George Mason University
College of Education and Human Development
PhD in Education Program
Science Education Research Specialization

EDUC 860 (001) - STEM Education Research and Policy
3 Credits, Spring 2018
Mondays, 4:30-7:10 pm, Peterson Hall, Room 1111, Fairfax Campus

Faculty

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Prerequisites/Corequisites

Concurrent enrollment in EDRS 810 or successful completion of EDRS 810.

University Catalog Course Description

Examines research on science, technology, engineering and mathematics (STEM) education issues and education policy issues including the rationale for STEM education, STEM education policy, models of STEM schools in K-12 education, STEM education leadership, informal STEM education, STEM curriculum and instruction, and research in STEM education.

Course Overview

This doctoral level course examines the body of research across many facets of STEM education to provide students with a well-rounded and informed perspective on STEM education. The course begins with broad issues in STEM education such as national and state policy on STEM education and moves to specific issues in STEM education such as models of schools, curriculum and instruction, leadership in STEM education, learning STEM in an informal setting, and indicators of success in STEM education. Students will complete a capstone research proposal at the end of the class that focuses on a STEM education issue that will add to the current body of knowledge.

Course Delivery Method

Each face-to-face class will include a variety of activities and exercises. The course has scheduled a number of guest speakers who are leaders in the field, so that students gain a broad understanding of the emerging and relatively new field of STEM education research. Some of the sessions will be

conducted through use of the course Blackboard site (http://mymasonportal.gmu.edu/) by providing questions and online interactions. Web-based resources will also be collected by means of the Blackboard class site.

Classes will reflect a balance of activities that encourage the exploration of the use of educational research in science teaching and learning. To promote an atmosphere that allows us to accomplish this, we will:

a. Agree to disagree respectfully during class discussions;
b. Backup claims with evidence;
c. Strive to be open to new ideas and perspectives; and
d. Listen actively to one another.

Students are expected to:

a. Write papers that are well researched, proofed, submitted in a timely fashion, and that conform to APA guidelines;
b. Participate actively in class discussions in a manner that challenges the best thinking of the class;
c. Provide constructive feedback to others both on their ideas and on their written work, striving to learn from each other and to test each other's ideas.

We will endeavor to create a classroom climate that approximates what we know about communities of practice. As such, it is important that we create a space that allows participants to try out new ideas and voice opinions without fear of ridicule or embarrassment. The hallmark of a community of practice is a balance between openness and constructive feedback; hence, everyone is expected to:

a. Come fully prepared to each class;
b. Demonstrate appropriate respect for one another;
c. Voice concerns and opinions about class process openly;
d. Recognize and celebrate each other's ideas and accomplishment;
e. Show an awareness of each other's needs.

Learner Outcomes or Objectives

This course is designed to enable students to do the following:

1. Articulate a position regarding the purpose of STEM education
2. Define several models of integrated STEM education
3. Create a vision for a STEM high school and a STEM-focused elementary school based on research-generated components of STEM schools
4. Locate and synthesize research on the National Science Foundation STEM Indicators
5. Develop a research proposal designed to potentially expand on the current research literature in STEM education

Professional Standards National Science Teachers' Association

Upon completion of this course, students will have met the following professional standards:
Standard 2: Nature of Science
Standard 3: Inquiry
Standard 4: Issues
Standard 6: Curriculum
Standard 7: Science in the community
Standard 10: Professional growth

Required Texts

Bybee, R. W. (2011). *The case for STEM education.* Arlington, VA: NSTA press.

Johnson, C. C., Peters-Burton E. E. & Moore, T. J. (Eds.). (2015). *STEM road map: A framework for integrated STEM education.* New York: Routledge.

Other required articles will be available on Blackboard.

Course Performance Evaluation

Students are expected to submit all assignments on time in the manner outlined by the instructor (e.g., Blackboard, Tk20, hard copy).

