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STEM Teaching

Program Description

Teach@Mines is an interdisciplinary University Honors and Scholars program that offers graduate students a non-thesis MS in STEM Education preparing them to teach K-12 Math, Science, or Computer Science. Teach@Mines coursework prepares students to teach using best practices from mathematics, science, engineering, and computer science education research. Sample core topics include educational psychology, student motivation and engagement techniques, and classroom management. In addition, students engage in intentional teaching experiences through field hours spent in K-12 classrooms with experienced mentor teachers throughout the program. The state requires a minimum of 24 credits of content in math, science, computer science, or engineering and 24 credits of educational coursework that includes 800 hours of K-12 field experience. The full 24 credits of required educational coursework are built into the MS in STEM Education. The MS in STEM Education can be completed in as little as two semesters with additional evening classes. Teach@Mines offers pathways for licensure in: Secondary Science (Grades 6-12), Secondary Mathematics (Grades 6-12), Middle School Mathematics (Grades 6-8), and Computer Science (Grades K-12). Students completing the MS in STEM Education may continue to pursue careers in K-12 teaching and higher education.

Student Learning Outcomes

After completing the MS in STEM Education, students will be able to:

- Translate the science of teaching, learning, and assessing to formal and informal educational spaces.
- Create engaging learning environments that are effective for all students by providing access, support, and challenge for every student as well as differentiating instruction to meet the needs of all students.
- Apply evidence-based classroom management techniques to create a positive learning environment.
- Nurture and develop students' understanding of science practices and engineering design, mathematical practices, and computer science practices.
- Prepare pre-service STEM teachers to respectfully provide compassionate, ethical, and innovative curriculum and education, resulting in rewarding teaching careers.
- Prepare students to be innovators in STEM education.

Contact

Christine Liebe, PhD

https://www.mines.edu/teacherprep/

Christine Liebe

Master of Science in STEM Education (Non-Thesis)

Teach@Mines, situated within University Honors and Scholars programs, offers a Master of Science in STEM Education (non-thesis). This degree program is designed to prepare students with at least a Bachelor of Science degree in a STEM discipline to teach K-12 or at the college level. The coursework prepares students to teach using best-practices from

mathematics, science, engineering, and computer science education research.

Non-thesis master of science in STEM Education

The Master of Science degree (non-thesis option) requires 30 credits of coursework. Students pursuing the degree may double count up to 6 graduate credits which were used in fulfilling the requirements of their undergraduate degree toward their graduate program. All courses must have been passed with a B- or better. For all three specialty areas – Science Teaching, Mathematics Teaching, and Computer Science Teaching – the curriculum structure consists of 1) a set of required courses, 2) a pair of discipline specific pedagogy courses, and 3) general elective courses that serve to supplement the student's technical interests.

Specialty in Science Teaching

Required (18 credits):

SCED562	K-12 FIELD EXPERIENCE AND BUILDING STUDENT RELATIONSHIPS	3.0		
SCED533	EDUCATIONAL PSYCHOLOGY AND ASSESSMENT [*]	3.0		
SCED563	DYNAMIC TEACHING: MOTIVATION, CLASSROOM MANAGEMENT, AND DIFFERENTIATION OF INSTRUCTION	3.0		
SCED564	CAPSTONE CURRICULUM DESIGN I	3.0		
SCED565	CAPSTONE CURRICULUM DESIGN II	6.0		
Discipline specific pedagogy courses (6 credits):				
SCED515	SCIENTIFIC PRACTICES VS ENGINEERING DESIGN AND THE NATURE OF SCIENTIFIC KNOWLEDGE [*]	3.0		
SCED545	PHYSICS AND CHEMISTRY TEACHING TECHNIQUES	3.0		
Finally, the ren	naining 6 credits come from general elective			

courses that may be taken in other departments on campus to satisfy this requirement.

* *SCED533, SCED563, and SCED515 are approved to count as H&SS Restricted Electives.

Specialty in Mathematics Teaching

Required (18 c	credits):			
SCED562	K-12 FIELD EXPERIENCE AND BUILDING STUDENT RELATIONSHIPS	3.0		
SCED533	EDUCATIONAL PSYCHOLOGY AND ASSESSMENT	3.0		
SCED563	DYNAMIC TEACHING: MOTIVATION, CLASSROOM MANAGEMENT, AND DIFFERENTIATION OF INSTRUCTION	3.0		
SCED564	CAPSTONE CURRICULUM DESIGN I	3.0		
SCED565	CAPSTONE CURRICULUM DESIGN II	6.0		
Discipline specific pedagogy courses (6 credits):				
MAED505	MATHEMATICAL PRACTICES AND THE SOCIAL CONTEXT OF MATHEMATICS	3.0		
MAED525	PRE-ALGEBRA AND ALGEBRA TEACHING TECHNIQUES	3.0		

Finally, the remaining 6 credits come from general elective courses that may be taken in other departments on campus to satisfy this requirement.

* SCED533, and SCED563 are approved to count as H&SS Restricted Electives.

Specialty in Computer Science Teaching

Required (18 credits):

SCED562	K-12 FIELD EXPERIENCE AND BUILDING STUDENT RELATIONSHIPS	3.0		
SCED533	EDUCATIONAL PSYCHOLOGY AND ASSESSMENT	3.0		
SCED563	DYNAMIC TEACHING: MOTIVATION, CLASSROOM MANAGEMENT, AND DIFFERENTIATION OF INSTRUCTION *	3.0		
SCED564	CAPSTONE CURRICULUM DESIGN I	3.0		
SCED565	CAPSTONE CURRICULUM DESIGN II	6.0		
Discipline specific pedagogy courses (6 credits):				
MAED505	MATHEMATICAL PRACTICES AND THE SOCIAL CONTEXT OF MATHEMATICS	3.0		
or SCED515	SCIENTIFIC PRACTICES VS ENGINEERING DESIGN AND THE NATURE OF SCIENTIFIC KNOWLEDGE			
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Finally, the remaining 6 credits come from general elective courses that may be taken in other departments on campus to satisfy this requirement.

* SCED533, SCED563, and SCED515 are approved to count as H&SS Restricted Electives.

