EDCI 663 Research in Science Teaching
Spring 2005

Monday 4:30 - 7:10 PM, A412 Robinson Hall
3 graduate credits

Donna R. Sterling
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Online Syllabus and Resources:  http://blackboard.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 teacher will:

- Follow new developments in science research;
- Identify past, present, and future movements in science education reform;
- Evaluate local, state, and national science education standards;
- Build a repertoire of research-based science teaching and assessment strategies by reading, writing, observing, participating in, reflecting on, and discussing the teaching of science;
- Create laboratory 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 see relationships among science, mathematics, technology, and society;
- Adapt science lessons and hands-on experiences to address the needs of a variety of student populations, for example, the learning disabled, gifted and talented, minority and culturally diverse groups; and
- Work collaboratively with peers to teach and discuss science and science teaching.

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 Donna R. Sterling, Center for Restructuring Education in Science and Technology, George Mason University

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). EDCI 663 expands the teachers’ knowledge and skills in research-based assessment and instruction.

Nature of Course Delivery:

Most class sessions start with approximately 40 minutes of cooperative or collaborative group activities based on the project that is due that week. This is an opportunity to share what you have developed and to expand your repertoire. During the rest of class, a variety of teaching and learning strategies will be used to explore the themes of the week. All students will continuously analyze and evaluate teaching strategies, as well as, science content and processes. Please dress for hands-on (occasionally messy) problem solving activities that will require mental and physical activity.

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.
• University Honor Code. Students must follow the guidelines of the University Honor Code. See http://www.gmu.edu/catalog/apolicies/#TOC_H12 for the full honor code.
• Responsible Use of Computing. Students must agree to abide by the university policy for Responsible Use of Computing. See http://mail.gmu.edu and click on Responsible Use of Computing at the bottom of the screen.
• 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:


Online Resources:

Donna R. Sterling, Center for Restructuring Education in Science and Technology, George Mason University
National Standards

- American Association for the Advancement of Science (200?). *Atlas of Science Literacy*. Online flash movie: [http://www.project2061.org/video/atlas/promo.htm](http://www.project2061.org/video/atlas/promo.htm)

Virginia Standards


Assessment

- Trends in International Mathematics and Science Study (TIMSS) [http://isc.bc.edu/](http://isc.bc.edu/)
- National Assessment for Educational Progress (NAEP) [http://nces.ed.gov/nationsreportcard/about/](http://nces.ed.gov/nationsreportcard/about/)
- Standards of Learning Assessment (SOLA) (SOLA) [http://www.pen.k12.va.us/VDOE/](http://www.pen.k12.va.us/VDOE/)

Measurement

- NCTM Position Statement on Metrication [http://www.nctm.org/about/position_statements/position_statement_09.htm](http://www.nctm.org/about/position_statements/position_statement_09.htm)
- History - A chronology of the SI metric system [http://lamar.colostate.edu/~hillger/dates.htm](http://lamar.colostate.edu/~hillger/dates.htm)

Research

- Bloom’s Taxonomy [http://www.coun.uvic.ca/learn/program/hndouts/bloom.html](http://www.coun.uvic.ca/learn/program/hndouts/bloom.html)
- [http://www.officeport.com/edu/blooms.htm](http://www.officeport.com/edu/blooms.htm)
• Multiple Intelligences - Howard Gardner  
 http://www.pz.harvard.edu/PIs/HG.htm  

• Wait Time - Mary Budd Rowe  

Postponement of Class

When inclement weather or other unforeseen events causes the class to be cancelled or the university to close, the canceled class session will be combined with the following week’s session. If more than one class is cancelled, makeup classes will be scheduled. Please check the class Blackboard website to confirm the date, time, and place of makeup sessions and/or class schedule revisions. All assignment due dates will remain the same and not be postponed. Assignments due for canceled classes will be emailed as an attachment to the instructor or turned in during the next class along with any assignments due that class.

2005 Themes

National, State, and Local Science Education Standards and Reform Movements  
International, National, and State Science and Mathematics Education Assessment  
Measurement Skills, Experimental Design, and Data Analysis  
Education Research

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. Each graded assignment will be assessed using a scoring rubric. Approximately half the rubric will be based on fulfilling the specified criteria for the project and half the rubric will be based on the quality of work. 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.

5% Science in the News  
20% National, State, and Local Standards Comparison Chart  
25% SOL, NAEP, and TIMSS Comparison Chart and Presentation  
20% Measurement Skills, Experimental Design, and Data Analysis Teaching Materials  
20% Journal Article Critiques (2)  
10% Science Experiment Critique

Assignments:

Donna R. Sterling, Center for Restructuring Education in Science and Technology, George Mason University
All written assignments are to be word-processed. On the cover page include your name(s), course title, project title, date, and as appropriate describe the target student population including the grade level, subject, and unit of study. Staple all pages in one assignment together. Make each project something that you could actually use in your teaching.

Since mathematics is embedded in science, mathematics teachers will focus on science applications of mathematics.