- **Assignments and/or Examinations**
  Rationale for or Critique of STEM education. (10%) Students will write a one-page paper explaining their rationale for or critique on STEM education using research to back up their claims. A rubric for this assignment is found on blackboard. The paper should include the following:
    - A clear definition of STEM education (as there are many, students will need to choose one and defend their choice)
    - A clear vision of the need for STEM education outcomes or critique on STEM education
    - Next steps that should be attempted to enact this vision

  Building a STEM high school. (20%) Students will form groups and create a blueprint for a STEM high school (selective, inclusive or CTE) that addresses the critical components found in the research on STEM high schools. Students will be able to express their design for a STEM high school in a manner of their choice, as long as it reflects and communicates the research that supports their decisions. Students will also present their models to the class for peer review. A rubric for this assignment is found on blackboard.

  The critical components to be addressed are:
  1. College-Prep, STEM Focused Curriculum for All
  2. Reform Instructional Strategies and Project-Based Learning
  3. Integrated, Innovative Technology Use

4. STEM-rich, Informal Experiences
5. Connections with Business, Industry, and the World of Work
6. College Level Coursework
7. Well-Prepared STEM Teachers and Professionalized Teaching Staff
8. Inclusive STEM Mission
9. Flexible and Autonomous Administration
10. Supports for Underrepresented Students
11. Dynamic Assessment Systems for Continuous Improvement
12. Innovative and Responsive Leadership
13. Positive School Community and Culture of High Expectations for All
14. Agency and Choice

Building a STEM-focused elementary school. (20%) Students will form groups and create a blueprint for a STEM-focused elementary school that addresses the critical components found in the research on effective elementary schools and STEM schools. Students will be able to express their design for a STEM-focused elementary school in a manner of their choice, as long as it reflects and communicates the research that supports their decisions. Students will also present their models to the class for peer review. A rubric for this assignment is found on blackboard.
The critical components to be addressed are:

Learning Opportunities
1. STEM is integrated throughout school curricula
2. School schedule includes more than required minutes of science instruction
3. School programs are coherent and supportive of STEM
4. Instructional approaches include project-based learning and other reform strategies
5. Teaching & learning emphasize inquiry or design thinking
6. Students learn and use workplace and life skills
7. Students experience autonomy in learning
8. Teachers facilitate student interest in STEM
9. Out-of-school programs and resources provide STEM-rich experiences
10. Students participate in service learning or other community activities

School Staff
11. Teachers are supported in STEM through collaboration, training, and resources
12. Teachers are open to innovation and continual learning
13. School leadership is inclusive and focused on instruction

Assessment
14. Dynamic assessment systems inform instruction

Technology
15. Technology is integrated into activities of both students and teachers

Families and Community
16. School establishes and maintains a community presence

17. Parents are included in classrooms and the school
18. School population represents district or local community

School Culture

19. Trust and respect are shared among staff and students
20. School builds college awareness, college-going culture, and career awareness

NSF STEM indicators project. (10%) Students will find NSF grant abstracts awarded for the work on the STEM Indicators and locate research by the PIs and co-PIs that addresses the questions asked on the STEM Indicator project. Students will each be assigned a few of the 14 indicators (depending on the enrollment of the class), will compose an annotated bibliography of the PIs and co-PIs work, and will present their findings in order to help all members of the class understand the current research on the STEM indicators. A rubric for this assignment is found at on blackboard.

Research proposal on STEM education. (30%) Students will develop a problem statement, background literature, conceptual framework, research question(s), research design, methods, and proposed analysis on a topic in STEM education. Students are expected to have at least 15 citations to back up their project. Students will also create a poster for their project and the class will peer review the posters in a gallery walk. A rubric for this assignment is found at the end of the syllabus.

- **Other Requirements**

  Class participation. (10%) Learning depends on the active engagement of the participant and frequent checking by the instructor as to the progress of the learner. Smaller assignments will be given as necessary in class in order to inform your learning and my teaching. Your participation in these assignments is essential to valuable class discussions and will help to "chunk" the large assignments into smaller, more attainable learning goal. Your classmates depend on your comments to extend their learning. Attendance for each class is necessary – please contact the professor BEFORE any absence. A rubric class participation is found on blackboard.