Mines Combined Undergraduate/Graduate Degree Program

Students enrolled in Mines' combined undergraduate/graduate program may double count up to 6 credits of graduate coursework to fulfill requirements of both their undergraduate and graduate degree programs. These courses must have been passed with B- or better, not be substitutes for required coursework, and meet all other university, uepartment, and program requirements for graduate credit.

Students are advised to consult with their undergraduate and graduate advisors for appropriate courses to double count upon admission to the combined program.

SCED515. SCIENTIFIC PRACTICES AND ENGINEERING DESIGN AND THE NATURE OF SCIENTIFIC KNOWLEDGE. 3.0 Semester Hrs.

The goal of this course is to prepare students to integrate knowledge of scientific and engineering practices into their teaching as articulated in the Colorado Academic Standards and the Next Generation Science Standards, including asking questions, defining problems, developing and using models, planning and carrying out investigations, analyzing and interpreting data, constructing explanations and designing solutions, engaging in argument from evidence, obtaining, evaluating and communicating information. These skills will be modeled, practiced and mastered in the context of science, specifically: 1) earthquakes and waves, 2) mitosis, meiosis, and reproduction, 4) periodic table of the elements, 5) energy conservation, and 6) forces in static equilibrium. In addition this course will prepare students to be able to communicate effectively in a variety of mediums (written, oral, and digital) as educators about scientific and engineering practices. **Course Learning Outcomes**

ourse Learning Outcomes

- Engage in appropriate scientific practices and support their students in doing the same.
- · Identify, adapt or develop lessons specifically designed to engage students in scientific and engineering practices, including but not limited to, asking questions (for science) and defining problems (for engineering); analyzing and interpreting data; engaging in argument from evidence; constructing explanations (for science) and designing solutions (for engineering); developing and using models; planning and carrying out investigations; obtaining, evaluating, and communicating information; and using mathematics and computational thinking. o compare and contrast "Scientific Practice" with "Engineering Design" o judge a student's abilities to do design practices in an informed way. o describe an engineering design cycle and how to apply it to design challenges o define and provide examples of design criteria and design constraints compare and contrast "Scientific Practice" with "Engineering Design"; judge a student's abilities to do design practices in an informed way; describe an engineering design cycle and how to apply it to design challenges; define and provide examples of design criteria and design constraints.
- · Effectively instruct students about and model the basic understandings about the nature of science: science as a way of knowing, scientists use a variety of methods, science is based on evidence, science is open to revision, scientists use models, laws, mechanisms, and theories, science assumes order and consistency in natural systems, science is a human endeavor, and science addresses questions about the natural and material world. o articulate how scientific knowledge is acquired in a way that secondary students can comprehend. o describe the practices that brought about at least one major breakthrough in each of the four primary disciplines of science and how this contributed to our modern understanding of science. o analyze differences in the process of scientific discovery as described in the course text. o formulate a generalization and assess the evidence used to support a generalization or scientific theory. o provide examples that demonstrate the necessity for observations and characterization of patterns to understand the invisible.
- Integrate current issues and events related to science, and age-/ grade-appropriate controversial topics presented from multiple science perspectives into lessons using an analytical approach without bias.
- Select, adapt, or develop lessons that explicitly engage students in scientific and engineering practices defined by the Colorado Academic Standards in science, and the Next Generation Science Standards (NGSS).
- Identify, adapt or develop lessons that reflect the interconnectedness of content areas/disciplines to help erase the disciplinary lines and reflect authentic situations; for example through cross-cutting concepts defined in NGSS.
- Illustrate the value of a model in understanding composition and in science.
- Create a mini-unit (3 days or more) that explicitly teaches some aspect of scientific or engineering practice.
- Clearly articulate their scientific ideas in writing. Analyze text based on occasion, audience, form and function. o compose one page reflections with an awareness about introductions, conclusions and topic sentences. o articulate the process of and compose with

an awareness about the composing process which is an iterative process of formulation, composition and revision. o incorporate and cite correctly all evidence used to support a text's claims.

 Clearly articulate their scientific ideas verbally. o delineate effective characteristics of multi-media presentations. o articulate scientific practices in a way that secondary students can understand and be motivated to explore these practices. o collaborate with others towards giving and receiving feedback on both oral and written work about teaching science as a way of knowing.

SCED533. EDUCATIONAL PSYCHOLOGY AND ASSESSMENT. 3.0 Semester Hrs.

An explosive growth in research on how people learn has revealed many ways to improve teaching and catalyze learning at all ages. The purpose of this course is to present this new science of learning so that educators can creatively translate the science into exceptional practice. This course covers field-defining learning theories ranging from behaviorism to cognitive psychology to social psychology and some lesser-known theories exceptionally relevant to practice, such as arousal theory. Together the theories, evidence, and strategies can be combined endlessly to create original and effective learning plans and the means to know if they succeed.

Course Learning Outcomes

- Describe in general what cognitive science has learned about how the brain works related to the topics of conceptual understanding, memory, motivation, expertise, study skills, sense of inclusion, problem solving, collaboration, and discovery.
- Analyze various effective teaching practices in math and the sciences and provide examples of how the above topics in cognitive science inform these practices.
- utilize research based methods of instruction that have been shown to be effective across context, including pairing graphics with words, linking abstract concepts with concrete representations, repeatedly alternating solved and unsolved problems, distributed practice, and assessment to boost retention.
- effectively integrate technology into instructional and assessment strategies, as appropriate to science and mathematical education and the learner including but not limited to the use of a variety of resources (e.g., manipulative materials, graphing calculators, everyday hands-on materials, probe ware, and computers).
- Explain the value of embedding disciplinary research into the high school classroom and provide an example in science or math of how this can be done.
- Define data driven instruction, brain plasticity, and individual differences.
- Utilize formative assessment daily to adjust to students' needs as they are teaching and to determine where instruction can be improved next time.
- Utilize pre/post-tests as a form of formative assessment on a unit basis to determine change, learning gains, and effect size by group; Then, use the results to modify their future instruction.
- · Use summative assessment to determine student level of mastery
- Provide accurate information about the teaching profession related to salary, benefits, and teacher satisfaction.
- Provide evidence for the nations' science and math teacher shortage and describe some research-based actions that can help change the direction of this trend.
- continuously improve their knowledge and understanding of the everchanging knowledge base of both content, and science/mathematics

pedagogy, including approaches for addressing inequities and inclusion for all students in science and math.

