George Mason University
College of Education and Human Development
Elementary Education
ELED 421 Section 002 – STEM in the Elementary Classroom (3 credits)

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Prerequisites: Admission to Elementary Education program

COURSE DESCRIPTION

A. Recommended Prerequisites/Corequisites

Admission to the Elementary Education program and successful completion of both Science Methods for the Elementary Classroom (ELED 453); Elementary Mathematics Methods (ELED 452) and/or recommendation of the STEM faculty.

B. University Catalog Course Descriptions

Develops skills and abilities in integrated STEM teaching at the elementary level, applications of math, science and technology through engineering design, safety practices, and creation of integrated curricula. Examines STEM teaching based on contemporary theory, practice, and standards.

Notes: Requires field experience in public schools.

C. Expanded Course Description

The primary goal of this course is to provide you with practical experience, theoretical background, and pedagogical skills that will allow you to be successful in your future career. The elementary classroom offers particular challenges in terms of the amount of content expectations placed on both teachers and students. Integrated STEM teaching provides a valuable way to make elementary teaching more efficient in terms of engaging children in multiple content and process standards that are couched in real-world challenges.

The NGSS call for "**three-dimensional learning**" in order to bring these real world challenges to life in the classroom. These dimensions are built on the **three** pillars that support each standard including Science and Engineering Practices, Crosscutting Concepts, and Disciplinary Core Ideas. These are also directly related to both content and process standards that comprise the NCTM standards. In particular, this STEM course will lean heavily on the following content standards: Number & Operations, Measurement, Data Analysis & Probability. The five NCTM process standards also directly relate to the scientific processes and engineering design practices: Problem solving, Reasoning & Proof, Communication, Connections and Representation. These

principles lean heavily on engineering design and the incorporation of technology for both the design process and the collection of meaningful data to support claims with evidence.

These STEM standards and practices will drive the class experiences with the following key goals that will be carried out through the duration of the course: 1) to facilitate the development of pedagogical approaches to inquiry-based, integrated STEM practice, and 2) to develop confidence and understanding for interrelated STEM content. With respect to content, the course will develop STEM background knowledge with the goal of successful teaching in an elementary context, meaning that you will need to have a solid understanding of large-scale STEM topics and the interrelationships between those content areas beyond what is expected of elementary children.

Most children come to school with a keen interest in the world around them, but often by the end of elementary school only a small percentage of students have retained this interest in STEM content. This is generally attributed to the ways in which "school" contexts often ignore the beauty, complexity and joy that can come from engaging with content and connecting STEM content understanding to the everyday experiences of children. Consequently, we will conceptualize STEM engagement as an active process where we are consider our wonders, build new knowledge and discover as opposed to the memorization of 'facts.' For this reason, we will utilize constructivist/problem-based approaches to learning in an effort to scaffold STEM content that is too often presented as an exercise in the acquisition of vocabulary.

This course will provide opportunities for students to enjoy and embrace the ideas that make us wonder about the world and our role within it. In many respects, STEM can be intimidating to learn in the ways it is presented in schools, media and the general public. Our goal is to unpack those social constructions of STEM practices to see it in a more realistic light. This class experience is merely a first step in your evolution toward becoming the kind of educator you wish to be. Lastly, you will be required to bring your curiosity to class for each session. Please make sure to nurture and feed it as we move through our work together.

LEARNER OUTCOMES

This course will enable students to:

A. Build pedagogical content knowledge base in STEM inquiry-based investigation
B. Conceptualize core principles regarding Engineering design, problem solving, evidence, explanation, inquiry, creativity and experimentation all help to frame STEM thinking
C. Develop lesson plans demonstrating inquiry-based principles in integrated STEM
D. Demonstrate age-appropriate safety standards when designing hands-on classroom experiences
E. Examine STEM standards, curricula and methods at local, state, and national levels
F. Develop viable assessment tools for STEM learning

KEY PROFESSIONAL STANDARDS ADDRESSED FOR PBA ASSESSMENTS

INTASC: Interstate Teacher Assessment and Support Consortium, Model Core Teaching Standards

#4. Content Knowledge. The teacher understands the central concepts, tools of inquiry, and structures of the discipline(s) he or she teaches and creates learning experiences that make the discipline accessible and meaningful for learners to assure mastery of the content.

