

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

EDCI 810.001 – CRN 83256  
Foundations of Science Education Research  
3 Credits, Fall 2022  
Mondays 4:30-7:10 pm; Thompson Hall L013 – Fairfax Campus

**Faculty**

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**Prerequisites/Corequisites**

- A. Prerequisite: Permission from instructor
- B. Co-Requisite: EDUC 800

**University Catalog Course Description**

Explores and analyzes the range of research designs currently utilized by science education researchers. Develops an understanding of the assumptions and frameworks of different types of science education inquiry through an examination of ways of knowing. Examines historical trends that have taken place in science education.

**Course Overview**

The purpose of this course is to introduce students to foundational work in science education research. From the perspective of major areas of study in science education research, we will also analyze types of science education research methods, adaptation of findings to other research and/or teaching practice, and epistemological underpinnings of science education. The course can be visualized as

1. Science Learning
2. Culture, Gender Society and Science Learning
3. Science Teaching
4. Curriculum and Assessment
5. Science Teacher Education

### **Course Delivery Method**

This course will be delivered using a majority of face-to-face format. However, several classes will be online and will be delivered asynchronously. Course contents will be available through the library or on Blackboard.

### **Learner Outcomes or Objectives**

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

1. Read and critique studies in science education.
2. Identify theoretical frameworks used by authors in published studies.
3. Locate science education research and describe the research focus of common science education and education research journals.
4. Identify issues in science education research and relate to practices and policies in science educational settings (i.e., precollege, higher education, and informal).
5. Conduct a literature review of research in a selected area of science education research.

### **Professional Standards - National Science Teachers Association STANDARDS:**

**Standard 1:** Content

**Standard 2:** Nature of Science

**Standard 3:** Inquiry

**Standard 4:** Issues

**Standard 5:** General teaching skills

**Standard 6:** Curriculum

**Standard 7:** Science in the community

**Standard 8:** Assessment

**Standard 10:** Professional growth

### **Required Texts**

This course will use historical literature found in science education journals available through the library electronically. Required readings for this course are included in the class schedule.

***Our course text is available on the Mason library site. All required handbook chapters and other required readings are also posted in our class Zotero group, which your instructor will share with you.***

Lederman, N. G., & Abell, S. K. (Eds.). (2014). *Handbook of research in science teaching, Volume II*. New York: Routledge.

It is recommended that students have access to the 7<sup>th</sup> edition to the APA manual, as all papers are required to be in APA format:

American Psychological Association. (2020). *Publication manual of the American Psychological Association* (7th ed.). Washington, DC: Author.

## Course Performance Evaluation

Students are expected to submit all assignments on time in the manner outlined by the instructor (most assignments should be submitted via Blackboard, in class drafts are required for draft review).

Assignments are listed on the syllabus and are available on the Blackboard site. Submit all assignments through Blackboard unless otherwise instructed.

## Assignments

<b>Assignment</b>	<b>Points</b>
Class Participation & Professionalism	20
Article Critique Discussions	10
Review of Literature (total 60 points)	
<i>Academic Research Review Table</i>	20
<i>Literature Review (Paper)</i>	40
Presentation	10
<b>TOTAL POINTS</b>	<b>100</b>

### **A. Class participation and professionalism (20%)**

Class participation and professionalism include multiple aspects of engagement in our course content, including: in-class experiences, article discussions, in and out of class work to advance the course objectives, reflective journaling, and peer evaluation and support in critical friends groups. Weekly readings represent different types of research from different threads in science education. We will discuss each reading and you will be required to talk about the articles in a scholarly manner. Further, we will discuss the process of scholarly writing and focus on writing abstracts, annotated bibliographies, conceptual frameworks and literature reviews. At some point in the semester, you will be given an article without an abstract and you will be asked to write one for that article.

