

Utah State Office of Education
Elementary STEM Endorsement Course Framework
STEM Practices with a focus on technology and problem-based learning

Course Description:

The *STEM Practices* course will engage participants in developing meaningful understandings of problem-based approaches to teaching, learning, and the integration of STEM practices across the curriculum using appropriate technology. Participants will demonstrate their skills through the development and creation of a problem-based, hands-on experience.

Course Objectives:

During this course students will:

- Demonstrate the ability to provide access for all students to STEM education including traditionally underrepresented groups that consider students of diverse backgrounds and perspectives.
 - Create a safe learning environment for all students to engage and learn.
- Use student achievement data to design authentic, innovative, problem-based learning experiences.
 - Use formative assessment to inform instruction.
- Implement appropriate assessment and technological tools to enhance STEM teaching, learning, student achievement, and college career readiness.
 - Demonstrate the ability to help learners learn “with” technology vs. “from” technology. STEM endorsed teachers will be confident users and implementers of educational technology tools in the classroom.
 - Design instruction to help students understand that they are both producers and consumers of the technological world.
- Develop and use effective methods for organization and management of a problem-based learning environment to engage students in STEM learning
- Students will demonstrate understanding of engineering design process.

Course Construction Recommendation:

- It is recommended that *STEM Practices* is a culminating class for the STEM endorsement program with an action research project/practicum included.
- The goal of this course is for class participants to integrate learning from content courses and create problem-based learning experiences for the elementary classroom. The course could be organized many ways, but class lessons and activities should lead to the creation of a culminating problem that provides evidence that students have accomplished course objectives.
- One possible method to organize this course might include the following structure:

- Pose a problem that will review and assess students' understanding of STEM practices:
 - asking questions
 - developing and using models
 - planning and carrying out investigation
 - analyzing and interpreting data
 - using mathematics and computational thinking
 - constructing explanations
 - engaging in argument from evidence
 - obtaining, evaluating and communicating information
 - Use class time to practice these skills as needed, based on assessment of student achievement.
 - Ask participants to bring examples of classroom lessons that incorporate STEM practices and technological tools for discussion.
 - Model problem-based learning experiences that incorporate meaningful integration of technologies.
 - Participants select readings or viewings that provide evidence of the effectiveness of problem or problem-based learning that they will present to other class members, using various tools of technology.
 - Participants design and demonstrate the function of a device to send and receive information, base on patterns of 1s and 0s.
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- Another possible resource to consider when organizing the technology aspect of this course could include use of the ISTE Standards found at <https://www.iste.org/standards>.

Course Topics:

- **STEM Practices**
 - Crosscutting concepts
 - Access for all learners
- **Technology**
 - Technology and instrumentation
 - Learning with technology versus from technology
- **Problem-based Learning**
 - Find and evaluate evidence of effective pedagogy
 - Design and implementation of classroom learning experiences
 - Integration of STEM across the curriculum
- Students will demonstrate understanding of engineering design process:
 - 3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
 - 3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based

on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Pedagogy Focus of Course

The purpose of this course is to ensure that practicing teachers can apply the pedagogical content knowledge needed to teach STEM concepts to students in the elementary grades. Course activities will model a variety of instructional strategies that can be used to teach STEM practices in the context of science, math, and engineering content. These practices and tools of technology will be used throughout the course to create a student-centered learning environment in which students investigate, engineer solutions to problems, and construct evidence-based explanations of real-world phenomena.

Knowledge of STEM for course participant:

- Employ prior knowledge of STEM skills, dispositions, beliefs and conceptions, to design and implement instruction around STEM content and practices;
- Apply knowledge of the literature around learning theory and STEM practices to classroom instruction;
- Apply knowledge of diverse learners to design and implement meaningful STEM instruction.

