

GEORGE MASON UNIVERSITY
COLLEGE OF EDUCATION AND HUMAN DEVELOPMENT
GRADUATE SCHOOL OF EDUCATION
ADVANCED STUDIES IN TEACHING AND LEARNING PROGRAM

EDCI 663 001 - Research in Science Teaching
CRN 83058

3 credits, Fall 2017

August 28-December 15

Monday, 7:20 – 10:00 PM, Thompson 1010 and Online



Professor:

Nancy Holincheck, Ph.D., NBCT

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Prerequisite:

Admission to the ASTL Program.

Course Description:

This three-credit graduate course for experienced science and mathematics teachers investigates the research and methodology involved in teaching and learning biological, chemical, physical, and earth sciences from kindergarten through grade twelve.

Course Delivery Methods

This is a hybrid course, with both face-to-face lecture and online components. Face-to-face components comprise approximately 50% of classes. Each face-to-face lecture class will include a variety of activities and exercises, with an emphasis on small group discussion.

Learning Outcomes:

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

- Connect past, present, and future movements in science education reform to research and practice;
- Identify types of research and understand their strengths and weaknesses;
- Examine initiatives taken to strengthen science teaching through research;
- Follow new developments in science research;
- Evaluate the validity of claims in current science teaching research in order to translate the results of research into classroom activities and practice;
- Build a repertoire of research-based science teaching and assessment strategies by reading, writing, observing, participating in, reflecting on, and discussing research on the teaching of science;
- Create activities for students that reflect research in effective science teaching and follow the national, state, and local standards;
- Develop strategies to help students to become scientifically literate, think critically and creatively, and create conceptions of the scientific enterprise, otherwise known as the nature of science; and
- Be fluent in recent research findings that are widely accepted to advise colleagues in their classroom practice.

Relationship to Program Goals and Professional Organizations:

This is the first course in a three-course sequence for experienced science teachers in the science education master's degree programs. The course follows the recommendations of the *National Science Education Standards*, *Benchmarks for Science Literacy*, and *Standards of Learning for Virginia Public Schools*. Additionally, it focuses on implementing the expectations for teaching and learning outlined by the National Council for Accreditation of Teacher Education (NCATE), the National Board of Professional Teaching Standards (NBPTS), and the Interstate School Leaders Licensure Consortium (ISSLC). Students in this course will become familiar with the communities of science education researchers and be able to access information from published findings to implement in class. EDCI 663 expands the teachers' knowledge and skills in research-based assessment and instruction.

These position statements indicate that the core knowledge expectations in science education include:

- Vary their teaching actions, strategies, and methods to promote the development of multiple student skills and levels of understanding.
- Successfully promote the learning of science by students with different abilities, needs, interests, and backgrounds.
- Successfully organize and engage students in collaborative learning using different student group learning strategies.
- Successfully use technological tools, including but not limited to computer technology, to access resources, collect and process data, and facilitate the learning of science.
- Understand and build effectively upon the prior beliefs, knowledge, experiences, and interests of students.
- Create and maintain a psychologically and socially safe and supportive learning environment.

Additionally, this course was designed with a vision for accomplished teaching, as indicated by NBPTS Science Standards for Early Adolescence

(http://www.nbpts.org/userfiles/File/ea_science_standards.pdf) and Adolescence and Young Adulthood (http://www.nbpts.org/userfiles/File/aya_science_standards.pdf) the Five Core Propositions of the National Board for Professional Science 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:

(note that this book may be downloaded for free from the NAP site)

- National Research Council. (2005). *How students learn: Science in the classroom*. Committee on *How People Learn*, A Targeted Report for Teachers, M.S. Donovan and J.D. Bransford, (Eds.) Washington, DC: National Academies Press.

Recommended Texts:

- Abell, S.K. & Lederman, N.G., (Eds.) (2007.) *Handbook on research in science teaching*. Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers.
- American Association for the Advancement of Science, (1993). *Benchmarks for Science Literacy*. New York: Oxford University Press.

- National Research Council. (2013). *Next Generation Science Standards*. Washington, DC: National Academy Press. Retrieved from <http://www.nextgenscience.org/next-generation-science-standards>
- National Research Council (1996) *National Science Education Standards*, Washington, DC: National Academy Press.

Required Access to Course Blackboard Site

Blackboard will be used for the online meetings of this course, as well as to post important information for this course. Announcements and resources are posted on the Blackboard site in between class sessions. You will submit assignments electronically through Blackboard. You are responsible for accessing the materials prior to class. In addition, you will need to login to Blackboard to upload assignments for the course.