SCED545. PHYSICS AND CHEMISTRY TEACHING TECHNIQUES. 3.0 Semester Hrs.

In this course students will engage as learners of physics and chemistry through evidence-based teaching strategies. After each unit of instruction, students will reflect on the practices used during the unit and why these practices are effective techniques for teaching science. The goal of this course is for teacher candidates to develop an awareness of 1) the common misconceptions and learning progressions associated with physics and chemistry; 2) evidence-based teaching strategies for physics and chemistry; and 3) the importance of and techniques for placing all content within a context that is familiar to and interesting to your specific student body. Students will leave this course with a minimum of a full month of curriculum annotated and ready to deliver to middle or high school physical science and high school physics courses. **Course Learning Outcomes**

- Plan at least the first month of instruction for a middle or high school physics or chemistry course using standards-based lessons experienced in this course.
- Identify lessons that are designed to build students knowledge as defined in the Colorado Academic Standards in science, mathematics, and literacy and the Next Generation Science Standards (NGSS)
- Articulate and offer recommendations for addressing the common student preconceptions associated with all of the topics listed above for physical science and physics.
- Integrate content within identified student personal interest to build student engagement and connections to the world around them.
- Utilize Just in Time Teaching to plan lessons that meet students current interests and background knowledge.
- Articulate the scope of the above standards related to the content knowledge necessary for teaching 7-12 students.
- Articulate and engage students in investigation of the major concepts, principles, theories, laws, and interrelationships in science that underlie what they encounter in teaching.

SCED562. K-12 FIELD EXPERIENCE AND BUILDING STUDENT RELATIONSHIPS. 1-3 Semester Hr.

This course is designed to provide Mines students with opportunities to participate in, analyze, and reflect on issues in a science K-12 school classroom setting. The overall goal is for Mines students to understand who their students are, build relationships, and begin exploring learner development and learner differences. Specifically, the course will focus on developing Mines students' ability to identify and practice basic classroom management, differentiate instruction, ask probing questions, science content preconceptions, language/activities that promote a growth mindset, and professional language. Furthermore, Mines students will begin exploring the factors that shape school norms and culture. In addition to an on-campus seminar, there is a 25-hour field experience requirement in the student's assigned partner school. **Course Learning Outcomes**

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- Identify and provide examples of differentiated instruction.
- Identify and provide examples of formative-assessment techniques used to evaluate what students are thinking during classroom activities
- · Articulate the value of reflecting on their practice.

- Explain different levels of questioning and how to ask probing questions as well as provide examples of how to use these types of questioning.
- Articulate reasons for, ways to, and examples of how they built relationships with each and every student in their classroom.
- Articulate and document the science content specific preconceptions that they observed students demonstrate during the field placement.
- · Identify the school policies and practices of their field placement.
- Identify factors that shaped the culture and norms of the school they experienced.
- Communicate effectively, model appropriate use of language (e.g., use of proper grammar, use of professional language, and use of discipline-specific vocabulary), and identify unprofessional language.
- Articulate the critical role of high ethical standards, including a belief in being committed to displaying ethical conduct towards students, performance and the profession, colleagues, and parents and the community.
- Recognize that with quality instruction and hard work, all students are capable of learning science and mathematics; use language, activities and feedback that is consistent with a growth mindset.

SCED563. DYNAMIC TEACHING: MOTIVATION, CLASSROOM MANAGEMENT, AND DIFFERENTIATION OF INSTRUCTION. 3.0 Semester Hrs.

Effective teaching is a dynamic process that requires the instructor to motivate, manage, and vary instruction for all learners in the classroom. The purpose of this course is to prepare future educators to be able to motivate students, manage classroom behavior, and differentiate their instruction so that all students can learn. This course will cover the field-defining theories of motivation, classroom management, and differentiation. Additionally, this course will introduce research-based practices that can be used to create learning environments where students are motivated and given the tools to be successful in their individual learning.

Course Learning Outcomes

- Describe theories of motivation and how classroom practices connect to those theories.
- Describe classroom management theories and how practices connect to those theories.
- Describe how differentiation techniques can be used to assist students with various exceptionalities.
- Create effective lesson plans that differentiate instruction for students in a classroom.
- Evaluate learning environments to recognize effective and ineffective motivation, management, and differentiation techniques in practice.
- Cultivate students' scientific/mathematics identify and confidence in learning science/math by connecting their instruction and content to students' background, providing ample opportunities for students to experience and reflect on success in learning science/mathematics content and practices, making their instruction and content relevant to students' lives, and helping students to contextualize the information being taught.
- Use classroom management, motivation, and differentiation practices to plan for and set the conditions of an effective learning environment.
- Apply evidence-based classroom management techniques (e.g., establishing rules and routines, utilizing praise and rewards, consistently disciplining misbehavior, and engaging students) to

create a positive learning environment (e.g., acceptable learning behaviors and maximizing time on task.).

• Demonstrate a commitment to and respect for diversity, while working toward common goals as a community and as a country.

SCED564. CAPSTONE CURRICULUM DESIGN I. 3.0 Semester Hrs.

This course provides Mines students an intensive teaching experience in a K-12 science, engineering, or STEM classroom. The goal of this course is for the student to develop and demonstrate competencies in the areas of planning, instructional methods, assessments, creating effective learning environments for all learners, classroom management and organization, content knowledge, and professionalism. In addition to a total of 15 hours of seminars (on campus and teacher professional development), there is an approximately 6 hours per week (100-hours total) field experience requirement in the student's assigned partner school. During this semester, the student will be responsible for planning and teaching at least five periods of classroom instruction as well as participate in other school related professional roles and will develop a mini-work sample (min-unit of instruction including: description of setting, learning objectives, three class periods or more of standardsbased lesson plans, pre/post assessment, and reflection). Prerequisite: Completed/concurrent 3 credits of SCED 562; completed/concurrent with SCED 515 or SCED 545. Co-requisite: Completed/concurrent 3 credits of SCED 562; completed/concurrent with SCED 515 or SCED 545. **Course Learning Outcomes**

