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

EDUC 860 (DL1) - STEM Education Research and Policy
3 Credits, Spring 2021
Mondays, 4:30-7:10 pm, online with Zoom
https://gmu.zoom.us/j/98603036633?pwd=L3RaQTJLY050Rm1seWRaRkZORzdFZz09

Faculty

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COVID 19 Procedures: Spring 2021

Students, please be aware of and follow all policies and procedures for Mason's Safe Return to Campus: https://www2.gmu.edu/Safe-Return-Campus

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

This course will be delivered online (76% or more) using a synchronous format via Blackboard Learning Management system (LMS) housed in the MyMason portal. You will log in to the Blackboard (Bb) course site using your Mason email name (everything before @masonlive.gmu.edu) and email password. The course site will be available on [January 18, 2021 at 9:00 am].

Under no circumstances, may candidates/students participate in online class sessions (either by phone or Internet) while operating motor vehicles. Further, as expected in a face-to-face class meeting, such online participation requires undivided attention to course content and communication.

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 7 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.

Technical Requirements

To participate in this course, students will need to satisfy the following technical requirements:

- High-speed Internet access with standard up-to-date browsers. To get a list of Blackboard's supported browsers see: https://help.blackboard.com/Learn/Student/Getting_Started/Browser_Support#supported-browsers

  To get a list of supported operation systems on different devices see: https://help.blackboard.com/Learn/Student/Getting_Started/Browser_Support#tested-devices-and-operating-systems

- Students must maintain consistent and reliable access to their GMU email and Blackboard, as these are the official methods of communication for this course.
- Students will need a headset microphone for use with the Blackboard Collaborate web conferencing tool. [Delete this sentence if not applicable.]
- Students may be asked to create logins and passwords on supplemental websites and/or to download trial software to their computer or tablet as part of course requirements.
- The following software plug-ins for PCs and Macs, respectively, are available for free download: [Add or delete options, as desire.]
  - Adobe Acrobat Reader: https://get.adobe.com/reader/
  - Windows Media Player: https://support.microsoft.com/en-us/help/14209/get-windows-media-player
  - Apple Quick Time Player: www.apple.com/quicktime/download/

Expectations

- Course Week: Our course week will begin on the day that our synchronous meetings take place as indicated on the Schedule of Classes.
- Log-in Frequency:
  Students must actively check the course Blackboard site and their GMU email for communications from the instructor, class discussions, and/or access to course materials at least 1 time per week. In addition, students must log-in for all scheduled online synchronous meetings.
- Participation:
  Students are expected to actively engage in all course activities throughout the semester, which includes viewing all course materials, completing course activities and assignments, and participating in course discussions and group interactions.
- Technical Competence:
  Students are expected to demonstrate competence in the use of all course technology. Students who are struggling with technical components of the course are expected to seek assistance from the instructor and/or College or University technical services.
- Technical Issues:
  Students should anticipate some technical difficulties during the semester and should, therefore, budget their time accordingly. Late work will not be accepted based on individual technical issues.
- Workload:

Please be aware that this course is **not** self-paced. Students are expected to meet *specific deadlines* and *due dates* listed in the **Class Schedule** section of this syllabus. It is the student's responsibility to keep track of the weekly course schedule of topics, readings, activities and assignments due.

- Instructor Support:
  Students may schedule a one-on-one meeting to discuss course requirements, content or other course-related issues. Those unable to come to a Mason campus can meet with the instructor via telephone or web conference. Students should email the instructor to schedule a one-on-one session, including their preferred meeting method and suggested dates/times.
- Netiquette:
  The course environment is a collaborative space. Experience shows that even an innocent remark typed in the online environment can be misconstrued. Students must always re-read their responses carefully before posting them, so as others do not consider them as personal offenses. *Be positive in your approach with others and diplomatic in selecting your words*. Remember that you are not competing with classmates, but sharing information and learning from others. All faculty are similarly expected to be respectful in all communications.
- Accommodations:
  Online learners who require effective accommodations to insure accessibility must be registered with George Mason University Disability Services.

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 professional development experiences for educators
5. Develop a research proposal designed to potentially expand on the current research literature in STEM education

Professional Standards: National Science Teaching 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

Johnson, C. C., Mohr-Schroeder, M.J., Moore, T.J., & English, L.D. (2020). *Handbook of research on STEM education.* Taylor & Francis.
Available for unlimited simultaneous users in GMU library at
https://www-taylorfrancis-com.mutex.gmu.edu/books/handbook-research-stem-education-carla-johnson-margaret-mohr-schroeder-tamara-moore-lyn-english/e/10.4324/9780429021381

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

CHOICE OF A or B

(A) Building a STEM school (any level). (30%) Students will form groups and create a blueprint for a STEM school (selective, inclusive or CTE; elementary, middle or high) that addresses the critical components found in the research on STEM 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 for High Schools 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

The critical components for Elementary Schools 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

There is no definitive research on Middle Schools focused on STEM, so if the group chooses this level of school, they may combine some of the elementary and high school components as needed.