Effective STEM teaching practices:

- Ability to Ask Scientific Questions and Define Problems
- Ability to Plan and Carry Out Investigations
- Ability to Analyze, Interpret Data, and Make Predictions
- Ability to Develop and Use Models
- Ability to Construct Explanations and Design Solutions
- Ability to Engage in Argument from Evidence
- Ability to Use Mathematical and Computational Thinking
- Ability to Obtain, Evaluate and Communicate Information

Knowledge of STEM curriculum and assessment:

- Demonstrate knowledge of common developmental paths related to STEM practices; use understandings of developmental paths and the needs of diverse learners to create a sequence of lessons or activities that will build safe learning environments that are developmentally appropriate and effective.
- Select, use, adapt and evaluate the suitability of teaching materials, including digital and/or analog tools of technology for particular learning goals.
- Demonstrate how to effectively incorporate a formative assessment cycle using a variety of assessment tasks, rubrics, or other tools to inform instruction.

- Provide appropriate interpretations of assessment results, and communicate results (in context) to specific individuals and groups (e.g., students, parents, caregivers, colleagues, administrators, policy makers, community members).
- Show evidence of student-produced products using technology to demonstrate understanding of STEM content and processes.

Possible Assignments:

- Develop and give students a formative assessment (pre-test) to determine student background knowledge in technology and engineering practices.
- Create and implement a lesson that incorporates STEM practices using a variety of activities to differentiate for all learners.
- Use analog or digital technologies to present an engineering concept.
- Develop problem-based learning activities.
- Keep a reflections log that discusses an engineering practice and:
 - an idea from a class
 - a question you may have
 - how you may apply your new understanding in your session classroom.
- Develop a classroom research project about teaching concepts of STEM for your own classroom informed by science, technology, engineering, and mathematics peer-reviewed journals.
- Develop and give students a post assessment and compare classroom results to others in the course. Discuss possible reasons for differences.

Possible Internships or Experiential Learning Recommendations:

- Engage in a field based experience and/or activity to develop understanding of applied science and engineering practices.
- Develop and implement an action research project.
- Develop a complete unit of study that incorporates the elements of the 6 Elementary Science Endorsement courses. This will also include a reflective dialogue.

Suggested Resources:

Baron, Kathy. (2014). *Six Steps for Planning a Successful Project*. Edutopia. <http://www.edutopia.org/stw-maine-project-based-learning-six-steps-planning>

Boss, Suzie. (2014). *Project-Based Learning: A Short History*. Edutopia. <http://www.edutopia.org/project-based-learning-history>.

Boss, Suzie. (2014). *The Hattie Effect: What's Essential for Effective PBL?* Edutopia. <http://www.edutopia.org/blog/hattie-effect-whats-essential-effective-pbl-suzie-boss>

Buck Institute for Education. (n.d.) *PBL Essential Elements Checklist*. http://bie.org/object/document/pbl_essential_elements_checklist

Buck Institute for Education. (2010). *Project Based Learning: Explained*. Youtube Video. <https://www.youtube.com/watch?v=LMCZvGesRz8>

Bybee, Roger. (2011). *Scientific and Engineering Practices in K-12 Classrooms: Understanding A Framework for K-12 Science Education*. NSTA.org. http://nsta.org/pdfs/ngss/resources/201112_Framework-Bybee.pdf

Engineering is Elementary. (n.d.) The EiE Curriculum. <http://www.eie.org/eie-curriculum>

Krauss, Jane & Boss, Suzie. (2013). *Thinking Through Projects: Guiding Deeper Inquiry Through Project-Based Learning*. Corwin Press.

Miller, Andrew. (2014). *Getting Started with Project-Based Learning (Hint: Don't Go Crazy)*. Edutopia. <http://www.edutopia.org/blog/project-based-learning-getting-started-basics-andrew-miller>

Weyers, Matt. (2014). *PBL: Jumping in Headfirst*. Edutopia. <http://www.edutopia.org/blog/pbl-pilot-jumping-in-headfirst-matt-weyers-jen-dole>