

## REVIEW OF THE M.S. IN MATHEMATICS

Classification of Instructional Programs (CIP) Code: 27.0101  
Mathematics, General

### OVERVIEW

The M.S. in Mathematics program is housed in the Department of Mathematics within the College of Arts and Sciences. The department also offers an undergraduate minor in Mathematics, a B.A., B.S. in Mathematics, and a Ph.D. in Mathematics Education. The last review of the M.S. in Mathematics program occurred in 2010-2011.

Students enrolling in the M.S. in Mathematics program choose one of four sequences of study (actuarial science, applied statistics, biomathematics, or elementary and middle school mathematics education) or they create a unique plan of study that better meets their career goals. Students completing the actuarial science sequence typically work in risk management positions with private companies, nationally or internationally. The sequence has an eight-year job placement rate of 94 percent. Students completing the applied statistics sequence often take positions involving analysis of big data, while biomathematics students most often pursue academic or research careers in the field. Students enrolling in the elementary and middle school mathematics education sequence typically are part-time students and full-time teachers who, after graduation, continue working at their school. The majority of students not choosing a sequence are part-time students and full-time high school teachers who either remain employed at their high school after graduation or seek work in community colleges. The M.S. in Mathematics program is also designed to prepare students for doctoral studies regardless of the plan of study they select.

#### **Enrollment by Plan of Study, Fall Census Day, 2011-2018** **M.S. in Mathematics, Illinois State University**

	2011	2012	2013	2014	2015	2016	2017	2018
No sequence	31	17	18	14	18	23	20	23
Actuarial Science sequence	37	41	43	33	30	25	21	26
Applied Statistics sequence	8	7	8	10	9	8	8	19
Biomathematics sequence	9	7	4	5	6	5	4	9
Elementary and Middle School Mathematics Education sequence	9	4	4	9	9	4	3	6
<b>Total</b>	<b>94</b>	<b>76</b>	<b>77</b>	<b>71</b>	<b>72</b>	<b>65</b>	<b>56</b>	<b>83</b>

#### **Degrees Conferred by Plan of Study, Graduating Fiscal Year 2011-2018** **M.S. in Mathematics, Illinois State University**

	2011	2012	2013	2014	2015	2016	2017	2018
No sequence	11	8	8	5	5	6	9	5
Actuarial Science sequence	19	10	15	19	13	14	11	12
Applied Statistics sequence	6	5	8	7	3	7	5	1
Biomathematics sequence	3	0	2	1	0	3	1	2
Elementary and Middle School Mathematics Education sequence	1	23	3	5	3	2	6	1
<b>Total</b>	<b>40</b>	<b>46</b>	<b>36</b>	<b>37</b>	<b>24</b>	<b>32</b>	<b>32</b>	<b>21</b>

Table note:

Graduating Fiscal Year consists of summer, fall, and spring terms, in that order. For example, Graduating Fiscal Year 2018 consists of the following terms: summer 2017, fall 2017, and spring 2018.

## **EXECUTIVE SUMMARY PROGRAM REVIEW SELF-STUDY REPORT**

### **Program goals**

General mathematics plan of study and actuarial science, applied statistics, and biomathematics sequences:

- The program will provide students with strong mathematical foundations plus specialized content knowledge and reasoning/communication skills that are necessary and appropriate in their sequence.
- Students will demonstrate the ability to formulate and evaluate questions seeking new knowledge in mathematics.
- The program will prepare students to continue their professional growth after completion of the program.

Elementary and middle school mathematics education sequence:

- The program will provide students with strong mathematical knowledge and reasoning/communication skills that are necessary and appropriate in their sequence.
- The program will provide students with strong pedagogical knowledge and reasoning/communication skills that are necessary and appropriate in their sequence.
- The program will prepare students to continue their professional growth after completion of the program.

