"What greater or better gift can we offer the Republic than to teach and instruct our youth?"
Cicero

George Mason University
College of Education and Human Development
Secondary Education Program

EDCI 473:001 Teaching Science in the Secondary School
Fall Semester, 2012

Instructor:	Dr. Stephen Burton
Date and Time:	(January 24 – May 8) Tuesdays 7:20-10 pm
Class Location:	Thompson 2020
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Office Hours:	By appointment

Text Resources

- Herr, N. (2008). *The sourcebook for teaching science: Strategies, activities and instructional resources (Grades 6-12).* San Francisco: Jossey-Bass.

Online Resources

- National Research Council (1996). *National science education standards*. Washington, DC: National Academy Press. Available online at http://www.nap.edu/openbook.php?record_id=4962

- Commonwealth of Virginia (2010). *Standards of Learning for Virginia Public Schools.* Richmond, Virginia. Retrieved on August 14, 2011 from http://www.doe.virginia.gov/testing/index.shtml

- Commonwealth of Virginia (2003). *Science Standards of Curriculum Framework Guides.* Retrieved on August 14, 2007 from http://www.pen.k12.va.us/VDOE/Instruction/sol.html#science.

- National Science Teachers' Association. *Science Class* newsletter. Retrieved on August 14, 2007 from http://www.nsta.org/publications/enewsletters.aspx.

- American Association for the Advancement of Science (1993). *Benchmarks for Science Literacy*. Retrieved on August 14, 2007 from http://www.project2061.org/tools/benchol/bolframe.htm.

- McComas, W. F. (1998). *The principle elements of the nature of science: Dispelling the myths.* Retrieved on August 14, 2007 from http://coehp.uark.edu/pase/TheMythsOfScience.pdf.

- Peters, E. E. (2006). *Why is teaching the nature of science so important?* Retrieved on August 14, 2007 from http://www.vast.org/content/File/v1n1/linkedwhole.pdf.

- American Chemical Society (2007). *Educators & Students page.* Retrieved on August 14, 2007 from http://www.chemistry.org/portal/a/c/s/1/educatorsandstudents.html.

- American Chemical Society (2003). *Safety in Academic Chemistry Laboratories Accident Prevention for Faculty and Administrators*. (800 227-5558) Free single copies or online: http://membership.acs.org/c/ccs/pubs/sacl_faculty.pdf

- U.S. Government Printing Office (2007). *Code of Federal Regulations.* Retrieved on August 14, 2007 from http://www.gpoaccess.gov/cfr/index.html.

- U.S. Department of Labor (2007). *Occupational Health and Safety Administration.* Retrieved on August 14, 2007 from http://www.osha.gov/.

- American National Standards Institute (2007). *American National Standards Institute Homepage.* Retrieved on August 14, 2007 from http://www.ansi.org/.

- Maryland Public Schools (2007). *Legal Aspects of Laboratory Safety.* Retrieved on August 14, 2007 from http://mdk12.org/instruction/curriculum/science/safety/legal.html.

Other articles/handouts will be distributed in class or posted on-line at the course website. (Your GMU email address is required for communication with the course instructor and for using Blackboard!)

Course Materials Online

The Blackboard site can be found at http://mymasonportal.gmu.edu. Use the same login as your GMU email. Materials will be added throughout the semester based upon needs from the course.

Course Description

EDCI 573 is the first course in a two-part sequence of science methods courses for pre-service and provisionally licensed science teachers. The course is designed to build fundamental knowledge of science teaching and learning including standards-based curriculum design and research-based teaching strategies. The course focuses on developing inquiry-based lessons for students to investigate science and assessing student understanding of science and the nature of science. The teachers will plan lessons for students to learn science, implement lessons in a high school classroom, observe students learning, and evaluate their teaching and student outcomes. Field experience is a required part of this course.