Access Blackboard through myMason:

- Go to <http://mymasonportal.gmu.edu>
- Enter your user login and password (the same as your GMU email login & password)
- Click the “Courses” tab at the top of the screen & select your course

Course Performance Evaluation

Students are expected to submit all assignments on time via Blackboard. 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
Actively translating research to practice	How Students Learn Metacognition Nature of Science Knowledge Action Research projects	Paper: Principles for how students learn Lesson revision – applying principles for how students learn Literature Review & Action Research Proposal – asking questions about your classroom, using literature to advise your actions and systematically organizing data collection
Being research consumers	Types of educational research Finding journals Reading research articles Critiquing research articles	Research Article Critique Literature Review & Action Research Proposal – asking questions about your classroom, using literature to advise your actions and systematically organizing data collection
Making informed decisions based on assessment	Standards of Learning Assessments (SOL) National Assessment of Educational Progress (NAEP)	Data display & presentation in class – SOL, NAEP, PISA, TIMSS comparison

data	Trends in International Mathematics and Science Study (TIMSS)	
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1) Paper - Principles for how students learn

The book, *How People Learn: Science in the Classroom*, compiles years of science education research and organizes this information into three principles:

- 1) addressing preconceptions,
- 2) knowledge of what it means to “do science”, and
- 3) metacognition.

In this assignment, you will write a 3-4 page (double-spaced, 1” margins, 12 point font) paper that will:

- A. Describe your interpretation of the three principles
 - i. What does each of the principles mean to you in your teaching?
 - ii. What things need to be done in a classroom to embrace the three principles?
(*think in terms of what students need to do AND what teachers need to do*)
 - iii. What barriers need to be overcome to enact the principles?

- B. Explain the types of activities that should be occurring in a science classroom in order to address preconceptions, do science, and have metacognition.
 - i. This part of the paper can be approached from a general sense – the second assignment (lesson revisions) will explore a specific activity.

2) Lesson revision – applying principles for how students learn

- A. Reflecting on what you have learned from the science education research in the book, *How People Learn: Science in the Classroom*, choose an activity (or series of activities) from your classroom. You will make adaptations to the activity(/ies) to explicitly demonstrate the three principles from the book and you will pilot the changes in your classroom. You will present the adaptations in class. This assignment has three parts, all of which will be presented in class:
 - i. Discuss the original assignment
 - ii. Discuss the changes made and how they align with the three principles
 - iii. Pilot the activity(ies) in your class and share your experiences with the class

3) Discussion & critique of science education research article

A valuable skill for a cutting-edge teacher is to be able to access and discern information from the latest science 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 science education research article and critique it using the Rubric for Article Critique and the Guide for Analyzing a Research Article found at the end of this syllabus. The article must be from either the *Journal of Research in Science Teaching* or *Science Education*. Identify the article and submit it to your classmates via Blackboard email at least one week before the class meeting in which you will present the article.
- B. Lead a class discussion in a face-to-face class related to the article.

4) Exploration of assessment data –NAEP, PISA, TIMSS

It is important that teachers make changes in their classrooms based on research data rather than on only “the flavor of the month”. In this project you will use data to inform your teaching and report on the state of science education in the World, the United States and in Virginia. The purpose of this project is to learn about assessment data gathered about science learning at the national, and international levels. You will learn how one of these assessments is structured, how they collect and analyze data, and what the findings indicate for science teaching and learning. For this assignment you will:

- A. Deepen your understanding of at least one of the following national or international assessments: NAEP, PISA, TIMSS.
- B. Examine education policy research literature related to the most recent administration of the test.
- C. Explore the relevant Data Analysis tool on the Institute for Educational Sciences (IES) website: <http://ies.ed.gov/data.asp> and create a graph or chart of data that is of interest to you. Present to the class with a brief presentation & discussion (5-8 minutes)
 - a. *Your presentation should include a graph or chart of the data you found, but should also include thoughtful discussion questions that draw on class readings as well as other relevant literature.*

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

- A. 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:
 - i. Identify a problem in an educational setting that you would like to explore
 - ii. Develop one or more research question(s) that would guide this project
 - iii. Explore the literature on this topic (minimum 6 articles) and write a 3-5 page review of the literature related to the problem.
 - iv. Using your knowledge of methodologies, design a study that would collect data to answer the research questions
 - v. Report to the class on your questions and design

6) Participation & Professionalism

Class participation and professionalism includes multiple aspects of engagement in our course content, including: the in-class experiences, article critique discussions, peer evaluations of student work, in & out of class work on examination of science education literature, exploration of data and presentation of data. In addition to being present in each class, this part of your grade also includes quality participation in class discussions and professionalism in all communication with your professor and your peers. During our online weeks, it is vital that students stay actively involved in the course modules. *Online classes are not weeks off! Online weeks require engagement in the asynchronous work embedded in the module.*

Points for Assignments:

Paper - Principles for how students learn	20 points
Lesson revision – Applying principles for how students learn	10 points
Discussion & critique of science education research article	10 points
Presentation – SOL, NAEP, PISA, TIMSS comparison	20 points
Action research literature review & proposal	30 points
Participation & Professionalism	10 points
TOTAL	100 points

Grading Scale:

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/policies-procedures/>

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 <http://oai.gmu.edu/the-mason-honor-code/>).
- 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/> .

