

STEM 4033: Introduction to STEM Education

University of Arkansas College of Education and Health Professions Department of Curriculum and Instruction

Program Affiliation: Career and Technical Education, Technology and Engineering Education concentration & Childhood/Elementary Education, STEM Graduate Certificate

Course Number and Title: STEM 4033: Introduction to STEM Education

Catalog Description: This course provides an introduction to the foundations of STEM education disciplines and the strategies used to deliver integrated STEM education in the elementary and secondary school setting. The nature of STEM education disciplines, STEM pedagogy, teaching strategies, integrated STEM learning, STEM careers, and problem-centered instruction are addressed.

Prerequisites: None

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Suggested Texts: International Technology and Engineering Educators Association (2020). Standards for technological and engineering literacy: The role of technology and engineering in STEM education. <https://www.iteea.org/Publications/stel.aspx>

Larmer, J., Mergendoller, J., & Boss, S. (2015). Setting the Standard for Project Based Learning: A Proven Approach to Rigorous Classroom Instruction. ASCD: Alexandria, VA.
<http://www.ascd.org/Publications/Books/Overview/Setting-the-Standard-for-Project-Based-Learning.aspx>

Relationship to Knowledge Base: This foundational course supports the “Specialty Studies” component of the Scholar-Practitioner model by providing the childhood education teacher education candidate with an in-depth study of project-based STEM education. The course includes an intense overview of the history, science, methods, and theories of integrated STEM education. The course will also provide an in-depth examination of curriculum that has been developed for integrated STEM education as well as the procedures for developing new curriculum.

Goals: This course is designed to provide the candidate with an understanding of integrated STEM education as well as instructional strategies for teaching these subjects in the elementary and middle school classroom.

Competencies: Upon successful completion of this course, candidates will demonstrate knowledge, skills and competencies in the following areas:

1. Develop (through the integration of the class readings, class discussions, personal use of technologies, and personal philosophy of education) a theoretically informed argument for embedding mathematical and scientific thinking strategies across the curricula;
2. Demonstrate a basic knowledge of the national standards in the fields of science, mathematics, and technology education; as well as basic knowledge of the Common Core Standards;
3. Demonstrate the ability to synthesize relevant information regarding the use of STEM thinking in elementary or secondary education;

4. Utilize the vocabulary, primary concepts, definitions, and models applicable to project-based STEM education;
5. Demonstrate an ability to collect, evaluate, synthesize, and share real-world data relevant to curricula in elementary or secondary education;
6. Demonstrate an ability to solve problems, evaluate the efficacy of possible solutions, and discuss strategies and processes needed for effective problem solving;
7. Demonstrate the ability to work in collaborative design teams to meet given criteria and solve design problems;
8. Develop innovative and alternative teaching methods and learning activities that promote STEM education;
9. Apply STEM cognitive tools (i.e., scientific model, design loop, etc.) and resources toward solving human and environmental problems;
10. Demonstrate an ability to use a variety of pedagogical strategies to enhance STEM thinking in elementary or secondary students;
11. Analyze attributes, strengths, and weaknesses of current STEM education programs, initiatives and policies at the local, state, and national levels; and,
12. Demonstrate knowledge of the historical background and development of the fields of science, mathematics, technology education, and engineering.

Course Outline:

1. Background and history of the STEM movement
 - a. What is the role of science, mathematics, technology, and engineering?
 - b. What is the difference between science and technology?
 - c. Why is STEM important?
 - i. The demand for skills
 - ii. National rankings and current trends
 - iii. The elementary gap
 - d. How is STEM different than traditional science and math
 - e. The role of problem solving and design
 - f. Barriers to STEM education
 - g. Strategies for effective STEM education
 - h. Problem-based learning
 - i. Performance-based teaching and learning
2. The power and promise of STEM education
 - a. Active learning and engagement
 - b. The role of the standards
 - c. Understanding by design--backwards design
 - d. STEM and 5E teaching
 - e. The relationship between the standards and engineering
 - f. Delivering the standards through engineering and design
 - g. Using standards to develop curriculum
3. Science as a way of knowing
 - a. Inquiry-based teaching and learning
 - b. How does science work
 - c. Position of science in the modern world
 - d. History and nature of science
 - e. Unifying concepts
 - f. Science, technology, and engineering
4. Mathematics as a way of knowing
 - a. Position of mathematics in the modern world
 - b. Mathematics as a way of knowing
 - c. Mathematical focal points
 - i. Mathematical thinking
 - ii. Mathematical importance
 - iii. Mathematical fit
 - iv. Mathematical connections
5. Technology and engineering
 - a. Foundational concepts
 - b. The engineering design loop

- c. Adhering to design parameters and constraints
 - d. Technological assessment
6. Integrated STEM Education
 - a. Disciplinary, interdisciplinary, and trans-disciplinary strategies
 - b. Questioning/clarifying the problem
 - c. Identifying constraints/limitations
 - d. Gathering research
 - e. Quantifying/mental modeling
 - f. Visioning and graphic representation
 - g. Drawing and modeling (including software usage)
 - h. Prototyping and assessment
 - i. Artifact development
 - j. Communicating the results of engineering/design
 7. Teaching integrated STEM Education
 - a. Teaching with the end in mind
 - b. The role of design and engineering in the classroom
 - c. Curricular assessment procedures, tools, and techniques
 - d. Developing curriculum and activities
 - e. Instructional methods for teaching STEM
 - f. Collaboration strategies and resources

Graduate Certificate in STEM: This course is a part of a STEM concentration in the Childhood Education (CHED) MAT program. This course will be taken as an introduction to STEM education during the senior year of the undergraduate CHED BSE degree prior to entering the CHED MAT--Additionally, the course may be taken as a graduate course by CHED MAT candidates who complete their BSE at other institutions (additional graduate level assignments are included). The course will prepare candidates to implement STEM content and pedagogy in the elementary classroom.