Goals

The pre-service and provisionally licensed teacher will:

- Build a repertoire of science teaching and assessment strategies by reading, writing, observing, participating in, and reflecting on the teaching and learning of science; RESEARCH-BASED PRACTICE; SPA STANDARDS 1, 3, 5, 6, 8, 10
- Develop strategies to help students become scientifically literate, think critically and creatively, understand the nature of science, and see the importance of science as a way of knowing; ETHICAL LEADERSHIP; INNOVATION; SPA STANDARDS 2, 3, 4
- Plan standards-based (local, state, and national) units of science study including daily lesson plans for students that reflect research in effective science teaching and learning; RESEARCH-BASED PRACTICE; SPA STANDARD 5, 6, 8, 10
- Construct science lessons that include alignment of objectives, activities, and assessments that address the needs of a variety of student populations including English language learner, special needs students, and gifted and talented students; ETHICAL LEADERSHIP; SPA STANDARDS 8, 10
- Learn about science laboratory safety and plan teaching activities that highlight safety; ETHICAL LEADERSHIP; SPA STANDARD 9
- Work collaboratively with peers to teach and discuss science and science teaching. COLLABORATION; SPA STANDARD 10
- Incorporate environmental sustainability into teaching paradigms and into daily life. SOCIAL JUSTICE; SPA STANDARD 4

Relationship to Program Goals and Professional Organizations

EDCI 473 is the first course in a two-course sequence of science methods courses for students seeking a secondary school teaching license in earth science, biology, chemistry, or physics. The course builds on students' knowledge of their subject matter. The course focuses on the teaching of science as called for by the state and national science standards and as outlined by the National Council for Accreditation of Teacher Education (NCATE), the National Science Teachers Association (NSTA), and the Interstate New Teacher Assessment and Support Consortium (INTASC). EDCI 473 builds a repertoire of science teaching and assessment strategies to facilitate student learning.

Nature of Course Delivery

A variety of teaching strategies will be used to explore the themes of the day. All students will continuously analyze and evaluate teaching strategies, as well as science content, processes, and ways of knowing in science.

Sustainability at GMU

George Mason University is focusing on making our community "greener" and reducing the impact on the environment. This course will contribute to this effort in the following ways. I hope that you will create other ways to contribute to contribute to this effort.

- Handouts will be available electronically through the Blackboard platform
- All assignments will be submitted through the blackboard on a Wiki site established fir each individual student.
- You should consider reducing waste in your teaching practice (ex: unnecessary paper) and in developing your unit plan
- Incorporate teaching sustainability in the content of your lesson plans (for example, human's role in reducing their impact on the environment.) Think about what the next generation needs to know about "greening".

College Expectations and University honor Code

The College Education and Human Development (GSE) expects that all students abide by the following: Students are expected to exhibit professional behavior and dispositions. See gse.gmu.edu for a listing of these dispositions. Students must follow the guidelines of the University Honor Code. See http://academicintegrity.gmu.edu/honorcode/ for the full honor code. Students must agree to abide by the university policy for Responsible Use of Computing. See http://universitypolicy.gmu.edu/1301gen.html for the full policy.
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.

Field Experience Signup

The State of Virginia requires a number of hours of field work before you can do your internship. You will acquire 30 of those hours during this class. The university will place you in the field.

The website to sign up is **http://cehd.gmu.edu/endorse/ferf.**

Learning Objectives:	Assessment:
A student will be able to consistently write measureable objectives	**Lesson Plan 3**
A student will be able to develop assessments aligned with measureable objectives	**Lesson Plan 3**
A student will be able to design a lesson in which students are actively engaged and follow a student-centered theory	**Lesson Plan 3**
A student will be able to use assessment data to evaluate student achievement of objectives	**Lesson Plan 3**
A student will be able to design a lesson in which students will learn characteristics of the nature of science	**Lesson Plan 3**
A student will be able to examine student achievement of objectives to evaluate and modify their lessons	**Microteaching Reflection Paper**
A student will be able to describe the safety issues and solutions for lessons	**Lesson Plan 3, Safety Assignment**
A student will be able to organize curriculum topics to build integrated student knowledge	**Planning Project**
A student will be able to explain the characteristics of the nature of science in context of actual science.	**Nature of Science Assignment**
A student will be able to be reflective about their own teaching and the teaching of others based upon evidence.	**Reflection Questions, Microteaching Reflection Paper, Field Experience Paper**

