Millikin University
Student Learning in the Mathematics and Computer Science Major
for Academic Year 2006-2007

By Daniel Miller
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Executive Summary

The Department of Mathematics and Computer Science supports Millikin's Mission in that the Department works:

1. To prepare students for professional success.
    a. Applied mathematics – we provide core mathematical experiences and a range of application areas to prepare students for work or graduate study.
    b. Mathematics education – we prepare students for the Illinois State Certification Exam, give them experience in teaching, and keep them current on the use of technology in mathematics education.
    c. Computer science – we train students in fundamental programming techniques and theory so that they can learn new technologies in this rapidly changing field.

2. To prepare students for democratic citizenship in a diverse and dynamic global environment.
    a. Applied mathematics- we provide fundamental tools to analyze dynamic events that will inform public policy.
    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.

Additionally, the department has developed specific goals for all three of its majors, Computer Science, Applied Mathematics, and Mathematics Education. These goals clarify and document the department's desire to produce highly qualified and successful majors.

The assessment results for data collected for 2006-2007 constitutes the department's first systemic attempt to quantify student achievement within the department. The results suggest that, for students in both Mathematics and Mathematics Education, program goals are being met. It will take at least two years of data to ensure that all goals for these programs are being met due to the two-year rotation of courses in the major and another two years after that to fully integrate the Computer Science assessment under development.

Report

<u>Goals</u>

The Department of Mathematics and Computer Science supports the mission of the university in preparing students for professional success, democratic citizenship in a global community, and a personal life of meaning and value. The mission of the department is to produce graduates who achieve the following learning outcome goals:

1. Applied Mathematics

   An applied mathematics major will

   a. be able to integrate and differentiate functions,
   b. be able to express and interpret mathematical relationships from numerical, graphical and symbolic points of view,
   c. be able to read and construct mathematical proofs in analysis and algebra, and
   d. be able to apply mathematics to at least two areas taken from biology, physics, chemistry, economics or computer science.

2. Mathematics Education

   A mathematics education major will

   a. be able to pass the Illinois high school mathematics certification exam,
   b. know in broad terms the history of calculus, algebra, and probability,
   c. have prepared at least 2 lesson plans in mathematics, and
   d. have served as an teaching intern for a member of the mathematics faculty

3. Computer Science

   A computer science major will

   a. be able to write, modify and debug programs in Java, C++, and at least one other programming language,
   b. understand the mathematical theory of computer science and how that theory is manifested in computer science practice,
   c. be comfortable working with a variety of operating systems and be able to write web software, and
   d. have had experience as an intern in information technology or computer science

These goals also reflect a connection to Millikin's Mission in that the Department works:

4. To prepare students for professional success.
   a. Applied mathematics – we provide core mathematical experiences and a range of application areas to prepare students for work or graduate study.

   b. Mathematics education – we prepare students for the Illinois State Certification Exam, give them experience in teaching, and keep them current on the use of technology in mathematics education.
   c. Computer science – we train students in fundamental programming techniques and theory so that they can learn new technologies in this rapidly changing field.

5. To prepare students for democratic citizenship in a diverse and dynamic global environment.
   a. Applied mathematics- we provide fundamental tools to analyze dynamic events that will inform public policy.
   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 and Computer Science guides students in the completion of three different majors: mathematics education, applied mathematics, and computer science. Currently, 46 students are following one of our major programs of study. There are 14 students majoring in computer science, 14 in mathematics education, and 18 in applied mathematics. The Department also serves elementary education students with mathematics concentrations.

General Description. The Department of Mathematics and Computer Science includes the disciplines of mathematics, computer science, and statistics. The department offers majors in Applied Mathematics, Mathematics- Secondary Teaching, and Computer Science. Minors are offered in Applied Mathematics and Computer Science. Elementary Education majors 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 plan to have careers in computer science;
- 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.
- On the other hand, computer science has gradually diverged from mathematics as it has become a deeper and more technical field. The Department has a single fulltime computer science professor (Rogers) who teaches nearly all the computer science courses.
- Students can earn either the Bachelor of Arts or Bachelor of Science in any of the three majors offered by the Department. 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 members of the Department have doctorate degrees and all save one are tenured or tenure-track. (See Table 1.)

