

# STEM Education

## College of Education

The mission of the Department of Science, Technology, Engineering, and Mathematics (STEM) Education is to engage in innovative scholarship, teaching, and service that contributes to improving the quality of P20 science, technology, engineering, and mathematics education in the Commonwealth, the nation, and the world. Faculty members in the department are committed to improving the lives of Kentuckians through scientific literacy, mathematical literacy, and technological literacy from preschool through graduate school and beyond. Faculty members have expertise in a diverse spectrum of specialties relating to research, teaching, and service in STEM Education, and have developed curricula that are widely disseminated locally and nationally. They conduct research on STEM Education issues, conceptual understanding in STEM education, curriculum implementation and teacher professional development. In addition, faculty members have developed a variety of novel courses in STEM Education to foster problem solving, critical thinking, and innovation in STEM Education. The department offers both master and doctoral programs in STEM Education with the flexibility of focusing on a specific discipline (i.e., mathematics education, science education), or a broader focus on STEM Education.

### Master of Science

The Department of STEM Education offers programs leading to a Masters of Science in STEM Education and offers a strand option in the Education Sciences PhD program (see Education Sciences for more info). The MS in STEM Education program is a 30-hour program designed to prepare candidates for advanced roles in K-12 educational settings in the STEM content areas or for a terminal degree route in a STEM Education field. Full-time students in the STEM Education graduate programs are not required to serve in a funded assistantship, but those interested are eligible for the positions available. Part-time enrollment in the program is allowed and the program can be completed in evening hours.

### Admission Requirements

Admission to the MS in STEM Education program requires completion of a bachelor's degree from an accredited institution of higher education. While this degree does not have to be specific to a STEM Education field, the applicant does need to have strong content knowledge and an interest in the STEM field as evidenced by the rest of the application materials. The applicant must have adequate GRE scores, GPA of at least 2.75 at the undergraduate level and 3.0 at the graduate level, transcripts from previous institutions, a statement of career goals, and three letters of recommendation. The TOEFL is required for students in which English is not their first language. Once the application has been reviewed, applicants will be required to participate in an impromptu writing sample and interview with STEM Education faculty before a final admission decision is determined.

### Doctor of Philosophy

The Department of STEM Education offers a PhD program through the Education Sciences Interdisciplinary PhD. For more information, see the information on Education Sciences in the Graduate Bulletin or contact the Director of Graduate Studies or Department chair for the Department of STEM Education.

### Graduate Courses

The department offers a variety of coursework in order to design a degree program that best meets the needs of the students in the program. Each student in the MS in STEM Education program is required to complete 12 hours of a specialization in a STEM content area (non-STEM Education courses). With the

addition of 6 hours of electives, candidates in the program can acquire 18 hours of graduate coursework in a content area to meet the minimum guidelines needed to teach college-level courses in that content area. The remaining 12 hours of the program are dedicated to STEM Education coursework with the following courses as options:

SEM 504	Designing Project-Enhanced Environments In STEM Education	(3)
SEM 603	Curriculum And Instruction In STEM Education (Required)	(3)
SEM 604	History Of STEM Education	(3)
SEM 610	Effective Use Of Technology For Modeling-Based Inquiry In STEM Education	(3)
SEM 620	Equity In STEM Education	(3)
SEM 670	Advanced Elementary Mathematics Methods	(3)
SEM 674	Advanced Studies In Teaching Elementary School Science	(3)
SEM 575	Mathematics Clinic	(3)
SEM 701	History Of Mathematics Education	(3)
SEM 706	Research In STEM Education	(3)
SEM 708	Engineering In STEM Education	(3)
SEM 770	Special Topics In STEM Education	(3)

### Course Descriptions

SEM 504 DESIGNING PROJECT-BASED ENVIRONMENTS IN STEM EDUCATION. (3)

SEM 504 will give students the opportunity to explore STEM contents, technologies, instructional strategies, and assessments necessary in designing and developing a research-based, interdisciplinary, project-enhanced environment. In SEM 504 students will experience, evaluate, and design interdisciplinary, project-enhanced environments within STEM classrooms. Although this course is designed as a distance course, there are some required face to face meetings.

