

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

**EDCI 663 001 & EDCI 663 002**  
**CRN 74725 & 81657**  
**Research in Science Teaching**  
**Fall 2014**

**Meeting Days/Times:**  
August 25-December 15  
Monday, 4:30-7:10



**Professor:**

**Nancy Holincheck, Ph.D., NBCT**

**Office Hours:** By appointment. Online via skype or collaborate by appointment.

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**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.

**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](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](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.

### **Nature of Course Delivery:**

Each face-to-face class will include a variety of activities and exercises. Some of the sessions will be conducted through use of the course Blackboard site

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

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

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

Students are expected to:

- Write papers that are well researched, proofed, submitted in a timely fashion, and that conform to APA guidelines;
- Participate actively in class discussions in a manner that challenges the best thinking of the class;
- 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.

### **Texts:**

#### Required

- 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

- 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 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

## Online Resources:

### National Standards

- American Association for the Advancement of Science (1989). *Science for All Americans*. Online: <http://www.project2061.org/tools/sfaaol/sfaatoc.htm>
- American Association for the Advancement of Science (1993). *Benchmarks for Science Literacy*. Online: <http://www.project2061.org/tools/benchol/bolframe.htm>
- National Research Council (1996) *National Science Education Standards*, Washington, DC: National Academy Press. Online: [http://www.nap.edu/openbook.php?record\\_id=4962](http://www.nap.edu/openbook.php?record_id=4962)
- American Association for the Advancement of Science (2000). *Atlas of Science Literacy*. Online: <http://www.project2061.org/publications/atlas/toc.htm>
- National Research Council. (2013). *Next Generation Science Standards*. Washington, DC: National Academy Press. Retrieved from <http://www.nextgenscience.org/next-generation-science-standards>

### Science Education Assessment Data

- Trends in International Mathematics and Science Study (TIMSS) <http://isc.bc.edu/>
- Program for International Student Assessment (PISA) <http://nces.ed.gov/surveys/pisa/>
- National Assessment for Educational Progress (NAEP) <http://nces.ed.gov/nationsreportcard/about/>
- Virginia Standards of Learning Assessment [http://www.doe.virginia.gov/testing/sol/standards\\_docs/](http://www.doe.virginia.gov/testing/sol/standards_docs/)

## Grading:

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 automatically 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	<b>Paper:</b> Principles for how students learn <b>Lesson revision</b> – applying principles for how students learn <b>Literature Review &amp; Action Research Proposal</b> – 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	<b>Two critiques</b> - research articles <b>Literature Review &amp; Action Research Proposal</b> – asking questions about your classroom, using literature to advise your actions and systematically organizing data collection
Making informed decisions based on assessment data	Standards of Learning Assessments (SOL) National Assessment of Educational Progress (NAEP) Trends in International Mathematics and Science Study (TIMSS)	<b>Data display &amp; presentation in class</b> – SOL, NAEP, PISA, TIMSS comparison

### 1) Paper - Principles for how students learn

- A. 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:
  - B. 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?
  - C. 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. 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:
- B. 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.
- C. Lead a class discussion in a face-to-face class related to the article. .

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

- A. 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:
- i. Deepen your understanding of at least one of the following national or international assessments: NAEP, PISA, TIMSS.
  - ii. Examine education policy literature related to the most recent administration of the test.
  - iii. Contribute to a class wiki in which the state, national and international tests are compared & contrasted.
  - iv. 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.

## 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 (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 answer the research questions
  - v. Report to the class on your questions and design

### 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
Data display – SOL, NAEP, PISA, TIMSS comparison	20 points
Action research literature review & proposal	30 points
Participation & Professionalism	10 points
<b>TOTAL</b>	<b>100 points</b>

### Grading Scale:

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

### Grading:

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 automatically 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.



