George Mason University
College of Education and Human Development
Graduate School of Education

EDCI 663
Research in Science Teaching
Fall 2013

Instructor:	Erin E. Peters-Burton, PhD, NBCT
Date and Time:	August 26th – December 18, 2013 (Tuesdays, 4:30 – 7:10 pm)
Class Location:	**Innovation Hall 328**
Telephone:	703-993-9695
E-mail:	epeters1@gmu.edu
Office:	Thompson 1404
Office Hours:	By appointment

Online Syllabus and Resources: http://mymasonportal.gmu.edu/

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.

Goals: The class is organized into three major themes:

Theme	Subtopics
Actively translating research to practice	How Students Learn Metacognition Nature of Science Knowledge Action Research projects
Being research consumers	Types of educational research Finding journals Reading research articles Critiquing research articles
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)

The learning targets for the class are:

- 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.

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:

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

Students are expected to:

a. Write papers that are well researched, proofed, submitted in a timely fashion, and that conform to APA guidelines;
b. Participate actively in class discussions in a manner that challenges the best thinking of the class;
c. Provide constructive feedback to others both on their ideas and on their written work, striving to learn from each other and to test each other's ideas.

We will endeavor to create a classroom climate that approximates what we know about communities of practice. As such, it is important that we create a space that allows participants to try out new ideas and voice opinions without fear of ridicule or embarrassment. The hallmark of a community of practice is a balance between openness and constructive feedback; hence, everyone is expected to:

a. Come fully prepared to each class;
b. Demonstrate appropriate respect for one another;
c. Voice concerns and opinions about class process openly;
d. Recognize and celebrate each other's ideas and accomplishment;
e. Show an awareness of each other's needs.

CEHD Syllabus Statements of Expectations

The College of Education and Human Development (CEHD) expects that all students abide by the following:

- Professional Behavior and Dispositions. Students are expected to exhibit professional behavior and dispositions. See gse.gmu.edu for a listing of these dispositions.
- All students must abide by the following:
  Students are expected to exhibit professional behavior and dispositions. See
- http://gse.gmu.edu/facultystaffres/profdisp.htm for a listing of these dispositions.
  Students must follow the guidelines of the University Honor Code. See http://oai.gmu.edu/honor-code/<http://oai.gmu.edu/honor-code> and http://universitypolicy.gmu.edu/policies/responsible-use-of computing/<http://universitypolicy.gmu.edu/1301gen.html> for the full honor code.
- Disabilities. Students with disabilities who seek accommodations in a course must be registered with the GMU Disability Resource Center (DRC) and inform the instructor,

in writing, at the beginning of the semester. See www.gmu.edu/student/drc or call 703-993-2474 to access the DRC.

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.

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
- 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/

Grading:

Since this is a graduate level course, high quality work is expected on all assignments and in class. Attendance at all classes for the entire class is a course expectation. All assignments must be completed to receive a passing grade for the course. All assignments are due at the beginning of class on the day they are due. 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.

Performance Based Assessments:

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

- Actively translating research to practice
  - Paper - Principles for how students learn
  - Lesson revision – applying principles for how students learn
  - Action research design – asking questions about your classroom and systematically organizing data collection
- Being research consumers
  - Two critiques - research articles
  - Lesson revision – informed by core ideas in selected NARST strand
- Making informed decisions based on assessment data
  - Data display – SOL, NAEP, TIMSS comparison
  - Power Point – presentation of SOL, NAEP, and TIMSS findings

Actively Translating Research to Practice

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 paper that will:

- Describe your interpretation of the three principles
  - What does each of the principles mean to you in your teaching?
  - What things need to be done in a classroom to embrace the three principles? (think students AND teachers)
  - What barriers need to be overcome to enact the principles?

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

2) Lesson revision – applying principles for how students learn

Reflecting on what you have learned from the science education research in the book, *How People Learn: Science in the Classroom*, choose an activity (series of activities) from your classroom. You will make adaptations to this activity(ies) to explicitly demonstrate the three principles from the book and present the adaptations in class. This assignment has two parts:

- Discuss the original assignment
- Discuss the changes made and how they align with the three principles
- Pilot the activity(ies) in your class and give a brief oral report to the class

3) Action Research Design - asking questions about your classroom 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:

- Identify a problem in an educational setting that you would like to explore
- Develop research questions that would guide this project
- Using your knowledge of methodologies, design a study that would collect data to answer the research questions
- Report to the class on your questions and design

Being research consumers

4) Two critiques - research articles

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:

- Choose one research article that uses primarily <u>qualitative</u> research methods 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*. Be sure to submit your analysis AND a copy of the article.
- Choose one research article that uses primarily <u>quantitative</u> research methods 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*. Be sure to submit your analysis AND a copy of the article.

