guides students in the completion of four different major tracks: mathematics education (6 students), mathematics including pre-engineering (19 students), actuarial science (11 students), and data science (3 students). Currently, 39 students are following one of our major programs of study. This is an enrollment decrease of 17 from last year. Thanks to the STEM recruiting efforts of Dr. Dam Miller and the addition of the dual degree programs in engineering with the University of Missouri at Kansas City, we welcomed approximately 20 new majors for the Fall 2017 semester and are expecting approximately 15 new majors for the Fall 2018 semester.

The Department of Mathematics includes the disciplines of mathematics and statistics. The department offers mathematics majors with options in mathematics, mathematics education, actuarial science, and data science. Additionally, minors in mathematics and computer science are offered. The curriculum is structured to meet the overlapping needs of students who fall in one or more of the following categories:

- those who plan to become high school mathematics teachers;
- those who intend to pursue graduate work in mathematics, computer science, or other related fields;
- those who plan to become actuaries; and
- those who will apply mathematics and/or computer science in the natural sciences, social sciences, business or other areas of quantitative studies such as actuarial science.

Additional Comments:

- The four majors offered in the department share courses and faculty. The mathematics and mathematics secondary education majors are particularly entwined with students taking common courses and interacting with the same faculty members. In many respects these two majors cannot be disentangled for analysis.
- Students can earn either the Bachelor of Arts or Bachelor of Science. The choice of B.A. or B.S. depends entirely on the student's interest in studying a foreign language. There is no distinction in departmental coursework between the B.A. and B.S. degrees. Therefore, this report will not separate the B.A. from the B.S.
- All fulltime tenure-track members of the department have doctorate degrees and are tenured. (See Table 1.) Our fulltime Math Center director has a masters degree. We hired two adjuncts, Ginger Artime and Katrina Ross, to teach a total of six sections of developmental mathematics.

The mathematics major is for students interested in immediate employment in a mathematical area or further study in mathematics. Mathematics majors take a minimum of 42 credit hours in mathematics as well as an additional 15 hours in a content area in which mathematics is applied. The selection of the core and required advanced mathematics courses was guided by in *Undergraduate Programs and Courses in the Mathematical*

Sciences: CUPM Curriculum Guide 2015 by the Committee on the Undergraduate Program in Mathematics of The Mathematical Association of America.

The mathematics education major is a rigorous course of study in mathematics and education. The major has 38 required credit hours in mathematics. Unique among institutions of comparable size we require a mathematics teaching internship experience as part of our program. During this experience the student is paired with a member of the faculty in teaching an undergraduate mathematics course.

The data science option integrates mathematical and statistical methods with computer science and information systems techniques to provide students with the skills necessary to analyze large set of data, such as those collected by large companies, government agencies, and educational institutions.

The actuarial science option is a rigorous treatment of the mathematics and business skills necessary for a major to enter the workforce as an entry-level actuary. Students who completed this option and all highly recommended courses in business will be prepared to take the first two Actuarial Examinations (1/P and 2/FM) of the Casualty Actuarial Society and the Society of Actuaries and have completed the three courses that are certified by the Society of Actuaries (SOA) for Verification of Educational Experiences (VEE) (Applied Statistical Methods, Corporate Finance, and Economics).

The Learning Story

All major tracks within the department have a common core of five classes. The material covered in these classes allow students to meet the first five common departmental goals. The sixth common departmental goal is met through our MA499 course, where mathematics, data science, and actuarial science students complete a research project, write a report on their findings, and give an oral presentation to the faculty (and occasionally at conferences external to the university). This goal is also met through MA425, MA471, and ED478 for mathematics education majors since they make a vast number of presentations about mathematics through teaching. The remaining requirements are tailored to meet the specific needs of each track, and they also address many of the common goals. The mathematics majors concentrate proof writing and applications of mathematics to other disciplines. Actuarial science students meet VEE requirements and prepare for SOA examinations. Data science students take information systems and computer science classes. Mathematics education majors study material covered on the state's content knowledge exam and hone their teaching skills in a number of courses.

Assessment Methods

All Millikin students are required to pass the mathematics placement exam or MA098 prior to receiving credit for a QR course or receive an equivalent math ACT sub-score (22). The department now tests all students wanting to take calculus with the Millikin calculus readiness exam, and students are placed by the score obtained on the exam. Students are assessed within our programs in numerous ways: course exams, problem sets, and written

and oral demonstrations. Additionally, every mathematics education student completes a teaching internship with a mathematics faculty member. Written evaluations from these experiences including evaluation by the students' supervisors are kept. Further, mathematics education majors must pass the state mathematics content test, complete a student-teaching experience in one of the area high schools, and pass the edTPA (Teaching Performance Assessment) before they can be certified to teach in the state of Illinois. Mathematics, data science, and actuarial science majors complete a research project during their senior year, leading to a formal paper and presentation to the mathematics faculty. While a project is typically advised by a single mathematics faculty member, the entire faculty has input into the assessment of the students' work.