#SEM 521 FOUNDATIONS IN STEM TEACHING. (1-5)

This course is intended to help future mathematics/science teachers build a theoretical background and gain the practical skills needed to begin to develop themselves as effective teachers in secondary classrooms. Students will be introduced to, and gain hands-on experience with a variety of instructional materials appropriate for teaching mathematics/science at the secondary level. Students are encouraged to be creative and reflective in developing, implementing, and evaluating practices associated with teaching concepts and skills. A strong emphasis is placed upon helping students to formulate an understanding of how to integrate the mathematical and scientific practices with the core ideas of the disciplines to develop deep conceptual understanding. The experiences in this course are designed to prepare teachers who will work among diverse populations and constantly be in tune with best practices and their implementation as a way to improve education in Kentucky and beyond. The course will focus on developing a number of general pedagogical skills; the integration of math and science candidates into this single class will enrich the conversations around such topics. SEM 521 will be taught as a hybrid course, with weekly face-to-face meetings paired with online modules that can be completed asynchronously. The course will have an accompanying university research / industry externship / informal STEM education experience associated with it for variable hours and variable credits. Prereq: Admission to the TEP and either the B.S. in STEM Education or the M.A.T. in Secondary STEM Education (Initial Certification – Secondary Ed) program.

SEM 575 SEE BLUE MATHEMATICS CLINIC. (3)

This course focuses on clinical techniques for working with K-12 students who are struggling and/or have disabilities in learning mathematics. It is a course designed to develop both theoretical understandings and operational skills in working with students who struggle in mathematics. Classroom applications of the techniques are discussed. This course is a combination of lecture and application with a student client.

**SEM 603 CURRICULUM AND INSTRUCTION IN STEM EDUCATION. (3)**

This course introduces the fundamental issues related to curriculum and instruction in STEM programs. Major topics addressed will include (but will not be limited to), defining STEM education, its curricula, purposes, and past and present social and political influences affecting the development and focus of STEM education. Additional discussion will address the stakeholders of STEM education that participate in the development, testing, implementation, and assessment of STEM curricula. A major focus of the course will be on the review of selected STEM curricular programs that reflect research-based “best practices” in STEM education.

**SEM 604 HISTORY OF STEM EDUCATION. (3)**

The History of STEM Education course will begin with researching the background and development of each individual component of STEM (i.e., Science, Technology, Engineering, and Mathematics) Education. This will follow with a historical comparison of these components highlighting their similarities as well as their differences. The course will conclude with a study of the entity, STEM Education, from the early 19th century America to the present focusing on reports and documents that have connected the Science, Technology, Engineering, and Mathematics disciplines and shaped current research and reform efforts.

**SEM 610 TEACHER LEADERSHIP IN STEM EDUCATION. (3)**

This course introduces fundamental issues related to classroom research, especially through the lens of action research, and what it means to be a teacher leader in the areas of STEM. Practical application will be the primary focus simultaneously with learning and learning to lead. Collaboration and group work is a hallmark of action research; students in this course will demonstrate their abilities to design, diagnose, plan, implement, observe, and reflect in cooperation with classmates. The various roles and skills necessary to be an effective researcher will be discussed, as well as important issues related to empowerment, contextualization, ethical considerations, and validity. In addition, students will examine action research through the lens of innovation and their role as a future teacher leader.

**SEM 613 EFFECTIVE USE OF TECHNOLOGY FOR MODELING-BASED INQUIRY IN STEM EDUCATION. (3)**

This course is designed to teach effective uses of educational technologies towards engagement in modeling-based inquiry in STEM Education. Students will learn the key components of facilitating modeling-based inquiry through their own building of accurate conceptual models of explanations of key STEM theories and underlying concepts. Utilizing technologies implemented in authentic STEM practice, students will learn how to facilitate pupils’ use of technologies to allow them to make controlled observations, analyze data, recognize patterns, propose and revise their models of explanation, and communicate their models to their peers. Prereq: EDC 317 and/or EDC 607 or its equivalent or permission of instructor.

**SEM 620 EQUITY IN STEM EDUCATION. (3)**

This course is a seminar designed to study equity issues in the teaching and learning of STEM disciplines in P-20 education. A primary focus will be on enhancing teachers’ ability to use research and reflection for learning and leading. Throughout the course the relationship between theory and practice will be emphasized in an attempt to understand some of the complexities and challenges in addressing issues of equity in mathematics learning and teaching. Prereq: Graduate standing.

**SEM 631 MATHEMATICS PEDAGOGY IN THE SECONDARY SCHOOL. (0-3)**

Through campus and school-based experiences, students will learn how to engage young people in learning mathematics and how to make decisions about planning instruction and develop assessment based on a sound knowledge base for applying content, materials, and methods (including educational technology) appropriate for high school students. May be repeated to a maximum of three credits.

Lecture, 1-3 hours; laboratory, 3-6 hours per week. Prereq: Admission to the M.A./M.S. in Education (Initial Certification Option-Secondary Education).

**SEM 634 SCIENCE PEDAGOGY IN THE SECONDARY SCHOOL. (0-3)**

Through campus and school-based experiences, students will learn how to engage young people in learning science and how to make decisions about planning instruction and develop assessment based on a sound knowledge base for applying content, materials, and methods (including educational technology) appropriate for high school students. May be repeated to a maximum of three credits. Lecture, 1-3 hours; laboratory, 3-6 hours per week. Prereq: Admission to the M.A./M.S. in Education (Initial Certification Option-Secondary Education).

