Master of Science in Secondary Mathematics Education
Graduate Arts and Sciences

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Five-Year B.S./M.S. Program in Mathematics and Mathematics Education

Program Description
The combined B.S/M.S. program in mathematics and secondary mathematics education offers students the opportunity to complete both an undergraduate major in mathematics and an M.S. in Mathematics Education, and obtain Commonwealth of Pennsylvania Secondary Teacher Certification in Mathematics. The curriculum emphasizes the unique character of mathematics learning theory, technology, and techniques for effective teaching in the discipline. The program strengthens traditional certification programs by incorporating a research experience.

Program Goals and Objectives
Students in the Five-year BS/MS in Mathematics and Mathematics Education Program complete all requirements of the undergraduate Mathematics major in the first four years and all requirements of the Secondary Education major by the end of the fifth year. In addition to the goals and objectives for those two programs, students in the 5-Yr Math and Math Education program will meet the following.

Learning Goal 1: Students will demonstrate knowledge of the mathematical content required for teaching secondary mathematics.

Objective 1.1: Students will know how to solve mathematical problems using multiple representations and using multiple mathematical approaches.

Objective 1.2: Students will understand the nature of proof and the sequence of observing examples, making conjectures and proving or disproving mathematical statements in a variety of mathematical disciplines.

Learning Goal 2: Students will be able to plan and align curriculum and assessment according to Pennsylvania State standards, Common Core State Standards and the standards put forth by the National Council of Teachers of Mathematics.

Objective 2.1: Students will be aware of current issues in and the evolving nature of mathematics education including the use of technology.

Objective 2.2: Students will be able to draw on a variety of resources including the research literature in mathematics education to enhance their teaching and examine curricular change.

Admission Requirements and Procedures
The five-year program is open only to undergraduate mathematics majors at Saint Joseph's. Students will be evaluated for acceptance into the program after the completion of the first semester of their junior year. Applicants must complete the standard graduate admissions application, including a complete undergraduate transcript, two letters of recommendation, and a personal essay describing the student's goals by April 15 of the junior year. A cumulative grade point average of 3.0 or better is required.

Program Structure and Curriculum
Students must complete all requirements for the undergraduate B.S. in Mathematics as described in the Undergraduate Catalog. To receive the M.S. in Mathematics Education, students must take an additional 30 credits at the graduate level in Education or Mathematics Education during the following summer and academic year. Graduate coursework must include:

Research Component
- MED 793 Research in Mathematics Education I (3 credits)
- MED 783 Research in Mathematics I (3 credits)

Student Teaching
- EDU 697 Secondary Student Teaching (6 credits)

Other Required Graduate Courses
- EDU616/61 Instructional Techniques - Mathematics with 6F Field Experience (credits)

Electives
- MED or EDU graduate level courses (18 additional credits)

Required undergraduate coursework:
- EDU 150/150F Schools in Society, with Field Experience – or
- EDU 160/160F
EDU 157/157F  Adolescent Development with Field Experience
SPE 160/160F  Introduction to Special Education with Field Experience
SPE 203/203F  Inclusive Classroom Management with Field Experience

Required coursework at either the undergraduate or graduate level:
EDU 246/246F  Literacy, Language & Culture w/ Field Experience
or
EDU 646/646F  Language and Culture with Field Experience
EDU 247  Literacy in the Content Areas
or
EDU 647  Literacy and Learning Across the Curriculum
SPE 310/310F  Assessment: Identification & Progress Monitoring (Secondary)
or
SPE 602/602F  Diagnostic Testing and Progress Monitoring

Required coursework in Mathematics at the undergraduate level (courses taken as mathematics electives as part of the major requirements)
MAT 321  Probability
MAT 322  Mathematical Statistics

Required coursework in Mathematics at either the undergraduate or graduate level:
MAT 233  History of Mathematics
or MED 551
MAT 332  Geometry
or MED 554

Note: MED courses may be used to satisfy requirements of the undergraduate mathematics major only with the approval of the Department Chairperson.

Certification Exams:
Specialty Area Test of Praxis

M.S. Program in Secondary Mathematics Education (without certification)
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Program Description
The M.S. program in secondary mathematics education offers students the opportunity to complete a graduate degree emphasizing both mathematical content knowledge and mathematical pedagogical knowledge. Students are required to complete coursework in both areas and have the option of incorporating a research experience. Designed for in-service teachers, the program aims to increase the mathematical knowledge needed for teaching at the secondary level and to support teachers’ growth as reflective practitioners.

The art of imparting mathematical knowledge to others can be traced back to ancient Greek and Babylonian culture. Teachers and students worked together on clay tablets, with sticks and rocks to solve practical mathematical problems encountered in daily living. Today mathematics has grown into a science that does much more than solve practical problems. This evolution has forced educators to rethink the way they teach mathematics. It is clear that changes in pedagogy have been and continue to be necessary for the sustained advancement of the science of mathematics. Thus the mission of the program leading to the degree Master of Science in Secondary Mathematics Education emphasizes both the acquisition of mathematical knowledge as well as innovative techniques for instruction.