Grading

High quality work and participation is expected on all assignments and in class. **Attendance at all classes for the entire class is a course expectation. For each unexcused absence, the course grade will be reduced by 5% points.** All assignments are graded. Each graded assignment will be assessed using a scoring rubric which will be handed out before the assignment is due. 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).

Assessments	Points	Due Date
Nature of Science Assignment	7	
Planning Project – Concept Map	5	
Lesson Plan 1	5	
Lesson Plan 2	5	
Safety Assignment	8	
Planning Project – Calendar	5	
Field Experience Report	15	
Lesson Plan 3	20	
Microteaching Paper	20	
Reflection Questions	5	
Professionalism	5	

Policy on Incompletes

If circumstances warrant, a written request for an incomplete must be provided to the instructor for approval prior to the course final examination date. Requests are accepted at the instructor's discretion, provided your reasons are justified and that a *major* percentage of your work has already been completed. Your written request should be regarded as a contract between you and the instructor and must specify the date for completion of work. This date must be at least two weeks prior to the university deadline for changing incompletes to letter grades.

Grading Scale

A = 93-100 pts
A- = 90-9 pts
B+ = 88-89 pts
B = 80-87 pts
C = 70-79 pts
F = Below 70 pts

Assignments

Science education research shows that frequent assessment of small amounts of material is most effective for learning science. Therefore, in this class formal and informal assessment will be continuously provided on assignments and class activities. Assessment is used as a tool for information that informs both learning and teaching, so this two-way communication loop is necessary for optimal learning.

Please submit assignments electronically through the Blackboard site. All written assignments are to be word-processed. Please use standard 12 point font (don't use "Chiller" or other poster font) and make your margins 1" on each side. All assignments should be double spaced and in APA format (check apa.org for more details). Make each project something that you will actually use in teaching.

You will find all assignments except the next two described in detail with instructions and when appropriate, rubrics, on the blackboard site under the assignments.

Professionalism

Learning depends on the active engagement of the participant and frequent checking by the instructor as to the progress of the learner. Smaller assignments will be given as necessary in class in order to inform your learning and my teaching. Your participation in these assignments is essential to valuable class discussions and will help to "chunk" the large assignments into smaller, more attainable learning goal. Your classmates depend on your comments to extend their learning. Attendance for each class is necessary – please contact the professor BEFORE any absence.

Other Resources

Barnekow, D. J. (1998). *Graphic organizers for science.* Portland, ME: J. Weston Walsh.

Bybee, R.W., Powell, J.C., & Trowbridge, L.W. (2008). *Teaching secondary school science: Strategies for developing scientific literacy.* Upper Saddle River, NJ: Pearson.

Cothron, J. H., Giese, R. N., Rezba, R. J. (2005). *Students and Research*. Dubuque, Iowa: Kendall/Hunt.

Hassard, J. (2005). *The art of teaching science: Inquiry and innovation in middle school and high school.* New York: Oxford University Press.

Johnson, D. W. & Johnson R. T. (1999). *Learning together and alone: Cooperative, competitive, and individualistic learning.* Boston: Allyn and Bacon.

Kagan, S. (1994). *Cooperative Learning.* San Clemente, CA: Resources for Teachers, Inc.

Keely, P., Eberle, F., & Farrin, L. (2005). *Uncovering student ideas in science: 25 formative assessment probes.* Arlington, VA: National Science Teacher Association Press.

