

Millikin University
Annual Assessment of Student Learning in Mathematics
By Dr. Joe Stickle, Chair
August 1, 2016

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 2016-17 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, and Mathematics Education 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. Stickle.

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.

Snapshot

The Department of Mathematics guides students in the completion of three different major tracks: mathematics education (9 students), mathematics (3 students) and actuarial science (10 students). Currently, 22 students are following one of our major programs of study. This is an enrollment decrease of 8 from last year. However, 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 are expecting approximately 20 new majors for the Fall 2017 semester.

The Department of Mathematics includes the disciplines of mathematics and statistics. The department offers mathematic majors with options in mathematics, mathematics education, and actuarial science. Additionally, a minor in mathematics is 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; 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 three 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. Since Christine Harshman was hired to be our Math Center director in January 2016, we have had no adjuncts teaching in the department.

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 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 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. 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 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 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 findings 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 B or better), and all students who took MA425 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, marking the first time a Millikin student passed this exam while still enrolled as a student.

Review of 2016-2017 Improvement Plans

- The department conducted a successful faculty search to replace Dr. Randal Beck. Dr. Emily Olson, Assistant Professor of Mathematics, will be teaching for us beginning in the Fall 2017 semester.
- Dr. Dan Miller served Director of STEM Recruiting.
- Dr. Jim Rauff taught an introductory computer programming course in the Spring 2017 semester. This is the first programming course that the department has offered since the Computer Science major was eliminated.
- Dr. Paula Stickles was on sabbatical for the Spring 2017 semester.
- The 3-2 program in engineering was implemented in partnership with the University of Missouri - Kansas City (UMKC).
- Christine Harshman served Coordinator of the Math Center. The Math Center is coping ably in their transitional space during the construction of the new Student Center.
- The Hawkes Learning System throughout our developmental mathematics sequence beginning in the fall 2016 semester, and it was used for College Algebra and Trigonometry.
- A detailed analysis of the effectiveness of the developmental mathematics sequence is continuing. We are particularly interested in success rates in the courses themselves, the success rates in subsequent courses, and the retention of students who enroll in these classes.
- With the retirement of Dr. Randal Beck, Dr. Joe Stickles has been working to replace Dr. Beck's role in overseeing the actuarial science program.
- We added a new track in Data Science and will be recruiting for this program that begins in Fall 2018.
- We updated the curriculum in the MA215 class to help prepare for the Exam FM exam, and we piloted a new review course for Exam P in the Spring 2017 semester.
- After ACT discontinued support of the COMPASS exam, Dr. Paula Stickles wrote both a new mathematics placement exam and a calculus readiness exam. These exams were administered for the first time during new freshman orientation and registration in June 2016. A preliminary analysis indicated the new placement exam is working well. We made some slight modifications to the exam for the Fall 2017 semester. We will continue to monitor our placement practices closely as we gather more data.

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. This will require the creation of two courses.

- Add a computer science minor.
- Mentor our new faculty member, Dr. Emily Olson.
- Disseminate the analysis of the effectiveness of the developmental mathematics sequence. Dr. Paula Stickles is spearheading these efforts. (This was the focus of her sabbatical.)
- 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.
Randal Beck	Ph.D.	Associate Professor	Tenured	1979	Partial Differential Equations, Statistics.	Finite Mathematics, Statistics, Numerical Analysis, Differential Equations.
Christine Harshman	M.S.	Lecturer	Non-tenure-track	2016	Remedial Mathematics	Arithmetic, Basic Algebra, Intermediate Algebra
Daniel Miller	Ph.D.	Professor	Tenured	1997	Mathematics Education, 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		

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.

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.