In addition to being present in each class (physically and mentally), this part of your grade also includes quality participation in class discussions and professionalism in all communication with your professor and your peers. This course operates under the assumption that knowledge is socially constructed, and the most meaningful learning opportunities include those where learners have the opportunity to offer and explore diverse perspectives with peers. It is expected that you actively build upon your prior knowledge, as well as your personal and educational experiences to connect, question, and extend class discussions.

### **B. Article Critique Discussion (10 points)**

A valuable skill for a researcher is to be able to access and discern information from the latest science education research journals and to engage in discussions about academic

research. This assignment is intended to develop these skills. For this assignment you will partner with a classmate and do the following:

1. Choose one empirical science education research article from the Journal of Research in Science Teaching, Science Education, the International Journal of Science Education, or another peer-reviewed journal that focuses on science or STEM. (*An empirical study reports on research the authors conducted. Abstracts of empirical studies generally address participants, the study conducted, and major findings.*) You may draw on the research studies provided in our Zotero group, or you may identify a new article, as long as it is peer-reviewed.
2. Critique the article using the Rubric for Article Critique and the Guide for Analyzing a Research Article found at the end of this syllabus.
3. Send the article to your classmates & instructor no later than the week before your presentation week.
4. Lead a class discussion during a class meeting about your research article. As you prepare for the discussion be sure to consider questions you will use to engage your peers. Plan to lead the article discussion for approximately 20 minutes.

### **C. Review of Literature (60 points)**

Each student will be asked to complete a review of literature on an area of interest in science education. This should include a search for relevant literature, an examination of these readings and the preparation of a paper that describes the review of literature including the historical changes in the area of interest. This assignment is split into two distinct parts:

#### **Academic Research Review Table (20 points)**

Review at least 15 peer-referenced articles on your topic. For each article you will complete a column in your Academic Reference Review Chart (aka literature review table), provided on our Blackboard site (under Assignments). You may modify the literature review table or use a slightly different template, if you prefer. Include one dissertation in your literature review table (we will discuss how to review a dissertation in class).

#### **Literature Review (40 points)**

The paper should include:

- (a) A review of a minimum of 15 published journal articles (not magazine or web reviews). The paper should be 15-20 pages (double spaced, 12-font, Times New Roman, 1-inch margins) in length.
- (b) The review should have a methods section for the journal search and focus on the methodologies, assessments used in the studies, and the contributions they make to the field of science education. Describe the inclusion criteria for the literature search conducted – as well as the exclusion criteria.
- (c) The literature review should be written using APA 7 format and written as if for publication (i.e., use academic voice and proof read extensively).

- (d) Your literature review should NOT be a series of book reports about the articles you review. Instead it should be organized around the themes you identify in the literature. Refer to the rubric at the end of the syllabus.
- (e) Be prepared to share your literature review outline and draft on the dates noted in the course schedule.

**D. Presentation of Research (10%)**

From your literature review, consider the critical ideas, trends in research, and assessment issues that are present for this area of inquiry.

- What are the theoretical frameworks that are used in these studies?
- How would you describe the progression of findings?
- What unanswered questions remain and what are some fruitful areas for future research?
- How would you design a research study to explore one of these unanswered questions?

The presentation should be 10 minutes with 5 minutes for questions. Each student should be prepared to ask/challenge the presenter during those last 5 minutes.

- **Grading**

A	93-100%
A-	90-92%
B+	88-89%
B	83-87%
B-	80-82%
C	70-79%
F	below 70%

**Professional Dispositions**

Students are expected to exhibit professional behaviors and dispositions at all times. See <https://cehd.gmu.edu/students/polices-procedures/>

