Mathematics and Science Education

Department of Mathematics and Science Education

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Chair:
TBD

Director, Graduate Programs:
N. G. Lederman

Mathematics and science education is primarily concerned with all aspects of the teaching and learning of mathematics and/or science at the secondary levels (i.e., grades 6-12). The department offers Professional Master's, Master of Science, and Ph.D. degrees in mathematics and science education. The master's programs are specifically focused on experienced teachers, individuals seeking certification and advanced study, or individuals working in educational settings other than schools (e.g., museums, zoos, etc.). Specific attention is placed on curriculum development, evaluation, advanced instructional models, supervision, learning and cognition, and action research.

The Ph.D. programs are designed for those individuals wishing to become university-level teacher educators and researchers. Extensive attention is given to quantitative and qualitative research designs, along with advanced work in evaluation, curriculum analysis, and supervision. Both M.S. and Ph.D. students will be required to complete additional subject matter courses (e.g. science and mathematics) equivalent to 9-12 credit hours.

Degrees Offered

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Research Areas

Research areas include informal science/math education, curriculum development, integration of science/math disciplines and across disciplines, and instructional methods; students and teachers' conceptions of scientific/mathematic inquiry and nature of science/math, instructional models, evaluation, and research design.

Faculty

Lederman, Judith S., Associate Professor of Mathematics and Science Education and Director of Teacher Education. B.A., Rhode Island College; M.S., Worcester Polytechnic Institute; Ph.D., Curtin University of Technology (Australia). Informal science education, curriculum development, integration of science disciplines and across disciplines, and instructional methods.

Lederman, Norman G., Distinguished Professor of Mathematics and Science Education. B.S., M.S. Bradley University; M.S., New York University; Ph.D., Syracuse University. Students' and teachers' conceptions of scientific inquiry and nature of science, instructional models, evaluation, and research design.

Popovic, Gorjana, Senior Instructor of Mathematics and Science Education. B.S., University of Belgrade (Serbia); M.S., Ph.D., Illinois Institute of Technology.
Admission Requirements

Bachelor’s (or Master’s, for Ph.D. programs) degree in mathematics (for mathematics education), science (for science education) or another field with documented evidence of success in working with school-aged youth

GRE score minimum for M.S. applicants:
900 (quantitative + verbal) 2.5 (analytical writing)

GRE score minimum for Ph.D. applicants:
1000 (quantitative + verbal) 3.0 (analytical writing)

TOEFL minimum 600/250/80* if from non-English speaking country

A minimum cumulative undergraduate GPA of 3.0/4.0

Two-page professional statement of goals/objectives

Curriculum Vita
Three letters of recommendation
An interview may be required

Additional requirements for Ph.D. programs:
Three years of teaching experience. Meeting the minimum standards does not guarantee admission. Test scores and GPA are just two of several important factors considered, and admission decisions are made based upon the totality of the application file.

* Paper-based test score/computer-based test score/internet-based test score.

Master of Science in Mathematics Education (Thesis)
Master of Mathematics Education (Professional Master’s, Non-Thesis)

33 credit hours
Thesis (Master of Science) or non-thesis (Professional Master’s) option

The objective of the master’s program is to provide practicing teachers, or individuals in education-related fields, with advanced education in the teaching and learning of mathematics. These advanced studies will enhance graduates’ ability to provide meaningful instruction in mathematics; critically analyze and implement empirical research findings in mathematics education; develop and evaluate curriculum; and become a leader in public school education at the state or local levels.

Required Courses
MSED 501 Advanced Strategies: Mathematics
MSED 540 Informal Education Practicum
MSED 550 Clinical Supervision in Science/Mathematics
MSED 552 Assessment and Evaluation

OR
MSED 560 Research and Evaluation
MSED 555 Middle and Secondary Level Mathematics Curriculum
MSED 580 Adolescent Psychology

Master of Science Thesis Option (6 credit hours)
MSED 591 Research and Thesis

Professional Master’s Non-Thesis Option (3 credit hours)
MSED 538 Inquiry and Problem Solving

And a minimum of three credit hours from the following:
MSED 531 Teacher Education/Professional Development in Mathematics
MSED 562 Action Research I
MSED 571 Problem Solving and Nature of Mathematics

AND nine credits of select coursework from discipline-specific mathematics courses
**Master of Science in Science Education (Thesis Option)**

**Master of Science Education (Professional Master’s, Non-Thesis)**

33 credits
Thesis (Master of Science) or non-thesis (Professional Master’s)

The objective of the M.S. program is to provide practicing teachers, or individuals in education-related fields, with advanced education in the teaching and learning of science. These advanced studies will enhance graduates’ ability to provide meaningful instruction in science; critically analyze and implement empirical research findings in science education; develop and evaluate curriculum; and become a leader in public school education at the state or local levels.