Llewellyn, D. (2002). *Inquire within: Implementing inquiry-based science standards.* Thousand Oaks, CA: Corwin Press.

McComas 2008. Proposal for core nature of science content in popular books on the history and philosophy of science: lessons for science education. In Lee, Y.J. & Tan, A.L. (Eds.) *Science education at the nexus of theory and practice.* Rotterdam: Sense Publishers.

National Resource 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, Editors. Division of Behavioral and Social Science and Education. Washington, DC: The National Academies Press.

Slavin, R. E. (1995). *Cooperative learning.* Boston: Allyn and Bacon.

Tomlinson, C. A. (1999). *The differentiated classroom: Responding to the needs of all learners.* Alexandria, VA: Association for Supervision and Curriculum Development.

Wiggins, G. & McTighe, J. (1998). *Understanding by design.* Alexandria, VA: Association for Supervision and Curriculum Development.

ATTACHED ARE TWO PERFORMANCE BASED ASSESSMENTS REQUIRED FOR NCATE/NSTA ACCREDITATION.

PERFORMANCE BASED ASSESSMENT 1

NATURE OF SCIENCE AND SCIENTIFIC INQUIRY ASSIGNMENT

Provide a product (lab write up, paper, presentation, poster) of an example where you think that you show that you have done scientific inquiry specifically in your certification field (biology, chemistry, earth science, physics). Provide a written reflection highlighting how your experience has assisted you in addressing the 9 core nature of science ideas (see table below). Further, describe in relative detail how you developed and used at least 10 of the science process skills (see table below). Finally, explain whether you feel that you might apply scientific inquiry in your classroom to teach a science concept.

NATURE OF SCIENCE-

1. Science cannot answer all questions
2. Science employs multiple methods and types of reasoning that share many common factors, habits of mind and norms
3. Science produces, demands, and relies on empirical evidence
4. Scientific knowledge is tentative, durable, and self-correcting
5. Laws and theories are related but distinct kinds of scientific knowledge and play central roles
6. Science is a creative endeavor
7. Social, historical and cultural factors play a role in the construction of scientific knowledge
8. Science and technology are not the same but impact one another

9.Science has a subjective element

SCIENCE PROCESS SKILLS

- -Classification – describes patterns in nature and is a human construct
- Measurement – standardized and reproducible way of collecting empirical evidence
- Observation – description of the natural world intended to be free from interpretation
- Analysis – interpreting empirical evidence
- Synthesis
- Using hypotheses to make predictions
- Generating falsifiable questions
- Finding appropriate resources/information/data to evaluate questions
- Generating falsifiable hypotheses
- Using models as a way to examine phenomena
- Identifying patterns
- Generating investigations and ability troubleshoot
- Dissemination of knowledge
- Generating inferences

McComas 2008. Proposal for core nature of science content in popular books on the history and philosophy of science: lessons for science education. In Lee, Y.J. & Tan, A.L. (Eds.) *Science education at the nexus of theory and practice.* Rotterdam: Sense Publishers.

NATURE OF SCIENCE ASSIGNMENT RUBRIC

Standard	Unsatisfactory	Acceptable	Target	Accomplished
1d - Understand research and can successfully design, conduct, report and evaluate investigations in science	Product submitted is not an example of scientific inquiry	Product provided is a classroom assignment in which candidate was given the question and methods for investigating the question but candidate conducts the investigation and reports on the findings.	Product provided is a classroom assignment in which candidate is given a question but designed and implemented the methods for investigating the question as well as reports on the findings.	Product provided is an independent investigation in which the candidate identifies the question, designs and implements the methods for investigating the questions and reports the findings.
Standard	Unsatisfactory	Acceptable	Target	Accomplished
1e - Understand and can successfully use mathematics to process and report data, and solve problems, in their field(s) of licensure.	Product has inappropriate or no examples of mathematics used to address report their investigation or solve problems.	Product provided is a classroom assignment that appropriately uses mathematics to report their investigation or solve problems but the procedures were largely defined by the instructor.	Product provided is a classroom assignment that appropriately uses mathematics to report their investigation or solve problems and the procedures were largely determined by the candidate.	Product provided is an independent investigation in which the candidate identifies the question, designs and implements the methods for investigating the questions and reports the findings. In the reporting the candidate appropriately uses mathematics to report their investigation or solve problems.

