

George Mason University
College of Education and Human Development
Advanced Studies in Teaching and Learning

EDCI 663 DL1 - CRN 83447
Research in STEM Teaching
3 credits, Fall 2024
August 26 – December 18, 2024

Meeting Days/Times

Online: Our week runs Tuesday-Monday starting August 26 through December 18
See course schedule for synchronous online meeting weeks

Faculty: Nancy Holincheck, Ph.D.

Email: nholinch@gmu.edu

Office Hours: By appointment online via Zoom: [Book time to meet with me](#)

Office Location: Thompson Hall 2605

Prerequisites

None

Course Description

Investigates the research and methodologies involved in teaching and learning across the STEM, technology, engineering, and mathematics (STEM) disciplines. Focuses on the role of the educator in engaging as an inquirer in their educational setting.

Course Delivery Method

This course will be delivered online (76% or more) using a mostly asynchronous format via Mason's Learning Management System (LMS). You will log in to the course site using your Mason email name (everything before @gmu.edu) and email password. The course site will be available no later than Monday, August 26. To access your course in Canvas: <https://canvas.gmu.edu/login/canvas>

Course delivery will be through mini-lecture, videos, structured collaborative reflective groups; discussion of readings and ongoing critical reflective practice will support learning experiences throughout the course and will complement your experiences and expose you to the major cultural perspectives; individual blogs and online journals based on topics aligned with national standards and program/learner outcomes will support learning. There will be scheduled synchronous Collaborate sessions during the semester.

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.

Technical Requirements

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

- High-speed internet access with updated browsers. Canvas supported browsers can be found here: <https://guides.instructure.com/a/720329>

- Consistent and reliable access to GMU email and the course LMS, as these are the official methods of communication for this course.
- Speakers and a microphone or a microphone-enabled headset for use with the synchronous web conferencing tools.
- Note that 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.

Expectations

- **Course Week:** Because asynchronous courses do not have a “fixed” meeting day, our week will start on Tuesday and finish on Monday. We will have regularly scheduled synchronous Zoom sessions throughout our semester. Attendance is required. You will be informed of the dates for synchronous meetings.
- **Log-in Frequency:** Students must actively check the course Canvas site and their GMU email for communications from the instructor, class discussions, and/or access to course materials at least 3 times 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, or use the instructor-provided link to schedule a meeting.
- **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 ensure accessibility must be registered with George Mason University Disability Services.

Learning Outcomes:

As a result of EDCI 663, students will be able to:

- Identify types of research methods applied in STEM education research and analyze their strengths and weaknesses.
- Review a range of STEM education research studies to understand how to evaluate and use education research.
- Connect past, present, and future movements in STEM education reform to research and practice.
- Critique STEM education research studies within their areas of interest.
- Develop informed perspectives on issues in education that are grounded in contemporary research.
- Describe how teachers or administrators can use research to enhance instruction and inform practice.

Relationship to Program Goals:

This course was designed with a vision for accomplished teaching, as indicated by NBPTS Science and Mathematics Standards for Early Adolescence and for Adolescence and Young Adulthood and the Five Core Propositions of the National Board for Professional Teaching:

- Proposition 1: Teachers are Committed to Students and Their Learning
- Proposition 2: Teachers Know the Subjects They Teach and How to Teach Those Subjects to Students
- Proposition 3: Teachers are Responsible for Managing and Monitoring Student Learning.
- Proposition 4: Teachers Think Systematically about Their Practice and Learn from Experience.
- Proposition 5: Teachers are Members of Learning Communities.

Required Texts:

Dana, N. F., & Yendol-Hoppey, D. (2019). *The reflective educator's guide to classroom research: Learning to teach and teaching to learn through practitioner inquiry*. Corwin

[Note that this is also a required text for ASTL's EDUC 613 and EDUC 606 courses.]

No additional texts are required for this class. Readings will include peer-reviewed articles and book chapters available from the Mason library.