**Required Courses**

MSED 502 Advanced Strategies: Science
MSED 540 Informal Education Practicum
MSED 550 Clinical Supervision in Science/Mathematics
MSED 552 Assessment and Evaluation

OR

MSED 560 Research and Evaluation
MSED 554 Middle and Secondary Level Science Curriculum
MSED 580 Adolescent Psychology

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**Master of Science/Mathematics Education**

**Teacher Certification Option**

45 credit hours

The Master of Science/Mathematics Education (Teacher Certification Option) is designed for individuals who already possess a bachelor’s degree (preferably in an area of science or mathematics) and wish to pursue both a teaching certification and a master’s degree. This accelerated course of study allows the student to achieve certification and a master’s degree in just 45 credit hours, instead of the 54 credit hours that would be required if certification and master’s degree were pursued separately.

**Required Courses**

MSED 300 Instructional Methods/Strategies I
MSED 400 Instructional Methods/Strategies II
MSED 450 Professional Internship (6 credit hours)
MSED 500 Analysis of Classrooms II (Practicum and Seminar)
MSED 501/502 Advanced Strategies: Mathematics/Science
MSED 538 Inquiry and Problem Solving
MSED 540 Informal Education Practicum
MSED 550 Clinical Supervision in Science/Mathematics
MSED 552 Assessment and Evaluation
MSED 554 Middle and Secondary Level Science/554/555 Mathematics Curriculum
MSED 580 Adolescent Psychology

AND nine credits from graduate level science/mathematics courses.
Mathematics and Science Education

Doctor of Philosophy in Mathematics Education

84 credit hours (Minimum of 51 hours of coursework)
Qualifying exam within the first two years of Ph.D. study
Composed of five position statements (ranked by faculty)
Top three ranked must be defended orally and in writing.
Oral comprehensive exam with the student’s graduate committee (The dissertation proposal is presented orally as part of the comprehensive examination).
Oral dissertation defense, involving the final thesis exam

The objective of the Ph.D. program is to provide students with advanced education in the teaching and learning of mathematics. These advanced studies will enable graduates to conduct theoretical and practical research in mathematics education; develop and evaluate curriculum; prepare future teachers; provide professional development to in-service teachers; or become a leader in public school education at the state or local levels.

Required Courses (30 credit hours)
MSED 545 Statistics for Educators I
MSED 546 Statistics for Educators II
MSED 550 Clinical Supervision in Science/Mathematics
MSED 552 Assessment and Evaluation
MSED 555 Middle and Secondary Level Mathematics Curriculum
MSED 580 Adolescent Psychology
MSED 601 Critical Analysis in Quantitative Research
MSED 602 Quantitative Research Design and Practicum
MSED 603 Critical Analysis in Qualitative Research
MSED 604 Qualitative Research Design and Practicum

Electives (minimum of nine credit hours)
MSED 501 Advanced Strategies: Mathematics
MSED 531 Teacher Education/Professional Development in Mathematics
MSED 538 Inquiry and Problem Solving
MSED 540 Informal Education Practicum
MSED 560 Research and Evaluation
MSED 562 Action Research I
MSED 571 Problem Solving and Nature of Mathematics
MSED 594 Special Projects (Independent Studies within MSED)
MSED 597 Special Problems

Up to eight hours from discipline-specific graduate coursework

12 credits of select coursework from discipline-specific mathematics courses/related fields

Total minimum coursework: 51 credit hours

MSED 691 Ph.D. Thesis Research (minimum 25 credit hours)

Total minimum credits: 84 credit hours

42 maximum transfer of graduate credits from master’s (24 credits from coursework/eight credits from research)
Mathematics and Science Education

**Doctor of Philosophy in Science Education**

84 credit hours (minimum 51 hours of coursework)

Qualifying exam within the first two years of Ph.D. study

Composed of five position statements (ranked by faculty)

Top three ranked must be defended orally and in writing.

Oral comprehensive exam with the student’s graduate committee (The dissertation proposal is presented orally as part of the comprehensive examination.)

Oral dissertation defense, involving the final thesis exam

The objective of the Ph.D. program is to provide students with advanced education in the teaching and learning of science. These advanced studies will enable graduates to conduct theoretical and practical research in science education; develop and evaluate curriculum; prepare future teachers; provide professional development to in-service teachers; or become a leader in public school education at the state or local levels.