**SEM 670 ADVANCED STUDY IN THE TEACHING OF ELEMENTARY SCHOOL MATHEMATICS. (3)**

New developments in modern elementary mathematics for teachers in the elementary schools will be reviewed. Special emphasis will be given to a study of new teaching methods, application of published research, techniques and trends in mathematics in the elementary school. Prereq: Graduate standing.

**SEM 674 ADVANCED STUDIES IN TEACHING ELEMENTARY SCHOOL SCIENCE. (3)**

An advanced course for classroom teachers that focuses on implementation of instructional strategies and assessments for teaching elementary science. A review of contemporary research in teaching and learning science will be closely related to classroom instruction. Specific focus will be given to technology integration, assessment, and addressing the needs of diverse student populations. Prereq: Graduate standing.

**SEM 701 HISTORY OF MATHEMATICS EDUCATION. (3)**

A study of mathematics education from early 19th century America to the present focusing on forces that connected mathematics, psychology, psychometrics, sociology, and technology. Prereq: EPE 651 or permission of the instructor.

**SEM 702 THEORETICAL FOUNDATIONS OF MATHEMATICS EDUCATION. (3)**

A survey of constructivism, cognitive science, and sociological and anthropological perspectives as fundamental theories for mathematical learning, and an overview of research context where these theories guide inquiries. Prereq: EDP 610 (Theories of Learning) or consent of instructor. Many concepts and theories in SEM 702 are related to learning theories. Past students felt better prepared for SEM 702 after taking EDP 610.

**SEM 703 ADVANCED RESEARCH IN MATHEMATICS EDUCATION. (3)**

An advanced seminar focusing on current critical research issues in mathematics education, the way research impacts education policies and practices, various methodological pursuits of researchers, and theory building.

**SEM 706 RESEARCH IN STEM EDUCATION. (3)**

Students will have the opportunity to learn about the research paradigms guiding STEM education research throughout history with critical analysis of those most utilized across the modern STEM education research communities. Students will acquire knowledge and skills that allow them to develop a research proposal with explicit discussion of their research assumptions and that targets meaningful and timely research questions in STEM education. Prereq: EDL 651, or EDP/EPE 557 and EPE 570, or EDP/EPE 660 or permission of instructor.

**SEM 708 ENGINEERING IN STEM EDUCATION. (3)**

SEM 708 will introduce students to the field of engineering and give them the opportunity to explore engineering concepts, engineering design, different fields of engineering, engineering curricular materials for K-12 students, research on including engineering in K-12 education, and assessments necessary in designing and developing research-based, interdisciplinary, engineering-design curricula for K12 students and teachers. In SEM 708 students will experience, evaluate, and design interdisciplinary, engineering design-based curricula to be used within STEM classrooms. Prereq: EDC 707 or permission of instructor.

**SEM 746 SUBJECT AREA INSTRUCTION IN THE SECONDARY SCHOOL. (0-9)**

Students will teach in their subject areas in the schools full-time, meet regularly to discuss teaching effectiveness and strategies for improvement and develop their professional portfolios. May be repeated to a maximum of nine credits. Lecture, 3-9 hours; laboratory, 618 hours per week. Prereq: The appropriate methods course in the subject area (SEM 631, EDC 632, EDC 633, SEM 634 or EDC 635). Admission to the M.A./M.S. in Education (Initial Certification Option-Secondary Education). (Same as EDC 746.)

**SEM 748 MASTER'S THESIS RESEARCH. (0)**

Half-time to full-time work on thesis. May be repeated to a maximum of six semesters. Prereq: All course work toward the degree must be completed.

**SEM 767 DISSERTATION RESIDENCY CREDIT. (2)**

Residency credit for dissertation research after the qualifying examination. Students may register for this course in the semester of the qualifying examination. A minimum of two semesters are required as well as continuous enrollment (Fall and Spring) until the dissertation is completed and defended.

**SEM 770 SPECIAL TOPICS IN STEM EDUCATION (Subtitle required). (1-4)**

This course is a seminar of topical offerings with variable topics in the study of philosophy, principles, trends and research associate with STEM Education. This seminar is designed to cover topical issues around current research and strategies in STEM Education as they relate to P-20 implementation. STEM Education is transdisciplinary and constantly changing. This course will address content specific and transdisciplinary issues within the context of new directives and initiatives. May be repeated to a maximum of twelve credits. Prereq: SEM 603 and/or SEM 706 or permission of instructor.

**SEM 781 INDEPENDENT STUDY IN STEM EDUCATION. (1-3)**

An independent study course for graduate students. May be repeated to a maximum of nine credits. Prereq: Consent of the Director of Graduate Studies and Program Advisor.