The courses in which the departmental goals will be assessed are summarized in the curriculum maps that are listed in the appendix. Most goals are assessed using the final exams for these courses. The department chair collects copies of the final exams and verifies that the goals are being addressed by the final exams. (For security reasons, the final exams are not included in this document. They can be examined upon request.) Goals pertaining to dissemination of research projects and educational practices are assessed using rubrics created either by the faculty member teaching the course or by committee (in the case of the research projects).

Assessment of Performance Learning

In many ways, all of mathematics is performance learning. One cannot learn mathematics without doing mathematics. Mathematics students must learn outside of the classroom by doing homework, completing projects, taking independent study courses, and studying for exams.

That being said, there are specific areas in which we can directly assess performance learning of our mathematics students. Our mathematics education majors are assessed several times throughout their studies. In both MA425 and MA471, students are expected to deliver lessons to mathematics classes at Millikin. Their lessons are video recorded, they reflect on both their preparation and their delivery, and they are evaluated according to a rubric developed by Dr. Paula Stickles, our mathematics education specialist. Further, all mathematics education students must successfully complete a student-teaching experience that is evaluated on five separate occasions by their university supervisor. Again, this is evaluated using a rubric, and students are given detailed feedback.

For our mathematics, data science, and actuarial science students, their performance learning builds slowly and more informally, requiring short in-class presentations, smaller project assignments, and increasing amounts of independent work. This all culminates in a research project they do their senior year that is formally evaluated by all the department's faculty. Students extend the content knowledge learned throughout the program, write up a formal report on their findings, and give a presentation to the department's faculty and their peers. Students who complete truly exceptional projects submit their finding to journals and give presentations at external conferences.

Analysis of Assessment Results

The department chair inspected the final exams for the courses offered during the 2016-17 academic year that have been designated as addressing departmental goals and concluded that all departmental goals indicated in the curriculum map were met. Further, all students who completed a research project in MA499 did so satisfactorily (all grades were C+ or better), and the student who took MA471 achieved a grade of C or better, which means that all students met the state's minimum grade requirement for required major courses. We had one student pass the Exam FM of the Society of Actuaries.

Review of 2017-2018 Improvement Plans

- Dr. Emily Olson, Assistant Professor of Mathematics, began teaching for us in the Fall 2017 semester.
- Dr. Dan Miller continued to serve Director of STEM Recruiting and won the Czerwinski Teaching Excellence and Campus Leadership Award.
- Dr. Jim Rauff taught two semesters of computer programming, and the department broadened its computer science offerings to the point where we are now able to offer a minor in computer science.
- Dr. Eun-Joo Lee was awarded a sabbatical for the Spring 2019 semester.
- Dr. Paula Stickles won the Research and Artistic Achievement Award.
- The Math Center move to the University Commons for the Fall 2017 semester before moving to SH204 in Spring 2018. It is coping ably in this new space.
- The Hawkes Learning System is now being used for all courses up through MA115.
- A detailed analysis of the effectiveness of the developmental mathematics sequence led to the elimination of MA087 and MA091. These courses have been replaced with the Mathematics Enrichment Program. Students who place below MA098 will need to complete this self-paced, zero-credit program before being able to enroll in MA098. Dr. Dan Miller will be supervising all students in this program, and we will monitor its effectiveness very closely over the next several semesters.
- We added a new track in Data Science. Three current students have declared this track as their major, and at least two incoming freshman will be in this track as well.
- We deleted MA215 from the actuarial science curriculum and added CS135 and CS235. We feel programming skills, particularly in Python, will be beneficial for students in this track as the industry is placing a higher value on these skills.
- After ACT discontinued support of the COMPASS exam, Dr. Paula Stickles wrote both a new mathematics placement exam and a calculus readiness exam. We administered a mathematics placement exam to every student new to the university who would place below MA109 by either their ACT or SAT score. We will monitor these students' progress through the developmental mathematics sequence as well as their performances in courses that count for the Quantitative Reasoning requirement.
- We created two new courses that will allow our actuarial science program to be listed as an Advanced Curriculum program as designated by the Society of Actuaries. We are still working through the approval process.

Improvement Plans for 2017-2018

- Continue work with Dr. Dan Miller in his STEM recruiting role, particularly for our new data science program. Additionally, we are hoping to increase the number of majors in our actuarial science and mathematics education tracks.
- Receive recognition from the Society of Actuaries as offering an advanced curriculum in actuarial science.
- Work with the Tabor School of Business on other synergies with our offerings.
- Continue to mentor Dr. Emily Olson.
- Continue to analyze of the effectiveness of the developmental mathematics sequence, especially the Mathematics Enrichment Program. Dr. Paula Stickles is spearheading these efforts.
- Continue supporting Dr. Joe Stickles' efforts in attaining the Associate credential from the Society of Actuaries.
- Improve student success rate on actuarial exams. Besides supporting Dr. Stickles' efforts, more needs to be done to help students pass at least one examination before graduation.
- Continue tracking the students who took the new placement and calculus readiness exams. Depending on students' success in the courses in which they were placed, we will adjust cut scores accordingly for future administrations of the exams.
- Finish handbook for MA499 to help better guide our mathematics and actuarial science students through the capstone research project process.