**Required Courses (30 credit hours)**

- MSED 545 Statistics for Educators I
- MSED 546 Statistics for Educators II
- MSED 550 Clinical Supervision in Science/Mathematics
- MSED 552 Assessment and Evaluation
- MSED 554 Middle and Secondary Level Science Curriculum
- MSED 580 Adolescent Psychology
- MSED 601 Critical Analysis in Quantitative Research
- MSED 602 Quantitative Research Design and Practicum
- MSED 603 Critical Analysis in Qualitative Research
- MSED 604 Qualitative Research Design and Practicum

**Electives (minimum of nine credit hours)**

- MSED 502 Advanced Strategies: Science
- MSED 530 Teacher Education/Professional Development in Science
- MSED 538 Inquiry and Problem Solving
- MSED 540 Informal Education Practicum
- MSED 562 Action Research I
- MSED 570 Inquiry and Nature of Science
- MSED 594 Special Projects (Independent Studies within MSED)
- MSED 597 Special Problems

Up to eight hours from discipline-specific graduate coursework

12 hours of select coursework from discipline-specific science courses/related fields

Total minimum coursework: 51 credit hours

- MSED 691 Ph.D. Thesis Research (minimum of 25 credit hours)

Total minimum credits: 84 credit hours

42 maximum transfer of graduate credits from master’s (24 credits from coursework/eight credits from research)
Doctor of Philosophy in Collegiate Mathematics Education

85 credit hours beyond the bachelor’s degree*
Qualifying exam
Comprehensive exam
Dissertation and Defense

This joint Ph.D. program is offered through the collaboration of the departments of Applied Mathematics (AM) and Mathematics and Science Education (MSED). The objective of the program is to provide advanced education in the teaching and learning of collegiate mathematics through coursework and original research. These advanced studies will enable graduates to teach a wide range of college level mathematics courses, conduct theoretical and practical research on collegiate mathematics teaching and learning, or develop and evaluate college mathematics curriculum.

AM Core Requirements (18 credit hours)
MATH 476 Statistics
MATH 500 Applied Analysis I
MATH 515 Ordinary Differential Equations and Dynamical Systems
MATH 532 Linear Algebra
MATH 553 Discrete Applied Mathematics I
MATH 577 Computational Mathematics I

MSED Core Requirements (18 credit hours)
MSED 598 Methods of College Teaching in Mathematics and Science
MSED 599 College Teaching Practicum
MSED 601 Critical Analysis in Quantitative Research
MSED 602 Quantitative Research Design and Practicum
MSED 603 Critical Analysis in Qualitative Research
MSED 604 Qualitative Research Design and Practicum

AM Electives (minimum of 12 credit hours)
MATH 402 Complex Analysis
MATH 420 Geometry
MATH 475 Probability
MATH 5xy (any 500-level AM courses)

MSED Electives (minimum of 9 credit hours)
MSED 501 Advanced Strategies: Mathematics
MSED 550 Clinical Supervision in Science/Mathematics
MSED 552 Assessment and Evaluation
MSED 555 Middle and Secondary Level Mathematics Curriculum
MSED 571 Problem Solving and Nature of Mathematics

The qualifying exam is fulfilled by achieving better than a 3.5/4.0 GPA on the MATH 476, MATH 500, MATH 553, and MATH 577 AM core courses and a 3.5/4.0 GPA on the MSED 601, MSED 602, MSED 603, and MSED 604 MSED core courses and passing an oral examination within the first five semesters of Ph.D. study. The oral exam consists of two one-hour parts covering AM and MSED core courses respectively. For the AM part, the candidate selects any two out of the four above-mentioned AM core courses plus another AM core course to be tested on during the oral exam. For the MSED part, the candidate proposes five position statements ranked by the faculty. The MSED oral exam is composed of the two position statements with the highest rankings. Position Statement 1: Written defense to support position with empirical research. Position Statement 2: Oral defense.

The comprehensive exam consists of an oral examination based on the student’s research proposal. The exam aims to ensure that the student has the background to carry out successful research in his/her chosen area and the proposed research has sufficient scholarly merit.

A minimum of 25 hours should be devoted to thesis research (CMED 691). The dissertation is expected to contain a distinct and substantial, original and publishable contribution to the field of study. An oral examination in defense of the thesis constitutes completion of the degree.

(*) 32 credits maximum transfer from master’s coursework; 42 maximum transfer of graduate coursework credits; the number of subjects allowed for transfer credit depends on what subject have been recently taken and is decided on a case-by-case basis

Admission Criteria: Admission to the joint Ph.D. program in collegiate mathematics education requires:

- A master’s or bachelor’s Degree in mathematics or applied mathematics. Candidates whose degree is in another related field (such as, computer science, physics, or engineering) and whose background in mathematics is strong are also eligible for admission and are encouraged to apply.
- GRE score 1100 (quantitative and verbal), 3.0 (analytical)
- TOEFL (minimum score of 600 for paper-based, 250 for computer-based, and 100 for internet-based test) if from non-English speaking country
- A minimum GPA of 3.0/4.0 is required
- Professional statement of goals/objectives (2 pages)
- Vita
- Three letters of recommendation
- An interview may be required
Course Descriptions

Numbers in parentheses indicate class, lab and total credit hours, respectively.