EDCI 663 Research in Science Teaching Class Schedule: Fall 2017

Date	Topics	What is due
Week 1 Monday, August 28 F2F Meeting	Introduction to research in science teaching: – Current education policy issues in science education – Overview of Learning Theory in the Classroom – Types of Educational Research – Finding Research Articles	
Week 2 Monday, Sept 4	Labor Day Holiday- No class	– Work on readings & draft of paper for 9/18
Week 3 Monday, Sept 11	Online class	– See readings & work in online module
Week 4 Monday, Sept 18	– Discussion- How Students Learn – Metacognition – Nature of Science (NOS)	– Read: Introduction and Chapter 9 in <i>How Students Learn: Science in the Classroom</i> – Bring draft of Assignment #1 – Paper: Principles for how students learn
Week 5 Monday, Sept 25	Online class	– See readings & work in online module – Submit assignment #1 by 11:59 on 9/15 - Paper - Principles for how students learn – Student 1: Email article for next week to classmates & instructor by 11:59 pm
Week 6 Monday, Oct 2	– Ideas for Lesson revision - Assignment #2 – Self-regulation of the nature of science – Consultation on action research questions	– Assignment #3: Student #1 Article critique – Read: either chapter 10 OR 11 in <i>How Students Learn: Science in the Classroom</i> – Read: Article provided by Student 1 – Assignment #5: Bring a list of 2-5 potential research questions to class for workshopping
Week 7 Monday, Oct 9 Tuesday, Oct 10	Online class (Monday 10/9 is Fall Break, Tuesday classes are canceled this week & Monday classes meet on Tuesday)	– See readings & work in online module – Find science education research articles in <i>JRST</i> or <i>SciEd</i> for your lit review/action research proposal – Student 2: Email article for next week to classmates & instructor by 11:59 pm
Week 8 Monday, Oct 16	– Qualitative based methodologies: Data collection & analysis methods	– Assignment #3, Student #2 Article critique – Read: chapter 12 in <i>How Students Learn: Science in the Classroom</i> – Read: Article provided by Student 2 – Present in class: Students 3 & 4: Assignment #2 - Lesson revision – applying principles for how students learn

Week 9 Monday, Oct 23	Online class:	<ul style="list-style-type: none"> – See readings & work in online module – Find science education research articles in <i>JRST</i> or <i>SciEd</i> for your lit review/action research proposal – <i>Student 3: Email article for next week to classmates & instructor by 11:59 pm</i>
Week 10 Monday, Oct 30	<ul style="list-style-type: none"> – Quantitative based methodologies: Data collection & analysis methods 	<ul style="list-style-type: none"> – Assignment #3, Student #3 Article critique – Read: Research articles posted to blackboard – Read: Article provided by Student 3 – Present in class: Students 1 & 2: Assignment #2 - Lesson revision – applying principles for how students learn
Week 11 Monday, Nov 6	Online class	<ul style="list-style-type: none"> – See readings & work in online module – Find science education research articles in <i>JRST</i> or <i>SciEd</i> for your lit review/action research proposal – Work on literature review for action research proposal – <i>Student 4: Email article for next week to classmates & instructor by 11:59 pm</i>
Week 12 Monday, Nov 13	<ul style="list-style-type: none"> – Consultation on action research questions – Critical Friend/Instructor feedback on Literature Review – Discuss methodologies for action research – Collecting data 	<ul style="list-style-type: none"> – Assignment #3, Student #4 Article critique – Read: Research articles posted to blackboard – Read: Article provided by Student 4 – Assignment #5: Bring draft of literature review to class
Week 13 Monday, Nov 20	Online class	<ul style="list-style-type: none"> – See readings & work in online module – <i>Work on action research proposal</i>
Week 14 Monday, Nov 27	<ul style="list-style-type: none"> – Critical friend feedback on methods – Exploring SOL, NAEP, PISA, TIMMS 	DUE: Assignment #4: Present data (chart or graph) & discussion from Exploration of assessment data
Week 15 Monday, Dec 4	Online class	<ul style="list-style-type: none"> – See readings & work in online module – <i>Work on action research proposal</i>
Week 16 Monday, Dec 11	<ul style="list-style-type: none"> – Compare chart categories and information 	<p>Present action research question, overview of literature</p> <p>DUE: Assignment #5: Action Research: Literature Review & Proposal: submit to BB by 11:59 pm on Monday, 12/11</p>

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?