### **Students learning outcomes**

General mathematics plan of study and actuarial science, applied statistics, and biomathematics sequences:

- Demonstrate core foundational knowledge.
- Demonstrate advanced content knowledge and reasoning/communication skills.
- Demonstrate ability to formulate and investigate new problems.

Elementary and middle school mathematics education sequence:

- Demonstrate core foundational knowledge.
- Demonstrate additional content knowledge and reasoning/communication skills.
- Demonstrate ability to apply pedagogical and content knowledge in an educational setting.

### **Program curriculum** (2018-2019)

Students may enroll in one of four sequences or complete the program without enrolling in a sequence. Sequences are actuarial science, applied statistics, biomathematics, and elementary and middle school mathematics education. Students choosing the actuarial science, applied statistics, or elementary and middle school mathematics education sequence or choosing the general mathematics plan of study may select as their culminating experience a master's project, comprehensive examination, professional practice, or thesis. Students enrolling in the biomathematics sequence must complete a thesis.

Graduation requirements (non-thesis):

32 credit hours including 26 credit hours in mathematics, 3 credit hours in the culminating experience, and electives needed to reach the credit hour minimum.

Graduation requirements (thesis):

30 credit hours including 24 credit hours in mathematics, 4-6 credit hours of thesis work, and electives as needed to reach the credit hour minimum.

More specific course requirements for each plan of study are set forth in the graduate catalog.

### **Program delivery**

The program is offered on the Normal campus.

The program is delivered primarily through face-to-face or blended face-to-face/online instruction.

### **Department faculty** (Fall 2018)

27 tenure track faculty members (16 Professors, 5 Associate Professors, and 6 Assistant Professors)

27 non-tenure track faculty members (20 full-time and 7 part-time, totaling 24.16 FTE)

Undergraduate student to faculty ratio: 5.8 to 1

Undergraduate student to tenure-line faculty ratio: 10.6 to 1

The 27 tenure track faculty members in the department contribute to instructing and mentoring students in the M.S. in Mathematics program.

### **Specialized accreditation**

In 2009 the actuarial science program at Illinois State University, consisting of actuarial science sequences in the undergraduate and graduate mathematics programs, was one of the first nine programs in the U.S. designated a Center of Actuarial Excellence by the Society of Actuaries (SOA). In 2014 the actuarial science program was subject to a comprehensive five-year review by SOA, which resulted in continued accreditation through Calendar 2019. In 2016 the Casualty Actuarial Society, the other major professional actuarial organization in the U.S., began its own system of recognizing actuarial science programs. The program at Illinois State was one of the first four such programs in the world recognized by the society.

### **Changes in the academic discipline, field, societal need, and program demand**

Numerous external factors, many of them related to technology, have impacted the M.S. in Mathematics program since the prior program review. As in most disciplines, advances in scholarly communications via the internet and World Wide Web have increased collaborations within the discipline and across disciplines. This has made it possible for the Department of Mathematics to create the Center for Collaborative Studies in Mathematical Biology, which relies on technology to foster collaborations among its 11 member institutions. With increased use of web-based open access article repositories, faculty and students have timelier access to research results. Technological advances have also made it possible for the department to make more resources available online so students can more easily access them to support their learning. The department has made actuarial examination reviews available online, and faculty members are working hard to develop a fully-online actuarial science master's program that would not have been feasible at the time of the last program review. Another development impacting the program is the large increase in the demand for mathematics graduates with knowledge of data science and predictive modeling. That demand has fueled interest and growing enrollments in the actuarial science and applied statistics sequences of the program. As computational power has increased and more sophisticated analytic tools have been introduced, more companies are seeking job applicants qualified to analyze large data sets. Mathematics faculty members have the expertise to prepare students for such positions, however a high speed computer/server is needed to help process the computations needed to support such learning. With regard to mathematics teacher education, it has been necessary for faculty to account for changes in Illinois Learning Standards and changes in state licensure of elementary and secondary school teachers. The changes have prompted practicing teachers to take graduate courses to become qualified to teach at different grade levels or to teach dual credit (high school/college) courses. Faculty in the department have been working to meet those needs. A decrease in the number of tenure-line faculty members in the department since the prior review has led to limits on course offerings and culminating experiences for students as well as limits on the new program opportunities faculty can pursue. Attention to instructional capacity is needed for faculty to continue providing high-quality experiences.