**MSED 500**  
Analysis of Classrooms II (Practicum & Seminar)  
This course includes a two-hour seminar on campus each week along with approximately five hours per week in an area school. This is an introductory course that provides students background learning theory, classroom management, aspects of effective teaching, critical classroom variables, and the school as a system.  
(3-0-3)

**MSED 501**  
Advanced Strategies: Mathematics  
A course that provides additional exposure and development of instructional strategies and models of mathematics teaching. Special emphasis is placed upon promoting critical thinking and decision making.  
(3-0-3)

**MSED 502**  
Advanced Strategies: Science  
A course that provides additional exposure and development of instructional strategies and models of science teaching. Special emphasis is placed upon promoting critical thinking and decision making.  
(3-0-3)

**MSED 509**  
Instructional Strategies for Middle School Mathematics  
This course addresses concerns of teaching grades 5 through 8 math by considering the social and psychological characteristics of students in transition from elementary to high school mathematics. The course uses a focus on rational number and reasoning (topics that span middle school curriculum) to study students’ development of powerful representational systems and conceptual flexibility. Participants will learn about building mathematical community in which students construct mathematical evidence for claims of perceived regularities and patterns on logical reasoning and mathematical thinking. Participants will select, adapt, and design math tasks to serve instructional purposes and will learn what it means to build an ongoing assessment system that integrates self, peer, teacher, and formative/summative assessment into best practice.  
(3-0-3)

**MSED 510**  
Problem Based Algebra  
Algebra is taught via a problem solving approach with connections to other topics such as geometry, statistics and probability. Explorations with and conjecturing about number relationships and functions provide experiences from which students develop algebraic habits of mind: Doing and undoing (algebraic thinking that involves reflective or reverse algebraic reasoning, doing problems and organizing data to representation situations in which input is related to output by well-defined functional rules); and abstracting from computation (developing the capacity to think about computations independently of particular numbers used). Instructor permission required.  
(3-0-3)

**MSED 511**  
Problem Based Number Theory  
Number theory is taught via a problem solving approach with connections to geometry, logic, and probability. Explorations with and conjecturing about number patterns provide experiences from which students study various topics including the following: factors, primes, and prime factorization; counting techniques; greatest common factor (GCF) and least common multiple (LCM); divisibility; number patterns (e.g., Pascal’s triangle, polygonal numbers, Pythagorean triples, Fibonacci numbers); Diophantine equations; remainder classes and modular arithmetic; iteration, recursion, and mathematical induction. Basic algebra and instructor permission required.  
(3-0-3)

**MSED 512**  
Philosophy of Science: Key Topics & Applications to K-12 Science Education  
This course presents fundamental topics and key issues from philosophy of science (e.g., explanation, representation/models, evidence, laws and causation, confirmation/inductive logic, etc.). The goal of the course is to enrich teachers’ understanding of philosophy of science so that they will be better prepared to design instructions both about science content and about NOS and NOSI. To achieve this, each course is explicitly linked to particular subject matter and concepts and/or NOS or NOSI ideas. Teachers will be facilitated to see why and how philosophy of science can inform science instruction.  
(3-0-3)

**MSED 513**  
Problem Based Statistics & Probability  
This course emphasizes statistics and probability as practical subjects devoted to obtaining and processing data with a view toward making statements that often extend beyond the data. These statements (i.e., inferences) take the form of estimates, confidence intervals, significance tests, etc. The content of this course is concerned with the production of good data, and involves consideration of experimental designs and sample surveys. The activities have their origin in real data and are concerned with processing the data in the widest contexts and with a wide variety of applications such as social, administrative, medical, the physical sciences and the biological sciences. Basic Algebra and Instructor permission required.  
(3-0-3)

**MSED 514**  
Problem-Based Geometry  
Geometry is taught via problem solving with connections to other topics such as algebra and number theory. Explorations of and conjecturing about fundamental concepts of Euclidean geometry in two and three dimensions and their application provide experiences from which students study various topics including the following: properties and relationships of geometric objects; geometric proof; area and volume; transformations, symmetry, and tessellations; trigonometric ratios; and visual modeling of algebraic operations as well as algebraic abstract concepts.  
(3-0-3)
MSED 515
Physical Science Research Practicum I
The purpose of this course is to provide a comprehensive, immerse experience in scientific research for current and prospective K-12 science teachers. It is intended as the second in a two-course sequence. In this course, students will begin by having a module covering key concepts in the sociology of science. The bulk of student work will be to participate in a laboratory placement. Prerequisite: Admission into Physical Science Initiative Cohort program, or approval of the instructor.  Prerequisite: [MSED 320 OR (MSED 514 OR (MSED 520)) AND (MSED 510)]  (3-0-3)