Science in the News. Each class session two students will share science, education, or science education news articles. The purpose of these discussions is to follow the changing field of science as it evolves, in particular research discoveries. The discussion will be 10-15 minutes long and be the first class activity most weeks. The presentations are to be informative to your peers. All sources are to be cited and only news published or reported from the date of the last class to the day of the presentation is to be presented. Use common news sources such as newspapers, the television news, or online news. Consider sharing several news events and then having a brief group discussion on one issue.

National, State, and Local Standards Comparison Chart. Using the tables function on your word processor, you will each create a chart that compares the science education standards at the national, state, and local levels. The chart will be several pages long and created over several weeks with a work in progress copy shared in class and turned in as listed on the schedule. In class, you will be part of a heterogeneous working group that shares your individual findings for the mutual benefit of all group members. The comparison chart will be shared for the first time with only the two national science education movements on it. The second time the chart will have the national and state standards on it. The finished chart will include the:

- Benchmarks for Science Literacy,
- National Science Education Standards,
- Standards of Learning for Virginia Public Schools or your state standards,
- your local program of studies.

List the four different standards that you are comparing across the top of the chart. Down the side of the chart develop appropriate categories to compare the movements such as who, what, when, where, how, why, publications, dates, grade levels, strengths, weaknesses, etc. As the last entry(s), choose a science topic and compare in the table how this topic is addressed by each set of standards. The most effective charts have many well-focused categories that make comparisons across reform movements easy.

You will bring your local school district program of studies (mapping document) for science to class. You and the other people from your school district will present a 15-minute overview of the POS/Mapping Document including what you think are the strengths and weaknesses. The presentations will be adapted (as determined in class) to the number of people from each school district.

SOL, NAEP, and TIMSS Comparison Chart and PowerPoint Presentation. The purpose of this project is to learn about assessment and evaluation for science teaching and learning at the state, national, and international levels. You will learn how evaluation programs are set up, how they collect and analyze data, and what the findings indicate for science and
mathematics teaching and learning? You will individually prepare a chart that compares the assessment and evaluation process and outcomes for the SOL, NAEP, and TIMSS. List the assessments you are comparing across the top of the chart. Down the side of the chart develop 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 findings. At the end include what you think are the strengths and weaknesses for each assessment. The most effective charts have many well-focused categories that make comparisons across assessments easy.

Additionally 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, and TIMSS and be easily readable by the audience.

Measurement, Experimental Design, and Data Analysis Teaching Materials. This is a group project where your team will design and create new teaching materials or student activities to use in your classes to help students learn measurement skills, the experimental design process, and/or data analysis. Small groups will be established by grade level. The number of new items to be developed is determined by multiplying the number of the people in the group by three (i.e. 2 people X 3 = 6 new items). At least the equivalent of one item per person should be hands-on laboratory-oriented. Be creative but practical about the items that you create. These should be something that you will really use. Consider creating/revising experiments, demonstrations, overhead transparencies, assessment instruments, posters, handouts, worksheets, etc. Each item you create needs to be ready to use. Write on or attach a sticky note to each item identifying the SOL and telling how and when you would use it. All materials will be shared and critiqued in class.

If you have access to science fair projects please bring in two projects (two different abilities) that we can use in class to analyze student understanding of experimental design.

Journal Article Critiques. You will write two research article critiques on effective science/mathematics teaching, one from each of the science education research journals *Science Education* and *Journal of Research in Science Teaching*. Each critique (~1500-2000 words, I am not counting) will include a brief summary of the major points of the article (~25% of the paper) and a thorough critique of the research including pros and cons (~75% of the paper). In the journals, you are looking for the recent seminal pieces of research on effective science teaching. Check the last several years in choosing your article. These journals can be found in the GMU library and some school division libraries. Check the schedule for each specific journal due date.

Start your article critique with a complete citation in APA format for the article. In the body of the critique, use headings to divide your paper into logical sections. Your critiques are to be individually written, but edited before they are due by a member of this class. For editing purposes the articles will be exchanged via email. When you edit an article, you will use the “track changes” tool in your word processing program. When you turn in the final copy of your
critique, also turn in a printout of the edited version you received. You will share ideas about the articles, the editing process, and the journals in class.

**Science Experiment Critique.** You are to photocopy a science experiment on a topic that you teach. You will critique the laboratory experiment, identifying pedagogical strategies and styles, accuracy of the science and mathematics, the strengths and weaknesses of the lab, state and national standards addressed by the lab, and ways to improve the lab. As appropriate identify and critique process skills, levels of questions, experimental design features, parts of the learning cycle, scientific methods, materials management, integration with other subjects, and applications to the real world. All comments will be written directly on the photocopy. You will also critique an experiment from one other student in the class who has already analyzed his/her experiment. Each person should write in a different color of ink. Both peoples' name will be included on the lab critiques.