### EDCI 663 Research in Science Teaching Class Schedule: Fall 2014

Date	Topics	Homework due
<b>Week 1</b> <b>Monday,</b> <b>August 25</b>	Introduction to research in science teaching: <ul style="list-style-type: none"> <li>– Current education policy issues in science education</li> <li>– Overview of Learning Theory in the Classroom</li> <li>– Types of Educational Research</li> <li>– Finding Research Articles</li> </ul>	
<b>Monday,</b> <b>Sept 1</b>	<b>Labor Day Holiday- No class</b>	<ul style="list-style-type: none"> <li>– <i>Work on readings &amp; draft of paper for 9/8</i></li> </ul>
<b>Week 3</b> <b>Monday,</b> <b>Sept 8</b>	<ul style="list-style-type: none"> <li>– Discussion- How Students Learn</li> <li>– Metacognition</li> <li>– Nature of Science (NOS)</li> </ul>	<ul style="list-style-type: none"> <li>– <b>Read:</b> Introduction and Chapter 9 in <i>How Students Learn: Science in the Classroom</i></li> <li>– Bring draft of Assignment #1 – Paper: Principles for how students learn</li> </ul>
<b>Monday,</b> <b>Sept 15</b>	<b>Online class</b>	<ul style="list-style-type: none"> <li>– <b>Submit assignment #1 by 11:59 on 9/15 - Paper - Principles for how students learn</b></li> <li>– <i>Student 1: email article for next week to classmates &amp; instructor by 11:59 pm</i></li> </ul>
<b>Week 5</b> <b>Monday,</b> <b>Sept 22</b>	<ul style="list-style-type: none"> <li>– Ideas for Lesson revision - Assignment #2</li> <li>– Self-regulation of the nature of science</li> <li>– Consultation on action research questions</li> </ul>	<ul style="list-style-type: none"> <li>– <b>Assignment #3: Student #1 Article critique</b></li> <li>– <b>Read:</b> either chapter 10 OR 11 in <i>How Students Learn: Science in the Classroom</i></li> <li>– <b>Read:</b> article provided by Student 1</li> <li>– <b>Assignment #5: Bring a list of 2-5 potential research questions to class for workshopping</b></li> </ul>
<b>Monday,</b> <b>Sept 29</b>	<b>Online class</b>	<ul style="list-style-type: none"> <li>– Find science education research articles in <i>JRST</i> or <i>SciEd</i> for your lit review/action research proposal</li> <li>– <i>Student 2: email article for next week to classmates &amp; instructor by 11:59 pm</i></li> </ul>
<b>Week 7</b> <b>Monday,</b> <b>Oct 6</b>	<ul style="list-style-type: none"> <li>– Qualitative based methodologies: Data collection &amp; analysis methods</li> </ul>	<ul style="list-style-type: none"> <li>– <b>Assignment #3: Student #2 Article critique</b></li> <li>– Read: chapter 12 in <i>How Students Learn: Science in the Classroom</i></li> <li>– <b>Present in class: Students 3 &amp; 4: Assignment #2 - Lesson revision – applying principles for how students learn</b></li> </ul>

<b>Monday, Oct 13</b>	<b>Online class:</b> Columbus week, Monday class “meets” on Tuesday:	<ul style="list-style-type: none"> <li>– Find science education research articles in <i>JRST</i> or <i>SciEd</i> for your lit review/action research proposal</li> <li>– <i>Student 3: email article for next week to classmates &amp; instructor by 11:59 pm</i></li> </ul>
<b>Week 9 Monday, Oct 20</b>	<ul style="list-style-type: none"> <li>– Quantitative based methodologies: Data collection &amp; analysis methods</li> </ul>	<ul style="list-style-type: none"> <li>– <b>Assignment #3: Student #3 Article critique</b></li> <li>– <b>Read:</b> Research articles posted to blackboard</li> <li>– <b>Present in class: Students 1 &amp; 2: Assignment #2 - Lesson revision - applying principles for how students learn</b></li> </ul>
<b>Monday, Oct 27</b>	<b>Online class</b>	<ul style="list-style-type: none"> <li>– Find science education research articles in <i>JRST</i> or <i>SciEd</i> for your lit review/action research proposal</li> <li>– Work on literature review for action research proposal</li> <li>– <i>Student 4: email article for next week to classmates &amp; instructor by 11:59 pm</i></li> </ul>
<b>Week 11 Monday, Nov 3</b>	<ul style="list-style-type: none"> <li>– Consultation on action research questions</li> <li>– Discuss methodologies for action research – collecting data</li> </ul>	<ul style="list-style-type: none"> <li>– <b>Assignment #3: Student #4 Article critique</b></li> <li>– <b>Read:</b> Research articles posted to blackboard</li> <li>– <b>Assignment #5: Bring draft of literature review to class</b></li> </ul>
<b>Monday, Nov 10</b>	<b>Online class</b>	<ul style="list-style-type: none"> <li>– <i>Work on action research proposal</i></li> </ul>
<b>Week 13 Monday, Nov 17</b>	<ul style="list-style-type: none"> <li>– SOL, NAEP, PISA, TIMMS</li> </ul>	<ul style="list-style-type: none"> <li>– <i>Assignment #4: Exploration of assessment data –NAEP, PISA, TIMSS start during class, complete by 11/24</i></li> <li>–</li> </ul>
<b>Monday, Nov 24</b>	<b>Online class</b>	<ul style="list-style-type: none"> <li>– <i>Work on action research proposal</i></li> <li>– <b>Complete Assignment #4: Exploration of assessment data –NAEP, PISA, TIMSS</b></li> </ul>
<b>Week 15 Monday, Dec 1</b>	<ul style="list-style-type: none"> <li>– Compare chart categories and information</li> </ul>	Present Action research question, overview of literature &
<b>Monday, Dec 8</b>	<b>Online class</b>	<b>DUE: Action Research: Literature Review &amp; Proposal: submit to BB by 11:59 pm on Monday, 12/8</b>

## 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?