MSED 516
Phys Sci Research Practicum II
The purpose of this course is to provide a comprehensive, immerse experience in scientific research for current and prospective K-12 science teachers. It is intended as the second in a two-course sequence. In this course, students will focus on making connections between the content of their research setting and the K-12 curriculum. The bulk of student work will be to participate in a laboratory placement.  Prerequisite: [MSED 515]  (0-0-3)

MSED 517
Problem-Based Calculus
This course is focused on the development of foundational ideas, concepts, and methods of introductory calculus and its basic applications with emphasis on various problem-solving strategies, visualization, mathematical modeling, and logic relevant to the middle school mathematics curriculum. Explorations with the SimCalc software and conjecturing about linking graphs, tables, and concrete to represent dynamic situations provide experiences from which students study various topics including the following: linear, quadratic, cubic, exponential, logarithmic, and trigonometric functions and their graphs; limits and continuity; rate of change, slope, tangent, and derivative; area under a curve and integration; and elements of infinite series.  Prerequisite(s): [(MSED 320) OR (MSED 514) OR (MSED 520)]  (3-0-3)

MSED 518
History of Science: Key Episodes, Topics, & Applications to K-12 Science Education
This course presents fundamental topics and key issues from history of science (the organization of science, science and religion, science and technology, scientific revolutions, etc.). The goal of the course is to enrich teachers’ understanding of history of science so that they will be better prepared to design instructions both about science content and about NOS and NOSI. To achieve this, each course is explicitly linked to particular subject matter and concepts and/or NOS or NOSI ideas. Teachers will be facilitated to see why and how history of science can inform science instruction.  Prerequisite(s): [(MSED 320) OR (MSED 514) OR (MSED 520)]  (3-0-3)

MSED 520
Geometry
The course is focused on selected topics related to fundamental concepts and methods of Euclidean geometry in two and three dimensions and their applications with emphasis on various problem-solving strategies, geometric proof, visualization, and interrelation of different areas of mathematics. Instructor permission required.  (3-0-3)

MSED 521
Perspectives in Analysis
This course is focused on selected topics related to fundamental concepts and methods of classic analysis and their applications with emphasis on various problem-solving strategies, visualization, mathematical modeling, and interrelation of different areas of mathematics. Instructor permission required.  (3-0-3)

MSED 523
Expedition Green – Environmental Science
The course is designed to prepare teachers to teach environmental processes and systems, an understanding of environmental issues, personal and civic responsibility, and critical thinking skills. Teachers will increase their knowledge of ecology, ecosystems, resource management, and sustainability. Each class explores how these environmental science topics can be brought back into the classroom using a variety of pedagogical skills and engaging activities. The Expedition Green course models the use of inquiry based, hands-on teaching methods as well as the multiple ways that an informal institution, such as the Museum of Science and Industry, can be used to enhance school curricula. This course meets during the academic year, six sessions, 8:00 a.m. to 3:00 p.m.  (3-3-3)

MSED 524
Get Energized – Physical Science
Get Energized is designed to help teachers become more proficient in key physical science concepts related to energy. Teachers can increase their comfort level in teaching energy related topics such as light, mechanical, heat, sound, and electrical. Each full-day workshop focuses on a particular energy topic and explores how that topic can be brought back to the classroom in an engaging way. This program also explores how to further the interaction of inquiry-based teaching methods into the classroom as well as the multiple ways that an informal institution can be used to further the curriculum objectives established. Major topics include energy transformation, potential and kinetic energy, mechanical energy, electrical energy, sound, and thermal. The course meets during the academic year, six sessions, 8:00 a.m. to 3:00 p.m.  (3-3-3)

MSED 525
All About You – Life Science
All About You focuses on life science, particularly the science of the human body. The teacher professional development series is designed to help teachers learn to utilize inquiry-based and hands-on/minds-on science curriculum both within and outside of the classroom setting. Through this intensive and engaging year-long program, the workshops focus on expanding science teachers’ capacity by building their content knowledge and enhancing their instructional practice. Aside from this program being broad based and interdisciplinary, this program explores how to further the interaction of inquiry-based teaching methods into the classroom as well as the multiple ways that an informal institution, such as the Museum of Science and Industry, can be used to further the curriculum objectives established. Major topics include cells, tissues and organs, genetics and evolution, body systems, health and wellness. The course meets during the academic year, six sessions, 8:00 a.m. to 3:00 p.m.  (3-3-3)
MSED 526  
**Great Lakes Rock – Earth Science**  
In Great Lakes Rock, late elementary and middle school teachers will increase their knowledge of earth systems science concepts and principles, especially those related to climate change and phenomena in the Great Lakes region. Teachers will discuss science content and practice inquiry-based classroom activities that address the following key topics: earth systems; great lakes ecosystems; and life and the environment.  
(3-0-3)