- **Grading**

  Course Performance Evaluation Weighting

Rationale for STEM education	10%
Building a STEM high school	20%
Building a STEM-focused elementary school	20%
NSF STEM indicators project	10%
Research proposal on STEM education	30%
Class participation	10%

Grading Policies
A = 93-100%
A- = 90-92%
B+ = 88-89%
B = 80-87%
C = 70-79%
F = Below 70%

Professional Dispositions

See https://cehd.gmu.edu/students/polices-procedures/

Class Schedule

Class meeting	Topic	Reading due	Homework due
Jan 22	Defining STEM education	*The case for STEM education* Chapters 1-5	
Jan 29	The need for STEM and critiques on STEM	*STEM Road Map* Chapters 1-3 Weis et al. (2015). In the guise of STEM education reform. *American Education Research Journal*, *52*(6), 1024-1059. Shaugnessy, J. M., *STEM: An advocacy position, not a content area.* NCTM online.	
Feb 5	STEM policy Emphasizing T, E, M	*The case for STEM education* Chapters 6-10 National Research Council 2011 *Successful STEM Education* *ITEA: Standards for Technology Literacy* Pages 1-89 *Engineering in K-12 Education* National Academies Press Pages 1-48 Hefty, L. J. *STEM gives meaning to mathematics.* NCTM.	Draft rationale/critique for STEM education

Feb 12	STEM learning outcomes **(Guest speaker – Dr. Vanessa Peters, Digital Promise)**	*STEM Road Map* Chapters 4-8 Means, B., Wang, H., Young, V., Peters, V., & Lynch, S.J. (2016). STEM-Focused High Schools as a Strategy for Enhancing Readiness for Postsecondary STEM Programs, *Journal of Research in Science Teaching, 53*, 709-736.	
Feb 19 ONLINE CLASS	Models of STEM high schools	Peters-Burton, E. E., Behrend, T., Lynch, S. J. & Means, B. (2014). Inclusive STEM high school design: 10 critical components. *Theory into Practice, 53*, 1-8. PUT IN JRST Article here Assigned case study of high school on https://ospri.research.gwu.edu/	Final rational for STEM education
Feb 26th	Models of STEM high schools	Peters-Burton, E. E., Kaminsky, S., Lynch, S. J., Behrend, T. Han, E., Ross, K., & House, A. (2014). Wayne School of Engineering: Case study of a rural inclusive STEM-focused high school. *School Science and Mathematics, 114*(6), 280 – 290. Assigned case study of high school on https://ospri.research.gwu.edu/	
March 5th	Present STEM high schools		STEM high school model
March 12th – Spring Break			
March 19th	Models of STEM-focused elementary schools **(Guest speaker – Dr. Ann House, SRI International)**	Firestone, W. A., & Herriott, R. E. (1982). Prescriptions for effective elementary schools don't fit secondary schools. *Educational Leadership, 40*(3), 51–53 Maltese, A. V., & Tai, R. H. (2010). Eyeballs in the fridge: Sources of early interest in science,	Research question for proposal

		International Journal of Science Education, 32(5), 669–685. Tai, R. H., Liu, C. Q., Maltese, A.V., & Fan, X. (2006). Planning early for careers in science. *Science, 312* (5777), 1143–1144. Walter Bracken STEAM Academy Blueprint	
March 26th	Present STEM-focused elementary schools		STEM-focused elementary school model
April 2	STEM school leadership **(Guest Speaker – Dr. Mike Ford, GWU)**	Spillane, N.K., Lynch, S.J., & Ford, M. R. (2016). Distributing leadership in Inclusive STEM High Schools: A Way to increase opportunities for underrepresented students. *Kappan, 97(*8), 54-59. Lynch, S. J., Peters-Burton, E. E., & Ford, M. R. (2014). Building STEM opportunities for all. *Educational Leadership, 72*(4), 54-60.	
April 9	Informal STEM learning	National Research Council. (2009). *Learning Science in Informal Environments: People, Places, and Pursuits*.	Draft of Research Proposal
April 16	NSF STEM Indicators **(Guest speaker – Dr. Jessica Mislevy, SRI International)**	National Research Council (2015). *Monitoring Progress Toward Successful K-12 STEM Education: A Nation Advancing?*	
April 23	Final consultation on Research Proposals		Final Draft of Research Proposals
April 30	Sharing STEM Indicators research		Annotated bibliography on selected STEM Indicator research
May 7	Reading day – no class		Final Research Proposal
May 14	Poster presentations		Poster Presentation