Description Computer Science. The Computer Science major is designed to prepare students for employment and/or graduate studies. Our program design follows the minimal recommendations of the *Final Report of the Joint ACM/IEEE-CS Task Force on Computing Curricula 2001 for Computer Science*. Students take between 37 and 46 credit hours in computer science. Some of the coursework is cross-listed with management information systems. Our program emphasizes software design and general principles of computer algorithms and computer organization.

Discussion of a merger of the computer science program with the management information systems program has not produced results. Both programs continue to exist and both are under scrutiny as to whether they will continue as viable programs at Millikin.

The data compiled within the QPC report was in error as to the number of majors and graduates from the Computer Science (CS) program. Corrected numbers with documentation were supplied to the Dean of Arts and Sciences. As of this writing, it is not known if the new data has been included in the updated QPC report. The largest discrepancy was indicating that the number of graduates from the CS program averaged one per year whereas the actual 5-year average is closer to 3 and it was 7 in the spring of 2007.

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, the student is paired with a member of the faculty in teaching an undergraduate mathematics course.

The Learning Story

Applied mathematics and mathematics education majors follow nearly the same curriculum within the Department. The Department believes that to be a good mathematics teacher one needs to know mathematics. Therefore, the education majors are expected to compete successfully with the applied majors in most of their mathematics courses. The program assumes entering students can start with calculus the fall of their freshman year. Additionally, education majors are advised to have completed the core of their mathematics courses by the spring of their junior year so that they are prepared for the state certification examination that must be passed prior to being placed for student teaching.

The applied mathematics curriculum focuses on the integration of mathematical theory and mathematical practice. Our majors learn concepts and techniques appropriate for actuarial science, ecological modeling, engineering, numerical analysis, and statistical inference. We assume that most of our applied mathematics majors will seek employment in commerce or industry, but the curriculum also prepares them for post-graduate work in mathematics.

Computer science is the fastest changing field of study. New technologies and applications will be developed during a student’s four-year course of study at Millikin. The Department acknowledges that we cannot hope to “train” our computer science majors in the specific software or systems that they will encounter in the work place. Rather, our curriculum is designed to ground our majors in the timeless fundamentals of digital computing. The computer languages we teach are vehicles for the language-independent concepts of problem solving, object-oriented programming, algorithm design and analysis, system architecture fundamentals, and human-computer interaction. Our graduates have the fundamental knowledge and skills needed to learn new languages, new applications, and new systems on the job.

The curriculum maps are included as Appendix 1-3.

Assessment Methods

All students are required to pass the Millikin mathematics placement exam prior to taking a QR course or receive an equivalent math ACT score. The Department expects our majors to score a 5 (the suggested score for placement into Calculus I). Computer science students are expected to start with Computer Programming I and Discrete Mathematics. Students are assessed within our programs in numerous ways: course exams, problem sets, and written and oral demonstrations. Additionally, the Department requires every student in Computer Science and Mathematics Education to complete an internship. Written evaluations from these experiences including evaluation by the students' supervisors are kept. Computer Science majors produce an artifact of professional quality in their senior capstone seminars. Mathematics Education majors take and pass the state certification examination and submit to a portfolio review. Applied Mathematics majors lead a graduate school like seminar their last semester.

Assessing the Applied Mathematics Major Goals

An applied mathematics major will

1. be able to integrate and differentiate functions,

   All Applied Mathematics majors are required to take and pass both Calculus I and Calculus II to graduate with an Applied Mathematics degree. It is the consensus of the department that it would not be possible to pass these two courses without the ability to integrate and differentiate functions. 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 Calculus I and Calculus II final exams each semester to verify the assertion that integration and differentiation of functions was necessary to pass the exams.

   a. In the spring of 2007 the department chair collected copies of all Calculus I and II exams. The instructors for each course were asked to verify that no student could pass the exam without having knowledge on how to integrate and differentiate functions. The department chair then independently verified this conclusion. The collected data is being maintained by the department chair.