Program Goals

Learning Goal 1: Students will demonstrate knowledge of the mathematical content required for teaching secondary mathematics.

Objective 1.1: Students will know how to solve mathematical problems using multiple representations and using multiple mathematical approaches.

Objective 1.2: Students will understand the nature of proof and the sequence of observing examples, making conjectures and proving or disproving mathematical statements in a variety of mathematical disciplines.

Learning Goal 2: Students will be able to plan and align curriculum and assessment according to
Pennsylvania State standards, Common Core State Standards and the standards put forth by the National Council of Teachers of Mathematics.

**Objective 2.1:** Students will be able to critically assess mathematics curricula.

**Objective 2.2:** Students will be able to use a variety of pedagogical approaches and assessment tools in their teaching of mathematics.

**Objective 2.3:** Students will be aware of current issues in and the evolving nature of mathematics education including the use technology.

**Objective 2.4:** Students will be able to draw on a variety of resources including the research literature in mathematics education to enhance their teaching.

**Admission Requirements and Procedures**
The MS Program in Secondary Mathematics Education is designed for practicing mathematics teachers but is open to anyone with a sufficiently strong background in mathematics and education. Typically we require a BS in a STEM discipline (science, technology, engineering or math); however, we would consider applicants with an undergraduate degree in any field with appropriate teaching experience in mathematics. In addition, students who have not had Calculus I, II and III would be required to take these courses before being fully admitted.

Applicants must complete the standard graduate admissions application, including all undergraduate and graduate transcripts, two letters of recommendation, and a personal essay describing the student’s goals.

**Program Structure and Curriculum**
Students are required to complete 30 credits; usually ten 3-credit courses but other combinations are possible. Students must complete at least 6 credits (2 courses) from the list of MED Content Courses and at least 6 credits (2 courses) from the list of MED Pedagogy Courses. The remaining 18 credits (6 courses) may be any combination of MED courses. In addition, with permission of the program director, up to 6 of these 18 credits (2 of the 6 courses) may be taken in Teacher Education (EDU), Special Education (SPE) or Educational Leadership (EDL). All research courses are arranged as independent studies with faculty mentors.

**Content Courses**
Offered every two years on a rotating basis:
MED 551 History of Mathematics – Fall, odd years
MED 552 Number Theory – Fall, even years
MED 553 Discrete Structures – Spring, odd years
MED 554 Geometry – Fall, even years
MED 555 Probability and Statistics – Fall, odd years
MED 556 Linear Algebra – Summer, even years
MED 557 Modern Algebra – Summer, odd years
MED 559 Mathematical Problem Solving – Spring, even years
Offered when there is demand:
MED 604 Advanced Perspectives on Secondary Mathematics
MED 605 Interdisciplinary Science and Mathematics Education
MED 771 Topics in Mathematics

**Pedagogy Courses**
MED 601 Communication and Technology in Mathematics
MED 602 Secondary Mathematics Curriculum
MED 603 Assessment in Secondary Mathematics
MED 611 Advanced Methodology of Teaching School Geometry
MED 770 Topics in Mathematics Education

**Research Courses**
MED 750 Reading and Research in Mathematics Education
MED 783, MED 784 Research in Mathematics I and II
MED 793, MED 794 Research in Mathematics Education I and II
MED 795, MED 796 Master’s Thesis – 6 credits

**Mathematics Education Course Descriptions**

**MED 551 History of Mathematics (3 credits)**
A survey of the development of mathematical ideas and techniques in social and cultural contexts. The trajectories of certain key problems will be followed, such as the nature of the Euclidean parallel postulate, the plane isoperimetric theorem and the solution of polynomial equations. The influence of practical needs (business, military, technological) will be considered.

Prerequisites: Calculus II or permission of the MED director.

**MED 552 Number Theory (3 credits)**
The study of integers, primes and factorization, Division Algorithm, Euclidean algorithm, Mathematical Induction, the Fundamental Theorem of Arithmetic, linear Diophantine equations, modular arithmetic, number theoretic functions,
Fermat’s last theorem, quadratic residues, primitive roots, Chinese Remainder theorem. 

Prerequisites: Calculus II or permission of the MED director.

MED 553 Discrete Structures (3 credits)  
An introduction to the basic concepts of discrete mathematics essential both to mathematics and many of its applications. Topics include logic, sets, relations, functions, recurrence equations, combinatorics, graphs. Techniques of mathematical proof will be developed.  
Prerequisites: Calculus II or permission of the MED director.

MED 554 Geometry (3 credits)  
Contemporary topics in Euclidean and non-Euclidean geometry. Topics include motion geometry, affine transformation, projective transformations, axiomatic systems, and applications of geometry.  
Prerequisites: MED 552 or MED 553 or permission of the MED director.

