

REVIEW OF THE PH.D. IN MATHEMATICS EDUCATION

Classification of Instructional Programs (CIP) Code: 13.1311
Mathematics Teacher Education

OVERVIEW

The Ph.D. in Mathematics Education 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 an M.S. in Mathematics. The last review of the Ph.D. in Mathematics Education program occurred in 2011-2012.

The Ph.D. in Mathematics Education program prepares individuals for careers as college or university professors in education or mathematics units. In those careers, program alumni conduct and direct basic research on the teaching and learning of mathematics in elementary and secondary schools, teach courses to mathematics teacher education students, and provide professional development opportunities for in-service elementary and secondary school mathematics teachers. Approximately 80 percent of students graduating from the program since the prior program review now hold tenure track faculty positions. Graduates are also qualified to assume positions as mathematics curriculum consultants or mathematics program supervisors in school districts, researchers in educational laboratories, and staff members in educational publishing companies.

While other universities in Illinois offer doctoral programs that include mathematics education as one of multiple emphases, the Ph.D. in Mathematics Education program is the only doctoral program in the state whose sole focus is mathematics education. The program differs from comparator programs in other states in that it is housed within a mathematics department rather than an education department, which allows for direct interactions and collaborations with mathematicians and statisticians.

Enrollment and Degrees Conferred, 2011-2018 Ph.D. in Mathematics Education, Illinois State University

	2011	2012	2013	2014	2015	2016	2017	2018
Enrollment, fall census day	17	13	17	17	14	15	16	17
Degrees conferred, graduating fiscal year	5	3	2	5	2	3	2	2

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

- To encourage students to appreciate and understand the history and research literature related to the teaching and learning of mathematics.
- To prepare graduates for the teaching responsibilities typically expected of mathematics education faculty; more specifically, to teach mathematics content and pedagogy courses to prospective teachers and to provide professional development opportunities for K-12 mathematics teachers.
- To prepare students to formulate and investigate questions seeking new knowledge related to the teaching and learning of mathematics.

Students learning outcomes

- Students will be skilled in reading, interpreting, and evaluating research in general and, more specifically, research related to the teaching and learning of mathematics.
- Students will understand the historical forces that have influenced mathematics education.
- Students will understand and apply the basic psychological and developmental principles of teaching mathematics for the grade levels associated with their selected program option (K-9 or K-12).
- Students will possess broad knowledge of mathematics content needed to educate prospective teachers, in-service teachers, and supervisors of mathematics programs.
- Students will develop, implement, and evaluate programs for prospective teachers, in-service teachers, and supervisors of mathematics programs.
- Students will demonstrate understanding of current theories of learning mathematics.
- Students will understand basic principles that influence the development, implementation, and evaluation of mathematics curricula.
- Students will be involved in research projects conducted by faculty members.
- Graduates will have designed, conducted, and reported original research.

Program curriculum (2018-2019)

Students select one of two options: K-9 or K-12.

Graduation requirements:

The typical plan of study consists of approximately 90 credit hours. Students are required to complete at least 6 credit hours in mathematics content courses; 30 credit hours in mathematics education courses; 3 credit hours earned through completion of a professional project; 12 credit hours in research methods courses; 6 credit hours in elective courses in areas such as mathematics, technology, curriculum, educational psychology, evaluation, supervision, human development, learning theory, or measurement; and at least 15 credit hours of dissertation work. Students must demonstrate competence in teaching pre-service and in-service mathematics teachers.

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

Twelve tenure track faculty members serve as the core faculty of the Ph.D. in Mathematics Education program. The 12 faculty members include 6 Professors, 4 Associate Professors, and 2 Assistant Professors.

Specialized accreditation

The Ph.D. in Mathematics Education program is not affiliated with a specialized accreditation association.