Standard	Unsatisfactory	Acceptable	Target	Accomplished
2b - Understand the philosophical tenets, assumptions, goals, and values that distinguish science from technology and from other ways of knowing the world;	Candidate cannot explain any of the following characteristics of the nature of science: 1. Science cannot answer all questions. 2. Science produces, demands, and relies on empirical evidence. 3. Science and technology are not the same but impact one another.	Candidate can explain all of the following characteristics of the nature of science in a superficial way: 1. Science cannot answer all questions. 2. Science produces, demands, and relies on empirical evidence. 3. Science and technology are not the same but impact one another.	Candidate can fully explain all of the following characteristics of the nature of science way BUT DO NOT connect them to their research product: 1. Science cannot answer all questions. 2. Science produces, demands, and relies on empirical evidence. 3. Science and technology are not the same but impact one another.	Candidate can fully explain all of the following characteristics of the nature of science way AND connects them to their research product: 1. Science cannot answer all questions. 2. Science produces, demands, and relies on empirical evidence. 3. Science and technology are not the same but impact one another.

Standard	Unsatisfactory	Acceptable	Target	Accomplished
3a - Understand the processes, tenets, and assumptions of multiple methods of inquiry leading to scientific knowledge;	Candidate cannot explain any of the following characteristics of the nature of science: 1. Science cannot answer all questions. 2. Science employs multiple methods and types of reasoning that share many common factors, habits of mind and norms 3. Science produces, demands, and relies on empirical evidence. 4.Scientific knowledge is tentative, durable, and self-correcting	Candidate can explain all of the following characteristics of the nature of science in a superficial way: 1. Science cannot answer all questions. 2. Science employs multiple methods and types of reasoning that share many common factors, habits of mind and norms 3. Science produces, demands, and relies on empirical evidence. 4.Scientific knowledge is tentative, durable, and self-correcting	Candidate can fully explain all of the following characteristics of the nature of science way BUT DO NOT connect them to their research product: 1. Science cannot answer all questions. 2. Science employs multiple methods and types of reasoning that share many common factors, habits of mind and norms 3. Science produces, demands, and relies on empirical evidence. 4.Scientific knowledge is tentative, durable, and self-correcting	Candidate can fully explain all of the following characteristics of the nature of science way AND connects them to their research product: 1. Science cannot answer all questions. 2. Science employs multiple methods and types of reasoning that share many common factors, habits of mind and norms 3. Science produces, demands, and relies on empirical evidence. 4.Scientific knowledge is tentative, durable, and self-correcting

Standard	Unsatisfactory	Acceptable	Target	Accomplished
4a - Understand socially important issues related to science and technology in their field of licensure, as well as processes used to analyze and make decisions on such issues;	Candidate cannot explain any of the following characteristics of the nature of science: 1. Science is a creative endeavor 2. Social, historical and cultural factors play a role in the construction of scientific knowledge 3.Science has a subjective element	Candidate can explain all of the following characteristics of the nature of science in a superficial way: 1. Science is a creative endeavor 2. Social, historical and cultural factors play a role in the construction of scientific knowledge 3.Science has a subjective element	Candidate can fully explain all of the following characteristics of the nature of science way BUT DO NOT connect them to their research product: 1. Science is a creative endeavor 2. Social, historical and cultural factors play a role in the construction of scientific knowledge 3.Science has a subjective element	Candidate can fully explain all of the following characteristics of the nature of science way AND connects them to their research product: 1. Science is a creative endeavor 2. Social, historical and cultural factors play a role in the construction of scientific knowledge 3.Science has a subjective element