- Utilize research-based instructional techniques that have been shown to be effective across context, including pairing graphics with words, linking abstract concepts with concrete representations, asking probing questions, repeatedly alternating solved and unsolved problems, distributed practice and assessment to boost retention.
- Identify, adapt, or develop lessons using a variety of active learning techniques based on how all students learn science, including lessons where students collect and interpret data in order to develop and communicate concepts and understand scientific processes, and identify relationships and natural patterns. Applications of sciencespecific technology are included in the lessons when appropriate.
- Use formative-assessment techniques (10 or more) to evaluate students' thinking during classroom activities and assess students' progress towards mastery of the learning outcomes in each lesson; reflect on implemented lessons and provide suggestions to improve future implementations to address gaps or needs identified from the formative assessment data, including but not limited to determining appropriate delivery of instruction based on identified student need; and to select appropriate tasks to reinforce and promote students' development of concepts and skills
- Apply evidence-based classroom management techniques (e.g., establishing rules and routines, utilizing praise and rewards, consistently disciplining misbehavior, and engaging students) to create a positive learning environment (e.g., acceptable learning behaviors and maximizing time on task.).
- Create engaging learning environments that are effective for all students by providing access, support, and challenge for every student as well as differentiating instruction to meet the needs of all students.
- Identify lessons that are well designed to build students' reading, writing, speaking and listening with science or mathematics classes.
- Engage in professional behavior expected of new teachers including o appropriate dress, o attendance and professional commitments, o teacher presence/appropriate boundaries (specifically, can describe the difference between being a student's teacher and being

their friend), o respectful collaboration (even if do not agree), o professional initiative, and o student confidentiality related to both academic performance and personal lives.

- Learn about their individual school context, policies and practices and through reflection on prior field experiences have an appreciation for different school cultures and understand that these are shaped by the school's teachers, administrators, parents, students and community in which it is situated.
- Provide proactive, clear and constructive feedback to families about student progress and develop a library of mechanisms to work collaboratively with the families and significant adults in the lives of their students.
- Reflect on their practice and use this reflection to set goals for further growth.
- Write standards-based lesson plans that include measurable learning objectives, applicable Colorado Content Standards, required materials, safety considerations, an outline of the lesson scaffolded with the five E's (engage, explore, explain, elaborate and evaluate) or other learning cycle model, accommodations, formative assessment and subject integration.

SCED565. CAPSTONE CURRICULUM DESIGN II. 6-12 Semester Hr.

This course provides Mines students an immersive student teaching experience in a K-12 science, engineering, or STEM classroom. The goal of this course is for the student to develop and demonstrate competencies in the areas of planning, instructional methods, assessments, creating effective learning environments for all learners, classroom management and organization, content knowledge, and professionalism. In addition to a total of 15 hours of seminars (on campus and teacher professional development), there is a 32-hour per credit hour enrolled field experience requirement in the student's assigned partner school. During this semester, the student will be responsible for planning and teaching at least five periods of classroom instruction for each 3 credit hours enrolled as well as participate in other school related professional roles and will develop a work sample (unit of instruction including: description of setting, learning objectives, three class periods or more of standards-based lesson plans, pre/post assessment, and reflection). Prerequisites: Completed SCED 564; completed/concurrent with SCED 333, SCED 363, SCED 515, and SCED 545. Corequisites: Completed/concurrent with SCED 333, SCED 363, SCED 515, and SCFD 545.

Course Learning Outcomes

- Utilize research-based instructional techniques that have been shown to be effective across context, including pairing graphics with words, linking abstract concepts with concrete representations, asking probing questions, repeatedly alternating solved and unsolved problems, distributed practice and assessment to boost retention.
- Identify, adapt, or develop lessons using a variety of active learning techniques based on how all students learn science or engineering, including lessons where students collect and interpret data in order to develop and communicate concepts and understand scientific processes, and identify relationships and natural patterns. Applications of science-specific technology are included in the lessons when appropriate.
- Use formative-assessment techniques (10 or more) to evaluate students' thinking during classroom activities and assess students' progress towards mastery of the learning outcomes in each lesson; reflect on implemented lessons and provide suggestions to improve future implementations to address gaps or needs identified from the formative assessment data, including but not limited to determining

appropriate delivery of instruction based on identified student need; and to select appropriate tasks to reinforce and promote students' development of concepts and skills.

- Apply evidence-based classroom management techniques (e.g., establishing rules and routines, utilizing praise and rewards, consistently disciplining misbehavior, and engaging students) to create a positive learning environment (e.g., acceptable learning behaviors and maximizing time on task.).
- Create engaging learning environments that are effective for all students by providing access, support, and challenge for every student as well as differentiating instruction to meet the needs of all students.
- Identify lessons that are well designed to build students' reading, writing, speaking and listening with science or mathematics classes.
- Engage in professional behavior expected of new teachers including o appropriate dress, o attendance and professional commitments, o teacher presence/appropriate boundaries (specifically, can describe the difference between being a student's teacher and being their friend), o respectful collaboration (even if do not agree), o professional initiative, and o student confidentiality related to both academic performance and personal lives.
- Learn about their individual school context, policies and practices and through reflection on prior field experiences have an appreciation for different school cultures and understand that these are shaped by the school's teachers, administrators, parents, students and community in which it is situated.
- Provide proactive, clear and constructive feedback to families about student progress and develop a library of mechanisms to work collaboratively with the families and significant adults in the lives of their students.

SCED598. SPECIAL TOPICS. 0-6 Semester Hr.

SCED598. SPECIAL TOPICS. 0-6 Semester Hr.

SCED598. SPECIAL TOPICS. 0-6 Semester Hr.

SCED599. INDEPENDENT STUDY. 0.5-6 Semester Hr.

SCED599. INDEPENDENT STUDY. 0.5-6 Semester Hr.

MAED505. MATHEMATICAL PRACTICES AND THE SOCIAL CONTEXT OF MATHEMATICS. 3.0 Semester Hrs. n/a.

Course Learning Outcomes

- nurture development of mathematical processes and practices. They
 anticipate how students' use of mathematical practices will look and
 sound within specific grade-band mathematical topics, knowing that
 over years of experience, their knowledge of students' ways of using
 mathematical practices will expand to more mathematical topics.
- identify, adapt, or develop lessons that explicitly teach mathematical process and practices demonstrating these as tools use to solve problems and communicate ideas.
- demonstrate that doing mathematics is a sense-making activity that promotes perseverance, problem posing, and problem solving.
- provide examples and connections for students to see that mathematics is a human endeavor that is practice in and out of school, across many facets of life.
- integrate the history of mathematics into content and share contributions from people with different gender and cultural, linguistic, religious, and racial/ethnic backgrounds.