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

Mathematical and statistical understanding continues to be an important need throughout society, especially as more quantitative data are gathered to inform decision making. Since quantitative skills are necessary for many well-paying jobs in many fields, quantitative literacy has become more important than ever in students' education. As such, there has been an increased focus on the teaching and learning of mathematics as an issue of social justice and equity in mathematics education. An important question in mathematics education is determining when a pedagogical intervention intended to improve student learning is effective and when it is not. As a result, it is

important that students in doctoral mathematics education programs are prepared to conduct large-scale studies involving statistical analyses of quantitative data gathered about student learning of mathematics. As with other disciplines, technology has made it possible for students studying mathematics education to participate in learning through web conferencing software and learning management systems without having to come to campus. Many of the resources students need to conduct research as part of their studies are also available online. Technology makes it possible for mathematics education programs to work with students who are interested in the discipline but have geographic limitations.

Responses to previous program review recommendations

The 2011-2012 program review resulted in recommendations related to student learning outcomes assessment, library resources, benchmark programs, enrollment, alumni tracking, and the curriculum. Regarding assessment, it was recommended that faculty refine the assessment plan to include methods for obtaining student, faculty, and alumni feedback. Faculty and students are involved in current student learning outcomes assessment strategies, however at this time feedback from alumni regarding their satisfaction with the program is only collected informally. Creating and administering an alumni survey to systematically gather feedback regarding the program should be a priority for the next program review cycle. Regarding library resources, it was recommended that faculty work more closely with the mathematics subject librarian at Milner Library to develop greater degree-specific integration of library resources into the program. Faculty has done so. Faculty and graduate students have continued to send requests for materials they need for their teaching and research to the subject librarian, who has almost always found funds to purchase them. As have most academic libraries, Milner Library has experienced fast-rising periodical costs in the last decade, which has necessitated reducing monograph purchases and cancelling some lower-use journal subscriptions to meet periodical literature needs of its patrons. The library has introduced initiatives to provide alternative, less-costly means of delivering resources faculty and students in the doctoral mathematics education program need, including an electronic book rental program and a per-article subscription service that provides rapid online delivery to library patrons. Regarding benchmark programs, it was recommended that faculty members continue to monitor the mathematics education program against comparator and aspirational programs to identify opportunities for program improvement. Faculty has continued to do so. Regarding the number of students in the program, faculty has worked to enroll between 13 and 17 students each fall, averaging 16.25 students since the prior review. However, the number of tenure track mathematics education faculty members in the department has decreased. Accordingly, ongoing monitoring of enrollment is needed to ensure an appropriate balance of faculty, students, and other program resources. Regarding alumni tracking, faculty has expanded its efforts to document the careers of program graduates. Faculty has been able to obtain contact and employment information for nearly all students who have graduated from the program since the last review. Regarding the curriculum, faculty has continued to monitor the need for changes in the curriculum in response to changes in the discipline. While the program structure and graduation requirements remain largely unchanged since the prior program review, changes have been made to individual courses.

Major findings

The Ph.D. in Mathematics Education program is succeeding in preparing students for post-secondary tenure track jobs by providing students a strong foundation in mathematics education and preparing them to conduct original research in the discipline. Almost all alumni have been hired into college or university mathematics positions since the prior program review, with over 80 percent of them hired into tenure track teaching and research positions. Looking towards the future in light of anticipated changes in the discipline, faculty has identified four aspects of the program that could be improved in order to better prepare students for their careers. First, as there is a need for more quantitative studies in the field, faculty would like to re-examine the quantitative methods courses taken by students in the program to see if the courses could provide an even stronger foundation for the data collection and analysis work that alumni are likely to encounter in their careers. While students in the program currently take quantitative methods courses offered by another department at the University, faculty would like to examine if expertise in quantitative methods could be developed in the mathematics education program through an appropriate tenure track faculty hire. Second, faculty has identified a need to incorporate more technology into the curriculum to equip students with better knowledge of learning technologies and how they influence mathematics learning. Additional content regarding technology might be provided in a stand-alone course or might be added to multiple courses across the curriculum. Third, it would be valuable to include more diverse perspectives in assigned readings. More inclusive perspectives and more non-Western perspectives embedded in the curriculum could help students prepare

for the diverse teaching and learning environments they are likely to encounter during their careers. Fourth, the program needs to adapt to a changing student population that may demand more flexibility regarding time spent in residence and availability of online course offerings.

