Millikin University
Student Learning in the Mathematics Major
By Daniel Miller
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NCATE special program accreditation from NCTM. There should be no additional assessment data necessary for the mathematics education major beyond what is collected for the yearly NCATE report completed by Dr. Paula R. Stickles.

   b. Mathematics education- in a world where political leaders are becoming increasingly numbers driven, we provide the teachers the skills to empower children by enhancing their ability to reason quantitatively.
   c. Computer science- we provide the skills necessary for students to succeed in an increasingly technological world

3. To prepare students for a personal life of meaning and value we help our students develop the intellectual framework, and instill in them the mindset, that will enable them to remain life-long learners. Our students are taught to think rigorously and rationally, and to revel in the sheer pleasure of thinking.

<u>Snapshot</u>

The Department of Mathematics guides students in the completion of three different majors: mathematics education, applied mathematics and actuarial science. Currently, 22 students are following one of our major programs of study. This is an enrollment increase of 3 from last year.

General Description. The Department of Mathematics includes the disciplines of mathematics and statistics. The department offers mathematic majors with options in Applied Mathematics, Mathematics- Secondary Teaching, and Actuarial Science. Additionally, a minor in Applied Mathematics is offered. Elementary Education majors may take a concentration in mathematics. 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 applied 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 applied 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.

with PACE contributing 1 FTE. For fall 2014 this number was reduced by 46 seats (.5 FTE) by increasing all developmental classes to at least 25 from 20.

Description Applied Mathematics**.** The applied mathematics major is for students interested in immediate employment or further study in applied mathematics or in actuarial sciences. Applied mathematics majors take a minimum of 33 credit hours in mathematics. The core courses and required advanced courses are those specified in *Undergraduate Programs and Courses in the Mathematical Sciences: CUPM Curriculum Guide 2004* by the Committee on the Undergraduate Program in Mathematics of The Mathematical Association of America.

Description Mathematics Education. The Mathematics-Secondary Teaching 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

each semester to verify the assertion that expressing and interpreting mathematical relationships from numerical, graphical and symbolic points of view was necessary to pass the exams.

a. See attached final exams and reviews of these finals by the individual faculty members.

3. be able to read and construct mathematical proofs in analysis and algebra, and

All Mathematics majors are required to take and pass Discrete Mathematics, Calculus III and Linear Algebra. It is the consensus of the department that it would not be possible to pass these three courses without the ability to read and construct mathematical proofs in analysis and algebra. Therefore verifying the completion of these two courses by all Applied Mathematics majors will assess fulfillment of this goal. Additionally, the department chair will collect copies of all Discrete Mathematics, Calculus III and Linear Algebra final exams each semester to verify the assertion that reading and constructing mathematical proofs in analysis and algebra was necessary to pass the exams.

a. Discrete Mathematics, Calculus III and Linear Algebra were all offered this year. A copy of the final exams from Calculus III and Linear Algebra are attached. A review of these exams support the contention that it would not be possible to pass these three courses without the ability to read and construct mathematical proofs in analysis and algebra. See attached final exams and reviews of these finals by the individual faculty members.

4. be able to apply mathematics to at least two areas taken from biology, physics, chemistry, economics or computer science.

All Mathematics majors are required to take Calculus I and II and Discrete Mathematics. The final exams from all sections of these courses will be review by the department chair to ensure that these routinely contain problems from biology, physics, chemistry, economics or computer science. Specifically, physics will be covered in Calculus I; biology, chemistry, and economics in Calculus II, and computer science applications in Discrete Mathematics.

a. This review was completed and verified that the exam contained appropriate problems involving biology, physics, chemistry, economics or computer science. All final exams for these courses are attached. Again, see attached final exams and reviews of these finals by the individual faculty members.

Assessing the Mathematics Education Major Goals

A mathematics education major will

1. be able to pass the Illinois high school mathematics certification exam,

The department chair will verify that each Mathematics Education major has

Buhrmann, J. Conference Presentation. *The U.S. Life Insurance Industry: Time Series Analysis*, Rose-Hulman Undergraduate Mathematics Conference, Terre Haute, IN, twenty

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.	