Course Performance Evaluation:

Students are expected to submit all assignments on time via the course learning management system. High-quality work is expected on all assignments and in class. Attendance at all class meetings for the entire class is a course expectation. All assignments must be completed to receive a passing grade for the course. Assignments are either due at the beginning of class or by midnight on the day they are due — please consult the Class Schedule for due dates & times. Graded assignments that are late will receive a ten percent grade reduction (one full letter grade lower). In the event a class is missed, the student will develop with the approval of the instructor an additional assignment that relates to the work being missed.

Assignments:

The assignments are organized according to the themes of the class.

Theme	Subtopics	Assignments
Understanding what came before	Historical and current research literature Reform initiatives in STEM education	Research in STEM Teaching Dialectical Notebook
Being research consumers	Types of educational research Finding journals Reading research articles Critiquing research articles	Research Article Critique Literature Review & Action Research Proposal
Actively translating research to practice	Identifying relevant recommendations from empirical research, including qualitative, quantitative, and Action Research projects	Literature Review & Action Research Proposal
Preparing to study your own teaching	Planning Classroom Research	Literature Review & Action Research Proposal Presentation: Journal Entry 1, Journal 2, Literature

1) Research in STEM Teaching Dialectical Notebook Responses

Each student will be provided a Google Slide deck in which to maintain their Digital Interactive Notebook (DINb). Follow the directions provided in the DINb and in Module 1.

2) Discussion & critique of STEM education research article

A valuable skill for an innovative teacher is to be able to access and discern information from the latest STEM education research journals to use for their practice. This assignment is given to develop your skills in locating and analyzing research that is of interest to you. For this assignment, you will:

- A. Choose one empirical STEM education research article from the *International Journal of STEM Education*, *Journal of Research in Science Teaching*, *Journal of Research in Mathematics Education*, or another STEM education journal.

(An empirical study reports on research the authors conducted. Abstracts of empirical studies generally address participants, the study conducted, and major findings.)

- B. Critique the article using the *Rubric for Article Critique* and the *Guide for Analyzing a Research Article* found at the end of this syllabus.
- C. Lead a class discussion during a synchronous class meeting about your research article. As you prepare for the discussion, be sure to consider questions you will use to engage your peers.

3) Lesson revision – Choose an activity (or series of activities) from your classroom. You will make adaptations to the activity(ies) to incorporate research-based recommendations into your teaching and pilot the changes in your classroom. This assignment has four parts:

- A. Discuss the original activity.
- B. Discuss the changes made and how they align with research recommendations.
- C. Pilot the revised activity(y/ies) in your class.

- D. Share your experiences with the class in synchronous class meeting OR in a video posted to our course site (5 minutes or less) and respond to your classmates' narratives.

4) Literature Review & Action Research Proposal Presentation– asking questions about your classroom, using literature to advise your actions, and systematically planning for data collection

By the end of this class, you will have a great deal of information about how educational research is conducted and reported. An important part of translating research to practice is for teachers to not only read about research, but conduct action research projects in their own classrooms. You will first review literature related to a topic in which you are interested, and then create an action research proposal presentation. Note that you are NOT expected to implement the action research project this semester.

For this assignment, you will complete the following assignments:

A. Journal Entry 1: Action Research Problem Statement

Identify a problem or situation in STEM teaching that you would like to understand better. Use references to support your discussion of the problem or situation - either/both peer-reviewed and non-peer-reviewed literature can be used in this discussion.

B. Journal Entry 2: Discussion of Research Questions

Develop and refine one or more research questions that would guide this project. In your journal, you should discuss what you are interested in understanding better and how the research questions will help you do this.

C. Journal Entry 3: Action Research Literature Review Table

Explore the literature on this topic (10 or more articles) and complete the literature review table & synthesis for at least 10 of these articles. See the table/template linked in Canvas.