### **Responses to previous program review recommendations**

The 2010-2011 program review resulted in three recommendations: compile a student learning outcomes assessment plan for each sequence of the program, investigate developing a five-year integrated biomathematics program, and continue efforts to develop a training program for graduate teaching assistants. In response to the recommendations,

the department has completed and submitted two assessment plans to University Assessment Services (one for the elementary and middle school mathematics education sequence and one for all other plans of study), developed and submitted proposals for two integrated programs (one for biomathematics and one for general mathematics), and developed a one-day workshop/orientation for graduate teaching assistants to acquaint them with the department and their teaching assistant responsibilities. The integrated programs have been designed to make it possible for well-prepared advanced students to earn both a bachelor's degree and a master's degree in general mathematics or biomathematics within five years rather than the usual six. The integrated program in biomathematics has been approved and is scheduled to begin in 2020. A proposal for a general mathematics program has been submitted for review by the appropriate curriculum committees.

### **Major findings**

Faculty of the M.S. in Mathematics program concludes from this program review that some plans of study in the program remain strong while some warrant attention to better meet students' needs. Faculty cites as exemplary the international recognition for the actuarial science sequence through designation of Illinois State University as a Center for Actuarial Excellence by the Society of Actuaries. Maintaining that designation should be a high priority for the department. Actuarial science faculty has embarked on design of a stand-alone actuarial science master's degree to further enhance that plan of study. Faculty hopes to offer the new program fully online for the convenience of practitioners. Faculty also cites increasing enrollment in the applied statistics sequence and the opportunities afforded by the biomathematics sequence for interdisciplinary inquiry. The Center for Collaborative Studies in Mathematical Biology, new since the prior program review, offers unique opportunities for students in the biomathematics sequence to collaborate with faculty at the 10 other institutions affiliated with the center. Beginning in 2020, well-prepared advanced students will be able to complete a bachelor's degree and a master's degree with an emphasis in biomathematics in five years rather than six through a new integrated biomathematics program. Among the opportunities for program improvements identified through this program review are adding an applied mathematics track to the general mathematics plan of study, which might attract more students and better prepare them for their chosen careers, and examining the curriculum and delivery of the elementary and middle school mathematics education sequence to identify ways to better meet the needs of practicing teachers seeking to advance their careers or qualify to teach dual credit (high school/college) courses. Faculty has also identified the need to revisit guidelines for all capstone experiences, to ensure consistency in their quality while maintaining flexibility to accommodate differences in students' academic and career goals. Maintaining and increasing enrollment is a program-wide priority as are recruiting for diversity and recruiting international students. Leveraging technology to create and disseminate more appealing promotional materials about the program should be a priority. In maintaining what is good about the program and addressing opportunities for program enhancements, resources may be an issue. The instructional capacity needed to offer more courses and new programs warrants attention. The ability to fund more graduate assistantships would also help attract high-achieving students, especially from overseas.

### **Initiatives and plans**

- Improve the graduate assistant orientation, and, if resources become available, provide an orientation for all new students (not just the graduate assistants).
- Improve program visibility by highlighting students' successes and providing more information about alumni so prospective students have a better sense of their career options if they were to complete the program.
- Involve more students in thesis writing and other research activities.
- Require Graduate Record Examinations (GRE) scores for all applicants.
- Increase the number of high-achieving full-time students enrolling in the general mathematics plan of study.
- Implement more creative student recruiting techniques.
- Increase students' participation in the annual University Research Symposium.
- Create a website to help guide students who are interested in pursuing a Ph.D. in mathematics or an allied field.
- Seek more creative ways to help students find graduate assistant positions outside the mathematics department.
- Find ways to raise the standard for the research project capstone experience, and create guidelines for both the research project capstone and the master's thesis so that expectations of both are clearer.
- Invite successful alumni to share their career experiences at new student orientations.
- Create a graduate student newsletter.
- Find ways to involve students with the Association for Women in Mathematics.
- Add a computer/technology/computational component to some four-credit-hour courses.