2. be able to express and interpret mathematical relationships from numerical, graphical and symbolic points of view,

   All Applied Mathematics majors are required to take and pass Discrete Mathematics, Differential Equations, and Numerical Analysis. It is the consensus of the department that it would not be possible to pass these three courses without the ability to express and interpret mathematical relationships from numerical, graphical and symbolic points of view. Therefore verifying the completion of these courses by all Applied Mathematics majors will assess fulfillment of this goal. Additionally, the department chair will collect copies of all Discrete Mathematics, Differential Equations, and Numerical Analysis final exams 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. In the spring of 2007 Differential Equations and Numerical Analysis were not offered. Dr. Rogers taught MA 208 Discrete Mathematics in the spring of 2007. This was his first time teaching this course. Data was colleted from this course and is currently being reviewed.

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

   All Applied 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. Again only Discrete Mathematics was taught from the above set of course and a review is underway.

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.

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 passed the state certification exam prior to student teaching. Additionally, the chair will note and analyze the subject area sub scores on an ongoing basis to determine the need for curricular change.

a. All students passed the state exam! A curricular concern was noted. The exam is partitioned into five content areas and no student received a passing score on the statistical portion of the exam. Dr. Beck is reviewing the content on this part of the exam and will be adjusting the required statistics courses.

2. know in broad terms the history of calculus, algebra, and probability,

   All Mathematics Education majors are required to take and pass Mathematics History to graduate with a Mathematics Education degree. It is the consensus of the department that it would not be possible to pass this course without knowing in broad terms the history of calculus, algebra, and probability. Therefore verifying the completion of this course by all Mathematics Education majors will assess fulfillment of this goal. Additionally, the department chair will audit the Mathematics History syllabus each semester to verify the assertion that the assignments cover the history of calculus, algebra, and probability. Samples of student work will also be collected.

   a. Math History was not offered in the spring of 2007.

3. have prepared at least 2 lesson plans in mathematics,

   All Mathematics Education majors will be required to submit 2 graded lesson plans to the department chair prior to student teaching. These lesson plan may come from a variety of courses; MA 425 Teaching Secondary and Middle School Mathematics, MA 471 Mathematics Internship, or any other education course that required the completion of a mathematics lesson plan.

   a. MA 425 was not offered in the spring of 2007. All secondary mathematics majors taking MA 471 were required to complete at least 1 graded lesson.

4. have served as a teaching intern for a member of the mathematics faculty

5.

   In support of this goal, all Mathematics Education majors are required to take and pass the departmental teaching internship MA 471 to graduate with a Mathematics Education degree. The departmental chair will collect and analyze the end of course reflection required for this internship to determine the effectiveness of the experience.

   a. All secondary mathematics majors taking MA 471 were required to complete an end of course reflection. The chair has reviewed these reflections.

Assessing the Computer Science Major Goals

A computer science major will

1. be able to write, modify and debug programs in Java, C++, and at least one other programming language,
2. understand the mathematical theory of computer science and how that theory is manifested in computer science practice,
3. be comfortable working with a variety of operating systems and be able to write web software, and have had experience as an intern in information technology or computer science

An assessment program for computer science is under development now. I expect it to be in place for the fall of 2007 unless the provost recommends a program change.

Analysis of Assessment Results

The assessment data collected for 2006-2007 constitutes the department's first systemic attempt to quantify student achievement within the department. The results suggest that, for students in both Mathematics and Mathematics Education, program goals are being met. It will take at least two years of data to ensure that all goals for these programs are being met due to the two-year rotation of courses in the major, and another two years after that to fully integrate the Computer Science assessment.