Rubric for Principles of How Students Learn Paper

	No Evidence 0	Developing 2	Accomplished 4	SCORE
Personal connections to the 3 principles of <i>How Students Learn</i>	Provides <i>no</i> discussion of personal connections	Provides discussion of how each of the principles connects to <u>her/his</u> teaching. Connection to the text is evident, but ideas may not be clearly synthesized or restated.	Provides thorough and thoughtful discussion of how each of the principles connects to <u>her/his</u> teaching. Synthesis of the material is evident—ideas from the text & from class are discussed in the writer’s own words.	
System changes required for each principle to be embraced broadly	Provides <i>no</i> discussion of systemic changes that would be required	Provides limited discussion of systemic (cultural, national, district or school-wide) changes that may be required for each of the principles to be embraced.	Thoughtfully discusses systemic (cultural, national, district or school-wide) changes that may be required for each of the principles to be embraced.	
Personal changes required for each principle to be embraced in your classroom	Provides no discussion of personal changes	Provides limited discussion of personal (classroom-based) changes that may be required for each of the principles to be embraced.	Thoughtfully discusses personal (classroom-based) changes that may be required for each of the principles to be embraced.	
Barriers to the implementation of changes (both systemic & personal)	Provides no discussion of barriers to implementation	Provides limited discussion of barriers to implementing the changes discussed (both systemic & personal).	Thoughtfully and thoroughly discusses barriers to implementing the changes discussed (both systemic & personal).	
Classroom connections: explanation of types of activities & specific examples from your teaching	Provides no discussion of classroom connections.	Provides broad examples of relevant activities to connect the principles of <i>How students learn</i> to real classroom experiences based on his/her teaching. Provides limited explanation of how these examples connect to the principles.	Provides clear & specific* examples of relevant activities to connect the principles of <i>How students learn</i> to real classroom experiences, based on her/his teaching. Thoroughly explains how these examples connect to the principles.	
Total Score				

**Note that specific examples should be provided, but only limited discussion of these examples is required. The Lesson Revision assignment provides you an opportunity to choose one of these examples & explore in greater depth.*

Approximate point breakdown for Assignment #2: Lesson Revision (10 points)

In class discussion 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 the three principles in *How People Learn: Science in the Classroom*
- 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

Approximate point breakdown for Assignment #3: Discussion & critique of science education research article (10 points)

- Article focuses on a relevant issue in Science Education. Article is submitted to peers by (at least) one week before discussion in class (1/10 points)
- In-class discussion: Student discussant should *lead* discussion around each of the following topics
 - Salient points of article (1/10 points)
 - Strengths & weaknesses of article (2/10 points)
 - How the article relates to his/her own teaching (2/10 points)
 - How the article relates to classmates' teaching (2/10 points)
 - Potential avenues for future research (2/10 points)

EDCI 663: Research in Science Teaching Action Research Proposal 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:

- i. Identify a problem in an educational setting that you would like to explore*
- ii. Develop one or more research question(s) that would guide this project*
- iii. Explore the literature on this topic (6-8 articles) and write a 3-5 page review of the literature related to the problem.*
- iv. Using your knowledge of methodologies, design a study that would collect data to address the research questions*
- v. Report to the class on your questions and design*

Recommended Structure of Proposal:

- Introduction & Literature Review
 - Problem Statement: Introduce topic & significance
 - Statement of purpose and research questions.
 - Literature Review: This section should include a relevant literature review to demonstrate a basic level of knowledge of the research that has already been accomplished in the field of interest. If you are replicating & extending a previous study, be sure to describe the original work. Approximately 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

**EDCI 663: Research in Science Teaching
Action Research Proposal Rubric**

	Excellent	Good	Fair	Poor
<p>Problem Statement: The problem or conflict is genuine and of importance to the teacher researcher. The problem is clearly related to science instruction and student learning in science. The problem is explicitly stated and discussed in terms of classroom impact.</p>	3	2	1	0
<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). Research question follows logically from the problem statement.</p>	3	2	1	0
<p>Literature Review: 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. The studies are appropriate for the topic. Analysis of the literature is well developed. It connects directly to the problem statement and the research question. 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>	9	7	5	0-4
<p>Research Method Connection between the purpose and the research design is described. The characteristics of the study participants are well described. Measures are adequately described. Measures will collect data that will, in fact, allow the questions to be answered. The procedure described in enough detail that it is clear what will be done and when. The plan will enable the researcher to answer the research questions. 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.</p>	9	7	5	0-4
<p>Writing, Mechanics & APA: Voice is appropriately academic, avoiding idioms and colloquialisms. Citations are used appropriately, but direct quotes are used rarely. Paper uses correct spelling, punctuation, sentence structure, word usage, and correct use of APA in body of paper, citations, and reference page.</p>	6	4	2	0-1
Total	/30			