Initiatives and plans

- Work to address the changing needs of the program and the field to provide students with a more comprehensive background in quantitative analysis.
- Increase efforts to recruit current K-12 teachers to the program.
- Increase support for international students who enroll in the program, especially resources to support their English language reading, speaking, and writing skills.
- Consider ways to restructure the program model to accommodate students who cannot be on campus full-time. Alternate delivery methods might include delivery of courses in an online format when appropriate and summer residencies with follow-up work during the academic year.

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 Ph.D. in Mathematics Education program to be in Good Standing.

The committee thanks the program and department for a concise, well-written self-study report that is critical and forward looking. The committee recognizes contributions the program continues to make to improving mathematics education for elementary and secondary school students throughout the state and country. The program prepares mathematics teacher education professors who, in turn, prepare undergraduate students to teach mathematics on the elementary and secondary school level. The program is the only stand-alone mathematics education doctoral program offered by an Illinois public university and one of only two such programs in the state. The program is relatively unique nationally in that it is administered by a department of mathematics rather than an educator preparation unit. As a result, students in the program benefit from regular interactions with mathematics content faculty.

From 2010 through 2014, the program conferred the seventh highest number of mathematics education doctorates in the U.S. The placement rates for program graduates remain high. Eighteen (18) of the 22 students who graduated from the program since the 2011-2012 program review have assistant or associate professor positions at institutions of higher education, and three work as adjunct faculty members. The committee recognizes the impacts the program continues to have on the discipline beyond the number of degrees conferred. Since the prior program review, the department served as the administrative home of the *Journal for Research in Mathematics Education* (a core journal in the field) for four years. In addition to contributions to research literature in the field, Department of Mathematics faculty published 17 mathematics or mathematics education textbooks from 2012 through 2017.

The committee recognizes faculty members for the many ways they support students in the program and encourage involvement of program alumni. The program director meets annually with each student to review feedback from faculty members regarding progress of the student toward program completion and to solicit feedback from the student regarding the program. Faculty members encourage students to join them in meetings of the Group for Educational Research in Mathematics in the department and supports an affiliated group organized specifically for students (Graduate Group for Educational Research in Mathematics). The department provides financial support for students to present their research at professional conferences. Since the prior program review, faculty has modified the dissertation defense timeline to provide students formative feedback regarding their draft dissertation before it is completed. Faculty continues to maintain close ties with students after they have graduated. The department hosts an alumni reception at the annual National Council of Teachers of Mathematics conference, periodically seeks feedback from alumni regarding the program, and invites alumni to join gatherings of the Group for Educational Research in Mathematics to help mentor students.

Recruitment efforts have contributed to steady enrollment since the last program review within the range established by faculty based on resources available to the program. The committee commends efforts by faculty to encourage persons self-identifying with racial or ethnic groups traditionally underrepresented in the discipline to apply for the

program. Those efforts include maintaining a presence in Chicago through teacher pipeline initiatives of the National Center for Urban Education in the College of Education. Of students enrolled in the program in fall 2015, 2016, and 2017, students identifying with traditionally underrepresented groups ranged from 25 percent to 30 percent (percentages exclude international students). Across those three years, women comprised 43 percent to 62 percent of program enrollment. The committee further commends faculty members for considering ways to incorporate more cultural perspectives into the curriculum and courses. Such efforts can contribute to maintaining an environment of inclusivity in the program and further student success.

The committee recognizes contributions students in the program make to undergraduate education at the University through their service as graduate teaching assistants. Students in the program teach either introductory mathematics courses for non-mathematics majors or a mathematics pedagogy course for undergraduate students preparing for initial licensure in the state.

In the self-study report, faculty has identified five program quality indicators and three universities with doctoral mathematics education programs that excel relative to one or more of the indicators. However, the report does not explain why faculty selected those programs, nor does the report identify actions faculty might take to meet or exceed the quality of the aspirational programs with respect to each quality indicator. 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 faculty has identified in the self-study report for the next program review cycle (e.g., providing students with a more comprehensive background in quantitative analysis; recruiting K-12 teachers to the program; assisting international students with English speaking, reading, and writing skills; or modifying the program model to accommodate students unable to attend classes on campus).