Appendix 1

Curriculum Matrix
Mathematics

	MA 140	MA 208	MA 240	MA 303	MA 304	MA 305	MA 313	MA 340	MA 403	MA 440	MA 499		MA 308	MA 314	MA 320	MA 420	MA 472	MA 491
Goal 1																		

Appendix 2

Curriculum Matrix
Mathematics Education

	MA 140	MA 240	MA 208	MA 301	MA 303	MA 304	MA 320	MA 425	MA 471		MA 340	MA 403	MA 305	MA 313	MA 314	MA 420	MA 440

Assessment of MA 140 Final Exam for Spring 2014

Goal: An applied mathematics major will be able to integrate and differentiate functions.

Assessment of goal:

Differentiation: Of the 17 problems on this final exam, problems , 3 7, 5, 6, 7, 11, 13, 14, and 15 either explicitly or implicitly required the students to take a derivative of some function in order to be able to solve the problem. Problem 1 required the students to understand the definition of the derivative. Problem 7 required the students to connect the first derivative of a function with the function increasing or decreasing and to connect the second derivative with the concavity of the function. Problem 11 required the students to apply differentiation techniques without having an explicitly stated function. Problem 13 required students to connect the derivative to optimizing a quantity given certain restrictions. Problem 14 required students to connect the derivative to a change in quantities with respect to time (related rates).

Integration: Of the 17 problems on this final exam, problems 2, 8, and 9 either explicitly or implicitly required students to integrate some function in order to be able to solve the problem. Problem 2 on the non-calculator part required the students to understand the definition of the definite integral to obtain the exact value of the definite integral. The remaining problems either explicitly or implicitly required students to integrate some function in order to be able to solve the problem.

As nearly every problem on this final exam involved either differentiation or integration (or both), it would be impossible for a student to pass this exam without knowing how to differentiate or integrate functions.

Goal: An applied mathematics major will be able to apply mathematics to at least two areas taken from biology, physics, chemistry, economics, or computer science.

Assessment of Goal: Problem 16 dealt with estimating integrals from a table of values; in particular. Since science students will be making inferences using experimental data, the ability to estimate derivatives and integrals from a table of values will be extremely useful. Problem 13 required students to determine the minimum value of some physical quantity. Though this particular problem did not explicitly bring in physics or chemistry per se, the technique required to solve this problem *does*

Assessment of MA 303 Final Exam for Spring 2014

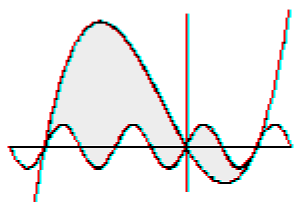
Goal: An applied mathematics major will be able to read and construct mathematical proofs in
analysis and algebra.

A mathematics education major will be able to pass the Illinois high school mathematics
certification exam.

Assessment of goal:

This course addresses the following Illinois State Board of Education and NCTM Content Standards.

Je m'appelle ______________



but do not evaluate, an integral (or integrals) that represents the area of R

[redacted]

Assessment of MA340 Final Exam for Fall 2013

: An applied mathematics major will be able to integrate and differentiate functions.

: All problems on the final exam required the students (directly or indirectly) to integrate or differentiate a function. Therefore, it is necessary for students to be able to integrate and differentiate functions in order to pass the final exam.

: An applied mathematics major will be able to apply mathematics to at least two areas taken from biology, physics, chemistry, economics or computer science.

: While not explicitly application problems, problems 6-9 required using theorems that have many applications to physics.

MA340 - Final Exam - Fall 2013

Let me be your ruler. You can call me ____________________________________.