#5. Application of Content. The teacher understands how to connect concepts and use differing perspectives to engage learners in critical thinking, creativity, and collaborative problem solving related to authentic local and global issues.

#6. Assessment. The teacher understands and uses multiple methods of assessment to engage learners in their own growth, to monitor learner progress, and to guide the teacher's and learner's decision making.

#7. Planning for Instruction. The teacher plans instruction that supports every student in meeting rigorous learning goals by drawing upon knowledge of content areas, curriculum, cross-disciplinary skills, and pedagogy, as well as knowledge of learners and the community context.

#8. Instructional Strategies. The teacher understands and uses a variety of instructional strategies to encourage learners to develop deep understanding of content areas and their connections, and to build skills to apply knowledge in meaningful ways.

Technology (ISTE NETS): International Society for Technology in Education / National Educational Technology Standards

Standard I. Teachers use their knowledge of subject matter, teaching and learning, and technology to facilitate experiences that advance student learning, creativity, and innovation in both face-to-face and virtual environments.

COURSE DELIVERY

Face to face, field-based, with some on-line sessions

REQUIRED TEXTS & READINGS

Readings will be required weekly and be posted on blackboard prior to the beginning of class.

Optional Texts:

Inquire with course professor, if you are interested in finding titles with further ideas for teaching elementary STEM.

COURSE ASSIGNMENTS AND EXAMINATIONS

1. Attendance and Participation 10%

It is expected that you attend all scheduled classes and asynchronous online meetings outlined within the syllabus. Absence from class to observe a religious holiday, to serve jury duty, or to participate in required military service, and medical emergencies are exceptions to the above policy. If you anticipate being absent for any of these reasons, please make arrangements in advance. This is a time intensive course and missing time will most certainly impact your ability to meet the goals of the course. In addition, this class operates with the assumption that *knowledge is socially constructed* and the most

meaningful learning opportunities are those where you have the opportunity to offer and explore diverse perspectives with peers; therefore, you are expected to contribute to both class and online discussions and activities as well as genuinely listen to peers as they do the same. In addition, you should be prepared for each class, which means having completed all assigned readings and tasks for that class. This includes engagement with and construction of a class journal to be used for all notes, questions and class activities.

2. STEM Wonders Journal 10%

Think about the STEM that you see in the everyday. Ask yourself questions, feel the movements and forces while you drive, look at the sky, watch your pet, engage with another human, think about your place in this world, go for a long walk and just think...no phone, no worries, just get lost in your thoughts. Remember this is homework so you have an excuse. Over the course of the semester…use a composition book/journal to make note of various things that you observe in the natural world around you and list, sketch, question, observe and record those things that capture your attention and imagination. These wonderings about the natural world are just that…what do you see, feel and think about those things that fascinate and frustrate you to think about. We will intentionally slow down and use old technology (paper and pencil) to engage with our wonders. Your wonders are yours and unique to how you envision the world around you. "Dance like nobody is watching" while you build your entries.

3. Longitudinal Reading Logs 10%

a. You will analyze each reading in terms of the reading and its connection to your school site and your unit. Record these responses in your longitudinal reading log for each reading. Use the template provided in Bb. Your reflection should…

1. be completed before the class period begins.
2. be brief, yet thoughtful, and demonstrate genuine consideration of the text
3. be accessible during <u>each</u> class session.

These will help in the construction and support of both your science unit and differentiation plan.

4. Inquiry-Based Unit Project 40%

The goal of this project is construct and teach (at least a portion of) an integrated STEM inquiry unit within your field site. This project will feature integrated content surrounding the four content areas involved in the course. We will design this work around the 5 E model of lesson planning. The unit will entail building a detailed and well-supported narrative description for the approach that will be employed. The lesson sequence will build STEM content understanding in engaging and dynamic ways for students within your field site and provide some key theoretical and research-based support for the content, approach and activities constructed. The unit will be scored via the rubric provided later in the syllabus as part of the PBA for STEM. Templates and approaches will be provided during the course.