## Class Schedule

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

Date	Topic	Readings & Assignments Due
Aug 22	Introductions & skills  <b>Building academic community (BAC):</b> Doctoral Committees	Review the syllabus Review the NARST website – find the Strands <ul style="list-style-type: none"> <li>• <a href="http://www.narst.org">www.narst.org</a></li> </ul>
Aug 29	<b>Student Learning</b> Foundations of science education research & epistemologies  <b>BAC:</b> Program of Study: Bring in your Program of Study	<ul style="list-style-type: none"> <li>• <b>Handbook Volume II - Chapter 1</b> Paradigms in Science Education Research</li> <li>• Journal Article: Berland et al. – Epistemologies in Action</li> <li>•</li> </ul>
<b>Sep 5: Labor Day: No Class</b>		
Sep 12	<b>Student Learning</b> Conceptual learning, Attitudinal, and Motivational Constructs in Science  <b>BAC:</b> Finding critical friends	<ul style="list-style-type: none"> <li>• <b>Handbook Volume II - Chapter 4:</b> Student Conceptions and Conceptual Change</li> <li>• <b>Handbook Volume II - Chapter 5:</b> Attitudes, Identity, and Aspirations Toward Science</li> <li>• Glynn et al. – Science Motivation Questionnaire</li> <li>• <b>Bring to class: One column of literature review table AND annotated bibliography for <u>one</u> journal article related to your individual topic of interest</b></li> </ul>
Sep 19	<b>Culture, Gender, Society and Science Learning</b> Race and Ethnicity in Science Education  <b>BAC:</b> Writing Literature Reviews	<ul style="list-style-type: none"> <li>• <b>Handbook Volume II - Chapter 9:</b> Unpacking and Critically Synthesizing the Literature on Race and Ethnicity in Science Education</li> <li>• <b>Handbook Volume II - Chapter 15:</b> Culturally Responsive Science Education for Indigenous &amp; Ethnic Minority Students</li> <li>• Rodriguez – Strategies for Counter-resistance</li> <li>• <b>++ ARTICLE PROVIDED BY PAIR 1</b></li> <li>• <b>PAIR 1 ARTICLE CRITIQUE IN CLASS</b></li> </ul>
Sep 26	<b>Culture, Gender, Society and Science Learning</b> Gender and Society in Science Learning <b>BAC:</b> Writing Literature Reviews	<ul style="list-style-type: none"> <li>• <b>Handbook Volume II - Chapter 10:</b> Gender Matters</li> <li>• Carlone &amp; Johnson – Science Experiences of Successful Women of Color</li> <li>• Miller et al. – Children’s Gender Science Stereotypes</li> <li>• <b>Bring to class: Literature Review Table with at least 5 articles</b></li> </ul>

Oct 3	<p><b>Culture, Gender, Society and Science Learning</b> Culturally &amp; Linguistically Diverse &amp; Exceptional Learners</p> <p><b>BAC:</b> Organizing your writing tools; Tips for being a productive writer</p>	<ul style="list-style-type: none"> <li>• <b>Handbook Volume II - Chapter 11:</b> English Learners in Science Education</li> <li>• <b>Handbook Volume II - Chapter 11:</b> Special Needs and Talents in Science Education</li> <li>• <b>++ ARTICLE PROVIDED BY PAIR 2</b></li> <li>• <b>PAIR 2 ARTICLE CRITIQUE IN CLASS</b></li> </ul>
<p><b>October 11</b> (Monday classes meet on Tuesday this week; Tuesday classes do not meet)</p> <p><b>Online Asynchronous Class Meeting (no f2f meeting)</b></p> <ul style="list-style-type: none"> <li>• <b>Submit to Blackboard: Literature Review Table with 15 articles</b></li> </ul>		
Oct 17	<p><b>Science Teaching</b> Discourse and Argumentation</p> <p><b>BAC:</b> Professional Organizations, Journals and Conferences</p>	<ul style="list-style-type: none"> <li>• <b>Handbook Volume II - Chapter 17:</b> Discourse Practices in Science Teaching and Learning</li> <li>• Osborne et al. - Argumentation Learning Progression</li> <li>• <b>++ ARTICLE PROVIDED BY PAIR 3</b></li> <li>• <b>PAIR 3 ARTICLE CRITIQUE IN CLASS</b></li> </ul>
Oct 24	<p><b>Science Teaching</b> Domain-based teaching</p> <p><b>BAC:</b> Publishing and authorship</p>	<ul style="list-style-type: none"> <li>• <b>Choose one disciplinary-focused chapter in Handbook of Research on Science Education Volume II:</b> Chapter 19 – Elementary Science Chapter 20 – Interdisciplinary Chapter 21 – Biology Chapter 22 – Physics Chapter 23 – Chemistry Chapter 24 – Earth Science Chapter 25 – Environmental education <b>Be ready to discuss your chapter with the class based on the Article Critique criteria</b></li> <li>• <b>Bring to Class: Outline of literature review</b></li> </ul>