At the end of the experiment or on a separate page, summarize how this experiment does or doesn’t demonstrate the application of research. Be sure to cite specific research.
# EDCI 663 Research in Science Teaching

## Spring 2005 Schedule

<table>
<thead>
<tr>
<th>Date</th>
<th>Topics</th>
<th>Projects Due</th>
</tr>
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<tbody>
<tr>
<td><strong>January 24</strong></td>
<td><strong>Introduction</strong>&lt;br&gt;Data Driven Decision Making&lt;br&gt;Research in Science Teaching&lt;br&gt;Syllabi&lt;br&gt;Science in the News - groups</td>
<td><em>(Stds Comparison Chart - Nat’l Std)</em>&lt;br&gt;Science in the News - ______ &amp; ______</td>
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<tr>
<td><strong>January 31</strong></td>
<td><strong>National Science Standards</strong>&lt;br&gt;50 yrs of science and math reform&lt;br&gt;Science in the News</td>
<td><em>(Stds Comparison Chart - Virginia)</em>&lt;br&gt;Science in the News - ______ &amp; ______</td>
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<tr>
<td><strong>February 7</strong></td>
<td><strong>Virginia Science Standards</strong>&lt;br&gt;Local districts planning&lt;br&gt;Science in the News</td>
<td><em>(Stds Comparison Chart - All Local Standards Presentation)</em>&lt;br&gt;Science in the News - ______ &amp; ______</td>
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<tr>
<td><strong>Feb. 14</strong></td>
<td><strong>Local Science Standards</strong>&lt;br&gt;Presentation&lt;br&gt;Assessment and Evaluation Intro&lt;br&gt;Assessment versus evaluation&lt;br&gt;Science in the News</td>
<td><em>(TIMSS)</em>&lt;br&gt;Science in the News - ______ &amp; ______</td>
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<td><strong>Feb. 21</strong></td>
<td><strong>TIMSS Assessment</strong>&lt;br&gt;(international)&lt;br&gt;Science in the News</td>
<td><em>(NAEP)</em>&lt;br&gt;Science in the News - ______ &amp; ______</td>
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<td><strong>Feb. 28</strong></td>
<td><strong>NAEP Assessment</strong>&lt;br&gt;(national)&lt;br&gt;Science in the News</td>
<td><em>(Assessment Chart and Presentation)</em>&lt;br&gt;Science in the News - ______ &amp; ______</td>
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<tr>
<td><strong>March 7</strong></td>
<td><strong>SOL Assessment</strong>&lt;br&gt;(state)&lt;br&gt;Science in the News&lt;br&gt;Measurement&lt;br&gt;Accuracy&lt;br&gt;Significant figures</td>
<td><em>(Assessment Chart and Presentation)</em>&lt;br&gt;Science in the News - ______ &amp; ______</td>
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<td><strong>March 14</strong></td>
<td><strong>Spring Break - No Class</strong></td>
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<td><strong>March 21</strong></td>
<td><strong>Measurement</strong>&lt;br&gt;History of the metric system&lt;br&gt;Politics&lt;br&gt;Resources for teaching&lt;br&gt;Rounding off numbers&lt;br&gt;Science in the News</td>
<td><em>(Students and Research - scan)</em>&lt;br&gt;Science in the News - ______ &amp; ______</td>
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<td><strong>March 28</strong></td>
<td><strong>Experimental Design</strong>&lt;br&gt;Exp. Design Diagram&lt;br&gt;Variables, Constants&lt;br&gt;Control Group, Repeated Trials&lt;br&gt;Science in the News</td>
<td><em>(Students and Research - ch 1-4,6)</em>&lt;br&gt;Science in the News - ______ &amp; ______</td>
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<td><strong>April 4</strong></td>
<td><strong>NSTA Conference - No Class&lt;br&gt;Team Planning</strong></td>
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<td><strong>April 11</strong></td>
<td><strong>Experimental Design/Data Analysis&lt;br&gt;Charts and graphs</strong></td>
<td><em>(Students and Research - ch1-4,6)</em>&lt;br&gt;Science in the News - ______ &amp; ______</td>
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<tr>
<td>Date</td>
<td>Topic</td>
<td>Additional Information</td>
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<td>April 18</td>
<td>Scientific Fair Projects</td>
<td>Sample Science Fair Projects</td>
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<td>M Skills, Exp Design, Data Analysis</td>
<td>MS, ED, DA Teaching Materials</td>
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<td>Research</td>
<td>Students and Research - ch 5, 8, 9</td>
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<td>Science Education</td>
<td>Science in the News - ______ &amp; ______</td>
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<td>Science in the News</td>
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<td>April 25</td>
<td>Research</td>
<td>Science Education Critique</td>
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<td>JRST</td>
<td>Science in the News - ______ &amp; ______</td>
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<td>Science in the News</td>
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<td>May 2</td>
<td>Research</td>
<td>JRST Critique</td>
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<td>Science Experiment Critique</td>
<td>Science in the News - ______ &amp; ______</td>
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<td>Bloom's Taxonomy</td>
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<td>Multiple Intelligences (Gardner)</td>
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<td>Learning Cycle (Karplus-Trowbridge)</td>
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<td>Science in the News</td>
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<td>May 9</td>
<td>Research in Science Teaching</td>
<td>Science Experiment Critique</td>
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<td>Data Driven Decision Making</td>
<td>Read Online Research Articles</td>
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<td>Science in the News - ______ &amp; ______</td>
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<td>(Assignments in progress)</td>
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