MED 555 Probability and Statistics (3 credits)  
Descriptive statistics, random variables, discrete and continuous probability distributions, moments, correlations, sampling distributions, estimation, confidence intervals, hypothesis testing, linear regression and analysis of variance. Additional topics as time permits may include factor analysis, contingency tables, multilinear regression and nonparametric methods.  
Prerequisites: Calculus II or permission of the MED director.

MED 556 Linear Algebra (3 credits)  
Linear systems, vector spaces, dimension, linear transformations, matrices, inner product, orthogonality, characteristic polynomials, diagonalization, eigenvalues, eigenvectors.  
Prerequisites: Calculus II or permission of the MED director.

MED 557 Modern Algebra (3 credits)  
This course discusses modern topics in abstract algebra – groups, rings, ideals, fields, vector spaces. Axiomatic systems are used to prove theorems and discuss relationships such as homomorphism and isomorphism. Applications in elementary geometry and algebra are discussed.  
Prerequisites: Calculus II, and MED 552 or MED 553 or permission of the MED director.

MED 559 Mathematical Problem Solving (3 credits)  
Techniques of solving mathematical problems which draw on a wide mathematical background. Solutions may incorporate concepts from linear algebra, analysis, modern algebra, combinatorics, geometry and applied mathematics.  
Prerequisites: Calculus II and MED 552 or MED 553 or permission of the MED director.

MED 601 Communication and Technology in Mathematics (3 credits)  
This course is designed to introduce pre-service teachers to the different types of technology available to the mathematics classroom. The use of manipulative devices, portfolios or journals, writing and verbal communication in the mathematics classroom will be discussed. Emphasis will be placed on the appropriate use of the graphing calculator, applications for the personal computer, and the internet in the mathematics classroom. Ethical and practical issues surrounding the use of technology will be discussed.

MED 602 Secondary Mathematics Curriculum (3 credits)  
This course examines the ways in which high school students acquire mathematical knowledge, considers the particular mathematical knowledge they should have at each grade level (as articulated by the Principles and Standards of School Mathematics), and applies this understanding to the design of secondary mathematics curricula.

MED 603 Assessment in Secondary Mathematics (3 credits)  
This course is a practical guide to designing a variety of assessment tools. Students will learn how to design projects, group activities, writing activities, portfolios and tests that together can be used to assess what students know and can do. The role of assessment is twofold: to assess what students have learned, and to modify our teaching strategies to enhance student learning. Students will be concerned with the curriculum of the secondary mathematics program, grades 7-12.

MED 604 Advanced Perspectives on Secondary Mathematics (3 credits)  
This course is an in depth study of the mathematics typically learned in middle and high school mathematics classes. We will identify core mathematical ideas and then also the common errors that students make, the misunderstandings they frequently have, and the questions they ask. We will develop strategies for addressing misconceptions and compose answers to questions that might arise in the classroom and in so doing
further our own understanding of mathematics. We will situate the ideas within a broader mathematical context to be sure that we are generating responses that further students' mathematical development. We will use this information to create examples, problems and projects that would enrich students' understanding.

MED 605 Interdisciplinary Mathematics and Science Teaching (3 credits)
This course explores ways to integrate math and science teaching at the secondary level. We review the mathematics and science secondary curricula and identify places where connections can be made and determine approaches to teach math and science so that concepts learned in one discipline can be used to reinforce concepts learned in the other. We consider existing projects that combine mathematics and science and use what is learned to develop new projects.

MED 611 Geometry for Teachers: from Problem Solving to Proof (3 credits)
This course discusses specific topics from geometry, their impact on the changing geometry curriculum, their application through technology and their connection to other areas within and outside mathematics. Students will examine recent research trends and practical methods for teaching geometry at the secondary level and explore several methods of geometry curriculum design and instruction. Students will learn what role the processes of visualization, construction and reasoning play in learning and teaching geometry. Classroom materials, activities and techniques are discussed and developed and concepts explained and explored through a variety of modes including manipulatives, interactive computer software and graphing calculators.
Prerequisite: MED 554 or permission of the MED director.

MED 770 Topics in Mathematics Education (3 credits)
Topics and issues in secondary mathematics teaching, from theoretical underpinnings to practical applications. Topics will vary depending on interests and backgrounds of students. Permission of the MED director required.

MED 771 Topics in Mathematics (3 credits)
Topics in mathematics such as advanced abstract algebra, real analysis, combinatorics, graph theory, topology, logic, and dynamical systems. Topics will vary depending on interests and backgrounds of students.
Prerequisites: MED 559 or permission of the MED director.

MED 783 Research in Mathematics I (3 credits)

MED 784 Research in Mathematics II (3 credits)
Students will design and carry out a research project in mathematics as an independent study, working closely with a faculty mentor. Permission and approval by the mentor and MED director are required.

MED 793 Research in Mathematics Education I (3 credits)

MED 794 Research in Mathematics Education II (3 credits)
Students will design and carry out a research project in mathematics education as an independent study, working closely with a faculty mentor. Permission and approval by the mentor and MED director are required.