Millikin University
Student Learning in the Mathematics and Computer Science Major

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 departments desire to produce highly qualified and successful majors.

Report

Goals

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, 68 students are following one of our major programs of study. There are 37 students majoring in computer science, 18 in mathematics education, and 13 in applied mathematics. The Department also serves 15 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.) The members of the Department have collectively published 59 journal articles, book chapters and reviews since 2000. They have also given 40 talks and presentations at local, state, regional, national and international meetings since 2000.
- The Department eliminated the pure mathematics major in 2004 because we lacked the staff to support it. We also eliminated some courses at that point and redesigned the mathematics curriculum to integrate mathematics education and applied mathematics coursework.

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 began in 2005 and continues at this writing. It is expected that a new program in computer and information sciences will emerge from these discussions. The new program is scheduled to begin in Fall 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 successfully compete with the applied majors in most of their mathematics courses. The program assumes entering students can start with calculus the fall of their freshmen 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 major will seek employment in commerce or industry, but the curriculum 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 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. 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 to complete an internship. Written evaluations from these experiences including evaluation by the students' supervisors are kept. Applied mathematics and computer science majors produce an artifact of professional quality in their respective senior capstone seminars. Mathematics education majors take and pass the state certification examination and submit to a portfolio review.

The Department is currently developing a structure for long-term data collection on our majors. As of now the most significant data that is collected are the required state exam results for education majors. Additionally, the department is developing assessment instruments to meet National Council of Teachers of Mathematics (NCTM) accreditation guidelines. These will be required for all mathematics and mathematics education majors. Three assessments are planed. One will cover the content of min/max problems and be developed in consultation with Dr. Stickles. The second will cover writing in the content area and will be integrated into MA 320 math history. Dr. Rauff will lead the development of this assessment. Finally a more formal assessment of lesson plan design and implementation will be included in MA 471 the mathematics teaching internship. All of these new assessments will be fully documented by the fall of 2006 for the NCTM accreditation report.

Assessment in computer science has been put on hold while the programs viability and structure are being studied. It is currently believed that the program will be merged with information systems technology in the Tabor school by the fall of 2007.

Analysis of Assessment Results

Placement Computer Science: The 2001-2005 mean placement rate for our computer science majors was 93.25%. Millikin computer science graduates are at work at Apple, Sun Microsystems, Microsoft, ADM, Tate and Lyle, State Farm, and many smaller high tech firms.

Placement Applied Mathematics. Our mathematics majors have enjoyed 100% placement since 2002. Our graduates are working as actuaries, engineers, analysts, realtors, and college professors.

Placement Mathematics Education. Since 2002, 100% of Millikin's mathematics-secondary teaching graduates have found positions as high school mathematics teachers in the year they graduated.

The above data strongly suggest the quality of the programs. Over time with the new assessments in place starting fall of 2006 additional measures of quality will become available.

Improvement Plans

For computer science, we are at a wait and see time. The current thinking is that computer science will be merged into existing Tabor programs. If this is the case the mathematics department will have little influence over the program moving forward. If not, there is a strong needs to advertise the program to attract students, see QPC report. The quality of the program is viable as is but without more students the program is not cost justifiable.

In mathematics and mathematics education major improvement is set for the fall of 2006 with the appointment of two new faculty members. Both are tenure track and both have Ph.D.s in highly valued areas for the department. Dr. Stickles will take the lead in the development of the Calculus series while Dr. Lee will focus of advanced statically courses. As far as I know, we will be the only division III School in the area with two Ph.D. statisticians on faculty.

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 last hire to additionally strengthen the program.

Finally, the department is applying for NCTM accreditation. The process will surly identify additional needs but also opportunities for improvements.

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, Ethnomathematics.	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.

Appendix 1

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

Comment [MR1]: black → we do it
gray → we do it sort of
white → we don't do it

	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