5) Lesson revision – informed by core ideas in selected NARST strand

The National Association for Research in Science Teaching (NARST) is the premiere science education research organization in the United States. Each spring, the members of NARST gather to present their findings from the latest research in science education. Teachers who wish to be informed of the most recent research in science teaching and learning will find a plethora of information from this organization. For this assignment students will:

- Examine the 15 topic strands that NARST supports (ex: Strand 9 is Reflective Practice) and choose a topic of interest
- Review the abstracts from the last NARST conference to find trends in the types of problems the educational researchers are exploring
- Identify one major trend in their chosen topic strand and present these trends (this may be done individually or in a small group)
- Adapt a lesson to reflect the most current research findings (also alone or in a small group) and post the lesson adaptations online with a written explanation of the changes
- Comment on 2 other lesson postings on the blackboard site

6) Data display – SOL, NAEP, PISA, TIMSS comparison

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 state, national, and international levels. You will learn how assessments are structured, how they collect and analyze data, and what the findings indicate for science teaching and learning. For this assignment you will:

- Individually prepare a *chart or other method of displaying data* that compares the assessment and evaluation process and outcomes for the SOL, NAEP, PISA, and TIMSS. Your information should have categories to compare the assessment programs (i.e. who, what, when, where, how, why, publications, dates, grade levels, etc.), methods for developing the assessments (i.e. who, what, when, where, how, and why), collection process and procedures, data analysis process and procedures, and the most current findings. *The most effective charts have many well-focused categories that make comparisons across assessments easy.*

7) Power Point – presentation of SOL, NAEP, and TIMSS findings

In small groups, you will prepare a *PowerPoint presentation* summarizing the findings for each assessment. Plan a 20-minute presentation that would be suitable to present to parents or fellow teachers. Your PowerPoint presentation should clearly show the findings for the SOL, NAEP, PISA, and TIMSS and how these findings can be addressed in the classroom.

Points for Assignments:

Paper - Principles for how students learn	10 points
Lesson revision – applying principles for how students learn	10 points
Action research design	10 points
Qualitative research article critique	15 points
Quantitative research article critique	15 points
Lesson revision – informed by core ideas in selected NARST strand	10 points
Data display – SOL, NAEP, PISA, TIMSS comparison	20 points
Power Point – presentation of SOL, NAEP, PISA, and TIMSS findings	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%

EDCI 663 Research in Science Teaching

Schedule

Date	Topics	Homework due the following week
Tuesday, August 27	Introduction Syllabus How People Learn Science Learning Theory in the Classroom	* Read Introduction and Chapter 9 in *How Students Learn: Science in the Classroom* * Choose of the following chapters to read in the same book: 10,11, or 12 * Assignment #1 - Paper - Principles for how students learn
Tuesday, Sept 3	Discussion- How Students Learn Metacognition Nature of Science (NOS)	* Choose another chapter to read in *How Students Learn: Science in the Classroom*: 10, 11, or 12 * Assignment #2 - Lesson revision – applying principles for how students learn
Tuesday, Sept 10	Presentation of Assignment #2 Self-regulation of the nature of science	* NOS readings
Tuesday, Sept 17	Nature of Science Activities Lesson Adaptations	
Tuesday, Sept 24	Types of Educational Research Finding Research Articles	* Find a qualitative and quantitative science education research article in *JRST or SciEd (ongoing)*
Tuesday, Oct 1	ONLINE Class – Find articles	* Find a qualitative and quantitative science education research article in *JRST or SciEd (ongoing)*
Tuesday, Oct 8	Qualitative based methodologies Action Research	*Assignment #4 - Work on article critiques
Columbus Day – No Tuesday Classes – Monday classes meet on Tuesday		
Tuesday, Oct 22	Quantitative based methodologies	*Assignment #4 – both written critiques due
Tuesday, Oct 29	Brief description of research from articles Choosing a NARST strand	*Assignment #3 – action research question

Tuesday, Nov 5	Consultation on action research questions Review Abstracts from past NARST conferences	* Assignment #3 – methodology for collecting data *Assignment #5 – present trends for chosen topic strand
Tuesday, Nov 12	Present trends in NARST topic strand	* Assignment #5 - Post adapted lesson for NARST topic strand online
Tuesday, Nov 19	Online class – discussion board on NARST trends	*Assignment #5 - comment on 2 posted lesson plans
Tuesday, Nov 26	SOL NAEP PISA TIMMS	*Assignment #6 – write up chart categories and fill in as much as you can * Assignment #3 – present action research questions and methods
Tuesday, Dec 3	Compare chart categories and information Present Action Research Project ideas – questions and methods	* Assignment #6 – presentation of SOL, NAEP and TIMMS information
Tuesday, Dec 10 or Dec 17	Present SOL, NAEP, and TIMMS findings	

Data Display Rubric: SOL, NAEP and TIMSS

CATEGORY	4 Advanced	3 Proficient	2 Emerging	1 Not Met
Categories	Wide variety of categories on chart	Adequate variety of categories on chart	A few categories missing to form a complete picture of the assessment	Many categories missing from chart
Observations	Quantitative observations were accurate and included units Qualitative observations were clear, consistent, and detailed	Quantitative observations were mostly accurate and units were included Qualitative observations were clear	Quantitative observations were inconsistent but units were included Qualitative observations were not complete	Quantitative observations were inconsistent and units were missing Qualitative observations were missing
Data Analysis	Analysis techniques were appropriate for the data collected and accurately performed	Analysis techniques were appropriate and had only a few errors	Analysis techniques were inappropriate and had many errors	Analysis techniques were missing or not comprehensible
Findings	Conclusions and evidence from data are very tightly connected and the connections are explained clearly	Conclusions and evidence from data are connected and the some of the connections are explained in the report	Conclusions and evidence from data are not connected or the connections are not clearly explained	Conclusions and evidence from data are contradictory and the connections are not explained at all
How assessments are structured, how they collect and analyze data	Background knowledge about the problem and conclusions are very tightly connected and the connections are explained clearly Background knowledge is accurate	Conclusions and background knowledge are connected and the some of the connections are explained in the report Background knowledge is accurate	Conclusions and background knowledge are not connected or the connections are not clearly explained Background knowledge is mostly accurate	Conclusions and background knowledge are contradictory and the connections are not explained Background knowledge is not accurate

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?