Oct 31 <b>Asynch Online Class</b> Work due by Tues night 11/1	<b>Curriculum and Assessment</b> Curriculum Reform  <b>Asynchronous Online Class</b>	<ul style="list-style-type: none"> <li>• <b>Handbook Volume II - Chapter 28 –</b> History of Science Curriculum Reform in the U.S</li> <li>• Benchmarks for Science Literacy <a href="http://www.project2061.org/publications/bsl/">http://www.project2061.org/publications/bsl/</a></li> <li>• National Science Education Standards (download for free) <a href="https://www.nap.edu/catalog/4962/national-science-education-standards">https://www.nap.edu/catalog/4962/national-science-education-standards</a></li> <li>• Next Generation Science Standards - <a href="http://www.nextgenscience.org/">http://www.nextgenscience.org/</a></li> <li>• Summarize all three standards (AAAS, NSES, and NGSS) and find one example of curriculum written from the standards</li> </ul>
Nov 7	<b>Curriculum and Assessment</b> Inquiry and NOS  <b>BAC:</b> Pursuing an academic position	<ul style="list-style-type: none"> <li>• <b>Handbook Volume II - Chapter 29:</b> Science Practices and Inquiry in the Science Classroom</li> <li>• <b>Handbook Volume II - Chapter 30:</b> Research on Teaching and Learning in the Nature of Science</li> <li>• Dolan et al. – Tool for Categorizing Complexity of Reasoning</li> </ul>
Nov 14	<b>Curriculum and Assessment</b> Assessment  <b>BAC:</b> Grant writing	<ul style="list-style-type: none"> <li>• <b>Handbook Volume II - Chapter 38:</b> The Central Role of Assessment in Pedagogy</li> <li>• <b>Handbook Volume II - Chapter 39:</b> Large Scale Assessments in Science Education</li> <li>• DeBoer – The Globalization of Science Education</li> </ul>
<p><b>November 21: Online Class – Small Group Meetings</b>  <b>Lit Review Draft due for Critical Friend Meetings &amp; Instructor Draft Review</b></p>		
Nov 28	<b>Science Teacher Education</b> Professional learning of pre-service & in-service (PD) teachers  <b>BAC:</b> Class choice	<ul style="list-style-type: none"> <li>• <b>Handbook Volume II - Chapter 43:</b> Learning to Teach Science</li> <li>• <b>Handbook Volume II - Chapter 44:</b> Research on Teacher Professional Development Programs in Science</li> <li>•</li> </ul>
Dec 5	Presentations and Celebration!	Last day of class
<p><b>December 12: Final exam date – No class meeting</b>  <b>Submit final literature review to Blackboard by 11:59 pm on Dec 12</b></p>		



## 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 VIA should be directed to [viahelp@gmu.edu](mailto:viahelp@gmu.edu) or <https://cehd.gmu.edu/aero/assessments> . 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, sexual harassment, interpersonal violence, and stalking:**

As a faculty member, I am designated as a “Non-Confidential Employee,” and must report all disclosures of sexual assault, sexual harassment, 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 or support measures from Mason’s Title IX Coordinator by calling 703-993-8730, or emailing [titleix@gmu.edu](mailto:titleix@gmu.edu).