5. STEM/STEAM Investigation 15%

This project is designed to evoke and engage future teachers in the possibilities that STEM/STEAM content holds for elementary contexts as well as for yourselves. Prior science and math experiences often generate negative feelings associated with

memorization and mind-numbing procedural approaches, which is not the norm in contexts that study these problems. The goal of this project is to pursue an idea that **you** find interesting. You will choose a STEM/STEAM topic from your wonder journal (or a new and different wonder) and pursue some answers, ideas and most importantly further questions related to that wonder. The goal is not necessarily to prove something, but to understand something to a greater degree and then consider all the new questions that come along with that wondering and investigating.
The project will entail the following:
- a public presentation (preferably a poster, museum display or other visual of some sort) that will highlight:
a) the wonder itself
b) the information identified to make more sense of that wonder (diagrams, sketches, etc.)
c) list key STEM/STEAM concepts behind that content (definitions, models, etc.); this will also include: Science and Engineering Practices, Crosscutting Concepts, and Disciplinary Core Ideas described by NGSS.
d) list further questions related to that wonder,
e) provide a few ways you might consider using wonder in a classroom context

6. **STEM Standards and processes synthesis paper** **15%**
This assignment is designed to project your vision of STEM as you interpret standards, curricula and the readings to build your vision for STEM. In 1,000 – 1,250 words build your understanding for the elementary STEM field including: theoretical positioning, challenges and opportunities, meaningful approaches and other key aspects of enacting STEM.

GRADING POLICIES:

Grade	GRADING	Grade Points	Interpretation
A	95-100	4.00	Represents mastery of the subject through effort beyond basic requirements
A-	90-94	3.67	
B+	87-89	3.33	Reflects an understanding of and the ability to apply theories and principles at a basic level
B	83-86	3.00	
B-	80-82	2.67	
C*	70-79	2.00	Denotes an unacceptable level of understanding and application of the basic elements of the course
D	60-69	1.00	
F*	<69	0.00	

**Note: A course grade less than a B- requires that you retake the course.*

WORK TIMELINESS EXPECTATIONS:

It is expected that all class assignments will be submitted on time to the correct location; therefore, **late assignments will not receive full credit**. Assignments turned in late will receive an automatic deduction of one letter grade making the highest possible score equivalent to 80% (B).

All assignments must be submitted bythe beginning of class (Eastern standard time) on the due date stated within the syllabus (see below) and should only be submitted via **Blackboard**.

If you are unable to complete an assignment due to an emergency or difficult circumstance, communication must be made with the instructor via email or in person. In situations that are deemed an emergency or a difficult circumstance, I will work with you to set a new submission date that will not be considered late.

OTHER EXPECTATIONS

All written papers are **expected to be double-spaced, with 1" margins, and in 12-point font** (Times New Roman, Calibri, or Arial). **APA format is expected**. If you do not have a 7th Edition APA manual, the OWL at Purdue is an excellent resource: https://owl.purdue.edu/owl/research_and_citation/apa_style/apa_style_introduction.html

***Please Note:** The GMU Writing Center offers online support via email. They will provide feedback on your writing within one hour. Graduate and professional writing can be difficult; I encourage you to take advantage of this service. http://writingcenter.gmu.edu/?page_id=177

Professional Dispositions
Students are expected to exhibit professional behaviors and dispositions at all times.

Core Values Commitment
The College of Education and Human Development is committed to collaboration, ethical leadership, innovation, research-based practice, and social justice. Students are expected to adhere to these principles: http://cehd.gmu.edu/values/.