- articulate how mathematics is based on constructed conventions and agreements about the meanings of words and symbols, and these conventions vary; algorithms considered as standard in the United States different from algorithms used in other countries.
- cultivate their students' mathematical identity by helping students realize the usefulness of mathematics by providing connections to students' everyday lives and building their students mathematics self-efficacy by encouraging hard work from every student and demonstrating the belief that every student is capable of learning and using mathematics
- identify and implement practices that draw on students' mathematical, cultural, and linguistic resources/strengths and challenge practices grounded in deficit-based thinking.
- select, adapt, or develop lessons that explicitly engage students the mathematical practices defined in the Colorado Academic Standards and Common Core in mathematics.
- identify, adapt, or develop lessons that reflect the interconnectedness of content areas/disciplines to help erase the disciplinary lines and reflect authentic situations.
- create a mini-unit (3 days or more) that explicitly teaches some aspect of mathematical practices or the social context of mathematics.
- clearly articulate their mathematical ideas in writing. o analyze text based on occasion, audience, form and function. o compose one page reflections with an awareness about introductions, conclusions and topic sentences. o articulate the process of and compose with an awareness about the composing process which is an iterative process of formulation, composition and revision. o incorporate and cite correctly all evidence used to support a text's claim/s.
- clearly articulate their mathematical ideas verbally. o delineate effective characteristics of multi-media presentations. o articulate mathematical practices in a way that secondary students can understand and be motivated to explore these practices. o collaborate with others towards giving and receiving feedback on both oral and written work about teaching mathematics as a community of inquiry.

MAED525. PRE-ALGEBRA AND ALGEBRA TEACHING TECHNIQUES. 3.0 Semester Hrs.

In this course teacher candidates will be exposed to evidence-based instructional practices to support students' learning of pre-algebra and algebra and model meaningful learning opportunities, common misconceptions and ways of thinking, and students' learning progressions (i.e., content trajectory). The goal of this course is for teacher candidates is to develop an awareness of 1) the common misconceptions and learning progressions associated with pre-algebra and algebra; 2) students learning progressions in pre-algebra and algebra, and 3) evidence-based and meaningful instructional strategies for pre-algebra and algebra. The teacher candidate analyzes conceptual algebra underpinnings, common misconceptions, and students' ways of thinking to create opportunities to learn.

Course Learning Outcomes

- plan at least the first month of instruction for a middle or high school pre-algebra or algebra course using standards-based lessons experienced in this course.
- construct and evaluate mathematical conjectures and argument to validate one's own mathematical thinking.
- identify and develop lessons that are designed to build students knowledge as defined in the Colorado Academic Standards in

mathematics and literacy. Candidates will be able to articulate the scope of the above standards related to the content knowledge necessary for teaching 7-12 students.

• describe mathematical ideas, using every day and mathematical language, in both verbal and written formats.

MAED562. K-12 FIELD EXPERIENCE AND BUILDING STUDENT RELATIONSHIPS. 1-3 Semester Hr.

This course is designed to provide Mines students with opportunities to participate in, analyze, and reflect on issues in a mathematics or computer science K-12 school classroom setting. The overall goal is for Mines students to understand who their students are, build relationships, and begin exploring learner development and learner differences. Specifically, the course will focus on developing Mines students' ability to identify and practice basic classroom management, differentiate instruction, ask probing questions, mathematics or computer science content preconceptions, language/activities that promote a growth mindset, and professional language. Furthermore, Mines students will begin exploring the factors that shape school norms and culture. In addition to an on-campus seminar, there is a 25-hour field experience requirement in the student's assigned partner school.

Course Learning Outcomes

- · identify and provide examples of differentiated instruction.
- identify and provide examples of formative-assessment techniques used to evaluate what students are thinking during classroom activities
- articulate the value of reflecting on their practice.
- explain different levels of questioning and how to ask probing questions as well as provide examples of how to use these types of questioning.
- articulate reasons for, ways to, and examples of how they built relationships with each and every student in their classroom.
- articulate and document the mathematics or computer science content specific preconceptions that they observed students demonstrate during the field placement.
- · identify the school policies and practices of their field placement.
- identify factors that shaped the culture and norms of the school they experienced.
- communicate effectively, model appropriate use of language (e.g., use of proper grammar, use of professional language, and use of discipline-specific vocabulary), and identify unprofessional language.
- articulate the critical role of high ethical standards, including a belief in being committed to displaying ethical conduct towards students, performance and the profession, colleagues, and parents and the community.
- recognize that with quality instruction and hard work, all students are capable of learning science and mathematics; use language, activities and feedback that is consistent with a growth mindset.

MAED564. CAPSTONE CURRICULUM DESIGN I. 3.0 Semester Hrs.

This course provides Mines students an intensive teaching experience in a K-12 mathematics or computer science classroom. The goal of this course is for the student to develop and demonstrate competencies in the areas of planning, instructional methods, assessments, creating effective learning environments for all learners, classroom management and organization, content knowledge, and professionalism. In addition to a total of 15 hours of seminars (on campus and teacher professional development), there is an approximately 6 hours per week (100-hours total) field experience requirement in the student's assigned partner school. During this semester, the student will be responsible for planning and teaching at least five periods of classroom instruction as well as participate in other school related professional roles and will develop a mini-work sample (min-unit of instruction including: description of setting, learning objectives, three class periods or more of standardsbased lesson plans, pre/post assessment, and reflection).. Prerequisites: Completed/concurrent 3 credits of SCED 562; completed/concurrent with MAED 505 or MAED 525. Corequisites: Completed/concurrent 3 credits of SCED 562; completed/concurrent with MAED 505 or MAED 525. **Course Learning Outcomes**