MSED 530  
**Teacher Education/Professional Development in Science**  
A course that stresses the empirical research on best practices in teacher education and professional development in science.  
(3-0-3)

MSED 531  
**Teacher Education/Professional Development in Mathematics**  
A course that stresses the empirical research on best practices in teacher education and professional development in mathematics.  
(3-0-3)

MSED 533  
**Expedition Green – Environmental Science**  
The course is designed to prepare teachers to teach environmental processes and systems, an understanding of environmental issues, personal and civic responsibility, and critical thinking skills. Teachers will increase their knowledge of ecology, ecosystems, resource management, and sustainability. Each class explores how these environmental science topics can be brought back into the classroom using a variety of pedagogical skills and engaging activities. The Expedition Green course models the use of inquiry based, hands-on teaching methods as well as the multiple ways that an informal institution, such as the Museum of Science and Industry, can be used to further science curricula. This course is a continuation of MSED 523.  
(3-0-3)

MSED 534  
**Get Energized – Physical Science**  
Get Energized is designed to help teachers become more proficient in key physical science concepts related to energy. Teachers can increase their comfort level in teaching energy related topics such as light, mechanical, heat, sound, and electrical. Each full-day workshop focuses on a particular energy topic and explores how that topic can be brought back to the classroom in an engaging way. This program also explores how to further the interaction of inquiry-based teaching methods into the classroom as well as the multiple ways that an informal institution can be used to further the curriculum objectives established. Major topics include energy transformation, potential and kinetic energy, mechanical energy, electrical energy, sound, and thermal. This course is a continuation of MSED 524.  
(3-0-3)

MSED 535  
**All About You – Life Science**  
All About You focuses on life science, particularly the science of the human body. The teacher professional development series is designed to help teachers learn to utilize inquiry-based and hands-on/minds-on science curriculum both within and outside of the classroom setting. Through this intensive and engaging year-long program, the workshops focus on expanding science teachers' capacity by building their content knowledge and enhancing their instructional practice. Aside from this program being broad based and interdisciplinary, this program explores how to further the interaction of inquiry-based teaching methods into the classroom as well as the multiple ways that an informal institution, such as the Museum of Science and Industry, can be used to further the curriculum objectives established. Major topics include cells, tissues and organs, genetics and evolution, body systems, health and wellness. This course is a continuation of MSED 525.  
(3-0-3)

MSED 536  
**Great Lakes Rock – Earth Science**  
In Great Lakes Rock, late elementary and middle school teachers will increase their knowledge of earth systems science concepts and principles, especially those related to climate change and phenomena in the Great Lakes region. Teachers will discuss science content and practice inquiry-based classroom activities that address the following key topics: earth systems; great lakes ecosystems; and life and the environment. This course is a continuation of MSED 526.  
(3-0-3)

MSED 538  
**Inquiry & Problem Solving**  
A group of authentic inquiry experiences supervised by practicing scientists or mathematicians.  
(3-0-3)

MSED 540  
**Informal Education Practicum**  
Placement in an informal educational setting such as museums and outdoor education. The focus of this course is on the use of informal setting to supplement classroom instruction.  
(3-0-3)

MSED 542  
**Energy & Forces**  
This course is the first in a three-course sequence designed to cover physical science content for middle grade teachers. The underlying theme for the course is the concept of energy. The course will follow a strategy of introducing fundamental principles, and then covering further material as applications of those principles. The course will address energy, forces and interactions, momentum, materials and phases of matter. Students will explore a variety of scenarios involving these principles to develop their abilities to apply physics concepts to novel situations.  
**Prerequisite:** Admission to the Physical Science Initiative Cohort program, or approval of the instructor.  
(3-0-3)
MSED 543  
**The Atomic World**  
This course is the second in a three-course sequence designed to cover physical science content for middle grade teachers. The underlying theme for the course is phenomena at the atomic scale. The course will follow a strategy of introducing broad, basic principles, and then covering further material as applications of those principles. The course will address issues of scale, historical model of matter, Heisenberg Uncertainty Principle, Young Double Slit Experiment, models of light, and reaction energies. Students will explore a variety of scenarios involving these principles to develop their abilities to apply physics concepts to novel situations.  
(3-0-3)