Directions: [illegible]

1. Consider [illegible]

$$\mathbf{F}(x,y,z) = (2xe^z\sin y - \ln z)\,\mathbf{i} + \left(x^2e^z\cos y + \ldots\right)\mathbf{j} + \left(x^2e^z \ldots\right)$$

$\ldots\sin y + \tan^{-1} y - \frac{x}{z} + \sec z\tan z\Big)\,\mathbf{k}$

Show that $\mathbf{F}$ [illegible]

(b) (10 points) Find a function f such that $\mathbf{F} = \nabla f$.

Assessment of MA440 Final Exam for Fall 2013

: An applied mathematics major will be to read and construct mathematical proofs in analysis and algebra.

: Advanced calculus is the first course mathematics majors see in the more abstract area of mathematics known as analysis. A quick perusal of the final for this course will demonstrate to the reader that the entire course was devoted to reading and constructing mathematical proofs in analysis.

MA440 - Final Exam - Fall 2013

1. (10 points) TRUE or FALSE?

(a) It is possible to find two functions f and g such that f is integrable with respect to g over $[a, b]$ ...

(h) If P and Q are partitions of $[a, b]$ with $P \subseteq Q$, then L ... $(Q, f) \leq U(P, f)$

(i) If g' exists and if f is integrable with respect to g, then $\int_a^b f\,dg = \int_a^b f g'\,dx$

(j) Every song's like gold teeth grey goose, trippin' in the bathroom

2. (10 points) Let $f(x) = \begin{cases} a, & 0 \leq x < 2 \\ \ldots \end{cases}$ Is f integrable on $[0, 4]$? Compute $\int_0^1 f\,dx$ and $\int_0^1 \ldots$ Why or why not?

(a) Let $f : [a, b] \longrightarrow \mathbb{R}$ be bounded. Then $f \in R(x)$ on $[a, b]$ if and only if for each $\varepsilon > 0$ there is a partition P such that $U(P, f) - L(P, f) < \varepsilon$.

4. (15 points) Answer the following:

(a) Prove the Differentiation Theorem for Riemann-Stieltjes integrals: Suppose that f is continuous ...

(b) Suppose f and g are continuous on $[a, b]$ with $\int_a^b f \ldots = \int_a^b \ldots$ Prove there exists ... such that $f(c) = g(c)$.

(OVER)

MA208 Final Exam
Sign in please: ______________________________________

Part I. Something Old

Subpart A. Calculations (50 points)

1.

a. Given that is true, is true, and is false. Determine the truth value of .

b. What truth value for would make the statement ( ) true for all truth values of and ?.

2. Write the negation of the converse of the proposition “If the Daleks invade the solar system, then the humans will be exterminated.”

3. Let 0,1,2,3,4,5,6 , 2,4 , and 1,2,3,4 . How many different functions f B^C A are there?

4. Write 3246 as a base 16 numeral.

5. Find integers and such that m n .

6. What is the number of distinct permutations of the letters in the word baboon?

7. In how many different ways can 9 diplomats be seated at a roundtable that has only 6 seats?

8. Five people (Amos, Barbara, Claude, Destiny, and Elmer) are lining up for a group photograph. They line up at random and a photograph is taken. Amos and Barbara are married to each other, but Destiny used to be married to Amos. In how many different ways can they line up so that Amos and Barbara are next to each other, but Destiny is not next to Amos?

Subpart B. Proofs (10 points each)

10. Prove: If f A A and g A C are one-to-one functions, then $g \circ f$ is one-to-one.

11. Let S be the sample space of an experiment and let E and F be disjoint subsets S. Prove that the probability of E F is equal to the sum of the probability of E and the probability of F.

12. Consider the binary relation , | is evenly divisible by 4 on the set of integers, . Prove that is transitive.

13. Let f be the function defined by f n n . Prove that f is onto.

3. Prove or disprove that the two graphs are isomorphic.

4. Prove that the number of edges in K_n is $\frac{n \; n}{\qquad}$ for all n .

7. Find a Hamiltonian circuit or prove that no such circuit exists.

8. Prove or disprove: The graph is planar.