- utilize research-based instructional techniques that have been shown to be effective across context, including pairing graphics with words, linking abstract concepts with concrete representations, asking probing questions, repeatedly alternating solved and unsolved problems, distributed practice and assessment to boost retention.
- identify, adapt, or develop lessons using a core set of pedagogical practices that are effective for developing students' meaningful learning of mathematics which include establishing goals, promoting reasoning and problem solving, connecting mathematical representations, meaningful discourse, purposeful questions, procedural fluency based on conceptual understanding, and productive struggle. While planning lessons program completers will also anticipate and attend to students' prior knowledge, problem solving approaches, mathematical practices, dispositions, mathematical identity, and mathematical communication.
- use formative-assessment techniques (10 or more) to evaluate students' thinking during classroom activities and assess students' progress towards mastery of the learning outcomes in each lesson; reflect on implemented lessons and provide suggestions to improve future implementations to address gaps or needs identified from the formative assessment data, including but not limited to determining appropriate delivery of instruction based on identified student need; and to select appropriate tasks to reinforce and promote students' development of concepts and skills.
- apply evidence-based classroom management techniques (e.g., establishing rules and routines, utilizing praise and rewards, consistently disciplining misbehavior, and engaging students) to create a positive learning environment (e.g., acceptable learning behaviors and maximizing time on task.).
- create engaging learning environments that are effective for all students by providing access, support, and challenge for every student as well as differentiating instruction to meet the needs of all students.
- identify lessons that are well designed to build students' reading, writing, speaking and listening with science or mathematics classes.
- engage in professional behavior expected of new teachers including o appropriate dress, o attendance and professional commitments, o teacher presence/appropriate boundaries (specifically, can describe the difference between being a student's teacher and being their friend), o respectful collaboration (even if do not agree), o professional initiative, and o student confidentiality related to both academic performance and personal lives.
- learn about their individual school context, policies and practices and through reflection on prior field experiences have an appreciation for different school cultures and understand that these are shaped by the school's teachers, administrators, parents, students and community in which it is situated.
- provide proactive, clear and constructive feedback to families about student progress and develop a library of mechanisms to work

collaboratively with the families and significant adults in the lives of their students.

- reflect on their practice and use this reflection to set goals for further growth.
- write standards-based lesson plans that include measurable learning objectives, applicable Colorado Content Standards, required materials, safety considerations, an outline of the lesson scaffolded with the five E's (engage, explore, explain, elaborate and evaluate) or other learning cycle model, accommodations, formative assessment and subject integration.

MAED565. CAPSTONE CURRICULUM DESIGN II. 6-12 Semester Hr.

This course provides Mines students an intensive teaching experience in a K-12 mathematics or computer science classroom. The goal of this course is for the student to develop and demonstrate competencies in the areas of planning, instructional methods, assessments, creating effective learning environments for all learners, classroom management and organization, content knowledge, and professionalism. In addition to a total of 15 hours of seminars (on campus and teacher professional development), there is a 2 hours per week (32-hours total) per credit hour enrolled field experience requirement in the student's assigned partner school. During this semester, the student will be responsible for planning and teaching at least five periods of classroom instruction for each 3 credit hours enrolled as well as participate in other school related professional roles and will develop a mini-work sample (minunit of instruction including: description of setting, learning objectives, three class periods or more of standards-based lesson plans, pre/post assessment, and reflection). Prerequisites: Completed MAED 564; completed/concurrent with SCED 333, SCED 363, MAED 505, and MAED 425. Corequisites: Completed/concurrent with SCED 333, SCED 363. MAED 505. and MAED 425. **Course Learning Outcomes**

- utilize research-based instructional techniques that have been shown to be effective across context, including pairing graphics with words, linking abstract concepts with concrete representations, asking probing questions, repeatedly alternating solved and unsolved problems, distributed practice and assessment to boost retention.
- identify, adapt, or develop lessons using a core set of pedagogical practices that are effective for developing students' meaningful learning of mathematics or computer science which include establishing goals, promoting reasoning and problem solving, connecting mathematical representations, meaningful discourse, purposeful questions, procedural fluency based on conceptual understanding, and productive struggle. While planning lessons program completers will also anticipate and attend to students' prior knowledge, problem solving approaches, mathematical practices, dispositions, mathematical identity, and mathematical communication.
- use formative-assessment techniques (10 or more) to evaluate students' thinking during classroom activities and assess students' progress towards mastery of the learning outcomes in each lesson; reflect on implemented lessons and provide suggestions to improve future implementations to address gaps or needs identified from the formative assessment data, including but not limited to determining appropriate delivery of instruction based on identified student need; and to select appropriate tasks to reinforce and promote students' development of concepts and skills.
- apply evidence-based classroom management techniques (e.g., establishing rules and routines, utilizing praise and rewards, consistently disciplining misbehavior, and engaging students) to

create a positive learning environment (e.g., acceptable learning behaviors and maximizing time on task.).

- create engaging learning environments that are effective for all students by providing access, support, and challenge for every student as well as differentiating instruction to meet the needs of all students.
- identify lessons that are well designed to build students' reading, writing, speaking and listening with science or mathematics classes.
- engage in professional behavior expected of new teachers including o appropriate dress, o attendance and professional commitments, o teacher presence/appropriate boundaries (specifically, can describe the difference between being a student's teacher and being their friend), o respectful collaboration (even if do not agree), o professional initiative, and o student confidentiality related to both academic performance and personal lives.
- learn about their individual school context, policies and practices and through reflection on prior field experiences have an appreciation for different school cultures and understand that these are shaped by the school's teachers, administrators, parents, students and community in which it is situated.
- provide proactive, clear and constructive feedback to families about student progress and develop a library of mechanisms to work collaboratively with the families and significant adults in the lives of their students.

MAED598. SPECIAL TOPICS. 0-6 Semester Hr.

MAED599. INDEPENDENT STUDY. 0.5-6 Semester Hr.

CSED530. COMPUTER SCIENCE PRACTICES AND TECHNOLOGICAL IMPACTS ON SOCIETY. 3.0 Semester Hrs.

Students will explore current industry practices in computer science, the impacts major technological changes have had on society, and importantly, how to explicitly incorporate these topics into your teaching alongside computer science content. They will interact with these topics in the context of software engineering practices and examples and also zooming out to reflect on the future of computer science at a 'meta' level. Students will explore research-based instruction of CS practices and ethics in K-12 through curriculum design and microteaching. Prerequisite: CSCI 128 or CSCI 101/102 or CSCI 200 or CSCI 220. Co-requisite: None.