GMU Policies and Resources for Students

Policies

- Students must adhere to the guidelines of the Mason Honor Code (see https://catalog.gmu.edu/policies/honor-code-system/).
- Students must follow the university policy for Responsible Use of Computing (see http://universitypolicy.gmu.edu/policies/responsible-use-of-computing/).
- Students are responsible for the content of university communications sent to their Mason email account and are required to activate their account and check it regularly. All communication from the university, college, school, and program will be sent to students **solely** through their Mason email account.
- Students with disabilities who seek accommodations in a course must be registered with George Mason University Disability Services. Approved accommodations will begin at the time the written letter from Disability Services is received by the instructor (see https://ds.gmu.edu/).

- Students must silence all sound emitting devices during class unless otherwise authorized by the instructor.

Campus Resources

- Support for submission of assignments to Tk20 should be directed to tk20help@gmu.edu or https://cehd.gmu.edu/aero/tk20. Questions or concerns regarding use of Blackboard should be directed to http://coursessupport.gmu.edu/.

- For information on student support resources on campus, see https://ctfe.gmu.edu/teaching/student-support-resources-on-campus

For additional information on the College of Education and Human Development, Graduate School of Education, please visit our website [See **http://gse.gmu.edu/**]

Emergency Procedures
You are encouraged to sign up for emergency alerts by visiting the website https://alert.gmu.edu. There are emergency posters in each classroom explaining what to do in the event of crises. Further information about emergency procedures exists on http://gmu.edu/service/cert

- Please *see safe return to campus PDF on class blackboard site*

ASSESSMENT RUBRICS:

STEM Unit Rubric (40% of total grade)
Assessment Summary: The project is meant to facilitate your understanding for the design and teaching of an inquiry-based science unit. This will require research into both inquiry-based lesson planning and science content. The goal is bring powerful learning theory to life in classrooms and design science experiences that both excite and engage elementary children.

Description and standard addressed	**Exceeds Expectations – 4**	**Meets Expectations – 3**	**Does Not Meet Expectations – 2**	**Does Not Meet Expectations – 1**
A. Overview (Background; content and context description) INTASC: #4, 5, 7; (5 pts)	Give excellent insight into key content ideas, provides powerful description of unit goals. Excellent listing and engagement for the content background teachers would need to know to carry out lesson goals. Excellent description of school and students that the unit is designed.	Give insight into the content and include several key content ideas. Lists and engages the content background teachers would need to know to carry out lesson goals. Provides a solid description for the school and students that the unit is designed.	Does not provide insight into the content and include several key content ideas. Does not completely provide the content background for teachers. Does not provide a detailed description of the school and students.	Missing

B. Curriculum Design and Assessment discussion (Theoretical background) (10 pts) INTASC: #8, 6	Utilizes inquiry-based lesson model (5E's), clearly describes pedagogical process that embodies inquiry. Uses a myriad of excellent and well-respected sources properly referenced within narrative descriptions. Describes diagnostic, formative and summative approaches throughout the unit.	Utilizes inquiry-based lesson model (5E's), clearly describes pedagogical process that embodies inquiry. uses dependable sources that properly referenced within narrative descriptions. Describes diagnostic, formative and summative approaches throughout the unit.	Does not provide complete descriptions or theoretical background; and/or is not self-explanatory. Does not utilize reputable sources within narrative descriptions and/or more needed clarity within narrative. Does not include all three types of assessment.	Missing
C. Detailed Lesson plans (Lesson Framework, pedagogical process & procedure) INTASC: #5, 7, 8 (12 pts)	Standards, objectives and lesson activities all seamlessly align and support one another. Utilizes inquiry-based lesson model (5E's), clearly describes pedagogical process that embodies inquiry. Clearly described, highly usable and innovative ideas with original elements; addresses issues of safety	There exists alignment between standards, objectives and they support lesson approach. Utilizes inquiry-based lesson model (5E's), clearly describes pedagogical process that embodies inquiry. Effectively describes, usable and effective ideas; addresses issues of safety	Standards, objectives and activities not clearly aligned or appropriate for the lesson. Difficult to use; does not have complete components; and/or is not self-explanatory. Does not address safety.	No consistent format nor serious professional commitment to student needs.
D. Assessment INTASC: #6 (5 pts)	Innovative, well-supported assessment strategies clearly linked to objectives; demonstrates all stated objectives, copies of assessments included. Includes diagnostic, formative and summative approaches throughout the unit.	Assessment clearly linked to objectives; demonstrates nearly all stated objectives, copies of written assessments are attached. Includes diagnostic, formative and summative approaches throughout the unit.	Assessment is not clearly linked to objectives; demonstrates some stated objectives, and/or copies of written assessments are not attached. Does not provide differing types of assessment strategies.	Missing
E. Support materials INTASC: #4, 5, 8 (5 pts)	Innovative materials used throughout that incorporates engaging, developmentally appropriate and scientifically accurate approaches; multiple connections are made to students' everyday lives and accessible.	Some innovative materials used throughout that incorporates engaging, developmentally appropriate and scientifically accurate approaches. These approaches make attempts to connect to students' everyday lives.	Lacks innovation and does not include activities that support inquiry. Activities might contain some scientific inconsistencies; little effort to connect to students everyday lives.	Missing