Improvement Plan

Since students are meeting the departmental goals for student learning, we do not plan to make any major changes to our curriculum. As noted previously, Dr. Beck will be reviewing and updating the statistics courses as needed to better align these courses to the content required for success on the Illinois state content exam for mathematics teachers.

The department expects to hire one additional tenure track faculty to replace a three-year term position at the conclusion of the current contract. The department will be using this hire to further strengthen the program.

The department is applying for NCTM accreditation. The process will surely identify additional needs but also opportunities for improvements.

Finally, we plan to review and implement the newly designed assessment program for Computer Science. Having seven seniors graduate from the program in 2007 and registering seven freshman Computer Science majors for Fall 2007, the program appears more than viable at this time.

Table 1. Full time faculty: Mathematics and Computer Science

Faculty	Highest Degree	Rank	Tenure Status	Year Hired	Specialty Field	Courses taught
James Rauff	Ph.D.	Professor	Tenured	1988	Formal Languages, Computational Linguistics, Ethno mathematics.	Discrete Math, Computing Theory, History of Math, Linear Algebra, Calculus, Remedial Algebra.
Randal Beck	Ph.D.	Associate Professor	Tenured	1979	Partial Differential Equations, Statistics.	Calculus, Statistics, Differential Equations.
Daniel Miller	Ph.D.	Associate Professor	Tenured	1997	Mathematics Education, Geometry, Educational Technology.	Teaching Methods, Precalculus, Geometry, Remedial Algebra,
Michael Rogers	Ph.D.	Associate Professor	Tenured	1998	Computer Science.	All courses.
Joe Stickles	Ph.D.	Associate Professor	Tenure-track	2006	Ring Theory.	Calculus, Liberal Arts Mathematics, Abstract Algebra.
Eun-Joo Lee	Ph.D.	Assistant Professor	Tenure-track	2006	Mathematical Statistics.	Statistics, Calculus.
Michael Fearheiley	Ph.D.	Assistant Professor	3-yr term	2000	Chemistry.	Remedial Algebra, Statistics.

Curriculum Matrix
Applied Mathematics

	MA 140	MA 240	MA 208	MA 301	MA 303	MA 304	MA 320	MA 471		MA 250	MA 302	MA 305	MA 313	MA 314
Goal 1														
Goal 2														
Goal 3														
Goal 4														
	Required Course									Elective Courses (Two-required)				

An applied mathematics major will

Goal 1: be able to integrate and differentiate functions.

Goal 2: be able to express and interpret mathematical relationships from numerical, graphical and symbolic points of view.

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

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

Appendix 2

Curriculum Matrix
Mathematics Education

	MA 140	MA 240	MA 208	MA 301	MA 303	MA 304	MA 320	MA 471		MA 250	MA 302	MA 305	MA 313	MA 314
Goal 1														
Goal 2														
Goal 3														
Goal 4														
	Required Course									Elective Courses (Two-required)				

Goal 1: A mathematics education major will be able to pass the Illinois high school mathematics certification exam.

Goal 2: A mathematics education major will know in broad terms the history of calculus, algebra, and probability.

Goal 3: A mathematics education major will have prepared at least 4 lesson plans.

Goal 4: A mathematics education major will have served as a teaching intern for a member of the mathematics faculty.

Appendix 3

Curriculum Matrix
Computer Science

	CS 130	CS 230	CS 337	MA 208	MA 308	CS 434	CS 471	CS 499		CS 335	CS 336	MA 342	MA 345	CS 350	CS 429	CS 430	CS 445
Goal 1																	
Goal 2																	
Goal 3																	
	Required Course									Elective Courses (Two-required)							

A computer science major will

Goal 1: be able to write, modify and debug programs in Java, C++, and at least one other programming language

Goal 2: understand the mathematical theory of computer science and how that theory is manifested in computer science practice

Goal 3: have had experience as an intern in information technology or computer science