Course Learning Outcomes

- A. Evaluate the impacts major technological changes have had on society (e.g., internet, mobile phones, AR/VR, AI).
- B. Analyze current effective computer science industry practices.
- C. Students will be able to engage in appropriate computer science practices and, as teachers, support their own students in doing the same.
- D. Students will be able to identify, adapt, and/or develop K-12 lessons to effectively develop students' understanding of computer science practices.
- E. Students will be able to integrate current issues and events related to computer science, and age-/grade-appropriate controversial topics presented from multiple perspectives into lessons using an analytical approach without bias.
- F. Students will be able to select, adapt, and/or develop lessons that explicitly engage students in directly learning about innovative computer science practices aligned with the Colorado Academic Standards.

- G. Students will be able to identify, adapt, and/or develop lessons that reflect the interconnectedness of content areas/disciplines to help erase the disciplinary lines and reflect authentic situations.
- H. Students will be able to clearly articulate their ideas in writing. This involves a. composing short synthesis opinion papers and longer research papers with an awareness about introductions, conclusions and topic sentences; b. incorporating and cite correctly all evidence used to support a text's claim/s.
- I. Students will be able to clearly articulate their ideas verbally. This involves a. delineating effective characteristics of multi-media presentations; b. articulating computer science practices in a way that K-12 students can understand and be motivated to explore these practices; and c. collaborating with others toward giving and receiving feedback on both oral and written work about teaching computer science practices.

CSED535. COMPUTER SCIENCE TEACHING TECHNIQUES. 3.0 Semester Hrs.

Students will investigate, practice teaching, deconstruct and design K-12 CS curriculum, instruction, and assessment by practicing curriculum design and teaching from elementary, middle school, and high school lesson plans. Interactive course activities include K-12 classroom observations and teacher guest speakers. Prerequisite: None. Correquisite: None.

Course Learning Outcomes

- · A. Objective: Students will apply knowledge of computational thinking and programming concepts to the creation of curriculum, appropriate instructional strategies, and related formative and summative assessments. 1. Outcome: Students will demonstrate in writing (e.g., lesson plans, reflections, essays) and in teaching presentations knowledge of: a. Computational thinking and programming concepts, namely: i. problem-solving skills, variables and control structures, abstraction and algorithms, including: 1. code comments, pseudocode, flowcharts and other documentation. 2. testing and debugging; ii. hardware and software systems, including: 1. inputs and outputs; 2. storage and the process of the transformation of data; 3. specific functions and use of hardware; 4. troubleshooting problems; iii. internet and network systems, including: 1. the internet's role as facilitator of the transfer of information; 2. a network as a series of interconnected devices and the internet as a series of interconnected networks; and 3. basic internet safety; iv. how to collect, store, transform, analyze, evaluate and secure data; and v. the impacts of computing, including: 1. the interaction between human and computing systems; 2. the history of computer science; 3. equity and access considerations; 4. laws and ethics associated with the field of computer science and the ramifications of the misuse of technology; and 5. tradeoffs between usability and security in hardware, networks, and the internet.
- B. Objective: Students will apply knowledge of computer science (CS) pedagogical theory and research-based instructional strategies incorporating age-appropriate and cultural and linguistically responsive curriculum and instruction based on national and state CS standards. 2. Outcome: Students will demonstrate in writing (e.g., lesson plans, reflections, essays) and in teaching presentations knowledge of and/or the ability to: a. create and foster an engaging environment in which all students develop the requisite computer science skills to participate more fully in a technologically based collaborative society; b. analyze and evaluate computer science curricula to ensure age- and grade-appropriate content; c. effectively integrate technology into instructional and assessment strategies, as appropriate to computer science

education and the learner; d. perform laboratory-based, hands-on activities, including unplugged activities, block-based programming and third-generation programming language, that demonstrate grade-appropriate programming concepts and proficiency; and e. implement instructional practices and grade-appropriate applications on the interrelationships between the field of computer science and disparate content areas to: i. make concrete and abstract representations; and ii. connect computer science with real-world situations.

- C. Objective: Students will apply content knowledge of CS on a variety of subdisciplines, programming concepts, and interdisciplinary approaches to enact engaging and motivating learning. 3. Outcome: Students will demonstrate in writing (e.g., lesson plans, reflections, essays) and in teaching presentations knowledge of and/or the ability to effectively instruct: a. artificial intelligence; b. computational sciences; c. computer programming; d. cybersecurity; e. data science; f. hardware and network systems; g. machine learning; and h. robotics.
- D. Objective: Students will cultivate K-12 students' CS identities by helping them realize the usefulness of CS by providing connections to students' everyday lives. Build CS self-efficacy by encouraging persistence and demonstrating the belief that every student is capable of learning and expressing their creativity and intelligence with CS. 4. Outcome: Students will demonstrate in writing (e.g., lesson plans, reflections, essays) and in teaching presentations knowledge of specific shifts in general instruction practices required for computer science education and the ability to assist K-12 students: a. develop resilience and perseverance with regard to computer science and computational learning experiences; b. attain a level of comfort with ambiguity and open-ended problems; c. see failure as an opportunity to learn and innovate; d. understand that computational thinking is a fundamental human ability and does not require a computer, and how that understanding can leverage the power of computers to solve a problem; e. recognize that not all problems can be solved computationally; and f. understand the role and importance of cybersecurity.
- E. Objective: Students will collaborate with others towards giving and receiving feedback on both oral and written work about teaching CS as a community of inquiry. 5. Outcome: Students shall demonstrate in writing (e.g., lesson plans, reflections, essays) and in teaching presentations the ability to self-assess and act upon feedback regarding the effectiveness of instruction based on the achievement of students.
- F. Objective: Students will develop an appreciation for teaching as a practice which requires ongoing study. 6. Outcome: Students will demonstrate knowledge about pursuing continuous professional development through appropriate activities, coursework and participation in relevant professional organizations to keep abreast of the ever-changing developments in technology.

CSED564. CAPSTONE CURRICULUM DESIGN I - PRACTICUM. 3.0 Semester Hrs.