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.

Sustain student recruitment efforts. The committee commends efforts by faculty to recruit students to the program, including students who identify with groups that are traditionally underrepresented in the discipline, and encourages faculty to sustain those efforts during the next program review cycle. The committee encourages the program to sustain its presence in Chicago through work with teacher pipeline initiatives of the National Center for Urban Education in the College of Education and supports efforts of the program to increase outreach to K-12 teachers throughout the state. One change that might aid recruitment efforts is revising the description of the program in the graduate catalog (which is also used online to describe the program) to clarify and expand on program requirements.

Develop strategies for assisting international students in the program with English language skills. The most recently available data suggests that between one-quarter and one-third of students enrolled in the doctoral program are international students. The percentage in the master's program is similar, but counts of international students in that program are even higher. In light of those figures, the committee is concerned about the needs cited in the self-study report to assist some international students with their English reading, writing, and speaking skills. According to the report, faculty members are doing their best to meet those needs. The committee surmises that other programs at the University may be encountering the same needs among some of their students, particularly given efforts by the University to enroll additional international students through the INTO partnership that began in summer 2018. The committee encourages the department to work with the College of Arts and Sciences, Academic English resources of the INTO Illinois State University program, and the Office of the Provost in strategizing ways to meet those international student needs.

Explore ways to serve more students through deployment of alternative program delivery models. The committee supports faculty in its efforts to explore ways to restructure or supplement the current program delivery model to accommodate persons unable to attend classes full time on campus, including in-service elementary and secondary school teachers in distal regions of the state or in other states. The committee encourages faculty to explore the numerous delivery models used by other educator preparation programs at the University. These include online-only instruction, blending occasional on-campus or off-campus meetings with synchronous or asynchronous

distance learning, delivering courses in other locations of the state, or delivering the same course simultaneously to an on-campus cohort and an off-campus cohort connected by videoconferencing technologies.

Explore increasing coverage of educational technologies in the curriculum. The self-study report cites a need on the part of faculty to explore ways to increase coverage in the curriculum of educational technologies. The committee supports faculty efforts to do so. Familiarizing doctoral students with the latest technologies used to teach mathematics and the research regarding efficacies of those technologies is important for preparing program graduates who will, in turn, be tasked with preparing the next generation of elementary and secondary school mathematics teachers. Increasing coverage of educational technologies in the curriculum might also provide faculty and students additional opportunities to contribute to the discipline through research about or involving those technologies.

Expand efforts to increase external funding for research. In the self-study report section regarding aspirational programs, faculty has indicated that more externally funded projects are needed to advance the program with respect to several quality indicators (such as faculty contributions to scholarship in the discipline, student-faculty research collaborations, or financial support for students). The committee recommends that faculty study this issue further and develop strategies for increasing external funding for research. Faculty might look to its aspirational programs for guidance in doing so.

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.

Draw upon doctoral students' teaching experiences to help improve training for graduate teaching assistants. Students in the Ph.D. in Mathematics Education program who serve as graduate teaching assistants make valuable contributions to undergraduate education at the University by teaching content and pedagogy courses. In doing so they draw from their experiences teaching mathematics at the elementary or secondary school levels, which is required for admission to the doctoral program. The doctoral students might also draw from those experiences to assist with an expanded orientation program for students new to the M.S. in Mathematics program who are selected to serve as graduate teaching assistants. Sharing their experiences might also benefit their doctoral program colleagues. The committee recommends that the department consider expanding graduate assistant orientation beyond a single day to provide in-depth training in pedagogy, tutoring, and classroom management. Graduate assistant training might also be enhanced by faculty or doctoral student mentoring of master's-level 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 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 the enhancements faculty might consider is formalizing administration of an alumni survey to systematically gather information regarding alumni accomplishments and to solicit suggestions from alumni regarding program enhancements. Faculty has cited this change as a priority for the next program review cycle, and the committee concurs.