D. Final Presentation: Presentation of proposed research

Using your knowledge of methodologies, design a study that would collect data to answer the research questions. Create a presentation to share an overview of the literature, your research questions, and the proposed research design

E. Final Action Research Literature Review and Proposal

You will write a 4-8 page action research literature review and proposal to describe the action research you would conduct, given the time and opportunity. The proposed study must be set within your own educational context and focus on some aspect of STEM teaching and learning. You will draw on the literature reviewed in journal entry 3 to write a literature synthesis and describe the action research study. The final section of your proposal should include a reflection in which you discuss how the literature you read this semester has influenced your thinking about STEM teaching and how action research may help you in terms of your professional growth in the future. This is **not** meant to be a summary of what you learned this semester but rather an opportunity to make connections and look forward in a meaningful way. Additional guidelines will be provided in class.

5) Participation & Professionalism

Class participation and professionalism apply to multiple aspects of engagement in our course content, including the in-class experiences, article critique discussions, peer evaluations of student work, and examination of STEM education literature. As this is an online course, it is critical that all students stay actively involved in the course modules. This part of your grade also includes quality participation in class discussions (live and/or in the Digital Interactive Notebook) and professionalism in all communication with your professor and your peers.

Points for Assignments:

Participation & Professionalism, includes DINb work	30 points
Discussion & critique of STEM education research article	10 points
Lesson revision	15 points
Action research literature review & proposal <i>Journal 1: (5 points)</i> <i>Journal 2: (5 points)</i> <i>Journal 3: (10 points)</i> <i>Presentation: (10 points)</i> <i>Action Research Literature Review, Proposal, & Reflection: (15 points)</i>	45 points
TOTAL	100 points

Grading Scale

| 95-100 =A | 90-94 =A- | 86-89=B+ | 83-85=B | 80-82= B- | 70-79=C | Below 70=F |

Use of Generative AI

Use of Generative AI tools should be used following the fundamental principles of Mason’s Academic Standards. This includes being honest about the use of these tools for submitted work and including citations when using the work of others, whether individual people or Generative AI tools.

Professional Dispositions (CEHD Student Guide)

Throughout study in the College of Education and Human Development, students are expected to demonstrate behaviors that reflect the positive dispositions of a professional. See <https://cehd.gmu.edu/current-students/cehd-student-guide>.

EDCI 663 Research in STEM Teaching
Class Schedule:
Syllabus & schedule are subject to change.

Wk	Date	Topics	What is due
1 & 2	Aug 26- Sep 2 & Sep 3-9	<i>Types of education research</i> <i>Finding relevant research articles</i>	Complete Module 1: see due dates in module Read: <ul style="list-style-type: none"> ● Rodriguez article ● Saul & Launius article ● Vincent-Ruz & Schunn article
3	Sep 10-16	<i>Critiquing research articles</i> <i>Developing research questions</i>	Complete Module 2: see due dates in module Read: <ul style="list-style-type: none"> ● Research article posted in module ● Dana & Yendol-Hoppey pp 3-15
4	Sep 17-23	<i>Developing research questions</i> <i>Revising lessons to incorporate best practices</i>	Complete Module 3: see due dates in module Read: <ul style="list-style-type: none"> ● Choose one action research study from articles posted in online course Due In week 4: Synchronous Class Meeting in Week 4 Due by 9/23: Journal Entry 1: Action Research Problem Statement
5	Sep 24-30	<i>Qualitative-based methodologies: Data collection methods</i> <i>Workshop RQs in week 5 DinB</i>	Complete Module 4: see due dates in module Read: <ul style="list-style-type: none"> ● Dana & Yendol-Hoppey ch. 3 ● Readings posted in module
6	Oct 1-7	<i>Qualitative-based methodologies: Data analysis methods</i>	Complete Module 5: see due dates in module Read: <ul style="list-style-type: none"> ● Dana & Yendol-Hoppey ch. 7 ● Readings posted in module Due by 10/7: Journal Entry 2: Action Research Discussion of Research Questions
7 & 8	Oct 8-14 Oct 15-21	<i>Quantitative based methodologies: Data collection & analysis methods</i>	Complete Module 6: see due dates in module Read: <ul style="list-style-type: none"> ● Reading posted in module