## **PROGRAM REVIEW OUTCOME AND RECOMMENDATIONS FROM THE ACADEMIC PLANNING COMMITTEE**

**Review Outcome.** The Academic Planning Committee, as a result of this review process, finds the M.S. in Mathematics program to be in Good Standing.

The committee thanks the program and department for a concise, complete, and clearly-written report. The committee recognizes the program for its blending of master's-level education in applied sub-disciplines (including actuarial science, applied statistics, biomathematics, and elementary and middle level education) and for its preparation of students interested in pursuing a doctoral degree. The committee congratulates faculty for the actuarial science plan of study being one of the first nine actuarial programs in the U.S. designated by the Society of Actuaries as a Center of Actuarial Excellence (reaffirmed in 2014) and for being one of the first four actuarial science programs in the world honored for its excellence by the Casualty Actuarial Society (in 2016).

The committee commends faculty for its ongoing review of the program for its relevance and currency and for the numerous changes faculty has made to the program to best position students for success after graduation. Faculty has made changes to sequence requirements, courses, and course content; continued to develop and grow enrollment in the actuarial science sequence; developed accelerated sequences at the undergraduate level to retain high-achieving students and encourage their enrollment in the master's program; participated in the INTO University Partners program to attract additional international students to the department; and has entered into an agreement with Jiangsu Normal University (China) for students from that institution to complete their Jiangsu undergraduate degree while in residence at Illinois State and to remain at the University to complete the M.S. in Mathematics program. The committee recognizes the work by faculty to attract high-achieving students to the program, to mentor them through the curriculum, and to provide numerous opportunities for them to be involved in research. Students are encouraged to attend and present research findings at conferences, the annual University Research Symposium, and at research seminars sponsored by the department. Since the last program review, program faculty members have annually collaborated with the Center for Insurance and Risk Management (Katie School) in the College of Business to sponsor a statistical research competition for students.

Faculty oversight of the curriculum and efforts to mentor students through the program have contributed to high rates of employment and admission to doctoral study for program completers. Placement rates for actuarial science graduates, for example, have averaged 94 percent since 2010. Across all sequences, program graduates are employed at nearly all major insurance companies, with government agencies, and with research institutions. Numerous graduates have subsequently completed a doctoral program and are now faculty members at postsecondary institutions.

In the self-study report, faculty has named several universities with mathematics programs that might serve as aspirational examples for the program at Illinois State and has identified aspects of those programs to which faculty aspires. However, faculty has not provided details regarding the aspirational programs nor has faculty identified specific actions that could be taken at Illinois State to implement initiatives or achieve levels of excellence similar to those of the aspirational programs. Accordingly, the committee asks faculty to continue its investigations and discussions regarding aspirational programs and to contextualize its findings in a follow-up report submitted to the Office of the Provost by December 15, 2019. Faculty might use this opportunity to develop strategies for achieving initiatives identified in the self-study report for the next program review cycle (e.g., improving graduate assistant training, involving more students in thesis writing and other research activities, or developing more creative recruiting techniques).

**Recommendations.** The Academic Planning Committee makes the following recommendations to be addressed within the next regularly scheduled review cycle. In the next program review self-study report, tentatively due October 1, 2026, the committee asks the program to describe actions taken and results achieved for each recommendation.