**For additional information on the College of Education and Human Development, please visit our website <https://cehd.gmu.edu/students/> .**

## Guide for Critiquing a Research Article

### Key Characteristics of a Research Article

1. Was the study conducted by an individual or research team? Where can
2. What was the purpose of the study?
3. What was (were) the research question(s)?
4. What were the topics of the literature review?
5. What type of research was conducted?
6. How did the researchers collect data? How did they analyze data?
7. What conclusions did the researchers report?

### Quantitative Research

1. Is the study experimental or non-experimental?
2. Were the participants assigned at random to treatment conditions?
3. If it is non-experimental, was the researcher attempting to examine cause-and-effect issues? If yes, did he or she use the causal-comparative method?
4. What types of measures were used? Did the authors give enough information to make a decision on validity and reliability on the instruments?
5. Did the instruments align with the research questions?
6. How was the sample of participants obtained?
7. What are the demographics of the sample?
8. Were there statistical differences in the results?
9. How did the researcher(s) assess validity and reliability of the data assessed?
10. Did the researcher critique his or her own work in the limitations section?

### Qualitative Research

1. Was the study conducted by an individual or research team?
2. Was the initial analysis conducted independently by more than one researcher?
3. Were outside experts consulted for peer review?
4. Did the researchers participate in member checking?
5. How were the participants obtained?
6. What are the demographics of the participants?
7. Do the researchers explain their methods of analysis?
8. How did the researcher(s) assess credibility, transferability, and trustworthiness?

### Holistic Rubric: Article Critique Discussion (10 points)

- Article focuses on a relevant research issue in Science Education. Article is submitted to peers by (at least) one week before discussion in class
- In-class discussion: Student discussant(s) should use questioning of peers to engage them in discussion. Rather than talking about the article, the discussant(s) *lead* discussion around each of the following topics:
  - Theoretical or conceptual framework used in article
  - Salient points of article
  - Strengths & weaknesses of article
  - How the article relates to their own research
  - How the article relates to their classmates' research
  - Potential avenues for future research

### Rubric for Literature Review

Criteria	Does not meet expectations	Meets Expectations	Exceeds Expectations
<b>Problem statement / introduction</b>	The problem statement is a collection of global assertions and its significance is neither discussed nor related to the problem	The problem and research need are clearly stated. The significance is not discussed OR does not place the problem in the context of the literature	The problem is clearly stated and its significance to the field is discussed in context to the field in both specific and more general terms
<b>Organized progression</b>	Report has no clear direction and subtopics are not connected.	There is a basic flow of ideas but not all sections follow a logical order.	Report goes from general to specific; transitions relate and connect sections.
<b>Relevant sources</b>	Major works are omitted; significance to field is not clear; criteria for inclusion not presented	Major works included but not covered in sufficient depth; significance of selected resources is discussed. Criteria for inclusion is addressed.	Appropriate resources are examined and covered in depth; significance of research is critiqued. Criteria for inclusion and process used in literature search clearly stated.
<b>Synthesis of ideas</b>	Does not attempt to synthesize the information or discuss the topic in the broader context of the scholarly literature. Literature is presented in "book report" style.	Some analysis and synthesis of ideas is evident. Some literature is organized by themes, but other articles are presented in book report style OR themes are discussed around single articles.	Clear analysis and synthesis presented; literature review is organized around themes from the literature; demonstrates insight into problem; conclusions strongly supported.
<b>Clarity of writing</b>	Ideas not expressed clearly; misspellings, incorrect grammar and punctuation.	Writing is clear but not concise; paragraph or sentence structure is repetitive or awkward.	Writing is clear and concise; ideas are well-developed and coherent. Academic voice is used.
<b>Citations &amp; references</b>	References are not provided OR in-text citations are not used OR references and/or in-text citations show consistent patterns of error.	Citations within text and reference list are included with some minor formatting problems.	In-text citations and reference list are complete; APA 7 <sup>th</sup> edition style is used throughout; at least one dissertation is cited.