9 & 10	Oct 22-28 Oct 29- Nov 4	<i>Planning a mixed methods study</i> <i>Reviewing literature</i>	Complete Module 7: see due dates in module Read: <ul style="list-style-type: none"> • TWO research articles shared by classmates by end of week 7 • Other reading posted in module Synchronous Class Meeting in Week 9 Students lead critical article discussion
11	Nov 5-11	<i>Reviewing literature & writing a literature review</i>	Complete Module 8: see due dates in module Read: <ul style="list-style-type: none"> • Reading posted in module • Due by 11/18: Journal Entry 3: Action Research Literature Review Table
12 & 13	Nov 12-18 Nov 19-25	<i>Research to practice: Education policy & STEM education reform</i>	Complete Module 9: see due dates in module Read: <ul style="list-style-type: none"> • Readings posted in module Due by 11/25: Share Lesson Revision with class Synchronous Class Meeting in Week 12 with Individual Check-in with Instructor
14	Nov 26- Dec 2	Thanksgiving Break: No online module	None
15 & 16	Dec 3- 9 Dec 10-13	<i>Final presentations</i> <i>Complete student evaluations of teaching</i>	Complete Module 10: Teaching Evals & Final Presentation Synchronous Class Meeting in Week 15 Due in week 15: Action Research Proposal Presentations (tentative date: 12/5) Due in week 16: Final Reflection (due 12/13)

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 Mason’s Academic Standards (see <https://catalog.gmu.edu/policies/academic-standards/>)
- 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 or <https://cehd.gmu.edu/aero/assessments>.*
- *Questions or concerns regarding use of your LMS (Canvas) should be directed to: <https://its.gmu.edu/service/canvas/>*
- *For information on student support resources on campus, see: <https://ctfe.gmu.edu/teaching/student-support-resources-on-campus>*
 - o *TimelyCare: <https://caps.gmu.edu/timelycare-services/>*
 - o *Writing Center: <https://writingcenter.gmu.edu/>*

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.

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

Rubrics

Holistic Rubric for Assignment #2: Discussion & critique of STEM education research article (10 points) *(Also see Guide for Analyzing a Research Article on the following page)*

- Article focuses on a relevant issue in **STEM** Education. Article is submitted to peers by (at least) one week before discussion in class
- In-class discussion: Student discussant should *lead* discussion around each of the following topics
 - Salient points of article
 - Strengths & weaknesses of article
 - How the article relates to his/her own teaching
 - How the article relates to classmates' teaching
 - Potential avenues for future research (teacher/action research OR traditional research)

Holistic Rubric for Assignment #3: Lesson Revision (10 points)

Presentation OR video should explicitly address the following points:

- What the original activity (or activities) looked like (3 points)
 - Explain why you wanted to make changes to the original activity
- What changes you made and why you made those changes (3 points)
 - How the changes align with research-based recommendations.
- Implementation of changed activity in your classroom (4 points)
 - What worked well? What could be improved in the future?
 - Will you continue using this activity, make changes to it, or revert to what you did before? Why?
 - This is your opportunity to be reflective and demonstrate thoughtfulness.
 - Examples of student work or student comments/feedback would strengthen this section

Guide for Analyzing a Research Article

Key Characteristics of a Research Article

1. What was the purpose of the study?
2. What was (were) the research question(s)?
3. What were the topics of the literature review?
4. What type of research was conducted?
5. What type of sampling was used?
6. How were the data collected?
7. How were the validity and reliability of the data assessed?
8. What descriptive and/or inferential analyses were used?
9. 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. 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?