F. References cited. (3 pts)	Uses well-respected sources properly referenced with no errors.	Uses well-respected sources properly referenced, but with a few small errors.	Mistakes in formatting and does not utilize well-respected reference materials.	Missing

Tentative Schedule:

Session	Topic/Learning Experiences	Readings & Assignments
Week 1 8/23	Course design • What is STEM? Convergence of Math, Science and Engineering. What about the Arts?	What is STEM? Why is STEM Important? The Impact of STEM On Society. Respond after reading in the discussion board.
Week 2 8/30	• Internship contexts… • What do you wonder about? • STEM road map for elementary	--Begin STEM wonder journal STEM VS STEAM? **Read the article: What's The Difference Between STEM & STEAM** Write what you think the difference is in the discussion board.
Week 3 9/13	• Making sense of Math •	--Readings: **Building STEM Education On A Strong Mathematical Foundation.**
Week 4 9/20	5E process – video highlighting process How might we best teach children inquiry? • Virginia SOL's, NCTM and NGSS • Physical Science – Aluminum foil boats	**Watch the 5 E Model with Hot Wheels:** https://www.youtube.com/watch?v=W_xZrRWwe_g https://www.youtube.com/watch?v=v7-C_5rBh1Q
Week 5 9/27	• Unit construction…**bring unit topic to class** • Lesson planning and sequencing • Writing learning objectives, planning for inquiry	

	• Designing a Monument	
Week 6 10/4	• The role of wonder in inquiry and STEM • Discussion on unit progress • Integrated approaches to STEM • Designing balloon racers	**Bring whatever materials you think you will need to build the balloon racers.** **https://www.youtube.com/watch?v=0m-sJBCTj0A**
Week 7 10/12 (class meets on Tuesday)	• Harnessing Solar energy and building solar fountain • Designing solar oven	
Week 8 10/18	• Meet with peer partner…planning and revisions • Meet individually with Mary Ann Settlemyre or STEPH DEAN for feedback	Work on units… **Bring hard copy draft of unit to class.**
Week 9 10/25	• Noticing and documenting the natural world **Details for sketch assignment**	**Final units due on Blackboard before class.**
Week 10 11/1	• Notions of scale • Animal adaptations	**Complete Reading**
Week 11 11/8	Making sense of our units in terms of the three pillars of NGSS (Next Generation Science Standards) – Disciplinary core ideas, interconnected, cross-cutting concepts	**Complete Reading**
Week 12 11/15	Discussing wonder project ideas…bring idea for final to class • Swing Set makeover • Conceptualizing wonder projects; discussion of wonders	**Complete Reading**
Week 13 11/22	• Fossils - Earth Science/Biology	**Wonder Journals due**

	• Patterns – Plant world	
Week 14 11/29	• Investigations into Environmental changes • Presentations of STEM/STEAM wonder projects	**--Wonder Investigation project due**