MSED 544  
**Physical Science Applications**  
This course is the third in a three-course sequence designed to cover physical science content for middle grade teachers. The underlying themes for the course are motion, astronomy, and earth science. The course will follow a strategy of applying the broad, basic principles covered in the previous two courses to new situations. The course will address the investigation of physical science content related to the nature of motion, astronomy, and earth science. Students will explore a variety of scenarios involving these principles to develop their abilities to apply physics concepts to novel situations.  
(3-0-3)

MSED 545  
**Statistics for Educators I**  
Part one of a two-part course. The course provides concepts and methods of gathering, describing and drawing conclusions from data. Statistical reasoning, probability, sampling, regression, correlation, forecasting, nonparametric statistics, conceptions and misconceptions about statistics, problem solving techniques and current research are included throughout the course.  
(3-0-3)

MSED 546  
**Statistics for Educators II**  
Part two of a two-part course. Statistical reasoning, probability, sampling, regression, correlation, forecasting, nonparametric statistics, conceptions and misconceptions about statistics, problem solving techniques and current research are included throughout the course.  
(3-0-3)

MSED 547  
**Physical Science Instrumentation Methods**  
This course is designed to explore investigation and experimentation methods in the physical sciences for middle grade teachers. The course will follow a strategy of introducing devices or tools used in experimentation and then designing and running fundamental experiments using these tools.  
(3-0-3)

MSED 550  
**Clinical Supervision in Science/Mathematics**  
Provides for the development of a variety of classroom observation techniques and clinical supervision skills.  
(3-0-3)

MSED 552  
**Assessment & Evaluation**  
Contemporary assessment and evaluation theory and the development of valid cognitive, affective, and psychomotor assessment items/tasks. In-depth attention is given to the development and scoring of alternative assessment techniques such as portfolios and projects.  
(3-0-3)

MSED 554  
**Middle & Secondary Level Science Curriculum**  
This course will develop a functional understanding of various factors that influence the development and direction of middle and secondary science curricula. Students will become familiar with strategies to integrate language arts, reading, and writing in the content area of science. Students will apply knowledge of subject matter, curriculum development, and curriculum theory to construct a hypothetical curriculum. Current trends, history of these trends, and rationales for science curriculum reform will be examined.  
(3-0-3)

MSED 560  
**Research & Evaluation**  
Analysis of qualitative and quantitative empirical research in science and mathematics education.  
(3-0-3)

MSED 562  
**Action Research I**  
Reviewing, designing, and conducting research studies within the context of the students’ own teaching.  
(Credit: Variable)

MSED 563  
**Action Research II**  
Reviewing, designing, and conducting research studies within the context of the students’ own teaching. This course is a continuation of MSED 562.  
(0-0-3)

MSED 564  
**Action Research III**  
Reviewing, designing, and conducting research studies within the context of the students’ own teaching. This course is a continuation of MSED 562 and MSED 563.  
(0-0-3)

MSED 570  
**Inquiry & Nature of Science**  
Developing a functional understanding of nature of science in the context of scientific inquiry.  
(3-0-3)

MSED 571  
**Problem Solving & Nature of Mathematics**  
Developing a functional understanding of nature of mathematics in the context of problem solving.  
(3-0-3)
MSED 573  
**Expedition Green – Environmental Science**  
The course is designed to prepare teachers to teach environmental processes and systems, an understanding of environmental issues, personal and civic responsibility, and critical thinking skills. Teachers will increase their knowledge of ecology, ecosystems, resource management, and sustainability. Each class explores how these environmental science topics can be brought back into the classroom using a variety of pedagogical skills and engaging activities. The Expedition Green course models the use of inquiry based, hands-on teaching methods as well as the multiple ways that an informal institution, such as the Museum of Science and Industry, can be used to enhance school curricula. This course is condensed and offered in the summer semester only.  
(1.5-1.5-3)

MSED 574  
**Physical Science – Get Energized**  
Get Energized is designed to help teachers become more proficient in key physical science concepts related to energy. Teachers can increase their comfort level in teaching energy related topics such as light, mechanical, heat, sound, and electrical. Each full-day workshop focuses on a particular energy topic and explores how that topic can be brought back to the classroom in an engaging way. This program also explores how to further the interaction of inquiry-based teaching methods into the classroom as well as the multiple ways that an informal institution can be used to further the curriculum objectives established. Major topics include energy transformation, potential and kinetic energy, mechanical energy, electrical energy, sound, and thermal. This course is condensed, offered summer semester only.  
(1.5-1.5-3)