EDCI 663: Research in STEM Teaching

Action Research Proposal Presentation Guidelines

Literature Review & Action Research Proposal - asking questions about your classroom, using literature to advise your actions and systematically organizing data collection

By the end of this class, you will have a great deal of information about how educational research is conducted and reported. An important part of translating research to practice is for teachers to not only read about research, but conduct action research projects in their own classrooms. For this assignment, you will:

A. Journal Entry 1: Action Research Problem Statement

Identify a problem or situation in STEM teaching that you would like to understand better. Use references to support your discussion of the problem or situation - either/both peer-reviewed and non-peer-reviewed literature can be used in this discussion.

B. Journal Entry 2: Discussion of Action Research Questions

Develop and refine one or more research questions that would guide this project. In your journal, you should discuss what you are interested in understanding better and how the research questions will help you do this.

C. Journal Entry 3: Action Research Literature Review Table

Explore the literature on this topic (10 or more articles) and complete the literature review table & synthesis for at least 10 of these articles. See the table/template linked in Canvas.

D. Final Presentation: Presentation of proposed research

Using your knowledge of methodologies, design a study that would collect data to answer the research questions. Create a presentation to share an overview of the literature, your research questions, and the proposed research design

E. Final Reflection on Action Research Proposal

Write a 1.5-3 page reflection in which you discuss how the literature you read this semester has influenced your thinking about STEM teaching and how action research may help you in terms of your professional growth in the future. This is **not** meant to be a summary of what you learned this semester but rather an opportunity to make connections and look forward in a meaningful way.

Recommended Structure of Final Proposal Presentation:

- Introduction & Literature Review
 - Problem Statement: Introduce topic & significance
 - Statement of purpose and research questions.
 - Literature Review: This section should present the themes you identified in the literature. You should not review studies in “book report style” – instead, seek to discuss the themes and recommendations that you identified as being common across studies.
 - At least 6-8 references (articles and/or books) should be referenced. References should be synthesized, not summarized.
- Research Method
 - Research design & connection to research purpose
 - Participants (describe students in class, including relevant demographic characteristics)
 - Measures/Data Collection Plan
 - Intervention (if applicable: include your control/alternate treatment)
 - Data Collection Procedures (all data you will collect should be described & procedures for collection stated clearly)
 - Ethical considerations
 - Proposed preliminary data analysis (how will you know if “it” worked?)
- APA Style References
 - Include your APA style references on slides at the end of your presentation.

**EDCI 663: Research in STEM Teaching
Action Research Proposal Presentation Rubric**

	No evidence	Beginning	Developing	Accomplished
<p>Problem Statement: The problem or conflict is genuine and of importance to the teacher researcher. The problem is clearly related to STEM instruction and student learning in STEM. The problem is explicitly stated and discussed in terms of classroom impact.</p>				
<p>Research Question: The research question and purpose are clear and concise, stated in “answer-able” terms (in ways that can be addressed by teacher research). The research question(s) follows logically from the problem statement.</p>				
<p>Literature Review: The literature review provides enough background to orient the reader to the current state of knowledge. At least six research studies are used to support the literature review. Literature review synthesizes literature by connecting the studies together (using common themes) and connects the literature back to the importance of the topic. Literature is not presented in book report style.</p>				
<p>Research Method: The connection between the purpose and the research design is explained. Participants, data collection plan, and procedures are explained in enough detail that it is clear what will be done and when. If relevant, measures are shared and discussed. Ethical considerations (including impact on student & researcher biases) are discussed. The plan discusses potential analysis techniques for the type of data collected and the nature of the research questions. <i>(Note that this must be addressed in the presentation using text AND discussion. Do not attempt to put all of these details in your slides.)</i></p>				
<p>Writing, Mechanics & APA: The slides are not overly wordy. The text is appropriately academic, avoiding idioms and colloquialisms. Citations are used appropriately, but direct quotes are used rarely. Uses correct citations based on APA 7th edition and has few or no spelling or grammatical errors. References are provided at the end of the presentation in APA style.</p>				
Total				/30