This course provides Mines students an intensive teaching experience in a K-12 science, engineering, or STEM classroom. The goal of this course is for the student to develop and demonstrate competencies in the areas of planning, instructional methods, assessments, creating effective learning environments for all learners, classroom management and organization, content knowledge, and professionalism. In addition to a total of 15 hours of seminars (on campus and teacher professional development), there is an approximately 6 hours per week (100-hours total) field experience requirement in the student's assigned partner school. During this semester, the student will be responsible for planning and teaching at least five periods of classroom instruction as well as participate in other school related professional roles and will develop a mini-work sample (min-unit of instruction including: description of setting, learning objectives, three class periods or more of standardsbased lesson plans, pre/post assessment, and reflection). Prerequisite: Completed/concurrent 3 credits of SCED 562; complete/concurrent with CSED 530 or CSED 535. Co-requisite: Completed/concurrent 3 credits of SCED 562; complete/concurrent with CSED 530 or CSED 535. **Course Learning Outcomes**

- reflect on their practice and use this reflection to set goals for further growth.
- write standards-based lesson plans that include measurable learning objectives, applicable Colorado Content Standards, required materials, safety considerations, an outline of the lesson scaffolded with the five E's (engage, explore, explain, elaborate and evaluate) or other learning cycle model, accommodations, formative assessment and subject integration.
- utilize research-based instructional techniques that have been shown to be effective across context, including pairing graphics with words, linking abstract concepts with concrete representations, asking probing questions, repeatedly alternating solved and unsolved problems, distributed practice and assessment to boost retention.
- identify, adapt, or develop lessons using a variety of active learning techniques based on how all students learn science, engineering or STEM, including lessons where students collect and interpret data in order to develop and communicate concepts and understand scientific processes, and identify relationships and natural patterns. Applications of science-specific technology are included in the lessons when appropriate.
- use formative-assessment techniques (10 or more) to evaluate students' thinking during classroom activities and assess students' progress towards mastery of the learning outcomes in each lesson; reflect on implemented lessons and provide suggestions to improve future implementations to address gaps or needs identified from the formative assessment data, including but not limited to determining appropriate delivery of instruction based on identified student need; and to select appropriate tasks to reinforce and promote students' development of concepts and skills.
- apply evidence-based classroom management techniques (e.g., establishing rules and routines, utilizing praise and rewards, consistently disciplining misbehavior, and engaging students) to create a positive learning environment (e.g., acceptable learning behaviors and maximizing time on task.).
- create engaging learning environments that are effective for all students by providing access, support, and challenge for every student as well as differentiating instruction to meet the needs of all students.
- identify lessons that are well designed to build students' reading, writing, speaking and listening with science or mathematics classes.
- engage in professional behavior expected of new teachers including

 appropriate dress, b. attendance and professional commitments,
 c. teacher presence/appropriate boundaries (specifically, can
 describe the difference between being a student's teacher and being
 their friend), d. respectful collaboration (even if do not agree), e.
 professional initiative, and f. student confidentiality related to both
 academic performance and personal lives.
- learn about their individual school context, policies and practices and through reflection on prior field experiences have an appreciation for

different school cultures and understand that these are shaped by the school's teachers, administrators, parents, students and community in which it is situated.

• provide proactive, clear and constructive feedback to families about student progress and develop a library of mechanisms to work collaboratively with the families and significant adults in the lives of their students.

CSED565. CAPSTONE CURRICULUM DESIGN II - STUDENT TEACHING. 6-12 Semester Hr.

This course provides Mines students an immersive student teaching experience in a K-12 science, engineering, or STEM classroom. The goal of this course is for the student to develop and demonstrate competencies in the areas of planning, instructional methods, assessments, creating effective learning environments for all learners, classroom management and organization, content knowledge, and professionalism. In addition to a total of 15 hours of seminars (on campus and teacher professional development), there is a 32-hour per credit hour enrolled field experience requirement in the student's assigned partner school. During this semester, the student will be responsible for planning and teaching at least five periods of classroom instruction for each 3 credit hours enrolled as well as participate in other school related professional roles and will develop a work sample (unit of instruction including: description of setting, learning objectives, three class periods or more of standards-based lesson plans, pre/post assessment, and reflection). Prerequisite: Completed CSED 564; completed/concurrent with SCED 533, SCED 563, CSED 530, and CSED 535. Co-requisite: Completed/concurrent with SCED 533, SCED 563, CSED 530, and CSED 535.

Course Learning Outcomes

- utilize research-based instructional techniques that have been shown to be effective across context, including pairing graphics with words, linking abstract concepts with concrete representations, asking probing questions, repeatedly alternating solved and unsolved problems, distributed practice and assessment to boost retention.
- identify, adapt, or develop lessons using a variety of active learning techniques based on how all students learn science, engineering or STEM, including lessons where students collect and interpret data in order to develop and communicate concepts and understand scientific processes, and identify relationships and natural patterns. Applications of science-specific technology are included in the lessons when appropriate.
- use formative-assessment techniques (10 or more) to evaluate students' thinking during classroom activities and assess students' progress towards mastery of the learning outcomes in each lesson; reflect on implemented lessons and provide suggestions to improve future implementations to address gaps or needs identified from the formative assessment data, including but not limited to determining appropriate delivery of instruction based on identified student need; and to select appropriate tasks to reinforce and promote students' development of concepts and skills.
- apply evidence-based classroom management techniques (e.g., establishing rules and routines, utilizing praise and rewards, consistently disciplining misbehavior, and engaging students) to create a positive learning environment (e.g., acceptable learning behaviors and maximizing time on task.).
- create engaging learning environments that are effective for all students by providing access, support, and challenge for every student as well as differentiating instruction to meet the needs of all students.

- identify lessons that are well designed to build students' reading, writing, speaking and listening with science or mathematics classes.
- engage in professional behavior expected of new teachers including

 appropriate dress, b. attendance and professional commitments,
 c. teacher presence/appropriate boundaries (specifically, can
 describe the difference between being a student's teacher and being
 their friend), d. respectful collaboration (even if do not agree), e.
 professional initiative, and f. student confidentiality related to both
 academic performance and personal lives.
- learn about their individual school context, policies and practices and through reflection on prior field experiences have an appreciation for different school cultures and understand that these are shaped by the school's teachers, administrators, parents, students and community in which it is situated.
- provide proactive, clear and constructive feedback to families about student progress and develop a library of mechanisms to work collaboratively with the families and significant adults in the lives of their students.

CSED598. SPECIAL TOPICS. 0-6 Semester Hr.

(I, II) Pilot course or special topics course. Topics chosen from special interests of instructor(s) and student(s). Usually the course is offered only once. Repeatable for credit under different titles.

CSED599. INDEPENDENT STUDY. 1-6 Semester Hr. CSED599. INDEPENDENT STUDY. 1-6 Semester Hr.