**Continue recruitment efforts to stabilize enrollment within enrollment targets.** Enrollment in the M.S. in Mathematics program steadily declined from 94 students in fall 2011 to 56 students in fall 2017. In response, faculty has established a target enrollment range based on resources available to the program and has adopted a more proactive approach to student recruitment to achieve enrollment within the target range. Examples include updating

information regarding the program on the university website and increasing the frequency and timeliness of communications with prospective students. Those efforts have already contributed to an enrollment rebound, to 83 students in fall 2018. The committee recommends continuation of recruitment efforts during the next review cycle. The committee also recommends periodic review of enrollment targets in light of changes in the discipline and changes to program resources.

**Continue to consider innovative approaches to master's-level mathematics education.** To best prepare students for employment or further graduate education in light of changes in the discipline, the committee encourages faculty to continue its discussions regarding the types of students the program might serve and the program structure, curriculum, and delivery methods best suited for each. The committee recommends as first priorities fully establishing and implementing the accelerated master's program to serve high-achieving students in the B.A., B.S. in Mathematics program and nurturing the collaboration with Jiangsu Normal University to increase enrollment resulting from that arrangement. If the Jiangsu Normal collaboration is successful, then faculty might seek similar arrangements with other universities. The committee encourages faculty to continue planning for elevation of the actuarial science sequence to a degree program that can be completed online. Depending on demand for the program from international students, faculty may want to consider providing for on-campus delivery of the program as well. The committee notes references in the self-study report of service to practicing high school teachers who seek credentials to teach dual credit mathematics courses (i.e., courses for high school and college credit). Providing additional opportunities for credentialing high school teachers to teach dual credit courses in general education disciplines, especially in less affluent communities and school districts, is a current priority in the state. Especially needed are opportunities delivered online for the convenience of practicing high school teachers. Biomathematics is another potential area of growth for the program. Faculty might explore ways to build on the unique inter-university collaborations of the Center for Collaborative Study in Mathematical Biology (Intercollegiate Biomathematics Alliance) housed in the Department of Mathematics. Faculty might, for example, explore establishing a certificate program taught collaboratively by faculty at Alliance member institutions. Given the numerous program innovations to explore and the limit to resources available to the department to do so, the committee recommends that faculty prioritize program initiatives for the next program review cycle and incorporate them into the strategic plan being completed by the department at this time.

**Implement strategies for increasing diversity among non-international students in the program.** The committee commends faculty for successful efforts to maintain gender balance among students enrolling in the program, particularly since women have historically been underrepresented in the discipline. The committee also recognizes the work faculty has done to recruit international students, which contributes to the university goal of internationalizing the institution. The committee notes that enrollment in the program of U.S. citizens who self-identify with traditionally underrepresented racial or ethnic groups has declined in recent years, from 16.7 percent in fall 2015 to 11.1 percent in fall 2017. The committee asks the program to develop and implement strategies for encouraging more students who identify with those groups to enroll in the program to further diversify the student population. Among the strategies faculty might pursue are recruiting from the increasingly diverse pool of undergraduate students in the department and encouraging high-achieving undergraduate students to enroll in the accelerated master's program after it has been established. Faculty might also target recruitment efforts to undergraduate students enrolled at universities in more diverse areas such as metropolitan Chicago.

**Continue efforts to increase faculty diversity.** According to the self-study report, the Department of Mathematics has achieved a stable gender balance in its faculty ranks whereby approximately half of its full-time faculty members and approximately 40 percent of its tenure-line faculty members are women. The report further states that nearly two-thirds of tenure-line faculty members were born outside the U.S. The report observes that there is room for increasing diversity among its U.S.-born faculty. The committee encourages the department to pursue doing so during the next program review cycle as opportunities to hire faculty arise. The committee recommends recruiting for diversity with respect to groups traditionally underrepresented in the discipline, including racial/ethnic groups, but also with respect to expertise, interests, and perspectives faculty members may bring to the department.