PERFORMANCE BASED ASSESSMENT 2

SAFETY ASSIGNMENT:

Safety Assignment

A **Safety Plan** is necessary for the health and safety of your students and yourself, as well as, for legal reasons. You will design a science safety plan which will include (1) a list of **safety rules/procedures** that ends with a **safety contract** for the parents and students to sign and date (front and back of one page – ready to distribute to students), (2) analyses of science classroom legal cases (which will be given in class), (3) a lesson analysis (provided online) that requires you to look at two labs and analyze it for safety, identifying the major aspects (one lab will be with animals), (4) a safety related assignment that engages students and teaches the importance of safety in the science classroom, and (5) active maintenance of safety equipment in a science classroom (which will be performed in class). Bring **two copies** of the entire assignment and **copies for the class** of the safety related assignment (number 3). I will copy the entire classes' safety assignments so you can use them throughout the year in your own classroom. These lessons make wonderful "emergency lesson plans."

SAFETY ASSIGNMENT RUBRIC

Standard	Unsatisfactory	Acceptable	Target	Accomplished
9a - Understand the legal and ethical responsibilities of science teachers for the welfare of their students, the proper treatment of animals, and the maintenance and disposal of materials	Unable to list the legal responsibilities as a teacher AND Unable to describe how to address these responsibilities	Able to list the legal responsibilities as a teacher AND Able to describe how hypothetically address these responsibilities	Given a hypothetical lab activity: Able to identify the legal responsibilities of the teacher AND Able to describe how to address these responsibilities within a specific lab	Within self-developed lessons and unit: Consistently identifies the legal responsibilities of the teacher AND Able to describe how to address these responsibilities
Standard	Unsatisfactory	Acceptable	Target	Accomplished
9b - Know and practice safe and proper techniques for the preparation, storage, dispensing, supervision, and disposal of all materials used in science instruction	Unable to list safe practices associated with non-living materials	Able list safe practices associated with non-living materials including preparation, storage, disposal and supervision	Given a hypothetical activity: Able list safe practices associated with non-living materials including preparation, storage, disposal and supervision AND Able to appropriate outline emergency procedures for the science lab and classroom	Within self-developed lessons and unit: Safely prepare, store, dispense, and dispose of materials used during science instruction AND Provide appropriate emergency procedures to share with students for the activity within the lesson

Standard	Unsatisfactory	Acceptable	Target	Accomplished
9c - Know and follow emergency procedures, maintain safety equipment, and ensure safety procedures appropriate for the activities and the abilities of students	Unable to describe emergency procedures, explain maintenance of any safety equipment, or determine and address safety concerns associated with a particular activity	Able describe emergency procedures, explain the maintenance of primary safety equipment and determine and address safety concerns associated with a particular activity	Given a hypothetical activity: Able to identify safety concerns associated, appropriate emergency procedures, and what safety equipment should be available and how to maintain that equipment	Within self-developed lessons and unit: Able to articulate to students safety concerns associated, appropriate emergency procedures, and what safety equipment should be available
Standard	Unsatisfactory	Acceptable	Target	Accomplished
9d - Treat all living organisms used in the classroom or found in the field in a safe, humane, and ethical manner and respect legal restrictions on their collection, keeping, and use	Unable to list safe and ethical practices associated with living organisms	Able to list safe and ethical practices associated with living organisms including humane and ethical treatment, safety (both human and of the living organism), husbandry or disposal	Given a hypothetical activity: Able to list safe and ethical practices associated with living organisms including humane and ethical treatment, safety (both human and of the living organism), husbandry or disposal	Within self-developed lessons and unit: Able to articulate to students safe and ethical practices associated with living organisms including humane and ethical treatment, safety (both human and of the living organism), husbandry or disposal