Table 1. Full time faculty: Mathematics

Faculty	Highest Degree	Rank	Tenure Status	Year Hired	Specialty Field	Courses taught
James Rauff	Ph.D.	Professor	Tenured	1988	Formal Languages, Computational Linguistics, Ethnomathematics	Discrete Math, History of Math, Linear Algebra, Calculus, Remedial Algebra.
Emily Olson	Ph.D.	Assistant Professor	Tenure-track	2017	Combinatorics	Finite Mathematics, Trigonometry, Discrete Mathematics, Linear Algebra
Christine Harshman	M.S.	Lecturer	Non-tenure-track	2016	Remedial Mathematics	Arithmetic, Basic Algebra, Intermediate Algebra
Daniel Miller	Ph.D.	Professor	Tenured	1997	Geometry, Educational Technology	Geometry, Remedial Algebra, College Algebra
Joe Stickles	Ph.D.	Professor	Tenured	2006	Ring Theory	Calculus, Discrete Math, Abstract Algebra.
Eun-Joo Lee	Ph.D.	Assistant Professor	Tenured	2006	Mathematical Statistics	Statistics, Calculus.
Paula Stickles	Ph.D.	Associate Professor	Tenured	2006	Problem Solving and Posing, Mathematical Modeling	Secondary Methods, Calculus, Remedial Algebra

Appendix

Curriculum Matrix
Mathematics Core Classes

	MA 140	MA 208	MA 240	MA 303	MA 304
Goal 1	X		X		X
Goal 2	X	X	X	X	X
Goal 3		X		X	
Goal 4		X	X		X
Goal 5	X	X	X	X	X

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1. integrate and differentiate functions,
2. express and interpret mathematical relationships from numerical, graphical, and symbolic points of view,
3. read and construct mathematical proofs,
4. analyze various discrete and continuous probability models,
5. apply mathematics to other disciplines, and
6. present mathematical results and arguments orally and in writing. (Addressed in MA499 for mathematics and actuarial science majors)

Curriculum Matrix
Mathematics

	MA 3 0 5	MA 3 1 3	MA 3 4 0	MA 4 0 3	MA 4 4 0	MA 4 9 9		MA 3 0 8	MA 3 1 4	MA 3 2 0	MA 4 2 0	MA 4 7 2	MA 4 9 1
Goal a				X	X			X		X	X		X
Goal b	X	X	X			X		X	X			X	X
Goal c						X							
	Required Courses							Elective Courses (Must take two)					

A mathematics major will:

- a. read and construct mathematical proofs in two advanced subject areas,
- b. apply appropriate mathematical techniques to solve problems within mathematics and in extra-disciplinary contexts, and
- c. complete a research project, including dissemination of the project's findings.

Curriculum Matrix
Actuarial Science

	MA 2 1 5	MA 2 3 0	MA 3 1 3	MA 3 1 4	MA 3 2 4	MA 3 4 0	MA 4 9 9	EC 1 0 0	EC 1 1 0
Goal a	X		X	X	X	X			
Goal b		X						X	X
Goal c							X		

An actuarial science major will:

- a. prepare for two Society of Actuaries' exams,
- b. satisfy two of the Validation by Educational Experience (VEE) requirements of the Society of Actuaries, and
- c. complete a research project, including dissemination of the project's findings.

Curriculum Matrix
Data Science

	MA 2 3 0	MA 3 1 4	MA 3 4 0	MA 4 9 9	IS 1 2 0	IS 2 4 0	IS 3 1 1	IS 3 2 1	IS 3 7 0	IS 4 7 0	IS 4 7 0	CS 1 3 5	CS 2 3 5	CS 3 3 7	CS 3 4 2
Goal a	X	X	X		X	X									
Goal b							X	X	X	X	X	X	X	X	X
Goal c				X											

A data science major will:

- a. learn foundational material in mathematics and statistics necessary for the study of data science
- b. apply this foundational material using techniques from computer science and information systems, and
- c. complete a research project, including dissemination of the project's findings.

Curriculum Matrix
Mathematics - Secondary Education

	MA 3 0 1	MA 3 2 0	MA 4 0 3	MA 4 2 5	MA 4 7 1		MA 3 0 5	MA 3 1 3	MA 3 1 4	MA 3 4 0	MA 4 2 0	MA 4 4 0	MA 4 9 1
Goal a	X	X	X				X	X	X	X	X	X	X
Goal b				X	X								
Goal c				X	X								
	Required Courses						Elective Courses (Two-required)						

A mathematics education major will:

- a. prepare for the Illinois Licensure Exam in mathematics,
- b. apply appropriate pedagogical techniques to teach mathematics through exploration and problem solving consistent with best practices in the field, and
- c. compile a portfolio of materials demonstrating the following in the field of mathematics: content knowledge, pedagogical content knowledge, an ability to plan instruction, and analyze and document one's impact on student learning.