Note: Faculty reserves the right to alter the schedule as necessary, with notification to students.

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 http://ods.gmu.edu/).
- Students must follow the university policy stating that all sound emitting devices shall be silenced 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, please visit our website https://cehd.gmu.edu/students/ .

Rubric for Research Proposal and Poster Presentation				
Criteria	**Outstanding (4)**	**Competent (3)**	**Minimal (2)**	**Unsatisfactory (1)**
Introduction • Description of the nature and importance of the problem • Justification for the need of the study is provided based on the literature, societal value, or other relevant sources • Research problem is well-formulated within the conceptual framework of the study • Purpose of research and research questions/hypotheses clearly stated	Introduction fully addresses all 4 criteria. The conceptual framework/theoretical basis for the study are aligned with the research problem. The research questions/hypotheses are well aligned with the research problem. The study addresses an important issue in the field.	Introduction addresses all 4 criteria. The conceptual framework/theoretical basis for the study are aligned with the research problem. The research questions/hypotheses are well aligned with the research problem.	Introduction does not address all 4 criteria. The conceptual framework/theoretical basis for the study are not adequately related to the research problem. The research questions/hypotheses are not well aligned with the research problem.	Introduction does not address the criteria. The conceptual framework/theoretical basis for the study are not provided. The research questions/hypotheses are not articulated.
Methods • Description of data sources and data collection for the study • Description of research design for addressing research questions/ problems/hypotheses	Methods fully address the data sources, data collection procedures, and research design. Data sources and research design are appropriate and thoroughly described. Selection and justification of methods	Methods address the data sources, data collection procedures, and research design. There are methodological concerns with data sources, research design, or procedures OR methods are appropriate, yet not fully described. The	Methods do not address all criteria. Data sources, research design, and/or data collection are not fully appropriate.	Methods do not address the criteria. Data sources, research design, and data collection are not appropriate.

	reflects contemporary educational research methodology. The research methods are well aligned and address the research problem and related questions.	research methods are aligned and address the research problem and related questions.		
Data Analysis and Expected Results • Description of data analysis procedures for the study • Description of expected results/findings	Planned data analysis is appropriate, complete, and accurately described. Expected results/findings are discussed	Planned data analyses are appropriate but are not complete or accurately described. Expected results/findings are discussed	Data analyses are not fully appropriate or are incomplete. Expected results/findings are not included	Data analyses and expected results are not addressed.
Limitations and Educational Implications • Identify limitations • Discuss implications of proposed work	Limitations and validity issues are thoughtfully addressed. Implications and directions for future research stem from the findings are well justified and explained.	Limitations and validity issues are addressed. Implications and directions for future research are provided. Some critical limitations or implications were not addressed.	Significant weaknesses in the discussion of limitations and educational implications. Few were identified and/or were inappropriate.	Limitations and validity issues are not addressed. Implications and directions for future research are not provided.
Poster Presentation • Poster is clear • Student discusses proposal	Poster is professional and all parts of the proposal are clearly presented. Student has polished	Poster has most parts of the proposal clearly presented. Student can speak knowledgably about most parts	Poster has only a few parts of the proposal clearly presented. Student has difficulty speaking	Poster is unclear. Student has difficulty speaking knowledgably about the proposal and

knowledgeably • Student answers questions well	presentation and can answer questions with references to research	of the proposal and can answer questions.	knowledgably about the proposal and cannot answer most questions.	cannot answer most questions.