Evaluation: Learning assessments (projects, assignments, etc.) are designed to prepare the student to deliver course related material in the elementary classroom. These assessments will also serve as continuing preparation to teach integrated STEM education as well as serving as a STEM advocate or resource person in the elementary school. Grades for participating students will be calculated based on completion of the following assignments and activities. Please see Blackboard for point values.

1. **Curriculum Development/Presentation and Design Challenges:** Each candidate will develop and present STEM lessons and/or design activities related to integrated STEM education throughout the course.

These projects include:

1. Design Process Assignment
 2. Literature-based Curriculum Design Challenge
 3. Technical Procedural Curriculum Design Challenge
 4. Construction Block Curriculum Design Challenge
 5. Quick Challenge Curriculum Design
 6. Electrical Circuits Curriculum Design Challenge
 7. Paper Engineering Quick Challenges
2. **Weekly Assignments:** Candidates will be required to *participate* in ongoing weekly and in-class readings and discussions, in/out of class lab activities, design and engineering activities, and other assignments.
 3. **Final Project:** Each candidate will develop a final STEM project related to ‘paper engineering’

Grading Scale: A=100-93; B=92-85; C=84-78; D=77-70; F=below 69.

Academic Honesty: As a core part of its mission, the University of Arkansas provides students with the opportunity to further their educational goals through programs of study and research in an environment that promotes freedom of inquiry and academic responsibility. Accomplishing this mission is only possible when intellectual honesty and individual integrity prevail. Each University of Arkansas student/candidate is required to be familiar with and abide by the

University's 'Academic Integrity Policy' which may be found at <http://provost.uark.edu/> Candidates with questions about how these policies apply to a particular course or assignment should immediately contact their instructor.

Attendance Policy: This course is reserved for candidates preparing to become professional teachers. Subsequently, the ethics and responsibilities of professional teachers will be expected of all participants. **Candidates are expected to attend every class** and must attend all classes to receive the maximum benefit and to avoid leaving their professional responsibilities in the hands of classmates. **Candidates are expected to arrive early, stay focused and attentive during the class, and submit all required materials prior to the due date. Late work will not be accepted for full-credit.**

Professionalism: Candidates are required to maintain professional decorum during class. All candidates are to complete their own work during the semester. Although candidates are allowed to share ideas and learn from one another throughout the semester, students are not allowed to copy another person's work. All assignments must be original and completed individually unless working as a team on a given assignment.

Spring 2021: This semester, STEM 4033, will be offered through a face-to-face course format. However, circumstances may need to shift to a remote distance delivery of course content. Content for the course will be posted weekly at <http://www.uastem.com/stem-4033/>. While some asynchronous delivery may be involved, the bulk of content will be delivered synchronously via Zoom during the regularly scheduled class time. Students are expected to be available at the designated class time. This may include interactions (such as small group active learning) among students, who may be face-to-face or remote. The STEM Laboratory (Peabody Hall 317) will be available for students to pick up materials, use specific tools and machines, and receive face-to-face assistance. It is important to remember that only 5 students will be allowed in the STEM lab at one time.

Access to a reliable Internet connection is required for this course. A problem with your Internet access may not be used as an excuse for late, missing, or incomplete coursework. If you experience problems with your Internet connection while working on this course, it is your responsibility to find an alternative Internet access point, such as a public library, hotspot, etc.

- The official mode of communication is through uark.edu email. Students are responsible for checking their UARK accounts regularly. All communication between student and instructor and between student and student should be respectful and professional.
- Your instructor will utilize our Blackboard course as the portal for the submission of assignments and announcements and UARK email for communications. Please check both of these areas immediately for guidance and directions.
- Your class will utilize Zoom to connect as a class during our regularly scheduled class days/times as needed.
- Your instructor will utilize Zoom to connect with students during regularly scheduled office hours and by appointment. Your instructor may also be available to meet with you in the STEM lab.

As remote learners, students must be proactive in their studies, able to balance academic responsibilities with life events, and able to dedicate an appropriate amount of time to a course. The most crucial skills are communication, time management, and staying organized. Please adhere to the following expectations.

- Log in to the course in Blackboard to check for class materials and announcements and check university email for course communications daily.
- Attend scheduled (synchronous) class sessions in Zoom, arriving on time and leaving at the end of the class session.
- Ensure that your environment is conducive to schoolwork and free from distractions.
- Treat each day like a class day - Attend synchronous sessions and complete homework as you would when in an on-campus course.
- While attending class, be prepared to use your video camera
- Make sure you are in a quiet location and mute your microphone when not speaking.
- Dress appropriately for video, and ensure backgrounds are appropriate.
- Limit conversations to those that are appropriate for a classroom setting. Personal chats or conversations not related to the learning environment should be conducted outside of remote course environments.

Syllabus Change: The instructor reserves the right to make changes as necessary to this syllabus. If changes are made, advance notification will be given to the class.