**Expand systematic efforts to connect with program alumni from all sequences in the program.** The committee recognizes concerted efforts of faculty to systematically track graduates of the actuarial science and biomathematics sequences since the last program review. Maintaining contacts with alumni can benefit the program and its students in many ways, such as obtaining advice for improving the program, recruiting alumni to mentor students, establishing endowments for scholarships and assistantships, and helping students obtain employment after

graduation. The committee supports faculty plans to expand its alumni tracking efforts to graduates of the general mathematics plan of study, the applied statistics sequence, and the elementary and middle school mathematics education sequence.

**Expand efforts to increase external funding for research.** Among the initiatives identified by faculty for the next program review cycle are involving more students in research activities, increasing graduate assistantship opportunities, and increasing program visibility. The self-study report cites having an insufficient number of faculty members as an impediment to successfully implementing these and other program initiatives. The committee encourages the department to continue working with the College of Arts and Sciences on its faculty resource needs but also recommends that faculty expand its efforts to seek external funding to support work of the department. Two existing research and service centers at the University might provide venues for helping faculty develop research initiatives and external funding requests to support them: the Intercollegiate Biomathematics Alliance (see above) and the Center for Mathematics, Science, and Technology. The department might also look to the Office of Research and Sponsored Programs on campus for guidance.

**Improve training for students in the program selected to serve as graduate teaching assistants.** Students in the M.S. in Mathematics program serving as graduate teaching assistants make valuable contributions to undergraduate education at the University. By facilitating discussion sections of high enrollment lecture courses, graduate assistants are able to provide a level of individualized attention to students that faculty members alone would have difficulty providing. The graduate assistants help faculty with introductory courses taken by undergraduate students across all programs at the University to prepare them for more advanced courses. The introductory courses meet general education requirements or prepare students to take general education mathematics courses. Graduate assistants may also work as tutors in the Mathematics Learning Assistance Center sponsored by the department. The self-study report cites as an initiative for the new program review cycle improving the orientation for graduate assistants. The committee concurs. The committee recommends that the department consider expanding graduate teaching assistant training beyond a single day to provide in-depth training in pedagogy, tutoring, and classroom management. Graduate assistant training might also be enhanced by faculty mentorship of graduate assistants throughout the academic year.

**Continue collaboration with Milner Library to provide research services and resources needed by students and faculty.** The committee recognizes collaborative efforts by program and library faculty to acquire research resources needed by students and faculty associated with the program and to provide assistance with their use. The committee is aware of the challenges faced by the program and library due to the ever-rising costs associated with research resources in STEM fields (Science, Technology, Engineering, and Mathematics). The committee commends the vigilance by the program and library to target available funds to research resources most needed by students and faculty. Since the last program review, Milner Library has introduced an article delivery service branded *Get It Now* to provide access to literature published in journals to which the library does not subscribe. The committee recommends that the department and library collaborate to increase awareness of the service among mathematics faculty and students. The committee also encourages program and library faculty to collaborate to further integrate information fluency training with the curriculum and with student learning outcomes assessment.

**Continue efforts to assess student learning and to utilize assessment findings to inform program planning.** The fall 2018 self-study report submitted by the program evidences implementation of the student learning outcomes assessment plan to guide the numerous changes made by faculty to the program in recent years, such as restructuring the master's project to permit students to complete the project over multiple semesters and adding content on data mining. The committee encourages faculty to continue assessing student learning, utilizing assessment findings to make program improvements if deemed necessary based on the findings, and documenting its assessment work including the rationale for program changes. The committee also encourages faculty to continue revising the assessment plan based on experiences with its implementation. Among enhancements faculty might consider are developing strategies for assessing learning of students who complete the non-thesis capstone option and using a reflective essay to assess learning as is done in the doctoral program. As faculty considers changes to the assessment plan, the committee encourages faculty to maintain a plan that can be sustained by the department given its faculty and staff resources.