(B) Design Elements of an Educator PD for Integrated STEM. (30%) Students will design a week-long professional development experience for elementary, secondary, or informal educators (student choice). The design of the PD will be governed by the research on education in the field of STEM. The schedule, explanation of activities, deliverables from the teachers, methods for feedback, and an indication of where the research is being applied will be required. A rubric for this assignment is found at on blackboard.

STEM Handbook Chapter leadership. (20%) Students will each choose one chapter each from the Handbook of Research on STEM Education that is scheduled for class discussion and lead the class discussion on this topic. Leadership will include a summary presentation, directed questions for the chapter, and a supplemental list of research articles from the past 5 years about the chapter topic with a summary of these articles findings.

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 school or Design a PD from research	30%
Leading Handbook Chapter class discussion	20%
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 25	Defining STEM education and epistemologies	Chapter 1: STEM Integration by Moore, Johnson and Glancy Peters-Burton, E.E. (2014). Is there a nature of STEM? *School Science and Mathematics, 114, 99-101.*	
Feb 1	The need for STEM and critiques on STEM	Chapter 14: History of Integrated STEM Curriculum by Jackson, Tank, Applegate, Jurgenson, Delaney, & Erden 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 8	STEM policy **Susan Poland, NASA**	Chapter 32: STEM Policy in the US and Canada by Johnson, Walton and Breiner One other choice of Chapters 33, 34, or 35	Draft rationale/critique for STEM education

Feb 15	Emphasizing T, E, M	Chapter 2: STEM Education Through the Epistemological Lens by Couso & Simmaro 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.	
Feb 22	STEM and Equity	Chapter 22: Race-related Factors in STEM by Jong, Priddie, Roberts, and Museus 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.	Final rational for STEM education
Mar 1	Models of STEM High schools	Chapter 31: STEM-Focused School Models by Peters-Burton, House, Peters, Remold, and Goldsmith 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. Lynch, S. J., Peters-Burton, E. E., Behrend, T., House, A., Ford, M., Spillane, N., Matray, S., Han, E., & Means, B. (2018). Understanding inclusive STEM high schools as opportunity structures for underrepresented students: Critical components. *Journal of Research in Science*	

		Teaching. DOI 10.1002/tea.21437	
March 8	Models of STEM-focused elementary schools	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, *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.	
March 15	Class choice of topic	TBA – chosen by class	Research question for proposal
March 22	Present STEM-focused schools		STEM-focused school model
March 29	STEM educator PD	Chapter 29: Research on K-12 STEM Professional Development by Luft, Diamond, Zhang, and White	
April 5	Informal STEM learning	Chapter 12: Informal STEM program learning by Blanchard, Gutierrez, Habig, Gupta, and Adams National Research Council. (2009). *Learning Science in Informal Environments: People, Places, and Pursuits*.	Draft of Research Proposal
April 12	Presentations of PD designs		PD design
April 19	Final consultation on Research Proposals		Draft of Research Proposals

April 26	Poster presentations		
May 3	No class		**Final Research Proposal**

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 https://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 https://its.gmu.edu/knowledge-base/blackboard-instructional-technology-support-for-students/.

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

Notice of mandatory reporting of sexual assault, interpersonal violence, and stalking:

As a faculty member, I am designated as a "Responsible Employee," and must report all disclosures of sexual assault, interpersonal violence, and stalking to Mason's Title IX Coordinator per University Policy 1202. If you wish to speak with someone confidentially, please contact one of Mason's confidential resources, such as Student Support and Advocacy Center (SSAC) at 703-380-1434 or Counseling and Psychological Services (CAPS) at 703-993-2380. You may also seek assistance from Mason's Title IX Coordinator by calling 703-993-8730, or emailing titleix@gmu.edu.

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	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	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.

• Purpose of research and research questions/hypotheses clearly stated	important issue in the field.			
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 reflects contemporary educational research methodology. The research methods are well aligned and address the research problem and related questions.	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 research methods are aligned and address the research problem and related questions.	Methods do not address all criteria. Data sources, research design, and/or data collection are not fully appropriate.	Limi
Data Analysis and Expected Results • Description of data analysis procedures for the study	Planned data analysis is appropriate, complete, and accurately described. Expected	Planned data analyses are appropriate but are not complete or accurately described. Expected	Data analyses are not fully appropriate or are incomplete. Expected results/findings are not included	Data analyses and expected results are not addressed.

• Description of expected results/findings	results/findings are discussed	results/findings are discussed		
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 knowledgeably • Student answers questions well	Poster is professional and all parts of the proposal are clearly presented. Student has polished presentation and can answer questions with references to research	Poster has most parts of the proposal clearly presented. Student can speak knowledgably about most parts of the proposal and can answer questions.	Poster has only a few parts of the proposal clearly presented. Student has difficulty speaking knowledgably about the proposal and cannot answer most questions.	Poster is unclear. Student has difficulty speaking knowledgably about the proposal and cannot answer most questions.