MSED 575  
**All About You – Life Science**  
All About You focuses on life science, particularly the science of the human body. The teacher professional development series is designed to help teachers learn to utilize inquiry-based and hands-on/minds-on science curriculum both within and outside of the classroom setting. Through this intensive and engaging year-long program, the workshops focus on expanding science teachers' capacity by building their content knowledge and enhancing their instructional practice. Aside from this program being broad based and interdisciplinary, this program explores how to further the interaction of inquiry-based teaching methods into the classroom as well as the multiple ways that an informal institution, such as the Museum of Science and Industry, can be used to further the curriculum objectives established. Major topics include cells, tissues and organs, genetics and evolution, body systems, health and wellness. This course is condensed, offered summer semester only.  
(1.5-1.5-3)

MSED 576  
**Earth Science – Great Lakes Rock**  
In Great Lakes Rock, late elementary and middle school teachers will increase their knowledge of earth systems science concepts and principles, especially those related to climate change and phenomena in the Great Lakes region. Teachers will discuss science content and practice inquiry-based classroom activities that address the following key topics: earth systems; great lakes ecosystems; and life and the environment.  
(3-0-3)

MSED 578  
**Adolescent Psychology**  
This course is designed to develop the participants' understanding of adolescent psychology. The main foci throughout the course are the unique aspects of adolescents and how those aspects influence behavior, learning, and social interactions, especially with regard to middle schools. Studies will include educational psychology theories and models, motivation and learning, developmental changes during adolescence, cognitive abilities, human ecology, diversity, and cultures. Additionally, participants will examine historical and philosophical perspectives of adolescent psychology and synthesize how these perspectives have influenced teaching, learning, and cultures in middle schools. The course will involve weekly readings and reflections, classroom experiences, short assignments, tests/quizzes, research projects, and formal class presentations. Requires admission into the secondary mathematics teacher certification program or instructor permission.  
(3-0-3)

MSED 583  
**Inquiry, Content & Nature of Science**  
This course is appropriate for continuing education of secondary education science teachers, who will be engaged in authentic scientific inquiry with practicing research scientists, learning about nature of science, scientific inquiry, and subject matter, and developing pedagogical knowledge and skills related to these concepts. The goal of the Project ICAN is to empower teachers to help their students to work toward scientific inquiry.  
(Variable:1-3)  
(Credit: Variable)

MSED 584  
**Inquiry, Context, Nature & Science**  
Understanding nature of science as it relates to subject matter, and developing pedagogical knowledge and skills related to these concepts.  
(3-0-3)

MSED 591  
**Research & Thesis M.S.**  
A course that provides the guidance and opportunity for authentic research projects in Science or Mathematics Education to fulfill thesis requirements for MS Candidates.  
(Credit: Variable)

MSED 594  
**Special Projects**  
Advanced projects involving independent study, and especially fieldwork and modeling projects.  
(Variable: 1-6)  
(Credit: Variable)

MSED 597  
**Special Problems**  
Current problems in science/mathematics education. May be repeated for credit with different topics.  
(Credit: Variable)

MSED 598  
**Methods of College Teaching in Mathematics & Science**  
The course is designed to allow each student to develop the theoretical background, practical knowledge, and skills for successful college level mathematics or science teaching. Specific emphasis will be placed upon instructional methods/models, curriculum development, and instructional planning.  
(3-0-3)
MSED 599
College Teaching Practicum
The purpose of the course is to enhance college level teacher preparation with an advanced learning experience joining together theory and practice. This course provides the student the opportunity to practice and improve knowledge and skills at teaching. The student may actively participate or act as an observer at a different college. In addition, students are required to prepare a Portfolio. The Portfolio provides the student an opportunity to demonstrate a readiness for teaching that describes their efforts and progress in preparing to teach science or mathematics at the college level.
(3-0-3)

MSED 601
Critical Analysis in Quantitative Research
A study of quantitative research designs and analytical procedures with critical analysis of perspectives of research in science/mathematics education.
(3-0-3)

MSED 602
Quantitative Research Design & Practicum
A study of quantitative research designs, analytical procedures, and in-depth analysis with specific applications in science/mathematics education.
(3-0-3)

MSED 603
Critical Analysis in Qualitative Research
A study of qualitative research designs and analytical procedures with critical analysis of perspectives of research in science/mathematics education.
(3-0-3)

MSED 604
Qualitative Research Design & Practicum
A study of qualitative research designs, analytical procedures, and in-depth analysis with specific applications in science/mathematics education.
(3-0-3)

MSED 691
Ph.D. Thesis Research
A course that provides the guidance and opportunity for authentic research projects in Science or Mathematics Education to fulfill thesis requirements for PhD Candidates. Instructor permission required.
(Credit: Variable)